Risks of Chlorothalonil Use to Federally Threatened Bay Checkerspot Butterfly (*Euphydryas editha bayensis*), 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)*

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List of Commonly Used Abbreviations and Nomenclature

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

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

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

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

1. Executive Summary

1.1. Purpose of Assessment

The purpose of this assessment is to evaluate potential direct and indirect effects on the Bay Checkerspot Butterfly (BCB, *Euphydryas editha bayensis*), California Tiger Salamander Central California DPS (CTS-CC DPS, *Ambystoma californiense*), Delta Smelt (DS, *Hypomesus transpacificus*), California Clapper Rail (CCR, *Rallus longirostris obsoletus*), California Tiger Salamander: Sonoma County DPS (CTS-SC DPS, *A. californiense*), California Tiger Salamander: Santa Barbara County DPS (CTS-SB DPS, *A. californiense*), California Freshwater Shrimp (CFWS, *Syncaris pacifica*), San Francisco Garter Snake (SFGS, *Thamnophis sirtalis tetrataenia*), and Tidewater Goby (TG, *Eucyclogobius newberryi*) arising from FIFRA regulatory actions regarding use of chlorothalonil 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, CTS-CC DPSDS, CTS-SB DPS, DS, and TG. This assessment was completed in accordance with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998), procedures outlined in the Agency's Overview Document (USEPA, 2004), and consistent with a suit in which chlorothalonil was alleged to be of concern to the BCB, CTS, DS, CCR, CFWS, SFGS, and TG (*Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS).

- **Bay Checkerspot Butterfly (BCB):** 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.
- **California Tiger Salamander (CTS):** 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 and associated spatial analysis as they occupy different geographic areas. 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 estimation.
- **Delta Smelt (DS):** The DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007a). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater.
- **CA Clapper Rail (CCR):** 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.
- **California Freshwater Shrimp (CFWS):** 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.

- **San Francisco Garter Snake (SFGS):** 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.
- **Tidewater Goby (TG):** 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

Chlorothalonil (2,4,5,6-tetrachloroisophthalonitrile; CAS 1897-45-6) is in the organochlorine class of chemicals. Chlorothalonil is a broad spectrum, non-systemic pesticide mainly used as a fungicide to control fungal foliar diseases of vegetable, field, and ornamental crops. Non-agricultural use sites include golf courses, lawns around commercial and industrial buildings, and other turfgrass such as professional and collegiate athletic fields. Chlorothalonil is also used is residential settings. It is recognized that chlorothalonil is used in many parts of the U.S.; however, the scope of this assessment limits consideration of the areas of use that may be applicable to the protection of the SF Bay and its designated critical habitat within the state of California. For a complete list of uses, please see **Section 2**. In addition, chlorothalonil is also registered for use as an industrial and consumer wood preservative, a fungicidal/mildewcidal/ algicidal paint, stain, and coating film preservative, and a material preservative for paper and paperboard (non-food contact) and for the "in-service" life of caulks and sealants, adhesives, grouts and joint compounds, wallboard, stucco.

Chlorothalonil is formulated in solid form as dust, water dispersible granules, pellets, tablets, and as a wettable powder. In liquid form, chlorothalonil is available as an emulsifiable, flowable, and soluble concentrate as well as a ready-to-use solution. Chlorothalonil is used as a preventative treatment and it is applied either by aerial or ground equipment, and can be used in tank mixes.

Application methods for the agricultural uses of chlorothalonil include aircraft, high and low volume ground sprayer, sprinkler irrigation, and tank-type sprayer. Although all potential uses are assessed, risks from ground boom and aerial applications are focused on in this assessment because they are expected to result in the highest off-target concentrations of chlorothalonil. Runoff associated with large rainfall events is expected to be responsible for the greatest off-target movement of chlorothalonil.

The end result of the EPA pesticide registration process (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 chlorothalonil in accordance with the approved product labels for California is "the action" being assessed.

Although current registrations of chlorothalonil allow for use nationwide, this ecological risk assessment and effects determination addresses currently registered uses of chlorothalonil in portions of the action area that are reasonably assumed to be biologically relevant to the SF Bay species and their designated critical habitat. Further discussion of the action area for the SF Bay species and their critical habitat is provided in **Section 2.7**.

1.2.2. Environmental Fate Properties of Chlorothalonil

As part of the problem formulation (US EPA, 2012) developed last winter, the fate dataset has been determined to have major deficiencies. No fate studies are classified as acceptable with the exception of two bioconcentration factor (BCF) studies. Based on supplemental information, chlorothalonil was shown to undergo a number of different chemical reactions including de-chlorination, hydroxylation and sulfonation in the environment to form a number of different transformation products. All the transformation products reported retain the phenyl ring with the exception of carbon dioxide (CO_2).

In summary, laboratory studies indicate chlorothalonil will transform primarily through aqueous photolysis in clear, shallow water. Chlorothalonil is also susceptible to microbial-mediated transformation, with transformation rates often departing from first-order kinetics. Degradation rates have been shown to be dependent on the application rate with higher chlorothalonil application rates resulting in slower degradation rates and vice versa. Data also suggest that chlorothalonil is rapidly transformed in water/sediment systems under both aerobic and anaerobic conditions. Field dissipation studies show that chlorothalonil dissipates (*e.g.*, transformation or relocation) with half-lives less than 100 days; however, in a few field dissipation studies, chlorothalonil was observed in soil samples taken after one year. Batch equilibrium data suggest chlorothalonil is slightly to hardly mobile in soil systems. A summary of submitted environmental fate studies as well as a detailed discussion of each of the relevant environmental fate studies is provided in **Section 3.4 Environmental Fate Properties**.

In addition to fate data, monitoring data suggest that chlorothalonil can dissipate in the environment after application via dissolved phase (dissolved in water); eroded sediment, spray drift, and volatilization are possible environmental transport mechanisms for chlorothalonil. Chlorothalonil applications can lead to surface water contamination as a result of spray drift as well as through runoff and sediment erosion. Aerobic soil metabolism data indicate that once chlorothalonil reaches the soil it can be transformed to 4-hydroxy-2,5,6-trichloro-1,3-dicyanobenzene, SDS-3701 (a transformation product of toxicological concern), as well as several other transformation products (discussed further in the environmental fate section of this document). The soil/water partitioning of chlorothalonil indicates that chlorothalonil runoff is generally by dissolution in runoff water rather than soil erosion (*i.e.*, chlorothalonil is not expected to readily sorb to soil and sediment). Chlorothalonil may also leach through the soil.

In general, deposition of drifting pesticides is expected to be greatest close to the site of application. Computer models of spray drift (AgDRIFT or AGDISP) are used to determine if the exposures to aquatic and terrestrial organisms are below the Agency's Levels of Concern (LOCs). AgDRIFT (version 2.1.1) is a mechanistic model based on empirical data that estimates off-site deposition of aerial and ground applied pesticides. Details concerning the specifics and uncertainties of AgDRIFT are available online at www.agdrift.com. AGDISP (version 8.26) predicts the motion of spray material released from aircraft, including the mean position of the material and the position variance about the mean as a result of turbulent fluctuations.

If the limit of exposure that is below the LOC can be determined using AgDRIFT or AGDISP, longer-range transport is not considered in defining the action area. For example, if a buffer zone <1,000 feet (the optimal range for AgDRIFT) results in terrestrial and aquatic exposures that are below LOCs, no further drift analysis is required. If exposures exceeding LOCs are expected beyond the standard modeling range of AgDRIFT or AGDISP, the Gaussian extension feature of AGDISP may be used.

Based on laboratory data, the vapor pressure (5.7×10^{-7} torr) and Henry's Law Constant (2.6×10^{-7} atm - m^3/mole) values for chlorothalonil indicate some degree of volatility from both soil and water (semi-volatile). However, volatilization would not be expected to be a major dissipation route. Nonetheless, studies have documented atmospheric transport and redeposition of chlorothalonil, from the Central Valley to the Sierra Nevada Mountains.[1] This is likely the result of prevailing winds blowing across the Central Valley eastward to the Sierra Nevada Mountains transporting airborne pollutants such as chlorothalonil into the Sierra Nevada ecosystems. In addition, local ambient air monitoring data from a site in North Dakota and three sites in California, to list a few, indicate that chlorothalonil was present in the air at application sites and at locations up to a mile away from the application sites.[2] Data from the state of Montana show detections of chlorothalonil in precipitation. This indicates that chlorothalonil volatility or particle phase transport plays a role in the dissipation of chlorothalonil and that it is possible for chlorothalonil exposure to occur adjacent to application sites, as well as areas distant from application sites (long range transport).

Several sources of surface water monitoring data were assessed including the USGS National Water Quality Assessment Data Warehouse (NAWQA[3]), California State Water Resources Control Board, Surface Water Ambient Monitoring Program (SWAMP) and California Department of Pesticide Regulation (CDPR) Surface Water Database. These sources indicate that chlorothalonil has been detected in surface water. Minimum reporting limit ranged from 0.01 to 4.1 µg/L. In general, sample frequencies are sporadic and range from once per year to a few times per month depending on the site and year for these datasets .

On a national basis, of the 7,214 NAWQA samples (951 sites), there are 29 reported detections (levels greater than the detection limit) of chlorothalonil. The highest detected concentration was 0.71µg/L in an urban location in New Jersey. The highest detection (0.68 µg/L) in an agricultural setting was observed in Georgia. Both detections were observed for filtered water (49306-chlorothalonil). Eight samples reported detection limits greater than 1 µg/L.

[1] LeNoir, J.S., L.L. McConnell, G.M. Fellers, T.M. Cahill, J.N. Seiber. 1999. Summertime Transport of Current-use pesticides from California's Central Valley to the Sierra Nevada Mountain Range, USA. Environmental Toxicology & Chemistry 18(12): 2715-2722.

[2] **JOURNAL OF PESTICIDE REFORM/** WINTER 1997 • VOL.17, NO.
http://64.233.161.104/search?q=cache:0yXOLRyW_IUJ:www.pesticide.org/chlorothalonil.pdf+chlorothalonil+monitoring&hl=en&gl=us&ct=clnk&cd=5

[3] USGS National Water Quality Assessment Data Warehouse; 49306-chlorothalonil water filtered (7121); 65071-chlorothalonil water filtered (2); 70314-chlorothalonil water unfiltered (87); 62904-chlorothalonil bed sediment (4)

For California, approximately 370 samples collected from 11 counties analyzed for chlorothalonil from March 18, 1993 to December, 22, 2005.[4] Surface water samples were collected in the counties (# of samples) including Alpine (4), Amador (6), Del Norte (1), El-Dorado (4), Merced (87), Nevada (4), Orange (10), Sacramento (109), San Bernardino (8), San Joaquin (61), and Stanislaus (74). The highest concentration detected in California is reported to be 0.29 µg/L from a sample collected in Merced County (USGS Station #1123500) on February 8, 1994. This specific sample is not included in the CalDPR dataset.

1.2.3. Evaluation of Degradates and Stressors of Concern

As mentioned above, chlorothalonil is likely to undergo chemical reactions in the environment to form a number of different transformation products. Currently, EPA only considers SDS-3701 (4-hydroxy-2,5,6-trichloro-1,3-dicyanobenzene) to be of potential toxicological concern. SDS-3701 is a major transformation product that forms under various environmental conditions. SDS-3701 is much more soluble (115.7 mg/L at 25 °C; EPI Web 4.0 WSKOW v. 1.41) than chlorothalonil. Laboratory studies suggest that SDS-3701 may also transform through microbial-mediated processes, and is more mobile (K_{FOC} = 351-559 mL/g_{OC}) than chlorothalonil (MRID 46786901). Based on the available ecotoxicology data, it appears that SDS-3701 is acutely less toxic to aquatic organisms than parent chlorothalonil; chronic aquatic toxicity data are not available for aquatic organisms. However, for terrestrial birds and mammals, based on the data available, it appears that SDS-3701 is more toxic than parent chlorothalonil. Therefore, both parent chlorothalonil and SDS-3701 will be evaluated for terrestrial animals, whereas only parent chlorothalonil will be assessed for aquatic animals and plants.

1.3. Assessment Procedures

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

1.3.1. Exposure Assessment

1.3.1.a. Aquatic Exposures

Tier-II aquatic exposure models are used to estimate high-end exposures of chlorothalonil in aquatic habitats resulting from runoff and spray drift from different uses. While major deficiencies were noted in the existing fate dataset, an updated kinetic analysis has been completed for chlorothalonil following the NAFTA degradation kinetic guidance[5]. The input values used in modeling were based on available data, to date (see **Table 3-2**). The models used to predict aquatic EECs are the Pesticide Root Zone Model coupled with the Exposure Analysis

[4] As reported in the CalDPR database and includes SWAMP and NAWQA sampling sites.
[5] Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media (December, 2012); Single First Order (SFO), Nth-Order Rate Model or Indeterminate Order Rate Equation Model (IORE), and Double First-Order in Parallel (DFOP)

Model System (PRZM/EXAMS). The AgDRIFT model is also used to estimate deposition of chlorothalonil on aquatic habitats from spray drift. The peak model-estimated environmental concentrations resulting from different chlorothalonil uses range from 3.4 µg/L (brassica) to 47.5 µg/L (Christmas trees).

These estimates are supplemented with analysis of available monitoring data from several of sources of surface water monitoring dataset including the USGS National Water Quality Assessment Data Warehouse[6], California State Water Resources Control Board, Surface Water Ambient Monitoring Program and California Department of Pesticide Regulation Surface Water Database.

1.3.1.b. Terrestrial Exposures

To estimate chlorothalonil exposures to terrestrial species resulting from uses involving chlorothalonil applications, the T-REX model is used for foliar and granular uses (*i.e.*, on sweet corn). The AgDRIFT model is also used to estimate deposition of chlorothalonil on terrestrial habitats from spray drift. The T-HERPS model is used to allow for further characterization of dietary exposures of terrestrial-phase amphibians and reptiles relative to birds.

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. Primary constituent elements (PCEs) were used to evaluate whether chlorothalonil has the potential to modify designated critical habitat. The Agency evaluated registrant-submitted studies and data from the open literature (where available) to characterize chlorothalonil 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.

As stated above in the environmental fate properties section, as part of the problem formulation that was previously conducted, the effect dataset has been determined to have data gaps and uncertainties. As such, toxicity data for quantitative evaluation were not available for all assessed taxa, and a qualitative assessment was conducted in these instances. Evaluations and assumptions conducted in the absence of data or the uncertainties are described throughout the assessment and in the Uncertainties section (Section 6.2).

Based on the available data, chlorothalonil is very highly toxic to freshwater and estuarine/marine fish; it is very highly toxic to freshwater and marine/estuarine invertebrates on an acute exposure basis. The 5-day EC_{50} and NOAEC values for the aquatic non-vascular plants (*Navicula pelliculosa*) are 12 and 3.9 µg a.i./L, respectively. The aquatic vascular plant 7-day EC_{50} and NOAEC values are 640 and 290 µg a.i./L. Regarding chronic exposure, toxicity data are available for freshwater fish and invertebrates. The most sensitive chronic no observed adverse effect concentration (NOAEC) for freshwater fish [fathead minnows (*Pimephales*

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[6] USGS National Water Quality Assessment Data Warehouse; 49306-chlorothalonil water filtered (7121); 65071-chlorothalonil water filtered (2); 70314-chlorothalonil water unfiltered (87); 62904-chlorothalonil bed sediment (4)

promelas)] is 1.3 µg a.i./L, based on a reduction in fecundity. The chronic NOAEC value for freshwater invertebrates is 0.6 µg a.i./L [*Daphnia magna*], based on parental immobility. Acceptable chronic toxicity tests are not available for estuarine/marine invertebrates, and a chronic toxicity study for estuarine/marine fish is not available. Additionally, the available acute toxicity data for estuarine/marine fish were adequate for a qualitative assessment only.

Based on the available data, SDS-3701 is sightly toxic to moderately toxic (less toxic than parent) to aquatic organisms (96-hr LC_{50} = 9.2 mg/L, bluegill sunfish; 48-h EC_{50} = 26 mg/L, daphnia) and less toxic than parent to green algae, *Selenastrum capricornutum* (EC_{50} = 33.7 mg/L). Chronic toxicity data for aquatic organisms with SDS-3701 are not available.

Chlorothalonil is classified as practically non-toxic to birds, mammals, and honey bees on an acute exposure basis. Chlorothalonil has reproductive effects on birds and mammals, affecting number of eggs produced as well as pup body weight in subsequent generations at 153 (bird) and 1200 (rat) mg a.i./kg-diet concentrations, respectively. Chlorothalonil is classified as practically non-toxic to honey bees on an acute contact exposure basis. The EC_{25} for terrestrial plants for the majority of species tested in both seedling emergence and vegetative vigor was > 16 lb a.i./A, the only concentration tested, with the following exceptions, there was a 26% inhibition in growth for onion in the seedling emergence study and a 26% inhibition in growth for cucumber in the vegetative vigor study at 16 lb a.i./A when compared to the negative control. Additionally, there was a significant difference in growth between the limit concentration and the control for soybean in the seedling emergence study and for oat in the vegetative vigor study. As such, the NOAEC for both the seedling emergence and vegetative vigor is <16 lb a.i./A.

For SDS-3701, acute toxicity data indicate that it is moderately toxic to very highly toxic (more toxic than parent) to small mammals (oral LD_{50} = 242 mg/kg-bw, rat acute) and slightly toxic to moderately toxic (more toxic than parent) to birds (LD_{50} = 158 mg/kg-bw, mallard duck acute oral toxicity; 1746 ppm, bobwhite quail sub-acute dietary toxicity). Chronic reproduction data for SDS-3701 are available for birds (NOAEC = 50 mg a.i./kg-diet, mallard duck, based on reduced egg-shell thickness) and mammals (NOAEC = 6 mg/kg-bw, rat, no effects at highest concentration tested).

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 chlorothalonil 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 chlorothalonil 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

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 chlorothalonil to SFGS, CCR, BCB, CTS, DS, CFWS, and TG and the designated critical habitat of BCB, CTS (CC DPS & SB DPS), DS, and TG.

Based on the best available information, the Agency makes a May Affect, Likely to Adversely Affect determination for the SFGS, CCR, BCB, CTS, DS, CFWS, and TG. Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, CTS (CC DPS & SB DPS), DS, and TG from the use of the chemical. Given the LAA determination for SFGS, CCR, BCB, CTS, DS, CFWS, and TG and potential modification of designated critical habitat for BCB, CTS (CC DPS & SB DPS), 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 SFGS, CCR, BCB, CTS, DS, CFWS, and TG and the critical habitat, given the uncertainties discussed in Section 6 and Attachment I, is presented in **Table 1-2** and **Table 1-3**. Use specific effects determinations are provided in **Table 1-4** and **Table 1-5**.

Table 1-2. Effects Determination Summary for Effects of Chlorothalonil on the SFGS, CCR, BCB, CTS, DS, CFWS, and TG

Species	Effects Determination	Basis for Determination
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: Chlorothalonil: dose and dietary-based RQs not calculated[1] however EECs overlap with $1/10^{th}$ highest tested concentration or dose for all assessed uses for small and medium-sized reptiles (based on toxicity data for birds); SDS-3701- dose and dietary-based RQs>0.1 for all assessed uses for small and medium-sized reptiles (based on toxicity data for birds) consuming arthropods and herbivorous mammals • Chronic: chlorothalonil and SDS-3701 - dietary-based RQs >1 for all assessed uses for small and medium-sized reptiles (based on toxicity data for birds) consuming arthropods and herbivorous mammals • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird toxicity data for SDS-3701) is 1 in 1, at a slope of 2.6 for SDS-3701
		Potential for Indirect Effects • SFGS prey base is affected based on LOC exceedances; SFGS feeds on invertebrates (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2); fish (fw fish RQs: acute: 0.19-2.64, chronic: 0.5-5.2), terrestrial invertebrates (RQs not calculated but EECs overlap with $1/20^{th}$ highest tested dose for a few uses), small mammals (SDS-3701-15g mammal RQs: acute: 0.47-5.18; chronic: not calculated[2] however EECs overlap with highest concentration tested; chlorothalonil acute RQs not calculated but EECs overlap with $1/5^{th}$ highest dose tested; chronic 0.69-36.7), reptiles and amphibians (birds RQs: SDS-3701 acute: 0.06-40.2; chronic: 2.05-57.8; chlorothalonil- acute RQs not calculated but EECs overlap with $1/5^{th}$ highest tested dose; chronic: 2.11-59.9, 20g reptile: SDS-3701-acute: 0.10-17.5; chronic:4.12-44.6; chlorothalonil-acute: RQs not calculated but EECs overlap with $1/5^{th}$ highest dose, chronic:4.21-45.9) • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: lab rat, bird, freshwater invertebrate/fish) ranges from 1 in x $4.08\ 10^{12}$ to 1 in 1
California Clapper Rail (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: chlorothalonil- acute RQs not calculated[1] but EECs greater than $1/10^{th}$ highest dose or concentration tested for all assessed uses; SDS-3701-dose-based RQs >0.1 for all assessed uses and dietary-based RQs>0.1 for all uses for small and medium-sized birds consuming arthropods and short grasses • Chronic: chlorothalonil and SDS-3701 - dietary-based RQs >1 for all assessed uses for small and medium-sized birds consuming arthropods and short grasses • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird toxicity data) is 1 in 1 at the slope of 2.6 for SDS-3701
		Potential for Indirect Effects • CCR prey base is affected; CCR feeds on aquatic invertebrates, worms, spiders (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2; terrestrial invert RQs not calculated but EECs greater than $1/20^{th}$ highest dose tested; e/m invert: acute: 0.9-13.2; chronic: 2.0-27.9), dead fish (fw fish RQs: acute: 0.19-2.64; chronic: 0.5-5.2), small mammals (SDS-3701-15g mammal RQs: acute: 0.47-5.18; chronic: not calculated[2] however EECs overlap with highest concentration

Species	Effects Determination	Basis for Determination
		tested; chlorothalonil acute RQs not calculated but EECs overlap with 1/5th highest dose tested; chronic 0.69-36.7), small birds and amphibians/frogs (Acute: chlorothalonil- acute RQs not calculated[1] but EECs greater than 1/10th highest dose or concentration tested for most assessed uses; SDS-3701-dose-based RQs >0.2 for all assessed uses and dietary-based RQs>0.2 for all uses for small and medium-sized birds consuming arthropods and short grasses and Chronic: chlorothalonil and SDS-3701 - dietary-based RQs >1 for all assessed uses for small and medium-sized birds consuming arthropods and short grasses • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: lab rat, bird, freshwater invertebrate/fish, estuarine/marine invertebrate) ranges from 1 in 4.08×10^{12} to 1 in 1
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Based on parent chlorothalonil only • Terrestrial invertebrate/ arthropod RQs not calculated[1] but EECs exceed 1/20th the highest concentration tested for use on golf courses (LOC of 0.05, the interim terrestrial invertebrate LOC). • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect not calculated due to RQs not calculated **Potential for Indirect Effects** • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint.
California Tiger Salamander (*Ambystoma californiense*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: Chlorothalonil- RQs not calculated[1] but EECs exceed 1/10th the highest dose and concentration tested for all uses; SDS-3701-dose and dietary-based RQs >0.1 for all assessed uses (except for grass for seed and grass forage, fodder and hay) for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Chronic: dietary-based RQs >1 all assessed uses for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Acute: RQs ≥ 0.05 for all uses assessed with respect to freshwater fish (which are a surrogate for aquatic-phase amphibians) • Chronic: RQs >1 for most uses, except grass grown for seed and lupine, with respect to freshwater fish (which are a surrogate for aquatic-phase amphibians) • Several fish kills reported which were attributed possibly to chlorothalonil use • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird and freshwater fish toxicity data) ranges from 1 in 4.08×10^{12} to 1 in 1 **Potential for Indirect Effects**

Species	Effects Determination	Basis for Determination
		• CTS prey base is affected; CTS feeds on algae, aquatic invertebrates/ zooplankton, freshwater snails, terrestrial invertebrates, worms (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2; terrestrial invert RQs not calculated[1] but EECs exceed 1/20th the highest dose tested; e/m invert: acute: 0.9-13.2; chronic: 2.0-27.9), fish (fw fish RQs: acute: 0.19-2.64; chronic: 0.5-5.2), small mammals (SDS-3701-15g mammal RQs: acute: 0.47-5.18; chronic: not calculated[2] however EECs overlap with highest concentration tested; chlorothalonil acute RQs not calculated but EECs overlap with 1/5th highest dose tested; chronic 0.69-36.7), amphibians and frogs (birds RQs: SDS-3701 acute: 0.06-40.2; chronic: 2.05-57.8; chlorothalonil- acute RQs not calculated but EECs overlap with 1/5th highest tested dose; chronic: 2.11-59.9, amphibian: acute: Acute: Chlorothalonil- RQs not calculated[1] but EECs exceed 1/5th the highest dose and concentration tested for most uses; SDS-3701-dose and dietary-based RQs >0.1 for all assessed uses (e.g., except for grass for seed and grass forage, fodder and hay) and RQs >0.2 for most assessed used for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Chronic: dietary-based RQs >1 all assessed uses for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals) • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: lab rat, bird, freshwater invertebrate/fish) ranges from 1 in 4.08 x 10^{12} to 1 in 1
Delta Smelt (*Hypomesus transpacificus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		• Acute: RQs ≥ 0.05 for all uses assessed, with respect to freshwater fish; RQs not calculated for estuarine/marine fish , but EECs greater than 1/20th the LC50 value for all uses • Chronic: RQs >1 all uses except for grass grown for seed and lupine using freshwater fish data; RQs not calculated for estuarine/marine fish, but EECs greater than NOAEC for many uses • Four fish kills incidences were reported possibly due to chlorothalonil • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on freshwater fish toxicity data) ranges from 1 in 1.43 x 10^9 to 1 in 1
		Potential for Indirect Effects
		• DS prey base is affected; adult DS feeds on planktonic copepods, cladocerans, amphipods and insect larvae and juvenile DS feed on zooplankton (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2; e/m invert: acute: 0.9-13.2; chronic: 2.0-27.9); the DS larvae feed on phytoplankton (non-vascular RQs: 0.3-4.0) • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: freshwater invertebrates) ranges from 1 in 4.08 x 10^{12} to 1 in 2.3

Species	Effects Determination	Basis for Determination
California Freshwater Shrimp (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		• Acute: RQs > 0.05 for all assessed uses using freshwater invertebrate data • Chronic: RQs > 1 for all assessed uses using freshwater invertebrate data • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on freshwater invertebrate toxicity data) ranges from 1 in 4.08×10^{12} to 1 in 2.3
		Potential for Indirect Effects
		• CFWS prey base is affected; CFWS feeds on zooplankton (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2), detritus, algae, aquatic macrophyte fragments, aufwuchs. • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: freshwater invertebrates) ranges 1 in 4.08×10^{12} to 1 in 2.3
Tidewater Goby (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		• Acute: RQs ≥ 0.05 for all uses with respect to freshwater fish; RQs not calculated for estuarine/marine fish , but EECs greater than 1/20th the 96-hr LC50 for all uses • Chronic: RQs >1 for all uses except grass grown for seed and lupine using freshwater fish data, with respect to freshwater fish; chronic RQs not calculated for estuarine/marine fish but EECs greater than chronic NOAEC for many uses • Four fish kills incidences were reported possibly due to chlorothalonil • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on freshwater fish toxicity data) ranges from 1 in 1.43×10^{9} to 1 in 1
		Potential for Indirect Effects
		• TG prey base is affected; adult TG feeds on small benthic invertebrates, crustaceans, snails, mysids, aquatic insect larvae, juvenile TG feeds on unicellular zooplankton (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2; e/m invert: acute: 0.9-13.2; chronic: 2.0-27.9) or phytoplankton (non-vascular RQs:0.3-4.0). • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: freshwater invertebrates) ranges from 1 in 4.08×10^{12} to 1 in 2.3

FW = freshwater; EM = estuarine/marine

[1] Acute RQ values were not calculated because the acute toxicity values resulted in non-definitive values (LD/LC50 value greater than highest concentration tested)

[2] No effects observed at highest dose tested in chronic mammalian study, therefore, RQs not calculated.

Table 1-3. Effects Determination Summary for the Critical Habitat Impact Analysis

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (Euphydryas editha bayensis)	Habitat Modification	• Risk to terrestrial plants and thus BCB habitat (esp. dwarf plantain, purple owl's clover, exserted paintbrush) was assumed. (RQs were not calculated given due to non-definitive values; however based on available incident data, risk to listed terrestrial plants was assumed.) • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint
California Tiger Salamander (Ambystoma californiense) [Central CA, Santa Barbara County]	Habitat Modification	• Terrestrial arthropod RQs not calculated due to non-definitive value, however EECs were greater than 1/20th the highest dose tested for use on turf (LOC 0.05, the interim terrestrial invertebrate LOC). • Risk to terrestrial plants was assumed. (RQs were not calculated given due to non-definitive values; however based on data available, risk to listed terrestrial plants was assumed.) • RQs for aquatic vascular plants were all <1; RQs for non-vascular aquatic plants >1 for several uses • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Mammal acute dose-based RQs >0.5 for most assessed uses; chronic: dose- and/or dietary-based RQs>1 for all assessed uses. • Bird (surrogate for terrestrial-phase amphibians) acute dose and dietary-based RQs >0.1 (listed sp.) and 0.2 (restricted use) for most assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals; chronic dietary-based RQs >1 for all assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals • Fish (surrogate for aquatic-phase amphibians) acute RQs ≥ 0.2 for all uses; chronic RQs >1 for all uses except grass grown for seed and lupine • Freshwater invertebrate acute RQs > 0.1 and 0.2 for most uses; chronic RQs >1 for all assessed uses
Delta Smelt (Hypomesus transpacificus)	Habitat Modification	• Risk to listed terrestrial plants was assumed. (RQs were not calculated given due to non-definitive values; however based on data available, risk to listed terrestrial plants was assumed.) • RQs for aquatic vascular plants were all <1; RQs for non-vascular aquatic plants >1 for several uses • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Freshwater invertebrate acute RQs > 0.1 and 0.2 for most uses; chronic RQs >1 for all assessed uses • Estuarine/marine invertebrate acute RQs > 0.5 for all assessed uses; chronic RQs >1 for all assessed use
Tidewater Goby (Eucyclogobius newberryi)	Habitat Modification	• Risk to listed terrestrial plants was assumed. (RQs were not calculated given due to non-definitive values; however based on data available, risk to listed terrestrial plants was assumed.) • RQs for aquatic vascular plants were all <1; RQs for non-vascular aquatic plants >1 for several uses • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Freshwater invertebrate acute RQs > 0.1 and 0.2 for most uses; chronic RQs >1 for all assessed uses • Estuarine/marine invertebrate acute RQs > 0.5 for all assessed uses; chronic RQs >1 for all assessed use

Table 1-4. Use Specific Summary of The Potential for Adverse Effects to Aquatic Taxa

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment:									
	DS, TG and Estuarine/Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Estuarine/Marine Invertebrates[4]		Vascular Plants[5]	Non-vascular Plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic		
almond	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
apricot, nectarine, peach, plum, prune, stone fruits	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
asparagus	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
beans, dried-type, peas, dried-type	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
beans, succulent (snap)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
blueberry	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
brassica	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
broccoli, Brussels sprouts, cabbage, cauliflower	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
bulb vegetables	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
carrot	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
celery	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
cherry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
christmas tree, conifers, forest trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
cole crops	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
commercial/i	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

ndustrial laws										
corn	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
cucumber, melon, pumpkin, squash	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
cucurbit vegetable	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
filbert (hazelnut)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
fruiting vegetables	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
garlic	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
ginseng	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
golf course	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
grass forage, fodder, hay	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
grass grown for seed	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	No
green onion	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
horseradish	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
leek	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
lupine, grain	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	No
mango	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
onion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
ornamental (laws, turf, sod farms), recreation area lawns	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
ornamentals plants and trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
papaya	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
parsnip	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
passion fruit	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
pistachio	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
potato	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No

rhubarb	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
rose	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
shallot	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
strawberry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
tomato	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
yam	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No

1 A yes in this column indicates a potential for direct effects to DS and TG and indirect effects to CCR, TG, and DS as a result of an effect to estuarine/marine fish.

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

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 as a result of an effect to freshwater invertebrates.

4 A yes in this column indicates a potential for indirect effects to CCR, TG, and DS as a result of an effect to estuarine/marine invertebrates.

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

Table 1-5. 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 and Amphibians**[3]		**SFGS and Reptiles**[4]		**BCB and Invertebrates (Acute)**[5]	**Dicots**[6]	**Monocots**[6]
	Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**			
almond	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
apricot, nectarine, peach, plum, prune, stone fruits	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
asparagus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
beans, dried-type, peas, dried-type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
beans, succulent (snap)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
blueberry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
brassica	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
broccoli, Brussels sprouts, cabbage, cauliflower	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
bulb vegetables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
carrot	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
celery	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
cherry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

christmas tree, conifers, forest trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
cole crops	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
commercial/industrial laws	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
corn	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
cucumber, melon, pumpkin, squash	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
cucurbit vegetable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
filbert (hazelnut)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
fruiting vegetables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
garlic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
ginseng	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
golf course	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
grass forage, fodder, hay	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
grass grown for seed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
green onion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
horseradish	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
leek	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
lupine, grain	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
mango	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
onion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
ornamental (laws, turf, sod farms), recreation area lawns	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ornamentals plants and trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
papaya	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
parsnip	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
passion fruit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
pistachio	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
potato	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
rhubarb	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
rose	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
shallot	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
strawberry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
tomato	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
yam	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

1 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS as a result of an effect to small mammals.
2 A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, CTS as a result of an effect to small birds.
3 A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS, SFGS, CCR as a result of an effect to terrestrial-phase amphibians (for which birds serve as surrogate).
4 A yes in this column indicates the potential for direct and indirect effects to SFGS and other reptiles as a result of an effect to reptiles (for which birds serve as a surrogate).
5 This value is based on a non-definitive acute toxicity and is expected to be conservative. A yes in this column indicates a potential for direct effect to BCB and indirect effects to SFGS, CCR, CTS as a result of an effect to terrestrial invertebrates.
6 A yes in this column indicates a potential for indirect effects to BCB, SFGS, CCR, CTS, TG, DS, and CFWS. For the BCB 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, SFGS, CCR, CTS, DS, CFWS, and TG life stages within the action area and/or applicable designated critical habitat. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the assessed species.
- Quantitative information on prey base requirements for the assessed species. While existing information provides a preliminary picture of the types of food sources utilized by the assessed species, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.
- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual species and potential modification to critical habitat.

2. Problem Formulation

Problem formulation provides a strategic framework for the risk assessment. By identifying the important components of the problem, it focuses the assessment on the most relevant life history stages, habitat components, chemical properties, exposure routes, and endpoints. The structure of this risk assessment is based on guidance contained in U.S. EPA's *Guidance for Ecological Risk Assessment* (USEPA, 1998), the Services' *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998) and is consistent with procedures and methodology outlined in the Overview Document (USEPA, 2004) and reviewed by the U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS/NMFS/NOAA, 2004).

2.1. Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the BCB, CTS, DS, CCR, CFWS, SFGS, and TG arising from FIFRA regulatory actions regarding use of chlorothalonil on a variety of agricultural and on agricultural 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.

- **Bay Checkerspot Butterfly (BCB):** 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.
- **California Tiger Salamander (CTS):** 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 estimation.
- **Delta Smelt (DS):** The DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007a). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater.
- **CA Clapper Rail (CCR):** 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.
- **California Freshwater Shrimp (CFWS):** 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.

- **San Francisco Garter Snake (SFGS):** 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.
- **Tidewater Goby (TG):** 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.

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

- **Bay Checkerspot Butterfly (BCB):** 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.
- **California Tiger Salamander (CTS):** 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.
- **Delta Smelt (DS):** 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.
- **Tidewater Goby (TG):** 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 chlorothalonil 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 LOCs. It is acknowledged that the action area for a national-level FIFRA regulatory decision associated with a use of chlorothalonil 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, CTS-CC DPS, DS, CTS-SB DPS, and TG and their designated critical habitat within the state of California. As part of the "effects determination," one of the following three conclusions will be reached separately for each of the assessed species in the lawsuits regarding the potential use of chlorothalonil 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

Chlorothalonil (2,4,5,6-tetrachloroisophthalonitrile; CAS 1897-45-6) is in the organochlorine class of chemicals. Chlorothalonil is a broad spectrum, non-systemic pesticide, mainly used as a fungicide to control fungal foliar diseases of vegetable, field, and ornamental crops. Additionally, non-agricultural use sites include golf courses, lawns around commercial and industrial buildings, and other turfgrass such as professional and collegiate athletic fields. Chlorothalonil is also used in residential settings. Chlorothalonil is also registered for antimicrobial uses as an industrial and consumer wood preservative, a fungicidal/mildewcidal/ algicidal paint, stain, and coating film preservative, and a material preservative paper and paperboard (non-food contact) and for the "in-service" life of caulks and sealants, adhesives, grouts and joint compounds, wallboard, stucco. This assessment considers only the currently registered conventional uses of chlorothalonil, as the Agency intends to evaluate the antimicrobial uses in the Preliminary Risk Assessment as part of the Registration Review process, in order to evaluate all registered chlorothalonil uses for potential exposure to fish, wildlife, and/or endangered species. Refer to the Uncertainties Section for additional information.

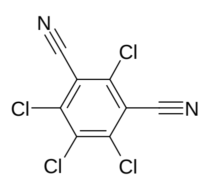


Figure 2-1. Chemical Structure of Chlorothalonil

Chlorothalonil is formulated in solid form as dust, water dispersible granules, pellets, tablets, and as a wettable powder. In liquid form, chlorothalonil is available as an emulsifiable, flowable, and soluble concentrate as well as a ready-to-use solution. For conventional uses chlorothalonil is used as a preventative treatment and it is applied either by aerial or ground equipment, and can be used in tank mixes.
Based on private market pesticide usage data from 1998-2010, the annual total agricultural usage averaged approximately nine million pounds for eight million treated acres. For these same years, the largest markets in terms of total pounds active ingredient applied are peanuts (37%), potatoes (26%) and tomatoes (8%). The crops with the most total area treated (total land) are peanuts (42%), potatoes (31%) and tomatoes (6%). The maximum percent cropped area treated

for chlorothalonil is for peanuts (80%), celery (70 %), tomatoes (70%) and watermelons (65%).[7] It is recognized that chlorothalonil is used in many parts of the U.S., however, the scope of this assessment limits consideration of the areas of use that may be applicable to the protection of the BCB, CTS, DS, CCR, CFWS, SFGS, TG and its designated critical habitat within the state of California.

Application methods for the agricultural uses of chlorothalonil include aircraft, high and low volume ground sprayer, sprinkler irrigation, and tank-type sprayer. Although all potential uses are assessed, risks from ground boom and aerial applications are focused on in this assessment because they are expected to result in the highest off-target concentrations of chlorothalonil. Runoff associated with large rainfall events is expected to be responsible for the greatest off-target movement of chlorothalonil.

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 chlorothalonil in accordance with the approved product labels for California is "the action" relevant to this ecological risk assessment.

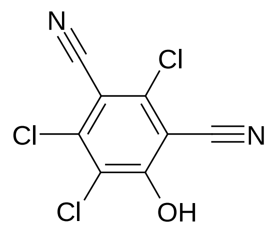
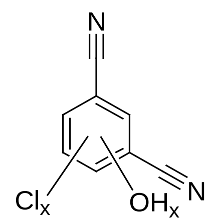
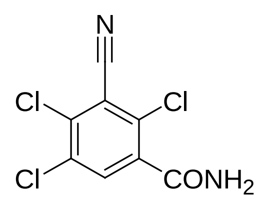
Although current registrations of chlorothalonil allow for use nationwide, this ecological risk assessment and effects determination addresses currently registered uses of chlorothalonil in portions of the action area that are reasonably assumed to be biologically relevant to the BCB, CTS, DS, CCR, CFWS, SFGS, and TG and their designated critical habitat. Further discussion of the action area for the BCB, CTS, DS, CCR, CFWS, SFGS, TG species and their critical habitat is provided in **Section 2.9**.

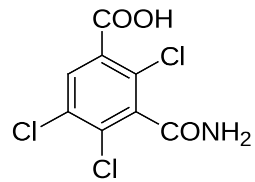
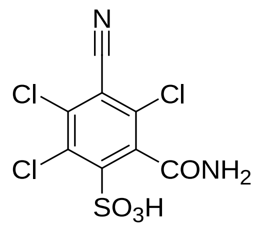
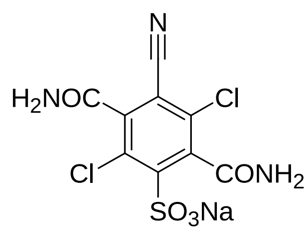
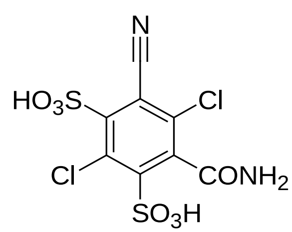
2.2.1. Evaluation of Degradates and Other Stressors of Concern

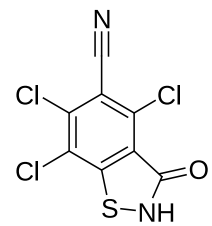
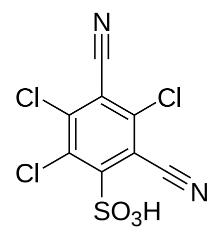
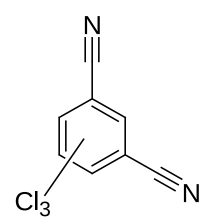
As mentioned above, chlorothalonil is likely to undergo chemical reactions in the environment to form a number of different transformation products. The maximum observed concentration of each of the reported transformation products is presented in **Table 2-1**. Currently, EPA only considers SDS-3701 to be of potential toxicological concern. SDS-3701 is a major transformation product that forms under various environmental conditions. SDS-3701 is much more soluble (115.7 mg/L at 25 °C; EPI Web 4.0 WSKOW v. 1.41) than chlorothalonil. Laboratory studies suggest that SDS-3701 may also transform through microbial-mediated processes, and is more mobile (KFOC = 351-559 mL/gOC) than chlorothalonil (MRID 46786901). Based on the available ecotoxicology data, it appears that SDS-3701 is acutely less toxic to aquatic organisms than parent chlorothalonil; chronic aquatic toxicity data are not available for aquatic organisms. However, for terrestrial animals, based on the data available, it appears that SDS-3701 is more toxic than parent chlorothalonil. Therefore, both parent chlorothalonil and SDS-3701 will be evaluated for terrestrial animals, whereas only parent chlorothalonil will be assessed for aquatic animals and plants.

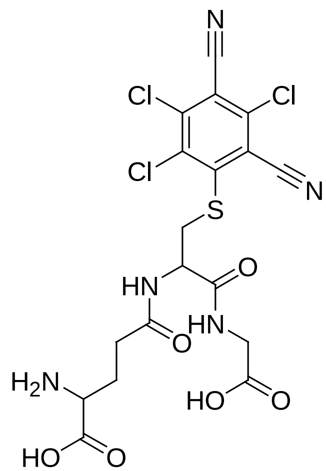
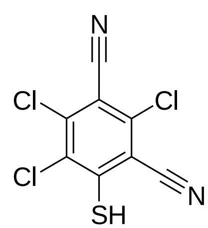
[7] USDA-NASS 2001-2008; private pesticide market research 2001-2008; and California Department of Pesticide Regulation 2000-2009.

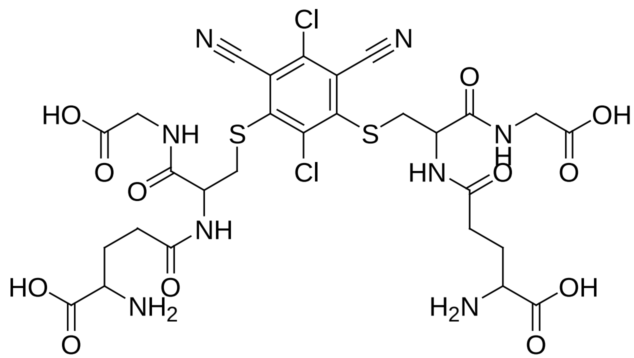
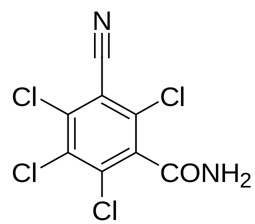
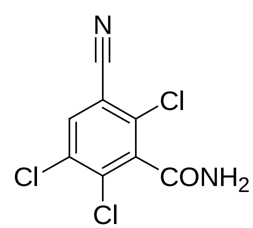
Table 2-1. Maximum Observed Concentrations of Chlorothalonil Transformation Products in Environmental Fate Laboratory Studies

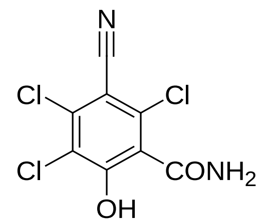
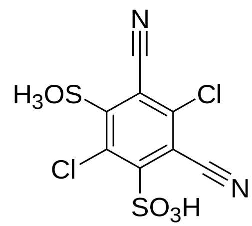
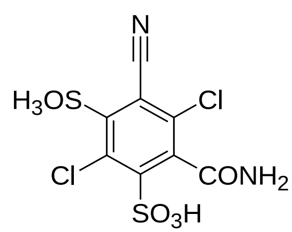
Code Name/ Synonym	Chemical Name SMILES Code	Chemical Structure	Study Type/ Corresponding OCSPP Guideline	MRID (classification)	Maximum % AR (interval)[1]
Major (>10%) Transformation Products					
SDS-3701 DCA-3701 DS-3701 R182281 CNIL/02	4-hydroxy-2,5,6-trichloro-1,3-dicyanobenzene C1(=C(C(=C(C(=C1Cl)C#N)O[H])Cl)Cl)C#N		Aquatic Photolysis 835.2240	45121803 Supplemental[2]	4.9 (9 hrs)
			Aerobic Soil Metabolism 835.4100	00040547 00087351 Supplemental	34.1 (60 days; loam soil)
			Aerobic Aquatic Metabolism 835.4300	45908001 Supplemental	16.2 (59 days)
	Hydroxy-chloro-1,3-dicyanobenzene (unspecified number of attached atoms (1-3)		Aquatic Photolysis 835.2240	45121803 Supplemental[2]	14.1(9 hrs)
SDS-47523 R611966 CNIL/05	3-cyano-2,4,5-trichlorobenzamide C1(=C(C(=CC(=C1Cl)C(=O)N([H])[H])Cl)Cl)C#N		Aerobic Soil Metabolism 835.4100	43879601 Supplemental[3]	10.39 (91 days)

Code Name/ Synonym	Chemical Name SMILES Code	Chemical Structure	Study Type/ Corresponding OCSPP Guideline	MRID (classification)	Maximum % AR (interval)[1]
SDS-46851 R611965 CNIL/04	3-carbamoyl-2,4,5-trichlorobenzoic acid C1(=CC(=C(C(=C1Cl)C(=O)N([H])[H])Cl)Cl)C(=O)O[H]		Aerobic Soil Metabolism 835.4100	43879601 Supplemental[3]	18.94 (181 days)
R417888 CNIL/10	2-amido-3,5,6-trichloro-4-cyanobenzenesulfonic acid C1(=C(C(=C(C(=C1Cl)C(=O)N([H])[H])[S](=O)(=O)O[H])Cl)Cl)C#N		Aerobic Soil Metabolism 835.4100	47207703 Supplemental	14.1 (7 days)
R471811 CNIL/13	Sodium 2,4-bis-amido-3,5,6-trichlorobenzenesulfonate C1(=C(C(=C(C(=C1Cl)C(=O)N([H])[H])[S](=O)(=O)[O-])Cl)C(N([H])[H])=O)C#N.[Na+]		Aerobic Soil Metabolism 835.4100	47207702 Supplemental	**11.9 (125 days)**
R419492 CNIL/12	4-amindo-2,5-dichloro-6-cyanobenzene-1,3-disulphonic acid		Aerobic Soil Metabolism 835.4100	47207703 Supplemental	**12.4 (120 days)**

Code Name/ Synonym	Chemical Name SMILES Code	Chemical Structure	Study Type/ Corresponding OCSPP Guideline	MRID (classification)	Maximum % AR (interval)[1]
SDS-67042 R613841	5-cyano-4,6,7-trichloro-2H-1,2-benzisothiazol-3-one 4,6,7-trichloro-5-cyano-2H-benzisothiazol-3-one C1(=C(C(=C2C(=C1Cl)C(NS2)=O)Cl)Cl)C#N		Aerobic Aquatic Metabolism 835.4300	42226101 Supplemental	31.91(1 day)
	2,5,6-trichloro-1,3-dicyanobenzene-4-sulphonate		Aerobic Soil Metabolism 835.4100	45908001 Supplemental	10.4 (0.25 days)
	Trichloro-1,3-dicyanobenzene		Aquatic Photolysis 835.2240	45121803 Supplemental[2]	6.9 (12 hrs)
			Aerobic Aquatic Metabolism 835.4300	45908001 Supplemental	28.3 (0.25 days)

Code Name/ Synonym	Chemical Name SMILES Code	Chemical Structure	Study Type/ Corresponding OCSPP Guideline	MRID (classification)	Maximum % AR (interval)[1]
SDS-66382	2,5,6-trichloro-4-(glutathion-S-yl)isophthalonitrile		Aerobic Aquatic Metabolism 835.4300	42226101 Supplemental	7.89 (16 days)
	Carbon Dioxide	CO_2	Aerobic Soil Metabolism 835.4100	47207703 Supplemental	**23.8 (120 days)**
Minor (<10%) Transformation Products					
SDS-13353	2,5,6-trichloro-4-(thio)isophthalonitrile		Aerobic Aquatic Metabolism 835.4300	42226101 Supplemental	8.55 (0.25 days)

Code Name/ Synonym	Chemical Name SMILES Code	Chemical Structure	Study Type/ Corresponding OCSPP Guideline	MRID (classification)	Maximum % AR (interval)[1]
SDS-66432	 2,5-dichloro-4,6-di-(glutathion-S-yl)isophthalonitrile		Aerobic Aquatic Metabolism 835.4300	42226101 Supplemental	9.62 (16 days)
DS-19221 SDS-19221 R613636 CNIL/03	3-Cyano-2,4,5,6-tertachlorobenzamide		Aerobic Soil Metabolism 835.4100	00040547 00087351 Supplemental	7.3 (30 days)
SDS-47524 R611967 CNIL/06	3-cyano-2,5,6-trichlorobenzamide		Aerobic Soil Metabolism 835.4100	43879601 Supplemental[3]	8.41 (14 days)

Code Name/ Synonym	Chemical Name SMILES Code	Chemical Structure	Study Type/ Corresponding OCSPP Guideline	MRID (classification)	Maximum % AR (interval)[1]
SDS-47525 R611968 CNIL/07	3-cyano6-hydroxy-2,4,5-trichlorobenzamide		Aerobic Soil Metabolism 835.4100	47207702 Supplemental	6.5 (2 days)
R418503 CNIL/11	2,5 Dichloro-4,6-dicyanobenzene-1,3-disulfonic acid		Aerobic Soil Metabolism 835.4100	47207702 Supplemental	**0.9 (125 days)**
R419492 CNIL/12	4-carbamoyl-2,5-dichloro-6-cyano-benzene-1,3-disulfonic acid		Aerobic Soil Metabolism 835.4100	47207702 Supplemental	**3.2 (125 days)**

1. Bold font indicates maximum concentration was observed at study termination; therefore, the formation and decline of the transformation product was not established in the experiment.
2. Aquatic photolysis study was reclassified to supplemental as all major transformation products were not adequately identified. Additional data are needed to identify all major transformation products or other residues of toxicological concern.
3. This aerobic soil metabolism study was reclassified to supplemental as all major transformation products were not adequately identified. Additional data are needed to identify all major transformation products or other residues of toxicological concern.

Applied Radioactivity (AR)

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 (U.S., EPA 2004; USFWS/NMFS 2004).

Chlorothalonil has registered products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **APPENDIX A**. The results of this analysis show that an assessment based on the toxicity of the single active ingredient of chlorothalonil is appropriate; the analysis indicated that the available data was insufficient to establish a difference in toxicity between the parent and the multiple active ingredient formulations. Therefore, there is uncertainty regarding the extent to which the multiple active ingredient formulations may be more toxic than parent chlorothalonil. For the purposes of this assessment, toxicity data from technical chlorothalonil was used.

In addition, aquatic toxicity data was available for some of the multiple active ingredient formulations for chlorothalonil (*e.g.,* propiconazole and azoxystrobin). The remaining chlorothalonil formulations only contain a single active ingredient (*i.e*., chlorothalonil). Available toxicity data for aquatic freshwater animals did not show any significant differences between formulated commercial products and the technical active ingredient (from single a.i. formulations). For species in which comparative data are available, the confidence intervals of the toxicity endpoints for freshwater fish and invertebrates exposed to the TGAI and formulated chlorothalonil overlap, thereby toxicity differences between chlorothalonil TGAI and formulated chlorothalonil could not be distinguished, for freshwater animals (see **APPENDICES G, I** and **J**). Toxicity data for birds are only available for the TGAI. For a study conducted using marine phytoplankton, *Dunaliella tertiolecta*, it was reported that a mixture of chlorothalonil and atrazine (1:1 ratio) were 1.83 times more toxic (based on growth rate) than in the individual toxicity tests using the Additive Index and Magnification Factor methodology (DeLorenzo and Serrano, 2003; E92068); a negative control group was not used in the study, only a solvent control (acetone, 0.1%), therefore, there is uncertainty in whether the solvent influenced the response. Additionally, brine shrimp, *Artemia salina*, were exposed to chlorothalonil and mixtures for 24-hours (using the Artoxkit M and DMSO (0.5%) as a co-solvent), and it was reported that a tertiary mixture of chlorothalonil, zinc pyrithione, and copper pyrithione exhibited synergism as well as a mixture of the previous three as well as dirunon as calculated using the mixture toxicity index and/or toxic unit summation methodology (Koutsaftis and Aoyama, 2007; E101947); however, binary mixtures of chlorothalonil and the above mentioned chemicals and other tertiary mixtures resulted in less than additive or antagonist results. As a result, the risk analyses were conducted using the most sensitive endpoint determined from toxicity studies using technical active ingredient.

2.3. Previous Assessments

Chlorothalonil has a long regulatory history, and several ecological risk assessments have been completed. Risk to non-target organisms was evaluated for conventional uses of chlorothalonil as part of the Re-registration Eligibility Decision (RED) in April 1999. A quantitative ecological risk assessment was not performed for antimicrobial chlorothalonil uses at the time of the RED because the Agency did not anticipate any exposure of concern to fish, wildlife, and/or endangered species based on the registered use patterns; furthermore, discharge to the environment complied with all Federal disposal laws and NPDES. For registration review, the Agency intends to conduct a comprehensive ecological risk assessment for both conventional and antimicrobial uses of chlorothalonil.

For conventional pesticide uses in the 1999 RED document, LOCs were exceeded for birds, mammals, fish, aquatic invertebrates and aquatic plants. As part of the ecological risk mitigation measures for conventional uses specified in the RED, the chlorothalonil registrants agreed to revise their product labels to include maximum individual application rates, minimum application intervals, and maximum seasonal application rates. Additionally, the registrants agreed to include a requirement for untreated buffers between treated agricultural fields and marine/estuarine water bodies (150 ft for aerial and air-blast applications and 25 ft for ground applications).

As part of a recent “me-too” registration for turf and ornamentals (DP328075, 220223, 301503, 301500; June 2006), new data were submitted that indicated greater toxicity of chlorothalonil to birds and daphnids than the data used in the 1999 RED. Additionally, ecological risk assessments for IR-4 uses on multiple crops (*e.g.*, fruiting vegetables, cucurbit vegetables, okra, persimmon, horseradish, rhubarb, ginseng, yams, lupine, lentils, brassica head and stem vegetables) have been conducted since the 1999 RED. The potential risks identified from the new uses were similar to those previously reported in the RED.

In October 2007, the Agency completed an assessment of the potential direct and indirect effects of conventional uses of chlorothalonil to the California red-legged frog (CRLF) and its designated critical habitat. Based on the information available at that time, the Agency made a May Affect and Likely to Adversely Affect determination for the CRLF from the use of chlorothalonil. Additionally, the Agency determined that there is the potential for modification of CRLF designated critical habitat from the use of chlorothalonil.

On March 22, 2012, the Agency completed a Registration Review Problem Formulation for Environmental Fate, Ecological Risk, Endangered Species, and Drinking Water Exposure Assessments for Chlorothalonil. As part of the Registration Review process, the environmental fate and ecological toxicity data were reevaluated as part of the Problem Formulation (USEPA, 2012). Additional data needs were identified in the Problem Formulation, which will be needed to complete the ecological exposure and risk assessment for chlorothalonil. These data include: avian acute oral toxicity study (850.2100), terrestrial plant study (850.4100, 850.4150), estuarine/marine fish acute (850.1075) and chronic studies (850.1400), estuarine/marine invertebrate chronic study (850.1350), freshwater and estuarine/marine sediment organism studies (850.1735 and 850.1740) and a special study (acute avian inhalation) toxicity studies.

According to the 1999 RED document for chlorothalonil, the 1984 Registration Standard for chlorothalonil required that levels of hexachlorobenzene (HCB), an impurity in technical chlorothalonil, be at or below 0.05%. Certification of HCB levels was required in the RED. Additionally, there was a 1987 Data Call-In (DCI) to identify and indicate the amount of other known impurities in technical chlorothalonil (*i.e.*, dioxins and dibenzofurans) via revised Confidential Statements of Formula (CSFs). At the time of the RED, these data were still outstanding. These impurities have not been considered in past ecological risk assessments; however, they will be considered in the ecological risk assessment conducted for chlorothalonil as part of the Registration Review process.

2.4. Environmental Fate Properties

Environmental fate properties of chlorothalonil are summarized in **Table 2-2**. The available fate dataset has major deficiencies. Based on limited information, chlorothalonil was shown to undergo a number of different chemical reactions including de-chlorination, hydroxylation and sulfonation in the environment to form a number of different transformation products. All the transformation products reported retain the phenyl ring with the exception of carbon dioxide (CO_2). Maximum concentration of each transformation product formed in each of the submitted environmental fate studies is reported in **Table 2-1**.

Table 2-2. Environmental Fate Parameters of Chlorothalonil

Parameter	Value	Source Classification; Comments
Abiotic Transformation Mechanisms		
Hydrolysis Half-life	No substantial degradation (pH 5 and 7)	MRID 00040539 Supplemental Some aspects of the study are invalid (*i.e.,* pH 9). Transformation of chlorothalonil was observed at pH 9; however, a mass balance was not provided and degradation products were only analyzed in one sample (day 89). Additional data are needed to assess the transformation of chlorothalonil under basic conditions (pH >9).
Soil Photolysis Half-life	No substantial degradation	MRID 00087349 Supplemental
	No substantial degradation	MRID 00040543 Supplemental
Aqueous Photolysis half-life	10.3 hours pH 7, 30 °North	MRID 45710223 Supplemental[3]
Biotic Transformation Mechanisms[1]		
Aerobic Soil Metabolism Half-life	58 days (SFO)/ 127 days (DFOP) STERILE CONTROL: 105 days (SFO) 39 mg/kg (~78 lb/a[2]); Illinois silty clay loam (pH 5.1 1.3% OC)	MRID 00087351 MRID 00040547 Supplemental

Parameter	Value	Source Classification; Comments
	15 days (SFO)/ 23 days (IORE) STERILE CONTROL: 32 days (SFO) 39 mg/kg (~78 lb/a^2); Iowa loam (pH 7.0 4.2% OC)	These two MRIDs are the same study. A substantial amount of chlorothalonil transformation is observed in the sterile controls; and a material balance could not be determined because unextracted residues were not measured directly.
	14 days (SFO)/ 23 days (IORE) STERILE CONTROL: 33 days (IORE) 39 mg/kg (78 lb/a^2); Texas sandy loam (pH 8.0 0.9% OC)	
	10 days (SFO)/ 16 days (IORE) STERILE CONTROL: 33 days (SFO) 3.9 mg/kg (8 lb/a^2); Ohio sandy loam (pH 6.0 1.9% OC)	
	5.4 days (SFO)/ 18 days (IORE) 1 mg/kg, 1.7 lb/a^2; Ohio loamy sand (pH 5.1, 1.5% OC, 2.6 %OM, 7.1, 7.0 CEC)	MRID 43879601 Supplemental
	21.3 days (SFO)/ 34.8 days (IORE) 10 mg/kg (20 lb/a^2); Ohio loamy sand (pH 5.1, 1.5% OC, 2.6 %OM, 7.1, 7.0 CEC)	
	0.5 days (SFO)/0.3 days (IORE) 0.1 mg/kg (0.2 lb/a^2); 18 acres (not reported)	MRID 47207702 Supplemental No data are provided for day 0 (assumed to be 100%), for this reason, chlorothalonil concentration at day 0 was assumed to be 100% of the applied radioactivity; soil characterization was not provided; duplicate samples were not analyzed; and no soil controls were provided.
	3 days (SFO)/ 18 days (IORE) 1 mg/kg (2 lb/a^2); 18 acres (not reported)	
	10 days (SFO) 10 mg/kg (20 lb/a^2); 18 acres (not reported)	
	18 days (SFO)/ 243 days (IORE) 25 mg/kg (50 lb/a^2); 18 acres (not reported)	
	1 day (SFO)/ 1.5 days (IORE) 1.5 kg/ha; 1.3 lb/a; 18 acres (pH 5.4, 4.5% OC, 4.5 %OM, 16.2 CEC)	MRID 47207703 Supplemental Application rates are not reflective of current maximum label rates and transformation of chlorothalonil has been shown to be concentration dependent.
	0.3 days (SFO)/ 0.5 days (IORE) 1.5 kg/ha; 1.3 lb/a; Chamberlain's Farm (pH 6.8, 3.2% OC, 3.2% OM, 8.0 CEC)	
	1.3 days (SFO)/ 1.7 days (IORE) 1.5 kg/ha; 1.3 lb/a; ERTC (pH 5.0, 1.3% OC, 1.3% OM, 4.4 CEC)	
	2.4 days (SFO)/ 4.1 days (IORE) 1.5 kg/ha; 1.3 lb/a; Munster (pH 4.8, 2.5% OC, 2.5% OM, 5.5 CEC)	
Anaerobic Soil Metabolism Half-life	no data available	
Aerobic Aquatic Metabolism Half-life	3.4 days (SFO)/ 8.5 days (IORE) Bury Pond [pH 5.2 (water) 8.0 (sediment), 1% OC, 16 CEC)], The concentrations varied substantially throughout the study.	MRID 45908001 Supplemental The stability of the parent and its transformation products during storage prior to analysis were not addressed; volatile transformation products were detected at ≥10% AR but not identified; and there is also a large amount of unidentified HPLC residues.
	0.1 day (SFO)/1.1days (IORE) Houghton Meadow [pH 6.73 (water) 7.3 (sediment), 5.8% OC, 51.4 CEC)]	

Parameter	Value	Source Classification; Comments
	0.06 days (SFO)/ 0.1 days (IORE) 0.6 mg/L; Ohio and DI water (pH 6.8)	MRID 42226101 Supplemental Studies were not conducted with natural water.
	0.3 days (SFO)/ 1.9 days (DFOP) 0.6 mg/L; Virginia with artificial sea water (pH 9.3)	
	2.6 days (SFO)[2] Emperor Lake (pH 7.4)	MRID 47207701 Supplemental Establishment of chlorothalonil transformation profile could not be determined; analytical methods were not suitable for isolating individual compounds; and not all major transformation products were identified.
	0.8 days (SFO)[2] Bury Pond (pH 7.9)	
Anaerobic Aquatic Metabolism Half-life	10.6 days (SFO) Tennessee silt loam (pH 6.0-7.2, 8.4-10.4 CEC)	MRID 00147975 Supplemental No data are provided for day 0 (assumed to be 100%), for this reason, chlorothalonil concentration at day 0 was assumed to be 100% of the applied radioactivity; for one test system the study was terminated before the pattern of dissipation of some of the major transformation products was established; distilled water was used instead of natural water and soil rather than sediment was used in this study; and although the test system was kept on nitrogen (30 days prior to study initiation) redox potentials and oxygen concentrations were not provided during the experiment so it cannot be determined that the test systems was anaerobic.
	9.7 days (SFO)/ 21.5 days (IORE) Ohio sandy loam (pH 5.7-6.0, 112.0-12.6 CEC)	
Mobility		
Range of Freundlich soil-water partition coefficients (K_F); exponent (1/n) values; and organic carbon-normalized coefficients (K_{FOC})	12, 14, 19, 56, 131, and 500 L/kg-soil; 0.66, 0.66, 0.72, 0.91, 1.1, and 1.2; and 1121, 2039, 2958, 5085, 6605, and 11935 mL/g_{OC}	MRID 00029406 Supplemental The temperature and the light conditions used in the definitive study were not reported; a desorption phase was not conducted; and material balance was not determined.

Parameter	Value	Source Classification; Comments
Field Dissipation		
Terrestrial Field Dissipation Half-life	58, 56, 74, and 81 days*	00071625 Supplemental *Sampling intervals were inadequate to define the half-life under field conditions. A storage stability study was not conducted. The pattern of formation and decline of the transformation products could not be determined. And the sampling depth was not sufficient to define leaching.
	33, 46, 50, 58, and 74 days*	MRIDs 00071627, 00087369, 00087332, and 00087301 Supplemental *Sampling intervals were inadequate to define the half-life under field conditions Analytical methods were inadequate in identifying transformation products of chlorothalonil.
Bioaccumulation		
Fish BCF edible, non-edible, and whole fish tissues	256, 5812 and 3077 at initial water exposure level of 0.1 µg/L chlorothalonil	MRID 45710224 Acceptable Chlorothalonil concentration in water during the exposure ranged from 39-97%. No data was provided on the depuration rates in this study.
	306, 5694 and 3041 at initial water exposure level 0.5 µg/L chlorothalonil	
Oyster BCF whole oyster	2660 (total residue primarily of transformation products)	MRID 43070601 Acceptable

1. Representative half-life values were calculated using the draft NAFTA degradation kinetics document: *Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* (draft document June 29, 2011); Single First Order (SFO), Nth-Order Rate Model or Indeterminate Order Rate Equation Model (IORE), and Double First-Order in Parallel (DFOP)
2. SFO kinetic analysis was the only method employed.
3. Aquatic photolysis study was reclassified to supplemental as all major transformation products were not adequately identified. Additional data are needed to identify all major transformation products or other residues of potential toxicological concern.

Applied Radioactivity (AR)
BCF: bioconcentration factor
Cation Exchange Capacity (CEC)
DI: deionized water
lb/a^2: pound per square acre
mg/kg: milligrams per kilogram
mL/g_{OC}: milliliters per gram of organic carbon
Organic Carbon (OC)
OM: organic matter
pH: One divided by the log of the hydrogen ion concentration

In summary, laboratory studies indicate chlorothalonil will transform primarily through aqueous photolysis in clear, shallow water. Chlorothalonil is also susceptible to microbial-mediated transformation, with transformation rates often departing from first-order kinetics. Degradation rates have been shown to be dependent on the application rate with higher chlorothalonil application rates resulting in slower degradation rates and vice versa. Data also suggest that chlorothalonil is rapidly transformed in water/sediment systems under both aerobic and anaerobic conditions. Field dissipation studies show that chlorothalonil dissipates (*e.g.*, transformation or relocation) with half-lives less than 100 days; however, in a few field dissipation studies chlorothalonil was observed in soil samples taken after one year. Batch equilibrium data suggest chlorothalonil is slightly to hardly mobile in soil systems. A summary of submitted environmental fate studies is provided in **APPENDIX N**. A detailed discussion of each of the relevant environmental fate studies is provided below.

Abiotic Degradation

Hydrolysis. One submitted study explored the hydrolysis of chlorothalonil at pH 5, 7 and 9 [MRID 00040539 (1976)]. The data suggest that chlorothalonil may hydrolyze (DT_{50} = 51 days) under basic conditions (pH >7), but that chlorothalonil is not susceptible to hydrolysis at pHs 5 and 7. Additional data are needed on chlorothalonil hydrolysis at pH 9 and until such data are received hydrolysis is considered a data gap. This data gap does not change the outcome of this assessment.

Aquatic Photolysis. Based on laboratory data [MRID 45710223 (1996)] generated using an artificial light source, chlorothalonil transformed under aqueous photolysis with an environmental predicted photo-transformation half-life of 10.3 hours (DT_{50} = 10.5 hours artificial light; MRID 45710223) at 30 °N latitude. Three major transformation products [47% of the applied radioactivity (AR)] were not identified.

Soil Photolysis. Three soil photolysis studies were available for chlorothalonil [MRIDs 00087349 (1975), 00040543 (1976) and 00156470 (1985)]. No substantial degradation of chlorothalonil was observed in these studies; therefore, chlorothalonil is considered stable to soil photolysis.

Biotic Degradation

Aerobic Soil Metabolism. Four aerobic soil metabolism studies are available for chlorothalonil and are discussed individually, below.

In one of the aerobic soil metabolism studies (MRIDs 00087351/00040547(1976)), two different application rates were used - 8 and 78 pounds of active ingredient per acre (lb a.i./a). The highest application rate is much higher (6 times) than the current maximum application rate (13 lb a.i./a) permitted on current chlorothalonil labels. Based on a kinetic analysis using Nth-Order Rate Model or Indeterminate Order Rate Equation Model (IORE), and Double First-Order in Parallel (DFOP) models, representative half-life values for chlorothalonil were determined to range from 16-127 days. Chlorothalonil concentrations decrease at the beginning of the study; however, after approximately 20-40 days chlorothalonil concentrations become steady at approximately 40-50% of the applied radioactivity (AR) in one soil and 10-20% of the AR in the other three soils tested. In general, the transformation of chlorothalonil depends on the application rate as the highest application rate resulted in the longest half-life while the lowest application rate resulted in the shortest half-life. A substantial amount of chlorothalonil transformation was observed in the sterile control (half-life values ranged from 33-105 days). It is unclear if this transformation is representative of another dissipation pathway or if the soils were not sterile. In three of the four sterile control experiments, chlorothalonil transformation can be described using single first order (SFO). Chlorothalonil transformation in the fourth control experiment is best described using IORE. Two transformation products were identified in this study, SDS-3701 (34.1% AR) and DS-19221 (7.3% AR). Although these transformation products were identified, a material balance could not be determined because unextracted residues were not measured or characterized, and it is unclear if all major, or potentially toxic, transformation products were identified. Up to 27% of the applied radioactivity was found in the aqueous extracts.

In another aerobic soil metabolism study, chlorothalonil was also investigated at application rates of approximately 2 and 20 lb a.i./a [MRID 43879601 (1995)]. The corresponding half-lives were 6 and 21 days using a non-linear SFO kinetic model, respectively. Nevertheless, chlorothalonil transformation was shown not to follow SFO kinetics. Upon additional kinetic analysis, the representative half-life values for chlorothalonil were determined to be 18 and 35 days using IORE, respectively. These results also suggest that chlorothalonil transformation depends on the application rate. Neither of the two application rates used in this study are representative of the current maximum single rate (13 lb a.i./a). Transformation products identified in this study include SDS-3701 (14% AR), SDS-19221 (6.35% AR), SDS-47523 (10% AR), SDS-47524 (13.77 % AR), SDS-47525 (4.73% AR), and SDS-46851 (19% AR). One major transformation product (representing up to 12% AR) was not identified in this study.

The third aerobic soil metabolism of chlorothalonil investigated a range of application rates [approximately 0.2-50 lb a.i./a; MRID 47207702 (2000)]. This study also showed that the transformation rate of chlorothalonil depends on the soil application rate. Estimated chlorothalonil half-lives ranged from less than a day to 18 days using SFO kinetics. The transformation of chlorothalonil is best described using IORE for three of the test concentrations and SFO for one of the test concentrations. The representative half-life values ranged from less than one day for the lowest application rate (0.2 lb a.i./a) to 243 days for the highest application rate (50 lb a.i./a). This study also shows that any chlorothalonil present after approximately 20-40 days is no longer metabolized. No data on transformation of chlorothalonil were provided until day two; therefore, the half-life values above were derived assuming that 100% of the applied radioactivity was present on day one. This introduces uncertainty in the representation of the calculated half-life values, especially for the lowest application rate tested as the estimated half-life value was less than two days. Transformation products identified in this study include SDS-3701, R417888, R471811, SDS-19221, SDS-47523, SDS-47524, SDS-47525, R419492, SDS-46851 and CO_2.

The last aerobic soil metabolism study [MRID 47207703 (2001)]for chlorothalonil indicates representative half-life values ranged from less than one day to up to four days based on IORE. These results are for chlorothalonil applications around 1 lb a.i./a, and are consistent with other studies conducted with a similar application rate; however, the results may not be a representative half-life value of the current maximum single chlorothalonil application rate (13 lb a.i./a) or a large number of other current maximum single chlorothalonil application rates (see

Table 2-3). Transformation products identified in this study include R182281, R417888, R419492, SDS-19221, SDS-46851, SDS-47523, R471811 and CO_2.

Taken together, these aerobic soil metabolism studies demonstrate that chlorothalonil can undergo a number of different chemical reactions in the soil to form a number of transformation products. All the transformation products reported retain the phenyl ring with the exception of CO_2. The transformation rate of chlorothalonil was also shown to be heavily influenced by the application rate. Higher application rates result in longer half-life values while lower application rates result in shorter half-life values (MRIDs 43879601, 47207702, 00087351 and 00040547). This is likely the result of a decrease in viability of the soil microbes after exposure to chlorothalonil. This is supported by a decrease in observed microbial activity at study termination as compared to study initiation (MRID 47207703). All aerobic soil metabolism kinetic analyses are provided in appendix of the recent problem formulation. In general, this suite of studies indicate that chlorothalonil degrades over the first 20 days; however, if any chlorothalonil remains after 20-40 days it is not likely to be metabolized or it is metabolized very slowly. This was generally observed for all application rates. Representative half-life values for chlorothalonil compared to application rates used in the submitted studies that span the current single maximum application rates are provided in **Table 2-3**. Based on the data presented in this table, the half-life value for the currently approved maximum application rate is likely between 18-35 days; nevertheless, these results are inconsistent with the terrestrial field dissipation studies (MRIDs 00071625, 00071627, 00087369, 00087332, and 00087301 which indicate much longer dissipation half-lives in the environment compared to the aerobic soil metabolism half-lives derived in laboratory studies. To address this uncertainty, the submission of additional data has been identified as part of the Problem Formulation for Registration Review.

Table 2-3. Representative Aerobic Soil Metabolism Half-life Values for Chlorothalonil in Relationship to Experimental Application Rates and Current Maximum Single Application Rate

Application Rate (lb a.i./a)	**Representative** Half-life (days)	**Source**	**Comments**
1	2	MRID 47207703	IORE best fit kinetic model
1	1		
1	2		
1	4		
2	18	MRID 43879601	
2	18*	MRID 47207702	
8	16	MRIDs 00087351/00040547	
20	35	MRID 43879601	
20	10*	MRID 47207702	SFO best fit kinetic model
50	243*	MRID 47207702	IORE best fit kinetic model

*The half-life value is estimated as data were not provided until two days after treatment.
Zigzag line represents current maximum single application rate.

Anaerobic Soil Metabolism. No anaerobic soil metabolism data has been submitted. This is considered a data gap. In absence of this data the anaerobic aquatic metabolism rate may be used as a surrogate. A supplemental anaerobic aquatic metabolism (MRID 00147975) study has been submitted (see discussion below).

Aerobic Aquatic Metabolism. Three different aerobic aquatic metabolism studies have been submitted for chlorothalonil, which indicate that chlorothalonil transformation is rapid (<1 day). One common deficiency is that none of the studies identified all the major transformation products. In one of the studies [MRID 45908001 (1996)] report fluctuating chlorothalonil concentrations (going up and down) In another study (MRID 42226101(1991)], artificial sources of water were used and the resulting half-life values may not accurately represent those found in natural water bodies. Additional data are needed on the transformation rate of chlorothalonil in aerobic aquatic systems.

Anaerobic Aquatic Metabolism. An anaerobic aquatic metabolism study [MRID 00147975 (1985)] suggests that chlorothalonil may transform under anaerobic conditions; however, there are some uncertainties about its metabolism rate under anaerobic conditions. Redox potentials and oxygen concentrations were not provided during the experiment; therefore, it cannot be confirmed that the system was anaerobic. Since the test system was purged with nitrogen for 30 days prior to study initiation it is assumed that the study was conducted under anaerobic conditions. In addition, no data are provided for day 0. For this reason, chlorothalonil concentration at day 0 was assumed to be 100% of the applied radioactivity. The study was also terminated before the pattern of formation and decline could be established for the transformation products in one of the test systems. The test systems used in this experiment are soil and distilled water (rather than natural water).

Adsorption/Desorption-Batch Equilibrium. One supplemental adsorption study [MRID 00029406 (1980)] indicates that chlorothalonil is slightly to hardly mobile in soils (Kf ranged from 12 to 500 L/kg-soil while Koc values range from 1121 to 11935 mL/gOC). The leaching potential of chlorothalonil through soil is correlated with the organic carbon fraction of the soil. The Freundlich exponent (1/n) ranges from 0.7 to 1.2, suggesting that adsorption is non-linear. This study did not investigate the desorption of chlorothalonil from soil.

Terrestrial Field Dissipation. Two supplemental terrestrial field dissipation studies [MRIDs 00071625 (1981) and MRIDs 00071627, 00087332, 00087369, 00087301 (1980, 1967 and 1965)] are available for chlorothalonil. Both of these studies also have limited characterization of environmental transformation products. The estimated half-life values suggest that substantial amounts of applied chlorothalonil could be available for runoff or soil-sorbed erosion transport for several weeks to months post-application (estimated half-life values ranged from 33 to 81 days). However, in both of these studies, sampling did not begin until at least one month after chlorothalonil applications. This limits the ability to estimate a representative half-life value for chlorothalonil, as well as for any chlorothalonil transformation products.

Fish Bioaccumulation. A fish bioconcentration [MRID 45710224 (1997)] study showed that chlorothalonil is absorbed by fish; however, it depurates when exposure ceases (approximately 31-35% decrease after one day). For the two different concentrations tested (0.1 μg/L and 0.5 μg/L) the BCF were determined to range from 256-306, 5694-5812 and 3041-3077 for the edible, non-edible, and whole fish tissues, respectively. Three transformation products were identified to form—triglutathione and diglutathione conjugates and SDS-3701. Several other transformation products were observed. These transformation products did not make up more than 10% AR combined. Up to 28 % of the AR was identified as polar components and not characterized while up to 15% of the radioactivity was not extracted.

An oyster bioconcentration (MRID 43070601) study showed that chlorothalonil is adsorbed by oysters. A total residue BCF (primary transformation products) was determined to be 2600 suggesting there is some potential for bioaccumulation of chlorothalonil transformation products.

Dissipation

Spray Drift. Based on conventional use patterns, there is the potential for chlorothalonil to drift following application. Spray drift results in deposition to adjacent areas including terrestrial habitats and aquatic environments that serve as habitat or source water for drinking water. In general, deposition of drifting or volatilized pesticides is expected to be greatest closest to the site of application.

As result of the 1999 RED, all agricultural labels were updated to include a buffer zone between agricultural fields (including sod farms, farms, forests, nurseries and greenhouses) and marine/estuarine water bodies. The required buffer is 150 feet for aerial and air-blast applications and 25 feet for ground applications.

Volatilization. Based on laboratory data, the vapor pressure (5.7 x 10-7 torr) and Henry's Law Constant (2.6 x 10-7 atm - m3/mole) values for chlorothalonil indicate some degree of volatility from both soil and water (semi-volatile). However, volatilization would not be expected to be a major dissipation route. Nonetheless, a number of studies have documented atmospheric transport and redeposition of various pesticides, including chlorothalonil, from the Central Valley to the Sierra Nevada Mountains. This is likely the result of prevailing winds blowing across the Central Valley eastward to the Sierra Nevada Mountains transporting airborne pollutants such as chlorothalonil into the Sierra Nevada ecosystems. In addition, local ambient air monitoring data from a site in North Dakota and three sites in California, to list a few, indicate that chlorothalonil was present in the air at application sites and at locations up to a mile away from the application sites. Data from the state of Montana show detections of chlorothalonil in precipitation. This indicates that chlorothalonil volatility or particle phase transport plays a role in the dissipation of chlorothalonil and that it is possible for chlorothalonil exposure to occur adjacent to application sites, as well as areas distant from application sites (long range transport).

The magnitude of transport via secondary drift depends on the amount of chlorothalonil that becomes mobilized into air and its eventual removal through wet and dry deposition of gases, and particles and photochemical reactions in the atmosphere. Currently, the Agency does not have data on direct and indirect chlorothalonil phototransformation (OCSPP 835.2370). Therefore, physicochemical properties of chlorothalonil that describe its potential to enter the air from water or soil (e.g., Henry's Law constant and vapor pressure), pesticide use data, modeled estimated concentrations in water and air, and available air monitoring data will be considered in evaluating the potential for atmospheric transport of chlorothalonil. In order to reasonably estimate concentrations of chlorothalonil in air, additional information is needed, including flux data, for chlorothalonil from a field volatility study (OCSPP 835.8100).

Runoff. Fate data indicate that chlorothalonil can dissipate in the environment after application via dissolved phase and sorption to eroded sediment. To gain a better idea of the potential exposure to chlorothalonil as a result of these dissipation pathways, PRZM (Pesticide Root Zone Model) is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field. In addition to model estimates, monitoring data are also evaluated.

Monitoring data can elucidate what is happening under current use practices and under typical conditions. Although monitoring data provide a direct estimate of the concentration of a pesticide in water, they do not always provide a reliable estimate of peak exposures because sampling may not occur where the highest pesticide concentrations are found and/or when the pesticide concentrations are the highest. In addition, monitoring is often conducted for purposes other than characterizing exposure from a particular pesticide. A brief summary of what is currently known about available monitoring data is provided below by media.

Several sources of surface water monitoring data were assessed including the USGS National Water Quality Assessment Data Warehouse (NAWQA[8]), California State Water Resources Control Board, Surface Water Ambient Monitoring Program (SWAMP) and California Department of Pesticide Regulation (CDPR) Surface Water Database. These sources indicate that chlorothalonil has been detected in surface water. Minimum reporting limit ranged from 0.01 to 4.1 µg/L. In general, for these datasets sample frequencies are sporadic and range from once per year to a few times per month depending on the site and year.

On a national basis, of the 7,214 NAWQA samples (951 sites) there are 29 reported detections (levels greater than the detection limit) of chlorothalonil. The highest detected concentration was 0.71µg/L in an urban location in New Jersey. The highest detection (0.68 µg/L) in an agricultural setting was observed in Georgia. Both detections were observed for filtered water (49306-chlorothalonil). Eight samples reported detection limits greater than 1 µg/L.

For California, approximately 370 samples collected from 11 counties analyzed for chlorothalonil from March 18, 1993 to December, 22, 2005.[9] Surface water samples were collected in the counties (# of samples) including Alpine (4), Amador (6), Del Norte (1), El-Dorado (4), Merced (87), Nevada (4), Orange (10), Sacramento (109), San Bernardino (8), San Joaquin (61), and Stanislaus (74). The highest concentration detected in California is reported to be 0.29 µg/L from as sample collected in Merced County (USGS Station #1123500) on February 8, 1994. This specific sample is not included in the CalDPR dataset.

[8] USGS National Water Quality Assessment Data Warehouse; 49306-chlorothalonil water filtered (7121); 65071-chlorothalonil water filtered (2); 70314-chlorothalonil water unfiltered (87); 62904-chlorothalonil bed sediment (4)
[9] As reported in the CalDPR database and includes SWAMP and NAWQA sampling sites.

Soil Leaching. Several interim reports [MRIDs 43959401 (1996), 43959402 (1996), and 44254801 (1997)] a small-scale prospective groundwater study suggest that chlorothalonil and some of its environmental transformation products can leach to groundwater.

SDS-3701

As mentioned above, chlorothalonil is likely to transform to form SDS-3701 under various environmental conditions. SDS-3701 is much more soluble (115.7 mg/L at 25 °C; EPI Web 4.0 WSKOW v. 1.41) than chlorothalonil. Laboratory studies suggest that SDS-3701 may also transform through microbial-mediated processes, and is more mobile than chlorothalonil. A summary of the environmental fate properties of SDS-3701 is provided in **Table 2-4**.

Table 2-4 Environmental Fate Parameters of SDS-3701

Parameter	Value	Source Classification; Comments
Abiotic Transformation Mechanisms		
Hydrolysis Half-life	No data	
Soil Photolysis Half-life	No data	
Biotic Transformation Mechanisms		
Aqueous Photolysis half-life	No data	Concentrations of SDS-3701 can be added to chlorothalonil in a total toxic residue approach to account for this uncertainty.[1]
Aerobic Soil Metabolism Half-life	No data	Concentrations of SDS-3701 can be added to chlorothalonil in a total toxic residue approach to account for this uncertainty.
Anaerobic Soil Metabolism Half-life	No data	Concentrations of SDS-3701 can be added to chlorothalonil in a total toxic residue approach to account for this uncertainty.
Aerobic Aquatic Metabolism Half-life	No data	Concentrations of SDS-3701 can be added to chlorothalonil in a total toxic residue approach to account for this uncertainty.
Anaerobic Aquatic Metabolism Half-life	No data	Concentrations of SDS-3701 can be added to chlorothalonil in a total toxic residue approach to account for this uncertainty.
Mobility		
Range of Freundlich soil-water partition coefficients (K_F); exponent (1/n) value; and organic carbon-normalized coefficients (K_{FOC})	5, 9, and 11 L/kg-soil 0.96, 0.87, and 0.91; and 718, 351 and 559 mL/g_{OC}	MRID 46786901 Supplemental
Field Dissipation		
Terrestrial field dissipation half-life	No data	Concentrations of SDS-3701 can be added to chlorothalonil in a total toxic residue approach to account for this uncertainty.
[1]This approach can only be used for SDS-3071 as it is identified in the chlorothalonil studies.		

2.4.1. Environmental Transport Mechanisms

In addition to fate data, monitoring data suggest that chlorothalonil can dissipate in the environment after application via dissolved phase (dissolved in water); eroded sediment, spray drift, and secondary drift (atmospheric transport) of volatilized or soil-bound residues are probable environmental transport mechanisms for chlorothalonil. Chlorothalonil applications can lead to surface water contamination as a result of spray drift as well as through runoff and sediment erosion. Aerobic soil metabolism data indicated that once chlorothalonil reaches the soil it can be transformed to SDS-3701 (a transformation product of toxicological concern) as well as several other transformation products (discussed further in the environmental fate section of this document). The soil/water partitioning of chlorothalonil indicates that chlorothalonil runoff is generally by dissolution in runoff water rather than soil erosion (*i.e.*, chlorothalonil is not expected to readily sorb to soil and sediment). Chlorothalonil may also leach through the soil. SDS-3701 may also reach surface water though runoff and sediment erosion. SDS-3701 as well as other chlorothalonil soil transformation products has been shown to leach to groundwater. Once in surface water, chlorothalonil is expected to transform rapidly via aqueous photolysis as well as metabolism.

2.5. Mechanism of Action

Chlorothalonil acts on mold, mildew, stain, and rot-causing fungi, staining and disfiguring algae, bacteria and microbes. Chlorothalonil targets multiple sites of the fungal pathogen upon contact (FRAC, 2011) affecting various enzymes and other metabolic processes in fungi; however, the exact mechanism of action is unknown. Chlorothalonil is believed to combine with glutathione in fungal cells tying up available glutathione. It inhibits spore germination, and is toxic to fungal cell membranes. Unlike many other fungicides, chlorothalonil resistance has not been reported. The mode of action for algae and bacteria is unknown.

2.6. Use Characterization

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

Conventional use registrations of chlorothalonil consist of use on a variety of terrestrial food and feed crops, terrestrial non-food crops, and greenhouse food/non-food crops. Chlorothalonil is formulated in solid form as dust, water dispersible granules, pellets, tablets, and as a wettable powder. In liquid form, chlorothalonil is available as an emulsifiable, flowable, and soluble concentrate as well as a ready-to-use solution.

For conventional uses, chlorothalonil is used as a preventative fungicidal treatment and it is applied either by aerial or ground equipment, and can be used in tank mixes. A summary of the conventional pesticide agricultural and non-agricultural uses of chlorothalonil is provided in the sections below based on information from the Biological and Economic Analysis Division

(BEAD).[10] Total chlorothalonil use is estimated to be approximately 13.5 million pounds per year, with California (9%) is one of five states with the most agricultural usage of chlorothalonil

Chlorothalonil is labeled for use on hundreds of terrestrial food crops including: almond, apricot, asparagus, banana, bean (dry), bean (snap, succulent), broccoli, Brussels sprouts, cabbage, carrot, cauliflower, celery, cherry (sweet and tart), cocoa bean, coffee bean, corn (sweet), cucumber, ginseng, horseradish, lentils, lupine (referred hereafter as lupine), mango, melon, mushroom, nectarine, okra, papaya, parsnip (root), passion fruit, pea (edible-podded), peach, peanut, persimmon, pistachio, plum (fresh and prune), pumpkin, rhubarb, soybean, squash (summer and winter), tomato and yam, and bulb vegetables.

Chlorothalonil labels may be categorized into two types: labels for manufacturing uses (including technical grade chlorothalonil and its formulated products) and end-use products. While technical products are not used directly in the environment, they are used to make formulated products. A complete list of all current conventional chlorothalonil uses for California and how EPA currently understands them, including the uncertainties for which reasonable conservative assumptions are made in the absence of additional label information, are listed in **Table 2-5**. For some uses, there are different label restrictions for agricultural and non-agricultural use labels for the same crop; these differences are also highlighted in **Table 2-5** as appropriate.

[10] Yourman, L.; Alsadek, J.; Ranville, M.; BEAD Chemical Profile for Registration Review: Chlorothalonil (089101) Oct. 25, 2011

Table 2-5. Chlorothalonil Uses Assessed for California

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
ALMOND: air/ground hull split, petal fall, popcorn to full bloom, postharvest, bud break, foliar	3.0	18.8*	NS [6[1]]	NS [3[2]]	- If 6 applications at 3.0 lb a.i./acre were made, an additional application of 0.8 lb a.i./acre could be made in that year to reach the 18.8 lb a.i./acre annual maximum application rate. *Do not apply more than 18.75 lbs a.i. per acre during each growing season (leaf fall through shuck split) - 150 day(s) preharvest interval.
APRICOT: air/ground hull split, petal fall, popcorn to full bloom, postharvest, bud break, foliar, delayed dormant, dormant, established plantings, late fall, pink through petal fall, popcorn	NS [3.14]	NS [15.5]	NS [5[1]]	NS [10]	- For ECHO® RTU (EPA Reg. No. 60063-30) the label does not specify a single max or annual max application rate for the following use sites: Peach, nectarine, apricot, cherry, plum, and prune. The application rate for these uses is provided as follows - "Apply full coverage spray to the point of runoff to thoroughly cover tree canopy including undersides of leaves." - 0 day(s) preharvest interval.
ASPARAGUS: air/ground early bloom, post-final harvest, postharvest	3.0	9.0	NS [3[1]]	14	- 180 day(s) preharvest interval
BEANS, DRIED-TYPE: air/ chemigation /ground early bloom through foliar, early bloom, Foliar	1.5	6.0	NS [4[1]]	7	- 14 day(s) preharvest interval. - Max number of applications on residential label 60063-16 is not specified.
BEANS, SUCCULENT (SNAP): air/ground early bloom through foliar	2.3	9.0	NS [4[1]]	7	- If 4 applications at 2.3 lb a.i./acre were made, it would result in 0.2 lb a.i./acre over the 9.0 lb a.i./acre annual maximum application rate. - 2.5 lb/a (residential) 60063-16 - 7 day(s) preharvest interval.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
BEANS: air/ground (not specified) early bloom, when needed	0.2034	0.2034	NS [1[1]]	7	- Max application rate is provided per 'season' not per year. - 7 day(s) preharvest interval.
BLUEBERRY: air/ground At bud break, delayed dormant, post-final harvest, postharvest	3.0	9.0	NS [3[1]]	10	- Buffer zone restriction. - 42 day(s) preharvest interval.
BRASSICA (HEAD AND STEM): air/chemigation/ground foliar, postemergence, posttransplant, transplant, when needed	1.5 1.1	8.8 10.5	NS [6[1]] NS [9[1]]	7	- Labels differ on the maximum single and maximum annual application rate allowed; therefore, rates associated with the maximum single and maximum annual application rate are provided. - If 6 applications at 1.5 lb a.i./acre were made, it would result in 0.2 lb a.i./acre over the 8.8 lb a.i./acre annual maximum application rate.
BROCCOLI: air/chemigation/ground Foliar, Postemergence, posttransplant, transplant, when needed	1.5	12.0	NS [8[1]]	7	- 7 day(s) preharvest interval.
BROCCOLI, CHINESE: air/chemigation/ground foliar, postemergence, transplant	1.5	12.0	NS [8[1]]	7	- 7 day(s) preharvest interval.
BRUSSELS SPROUTS: air/chemigation/ground foliar, postemergence, posttransplant, sprout, transplant, when needed	1.5	12.0	NS [8[1]]	7	- 0 day(s) preharvest interval.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
BULB VEGETABLES: air/chemigation/ground foliar	1.2	5.0	NS [4[1]]	7	- If 4 applications at 1.2 lb a.i./acre were made, an additional application of 0.2 lb a.i./acre could be made in that year to reach the 5.0 lb a.i./acre annual maximum application rate. - 00 day(s) preharvest interval.
CABBAGE: air/chemigation/ground foliar, postemergence, posttransplant, transplant, when needed	1.5	12	NS [8[1]]	7	- 00 day(s) preharvest interval (some labels do not specify while other specify a 7 day(s) preharvest interval.
CABBAGE, CHINESE: air/chemigation/ground foliar, postemergence, posttransplant, transplant, when needed	1.5	12.0	NS [8[1]]	7	- The max number of applications or maximum yearly application rate is not specified on labels 60063-16 and 100-1221. - 7 day(s) preharvest interval.
CARROT (INCLUDING TOPS): air/chemigation/ground foliar, when needed	1.5	15	NS [10[1]]	7	- 0 day(s) preharvest interval.
CAULIFLOWER: air/chemigation/ground foliar, postemergence, posttransplant, transplant, when needed	1.5	12	NS [8[1]]	7	- The max number of applications or maximum yearly application rate is not specified on labels 60063-16 and 100-1221. - 7 day(s) preharvest interval.
CELERY: air/chemigation/ground at planting, foliar, postemergence, posttransplant, seed bed, transplant	2.3	18.0	NS [8[1]]	NS [3]	- If 8 applications at 2.3 lb a.i./acre were made, it would result in 0.4 lb a.i./acre over the 18.0 lb a.i./acre annual maximum application rate. - 00 day(s) preharvest interval (some labels do not specify while other specify a 7 day(s) preharvest interval.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	**Maximum Application Rate (lb a.i./acre) Per Crop Cycle**	**Maximum Number of Applications Per Crop Cycle**	**Minimum Retreatment Interval (days)**	**Comments**
CHERRY: air/ground bloom, delayed dormant, dormant, established plantings, foliar, pink through petal fall, popcorn to full bloom, popcorn, postharvest	NS [3.2]	NS [15.5]	NS [5[1]]	10	- Not all of the labels for this use specify a max single or max annual application rate. For example, the label for ECHO® RTU (EPA Reg. No. 60063-30) does not specify a single max or annual max application rate for the following use sites: Peach, nectarine, apricot, cherry, plum, and prune. The application rate for these uses is provided as follows "Apply full coverage spray to the point of runoff to thoroughly cover tree canopy including undersides of leaves." - If 4 applications at 3.2 lb a.i./acre were made, an additional application of 2.7 lb a.i./acre could be made in that year to reach the 15.5 lb a.i./acre annual maximum application rate. - 00 day(s) preharvest interval.
CHRISTMAS TREE PLANTATIONS: air/ground nursery stock, before budbreak, after bud break,	4.2 4.5	16.5	NS [4[1]] NS [3[1]]	NS [3[2]]	- If 3 applications at 4.5 lb a.i./acre were made, an additional application of 3.0 lb a.i./acre could be made in that year to reach the 16.5 lb a.i./acre annual maximum application rate.
COLE CROPS: air/chemigation/ground foliar	1.0	12.0	NS [12[1]]	17	
COMMERCIAL/INDUSTRIAL LAWNS: ground foliar, late fall, fall, at seeding, late winter	11	26.0	NS [2[1]]	14	- If 2 applications at 11 lb a.i./acre were made, an additional application of 4.0 lb a.i./acre could be made in that year to reach the 26 lb a.i./acre annual maximum application rate. - Some labels (100-1231, 432-1486) do not specify the maximum number of applications or the maximum amount of chlorothalonil that can be applied per year.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
CONIFERS (PLANTATIONS/NURSERIES): air/chemigation/ground nurserystock, before budbreak, after bud break, spring, seed bed	4.5	16.5	NS [3[1]]	NS [3[2]]	- If 3 applications at 4.5 lb a.i./acre were made, an additional application of 3.0 lb a.i./acre could be made in that year to reach the 16.5 lb a.i./acre annual maximum application rate.
CORN (UNSPECIFIED): air/ground foliar, seed crop	1.5	9	NS [6[1]]	7	- 14 day(s) preharvest interval.
CORN, SWEET: air/ground foliar, seed crop, when needed	1.5	9.0	NS [6[1]]	NS 7 4 (for as needed low rate)	- 14 day(s) preharvest interval. - Retreatment interval not specified on 42519-31
CUCUMBER: air/chemigation/ground foliar, when needed	2.5 (foliar; home garden)	15.8	NS [7[1]]	7	- If 7 applications at 2.3 lb a.i./acre were made, it would result in 0.3 lb a.i./acre over the 15.8 lb a.i./acre annual maximum application rate. - 0 day(s) preharvest interval.
CUCURBIT VEGETABLES: air/chemigation/ground foliar	2.3	15.8	NS [7[1]]	5	- If 7 applications at 2.3 lb a.i./acre were made, it would result in 0.3 lb a.i./acre over the 15.8 lb a.i./acre annual maximum application rate. - 0 day(s) preharvest interval.
FILBERT (HAZELNUT): air/ground at bud break, delayed dormant, foliar, popcorn	3.0	9	NS [2[1]]	14	- Several labels restrict applications to Oregon only; however, other labels permits application in other states. - 120 day(s) preharvest interval.
FOREST TREES (SOFTWOODS, CONIFERS): nursery stock, before budbreak, after bud break, spring, seed bed	4.5	16.5	NS [4[1]]	NS [3[2]]	- Not all of the labels for this use specify a minimum application interval. - If 4 applications at 4.5 lb a.i./acre were made, it would result in 1.5 lb a.i./acre over the 16.5 lb a.i./acre annual maximum application rate.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
FRUITING VEGETABLES: air/chemigation/ground foliar	1.2	9	NS [8[1]]	7	If 7 applications at 1.2 lb a.i./acre were made, it would result in 0.6 lb a.i./acre over the 9.0 lb a.i./acre annual maximum application rate. - 3 day(s) preharvest interval. - 66222-154 does not specify a maximum number of applications per year or the maximum application rate per year.
GARLIC : air/chemigation/ground foliar, seed crop, when needed	2.3	15.1	NS [6[1]]	7	- If 6 applications at 2.3 lb a.i./acre were made, an additional application of 1.3 lb a.i./acre could be made in that year to reach the 15.1 lb a.i./acre annual maximum application rate. - 7 day(s) preharvest interval. - Some labels (100-1231, 432-1486) do not specify the maximum number of applications or the maximum amount of chlorothalonil that can be applied per year.
GINSENG (MEDICINAL): air/chemigation/ground foliar	NS [1.5]	NS [21]	NS [14[1]]	7	- Not all of the labels (66222-154) for this use specify a max single or max annual application rate. - 14 day(s) preharvest interval.
GRASS FORAGE/FODDER/ HAY: air/ground foliar, seed crop	1.6	4.5	NS [3[1]]	14	- If 3 applications at 1.6 lb a.i./acre were made, it would result in 0.3 lb a.i./acre over the 4.5 lb a.i./acre annual maximum application rate. - 14 day(s) preharvest interval.
GRASSES GROWN FOR SEED : air/chemigation/ground internode elongation	1.5	4.5	NS [3[1]]	14	- 14 day(s) preharvest interval.
HORSERADISH: air/chemigation/ground foliar	2.2	18.0	NS [8[1]]	7	- If 8 applications at 2.2 lb a.i./acre were made, an additional application of 0.4 lb a.i./acre could be made in that year to reach the 18.0 lb a.i./acre annual maximum application rate. - 14 day(s) preharvest interval.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
LEEK: air/chemigation/ground foliar, when needed	2.3	6.8	NS [3[1]]	7	- Do not make more than 3 applications per crop cycle. - 14 day(s) preharvest interval. - 7 day(s) preharvest interval (for lower rates). - 66222-154 does not specifically a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.
LUPINEE, GRAIN: air/chemigation/ground foliar	1.1	6.0	NS [5[1]]	7	- If 5 applications at 1.1 lb a.i./acre were made, an additional application of 0.5 lb a.i./acre could be made in that year to reach the 6.0 lb a.i./acre annual maximum application rate. - 66222-154 does not specifically a yearly/seasonal application rate maximum or the number of yearly/seasonal applications. - 14 day(s) preharvest interval.
MANGO: air/ground at bud break, early bloom through foliar, early bloom, popcorn	2.6	24	NS [9[1]]	7	- If 9 applications at 2.6 lb a.i./acre were made, an additional application of 0.6 lb a.i./acre could be made in that year to reach the 24.0 lb a.i./acre annual maximum application rate. - 21 day(s) preharvest interval.
MELONS: air/chemigation/ground foliar	2.5 (foliar)	15.8	NS [7[1]]	7	- If 7 applications at 2.3 lb a.i./acre were made, it would result in 0.3 lb a.i./acre over the 15.8 lb a.i./acre annual maximum application rate. - 0 day(s) preharvest interval. - Several labels do not specifically a yearly/seasonal application rate maximum or the number of yearly/seasonal applications. - 14 day(s) preharvest interval.
MUSHROOMS: chemigation/ground after spawning, plant bed	0.26 lb/12.5 gal	0.37	2	NS [3[2]]	- 5 day(s) preharvest interval.
NECTARINE: air/ground before bud break, bloom,	3.1	15.5	NS [5[1]]	10	- For ECHO® RTU (EPA Reg. No. 60063-30) the label does not specify a single max or annual max application rate for the following use sites: Peach, nectarine, apricot, cherry,

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
delayed dormant, dormant, established plantings, foliar, late fall, petal fall through foliar, petal fall, pink through petal fall, popcorn to full bloom, popcorn, postharvest					plum, and prune. The application rate for these uses is provided as follows "Apply full coverage spray to the point of runoff to thoroughly cover tree canopy including undersides of leaves." - 00 day(s) preharvest interval.
ONION: air/chemigation/ground foliar, in storage, seed crop, when needed	2.2	NS [15]	NS [7[1]]	7	- If 7 applications at 2.2 lb a.i./acre were made, it would result in 0.4 lb a.i./acre over the 15.0 lb a.i./acre annual maximum application rate. - Some labels (829-287, 6222-154, 100-1221) do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications. - 7 day(s) preharvest interval.
ONIONS (GREEN): air/chemigation/ground foliar, when needed	2.3	6.8	3	7	- Do not make more than 3 applications per crop cycle. - 14 day(s) minimum preharvest interval.
ORNAMENTALS (LAWNS, TURF, SOD FARMS) : air/ground	11.4	NS [27.0]	NS [2[1]]	7	- If 2 applications at 11.4 lb a.i./acre were made, an additional application of 4.2 lb a.i./acre could be made to reach the 27.0 lb a.i./acre annual maximum application rate. - Some labels (100-1231, 34704-878, and 432-1486 to list a few examples) do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications. - Aerial application permitted on 66222-154

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
GOLF COURSE: Ground **Greens**	11.4	73.0	7	7-14	- Several labels do not specifically a yearly/seasonal application rate maximum or the number of yearly/seasonal applications (100-1231, 34704-878, 432-1486 are just a few examples). - Retreatment intervals depends on application rate: 11.4 lb a.i./a =14 day <11.4 a.i./a =7 day - If 6 11.4 lb a.i./a applications are made to greens a 7th application can be made at 4.6 lb a.i./a - If 4 11.4 lb a.i./a applications are made to tees a 5th application can be made at 6.4 lb a.i./A. - If 2 11.4 lb a.i./a applications are made to fairways a 5th application can be made at 3.2 lb a.i./A. - If 6 applications at 11.4 lb a.i./acre were made, an additional application of 4.6 lb a.i./acre could be made in that year to reach the 73 lb a.i./acre
Tees	11.4	52.0	5		
Fairways	11.4	26	3		
ORNAMENTALS (PLANTS AND TREES): air/chemigation/ground	NS [1.5]	NS [36.36]	NS [24[1]]	NS [7]	- The application information is from 228-639; not all of the labels for this use specify a max single or annual application rate or provide a minimum application interval. - If 24 applications at 1.5 lb a.i./acre were made, an additional application of 0.36 lb a.i./acre could be made in that year to reach the 36.36 lb a.i./acre annual maximum application rate. - Some labels (34704-878 and 432-961 to list a couple examples) do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.
Other					
PAPAYA: ground foliar	2.3	6.8	3	14	- 00 day(s) minimum preharvest interval. - 60063-16 does not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.
PARSNIP: air/chemigation/ground foliar	1.6	6.0	4	7	- 10 day(s) preharvest interval. - 60063-16 does not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
PASSION FRUIT (GRANADILLA): ground bloom through foliar, bloom, foliar	1.7	7.5	NS [5[1]]	14	- If 4 applications at 1.7 lb a.i./acre were made, an additional application of 0.8 lb a.i./acre could be made in that year to reach the 7.5 lb a.i./acre annual maximum application rate. - 7 day(s) preharvest interval except 50534-8 which allows a 00 day(s) preharvest interval
PEACH: air/chemigation/ground before bud break, bloom, dormant, established plantings, foliar, Late fall, delayed dormant, petal fall through foliar, petal fall, pink through petal fall, popcorn to full bloom, popcorn, postharvest	3.1	15.5	NS [5[1]]	10	- For ECHO® RTU (EPA Reg. No. 60063-30) the label does not specify a single max or annual max application rate for the following use sites: Peach, nectarine, apricot, cherry, plum, and prune. The application rate for these uses is provided as follows "Apply full coverage spray to the point of runoff to thoroughly cover tree canopy including undersides of leaves." - 00 day(s) preharvest interval.
PEAS, DRIED-TYPE: air/chemigation/ground early boom	1.5	6.0	NS [4]	7	- 14 day(s) preharvest interval.
PISTACHIO: air/ground bloom	4.5	22.5	NS [5[1]]	28	- 14 day(s) preharvest interval.
PLUM: air/ground hull split, bloom, dormant, established plantings, Foliar, pink through petal fall, popcorn to full bloom, popcorn, petal fall, postharvest, bud break	3.1[3]	15.5[3]	NS [5[1]]	10	- 00 day(s) preharvest interval.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
POTATO, WHITE/IRISH: air/chemigation/ground at vine formation, foliar, when needed	1.4	NS [11.3] NS [6.7 (in FL)]; 15.9 (in ME, MN); 16.1 (in ND, NE, WI)]	NS	5	- The max annual application rate and max number of applications are not provided on all of the labels for this use. - 0 day(s) preharvest interval (5905-472).
PRUNE: air/ground bloom, delayed dormant, dormant, established plantings, foliar, pink through petal fall, popcorn to full bloom, popcorn	3.1	15.5	NS [5[1]]	10	- For ECHO® RTU (EPA Reg. No. 60063-30) the label does not specify a single max or annual max application rate for the following use sites: Peach, nectarine, apricot, cherry, plum, and prune. The application rate for these uses is provided as follows "Apply full coverage spray to the point of runoff to thoroughly cover tree canopy including undersides of leaves." - 00 day(s) preharvest interval.
PUMPKIN: air/chemigation/ground foliar, when needed	2.5	15.75	NS [7[1]]	7	- 0 day(s) minimum preharvest interval. Several labels do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.
RECREATION AREA LAWNS: chemigation/ground foliar, late fall, fall spring	11.4	NS [27]	NS	14	- Several labels (100-1221, 60063-30) do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications. - 00 day(s) preharvest interval.
RHUBARB: air/chemigation/ground foliar	2.3	NS [13.5]	NS	7	- 30 day(s) preharvest interval. - Several labels do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.
ROSE: ground foliar	1.1	NS [36]	NS [36]	7	- Preharvest interval not specified on label
SHALLOT: air/chemigation/ground foliar, when needed	2.2	6.7	NS [3[1]]	7	- Do not make more than 3 applications per crop cycle. - 7 day(s) minimum preharvest interval. - Some labels (100-1221 and 60063-16 to list a couple) do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.

Use: Method Timing (For Any Registration Number)	LIMITATIONS				
	Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
SQUASH (ALL OR UNSPECIFIED): air/chemigation/ground foliar, when needed	2.5	15.75	NS [7[1]]	7	- 0 day(s) minimum preharvest interval. Several labels do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.
STONE FRUITS: air/ground at bud break, hull split, pink through petal fall, popcorn	3.2	NS [15.5]	NS [5[1]]	10	- If 5 applications at 3.2 lb a.i./acre were made, an additional application of 3lb a.i./acre could be made in that year to reach the 15.5 lb a.i./acre annual maximum application rate. - 00 day(s) preharvest interval.
STRAWBERRY: air/chemigation/ground Nonbearing nursery stock, preplant, transplants	1.1	15	NS [14[1]]	NS [10]	- If 14 applications at 1.1 lb a.i./acre were made, it would result in 0.4 lb a.i./acre over the 15.0 lb a.i./acre annual maximum application rate. - 00 day(s) preharvest interval.
TOMATO: air/chemigation/ground foliar, fruiting, when needed	2.3	15.1	NS [6[1]]	7	- If 6 applications at 2.3 lb a.i./acre were made, an additional application of 1.3 lb a.i./acre could be made in that year to reach the 15.1 lb a.i./acre annual maximum application rate. - 0 day(s) minimum preharvest interval.
YAM: air/chemigation/ground foliar	0.94	NS [11.2]	NS [12[1]]		- If 12 applications at 0.9 lb a.i./acre were made, an additional application of 0.4 lb a.i./acre could be made in that year to reach the 11.2 lb a.i./acre annual maximum application rate. - 7 day(s) preharvest interval. - Some labels do not specify a yearly/seasonal application rate maximum or the number of yearly/seasonal applications.

* Table reflects current labels as of September, 2012.
The bracketed information represents the assumptions that will be made for risk assessment purposes in the absence of additional label information.
NS = 'not specified' on at least one of the labels for that use site.
Application rates may vary depending on if the label rates in lb a.i./a or if density mg/L were used to calculate single and yearly applications rates. This difference is not expected to change the risk assessment conclusions.

1. The maximum number of applications/year was calculated by dividing the maximum annual application rate by the single maximum application rate allowed on the label. If the single max application cannot be evenly divided into the max application rate, it is indicated this in the 'Comment' column. This implies that the use may not be modeled by simply multiplying the number of applications by the maximum single application rate.
2. A 3-day reapplication interval is assumed based on the shortest retreatment interval allowed on any label for any chlorothalonil use (i.e., celery).

Use: Method Timing (For Any Registration Number)	LIMITATIONS Maximum Single Application Rate (lb a.i./acre)	Maximum Application Rate (lb a.i./acre) Per Crop Cycle	Maximum Number of Applications Per Crop Cycle	Minimum Retreatment Interval (days)	Comments
3. Since this is a seed treatment use only one application is assumed per season; however, since onions specifically green onions can be planted up to three times per year in some locations the number of applications per year is assumed to be three.[11] This assumes that the label that specifies "onion" does not also include onion (green onion) limitations.					

[11] Kaul, M. Maximum Number of Crop Cycles Per Year in California for Chlorothalonil Use Sites. Date February 28, 2001.

Of all of the registered uses of chlorothalonil (excluding non-CA Special Local Needs [SLN] registrations), the following uses are excluded from our assessment because they are not registered for use in or applicable to CA:

- Banana (geographic restriction listed on the label: only allowed in Puerto Rico; not commercially grown in California)
- Cranberry (crop not grown in California)
- Garbanzos including chick peas (geographic restriction listed on the label: only allowed in Oregon, Washington)
- Lentils (not grown in California)
- Mint/peppermint/spearmint (geographic restriction listed on the label: only allowed in Indiana, Michigan, North Dakota, Oregon, and Wisconsin)
- Persimmon (geographic restriction listed on the label: only allowed in Florida and Hawaii)
- Plantain (geographic restriction listed on the label: only allowed in Puerto Rico)
- Soybean (crop not grown in California)
- Sugar Beet (geographic restriction listed on the label: only allowed in Oregon)
- Mushrooms are grown indoors; other use scenarios are expected to result in higher environmental exposure.
- Ginseng is only grown in northern areas of California (*i.e.*, Humboldt Co.); however, the likelihood of exposure is very low as most ginseng (>>90%) is grown in another state (i.e., MI). As such ginseng was not modeled for aquatic organisms as other use scenarios are expected to result in much higher exposure and development of a California specific ginseng scenario will not alter the risk assessment picture.

Most chlorothalonil product labels specify application rates on a per crop cycle basis (not on a per year basis). Since standard PRZM scenarios only consist of one crop per year, applications to only one crop per year were modeled. For uses where chlorothalonil is applied for multiple cropping cycles within a year (e.g. strawberry), the EECs presented in this assessment may underestimate the potential exposure.

The agricultural use of chlorothalonil is present in **Figure 2-2** for the 48 contiguous states. The map was prepared from data from the Agency's Biological and Economic Analysis Division (BEAD) that is based on private market surveys (proprietary source) of pesticide use in agriculture for 2006-2010 at the Crop Reporting District (CRD) level.[12] CRDs are boundaries created by USDA NASS which are aggregates of counties.[13] Pesticide usage is displayed as average pounds (for the years 2006-2010) per 1,000 acres of farmland in a CRD to normalize for the variation in farmland between CRDs. Farmland acreage was obtained from USDA.[14] The map is an illustration of a snapshot in time of chlorothalonil use for agricultural purposes and does not include non-agricultural uses.

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[12] Kaul, M. Chlorothalonil Usage Map by Crop Reporting District, October 26, 2011 (via email)
[13] USDA, 2006-2010. NASS Crop Reporting Districts. Online: http://www.ers.usda.gov/briefing/arms/resourceregions/resourceregions.htm#nass.
[14] USDA, 2007. Census of Agriculture. Online: http://www.agcensus.usda.gov/Publications/2007/index.asp.

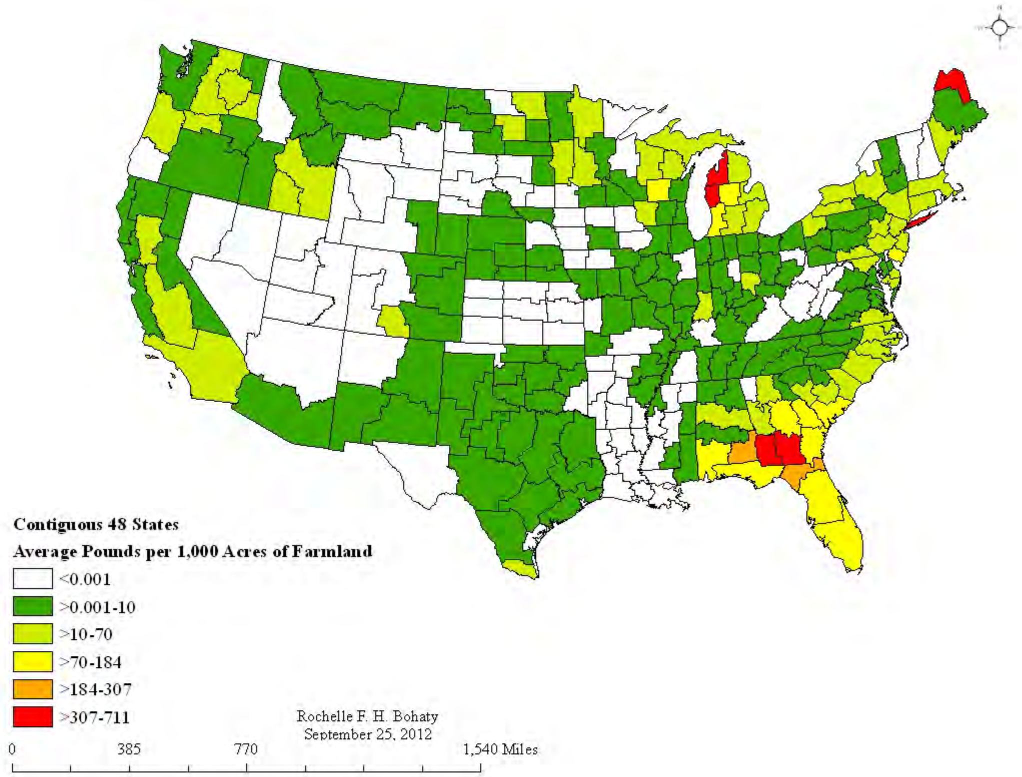

Figure 2-2. Agricultural Use Pattern Summary for Chlorothalonil for the Contiguous 48 States

BEAD also provided an analysis of both national- and county-level usage information (Kaul 2012) using state-level usage data obtained from USDA-NASS[15], 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[16]. 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 chlorothalonil by county in this California-specific assessment were generated using CDPR PUR data. Eleven years (1999-2010) of usage data were included in this analysis. Data from CDPR PUR were obtained for every agricultural pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system.[17] 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

[15] 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.

[16] 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.

[17] 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).

pounds applied, average annual area treated, and average and maximum application rate across all eleven years. The units of area treated are also provided where available.

It is important to note that the uses considered in this risk assessment represent all currently registered uses according to a review of all current labels. No other uses are relevant to this assessment. Any reported use, such as may be seen in the CDPR PUR database, represent either historic uses that have been canceled, misreported uses, or misuse. Historical uses, misreported uses, and misuse are not considered part of the federal action and, therefore, are not considered in this assessment.

CDPR PUR data for all chlorothalonil uses in California are presented in **Table 2-6**. All uses that were misuses, unknown uses, or uses that have been cancelled were not included in the table below. However, there are several other uses that appear to also not be registered uses (chicory, endive, fumigation, Gai choy, Gai lon, garbanzos, fruiting pepper, radish, rappini, rights of way, vertebrate control)

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

Site Name	Average Annual Pounds Applied	Maximum Annual Pounds Applied	Average Application Rate (lb a.i./unit area)	Maximum Application Rate (lb a.i./unit area)	Reported Unit Area Per Site
ALMOND	11	133	0.4	0.4	Misc. unit
ALMOND	64,537	217,300	2.9	48.2	Acres
APRICOT	3,248	9,929	2.6	18.1	Acres
BEAN, DRIED	1,134	6,167	1.4	3.0	Acres
BEAN, SUCCULENT	354	1,141	2.1	40.2	Acres
BEAN, UNSPECIFIED	129	265	1.8	11.7	Acres
BERMUDAGRASS	19	130	1.2	1.3	Acres
BOK CHOY	51	322	1.1	3.6	Acres
BOK CHOY	0	4	0.0	0.0	Square feet
BROCCOLI	7,051	11,663	1.1	50.2	Acres
BROCCOLI	28	129	0.0	0.0	Square feet
BRUSSELS SPROUT	5,574	8,359	1.4	11.3	Acres
CABBAGE	2,317	3,853	1.1	26.5	Acres
CABBAGE	0	1	0.0	0.0	Square feet
CANTALOUPE	332	732	1.5	3.0	Acres
CARROT	23,046	33,120	1.2	11.6	Acres
CARROT (FORAGE - FODDER)	16	195	1.6	1.6	Acres
CAULIFLOWER	2,212	4,694	1.1	11.6	Acres

Site Name	Average Annual Pounds Applied	Maximum Annual Pounds Applied	Average Application Rate (lb a.i./unit area)	Maximum Application Rate (lb a.i./unit area)	Reported Unit Area Per Site
CAULIFLOWER	0	1	0.0	0.0	Square feet
CELERY	46,248	60,988	1.8	113.3	Acres
CELERY	0	3	0.5	2.3	Square feet
CHERRY	777	1,695	2.8	32.1	Acres
CHINESE CABBAGE (NAPPA)	230	424	1.4	75.1	Acres
CHINESE GREENS	21	86	0.8	3.0	Acres
CHRISTMAS TREE	4	40	1.6	3.0	Acres
COLLARD	4	28	1.1	1.1	Acres
COMMODITY FUMIGATION	0	3			
CORN (FORAGE - FODDER)	14	77	0.3	1.9	Acres
CORN, HUMAN CONSUMPTION	154	1,161	1.3	2.3	Acres
CUCUMBER	2,283	18,293	1.6	10.7	Acres
CUCUMBER	0	0	0.0	0.0	Square feet
GARLIC	3,033	6,924	1.7	15.6	Acres
GRASS, SEED	0	3	1.4	1.4	Acres
KALE	4	20	2.0	2.3	Acres
LANDSCAPE MAINTENANCE	407	1,476	5.7	29.9	Acres
LANDSCAPE MAINTENANCE	77,863	134,982			
LANDSCAPE MAINTENANCE	36	126	0.0	0.0	Square feet
LEEK	955	5,413	3.4	150.7	Acres
LETTUCE, HEAD	9	37	1.5	3.1	Acres
LETTUCE, LEAF	23	179	2.2	6.0	Acres
MELON	402	1,457	1.4	6.8	Acres
MUSHROOM	32	174	0.0	0.0	Square feet
MUSTARD	1	16	2.2	2.2	Acres
N-GRNHS FLOWER	1	9			
N-GRNHS FLOWER	0	1	0.2	1.3	Misc. unit
N-GRNHS FLOWER	1,733	2,397	1.4	144.5	Acres
N-GRNHS FLOWER	91	153	0.0	0.0	Square feet
N-GRNHS PLANTS IN CONTAINERS	1	5	0.0	0.0	
N-GRNHS PLANTS IN CONTAINERS	848	1,338	3.0	112.4	Acres
N-GRNHS PLANTS IN CONTAINERS	7	35	0.1	6.7	Misc. unit
N-GRNHS PLANTS IN CONTAINERS	262	379	0.0	0.0	Square feet
N-GRNHS TRANSPLANTS	0	1	0.1	0.1	Tons

Site Name	Average Annual Pounds Applied	Maximum Annual Pounds Applied	Average Application Rate (lb a.i./unit area)	Maximum Application Rate (lb a.i./unit area)	Reported Unit Area Per Site
N-GRNHS TRANSPLANTS	4	21			
N-GRNHS TRANSPLANTS	1,144	2,968	1.3	75.2	Acres
N-GRNHS TRANSPLANTS	239	539	0.0	0.0	Square feet
N-OUTDR FLOWER	7	80			
N-OUTDR FLOWER	9,326	11,201	1.2	36.1	Acres
N-OUTDR FLOWER	172	893	0.0	0.0	Misc. unit
N-OUTDR FLOWER	225	1,665	0.0	0.0	Square feet
N-OUTDR PLANTS IN CONTAINERS	29	51	0.0	0.5	Misc. unit
N-OUTDR PLANTS IN CONTAINERS	177	422	0.0	0.0	Square feet
N-OUTDR PLANTS IN CONTAINERS	5,229	7,034	2.4	69.2	Acres
N-OUTDR TRANSPLANTS	652	1,021	0.0	0.0	Square feet
N-OUTDR TRANSPLANTS	3	30			
N-OUTDR TRANSPLANTS	9,101	11,121	1.0	74.9	Acres
N-OUTDR TRANSPLANTS	2,442	4,413	0.0	1.3	Misc. unit
NECTARINE	5,239	12,911	2.9	188.2	Acres
OAT	14	173	2.3	2.3	Acres
OAT (FORAGE - FODDER)	1	10	1.5	1.5	Acres
ONION, DRY	62,594	97,488	1.3	22.5	Acres
ONION, GREEN	1,115	3,227	1.5	2.5	Acres
PARSNIP	16	70	1.0	1.2	Acres
PEACH	1	7	0.0	0.1	Misc. unit
PEACH	7,310	14,000	2.8	124.8	Acres
PEAS	12	70	1.6	6.0	Acres
PISTACHIO	3,011	20,062	3.2	4.7	Acres
PLUM	3,719	7,855	2.9	141.3	Acres
POTATO	52,334	75,690	1.1	18.0	Acres
PRUNE	14,861	38,357	2.9	32.6	Acres
PUMPKIN	669	2,792	1.7	9.6	Acres
PUMPKIN	0	0	0.0	0.0	Square feet
SHALLOT	23	177	1.5	1.5	Acres
SOIL FUMIGATION/PREPLANT	214	955	1.4	2.3	Acres
SPINACH	17	68	1.0	1.5	Acres
SQUASH	293	1,079	1.6	6.0	Acres
SQUASH	1	8	0.3	1.5	Square feet

Site Name	Average Annual Pounds Applied	Maximum Annual Pounds Applied	Average Application Rate (lb a.i./unit area)	Maximum Application Rate (lb a.i./unit area)	Reported Unit Area Per Site
SQUASH, SUMMER	39	75	1.1	2.2	Acres
SQUASH, WINTER	48	279	1.5	2.3	Acres
SQUASH, ZUCCHINI	17	188	1.8	3.0	Acres
STONE FRUIT	1	3	1.5	3.0	Acres
STRAWBERRY	1,000	2,726	0.9	3.7	Acres
STRUCTURAL PEST CONTROL	244	642			
SUNFLOWER	3	37	3.7	3.7	Acres
SWEET POTATO	3	36	4.5	4.5	Acres
SWISS CHARD	0	3	1.0	1.1	Acres
TOMATO	59,252	79,228	1.6	18.1	Acres
TOMATO	0	1	0.0	0.0	Misc. unit
TOMATO	13	70	0.0	0.0	Square feet
TOMATO, PROCESSING	197,998	267,087	1.8	34.0	Acres
TOMATO, PROCESSING	152	1,788	0.2	2.3	Square feet
TURF/SOD	4,826	11,839	6.2	66.7	Acres
TURF/SOD	2	21	0.0	0.0	Cubic feet
TURF/SOD	36	253	0.0	0.0	Misc. unit
TURF/SOD	95	336	0.0	0.0	Square feet
TURNIP	1	11	2.2	2.2	Acres
UNCULTIVATED AG	50	259	1.3	2.1	Acres
UNCULTIVATED AG	16	193	1.5	1.5	Square feet
UNCULTIVATED NON-AG	1	11	0.3	0.9	Acres
UNKNOWN	94	598	6.5	33.0	Acres
UNKNOWN	1	6	0.0	0.0	Square feet
VEGETABLE	0	1	0.3	0.3	Acres
VERTEBRATE CONTROL	9	86	1.6	9.4	Acres
VERTEBRATE CONTROL	83	488			
WALNUT	2	9	2.6	2.7	Acres
WATER AREA	0	0			Acres
WATERMELON	1,389	10,809	3.2	97.3	Acres
WHEAT	19	124	1.3	1.4	Acres
WHEAT (FORAGE - FODDER)	2	27	1.3	1.3	Acres
1- Based on data supplied by BEAD (February 23, 2012).					

2.7. Assessed Species

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

- **Bay Checkerspot Butterfly (BCB):** 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.
- **California Tiger Salamander (CTS):** 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.
- **Delta Smelt (DS):** The DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007a). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater.
- **CA Clapper Rail (CCR):** 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.
- **California Freshwater Shrimp (CFWS):** 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.
- **San Francisco Garter Snake (SFGS):** 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.
- **Tidewater Goby (TG):** 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.

Table 2-7. Summary of Current Distribution, Habitat Requirements, and Life History Information for the Assessed Listed Species[1]

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
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
California Tiger Salamander (CTS) (*Ambystoma californiense*)	Adult 14.2-80.5 g[4]	CTS-SC is 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	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	<u>Emerge from burrows and breed:</u> fall and winter rains <u>Eggs:</u> laid in pond Dec. – Feb., hatch: after 10 to 14 days <u>Larval stage</u>: 3-6 months, until the ponds dry out, metamorphose late spring or early summer, migrate to small mammal burrows	<u>Aquatic Phase:</u> algae, snails, zooplankton, small crustaceans, and aquatic larvae and invertebrates, smaller tadpoles of Pacific tree frogs, CRLF, toads; <u>Terrestrial Phase:</u> terrestrial invertebrates, insects, frogs, and worms

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
		Fresno, and northern Tulare and Kings Counties), and the Central Coast Range (southern Santa Cruz, Monterey, northern San Luis Obispo, and portions of western San Benito, Fresno, and Kern Counties). CTS-SB is found in Santa Barbara County.				
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 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
California Freshwater Shrimp	Up to 50 mm	Marin, Napa, and Sonoma Counties, CA	Freshwater, perennial streams; they prefer	No	Breed once a year, typically in Sept. Eggs	Feed on detritus (algae, aquatic macrophyte

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
(CFWS) (*Syncaris pacifica*)	postorbital length (from the eye orbit to tip of tail)		quiet portions of tree-lined streams with underwater vegetation and exposed tree roots		adhere to the pleopods and are cared for 8 – 9 months; embryos emerge during May or early June.	fragments, zooplankton, and aufwuchs)
San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*)	Adult (46-131 cm in length), Females – 227 g, Males – 113 g; Juveniles – 2 g (Cover Jr. and Boyer, 1988) (18–20 cm in length)	San Mateo County	Densely vegetated freshwater ponds near open grassy hillsides; emergent vegetation; rodent burrows	No	<u>Oviparous Reproduction</u>[2] <u>Breeding</u>: Spring (Mar. and Apr.) and Fall (Sept. to Nov.) <u>Ovulation and Pregnancy</u>: Late spring and early summer <u>Young</u>: Born 3-4 months after mating	<u>Juveniles</u>: frogs (Pacific tree frog, CRLF, and bullfrogs depending on size) and insects <u>Adults</u>: primarily frogs (mainly CRLFs; also bullfrogs, toads); to a lesser extent newts; freshwater fish and invertebrates; insects and small mammals
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.

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).

Bay Checkerspot Butterfly Habitat

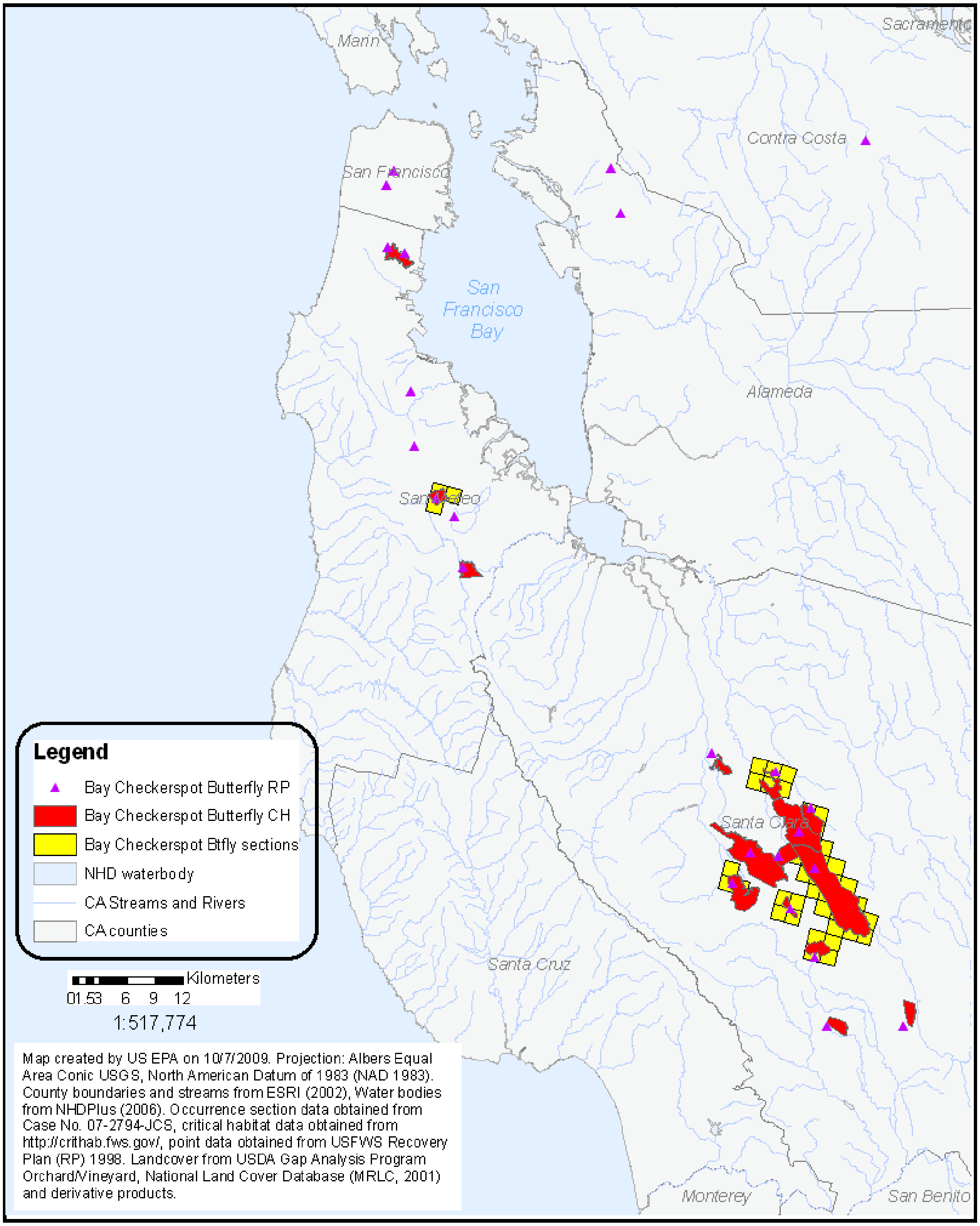

Figure 2-3. Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

California Tiger Salamander Habitat

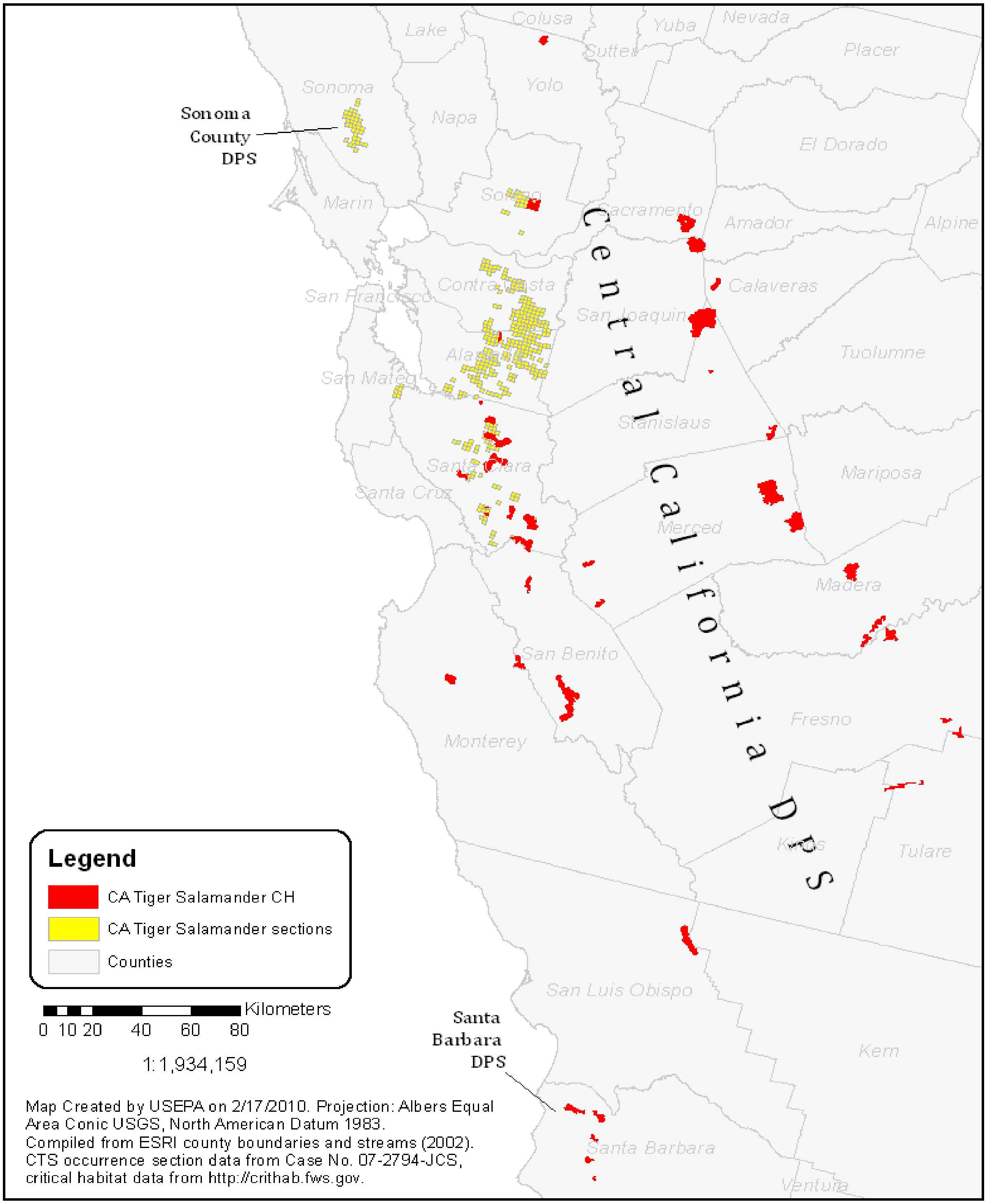

Figure 2-4. California Tiger Salamander (CTS) (*Ambystoma californiense*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

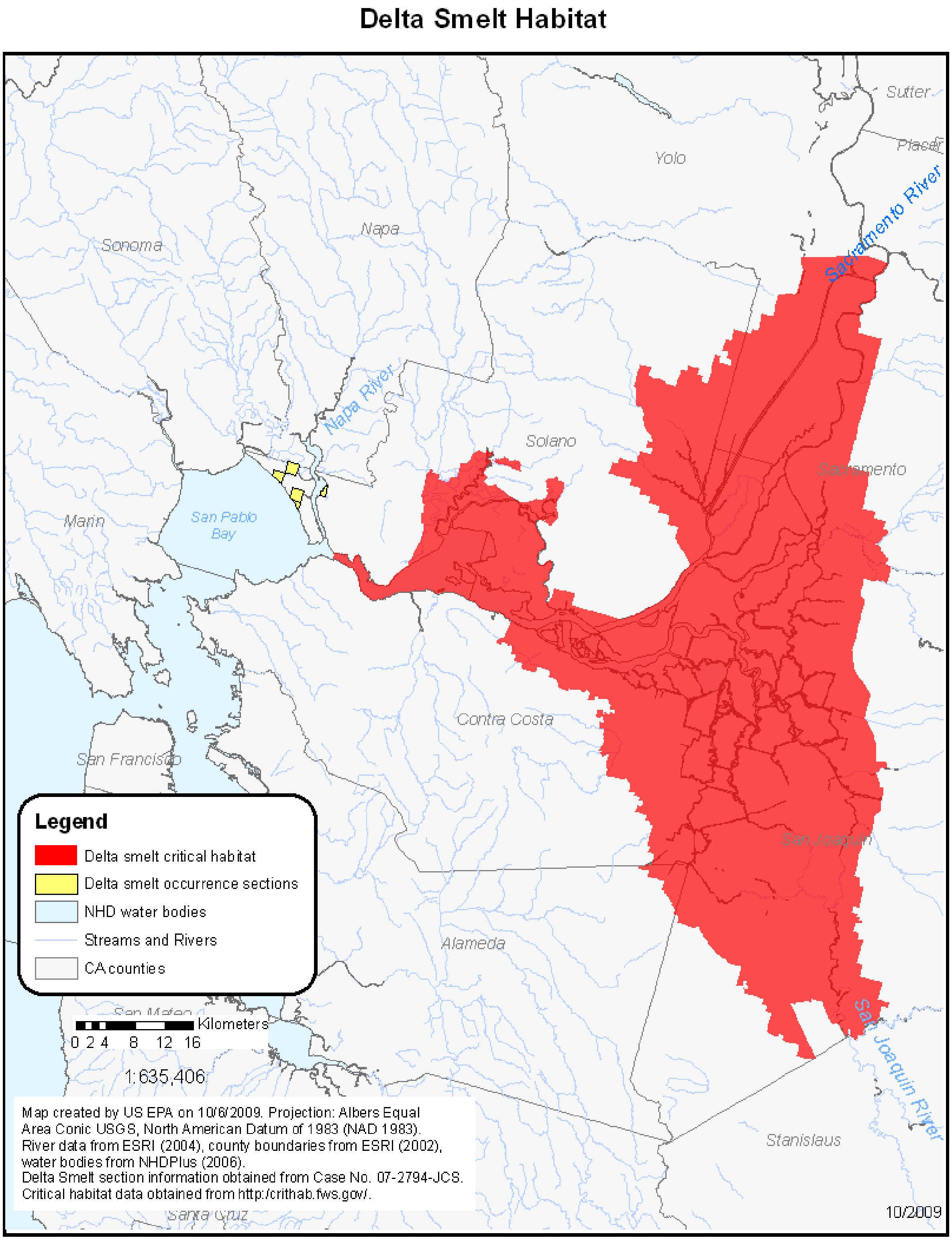

Figure 2-5. Delta Smelt (DS) (*Hypomesus transpacificus*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

California Clapper Rail Habitat

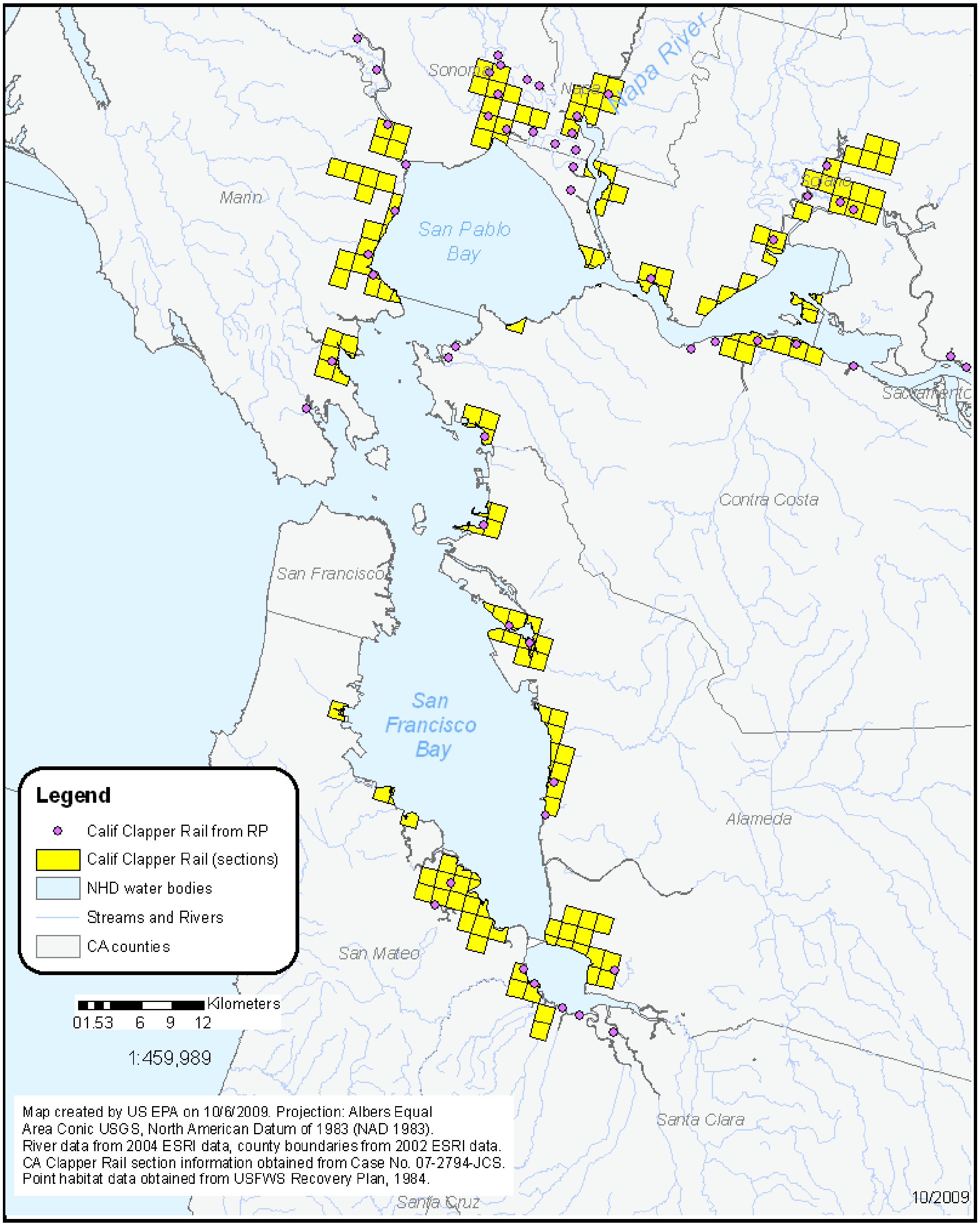

Figure 2-6. California Clapper Rail (CCR) (*Rallus longirostris obsoletus)* Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

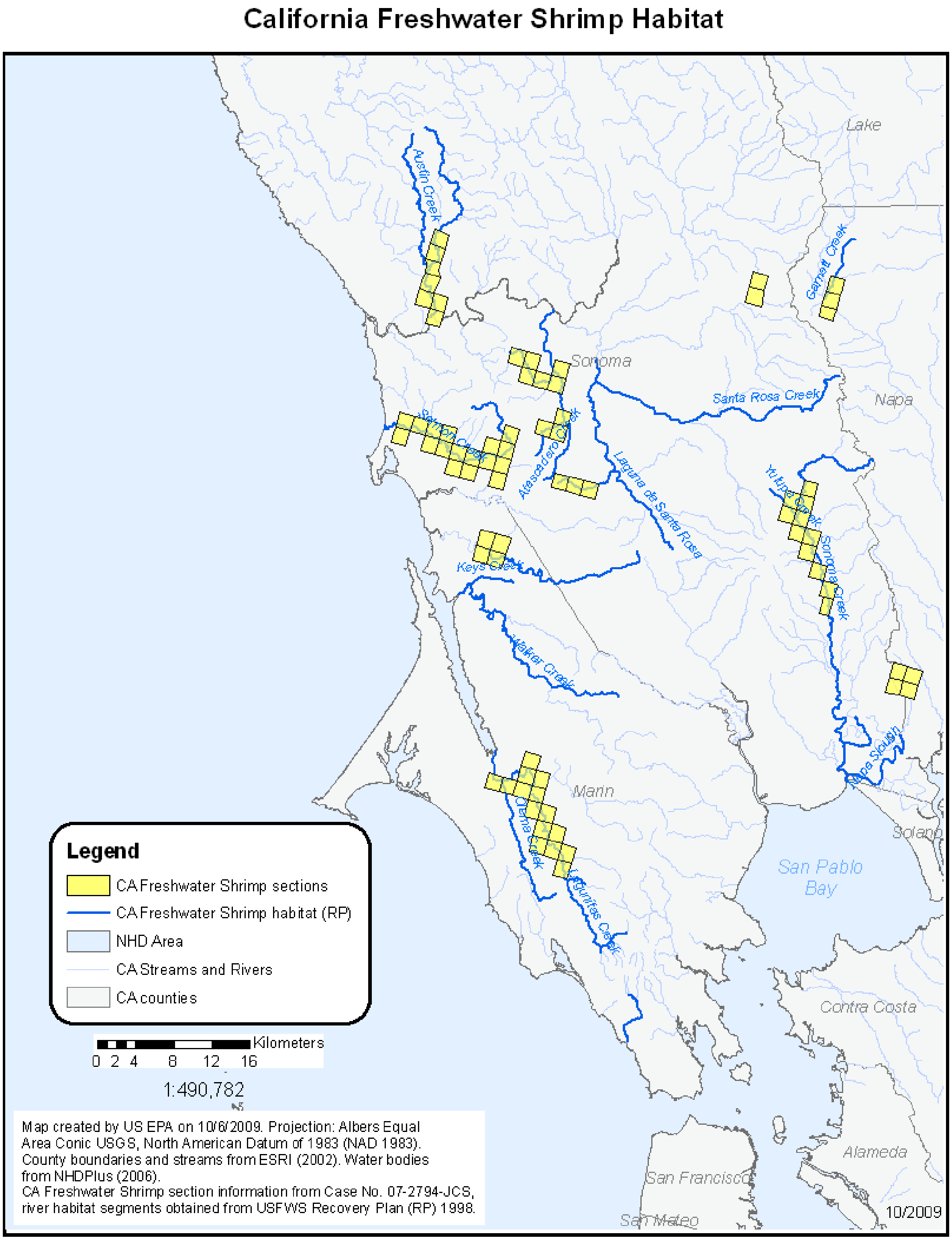

Figure 2-7. California Freshwater Shrimp (CFWS) (*Syncaris pacifica*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

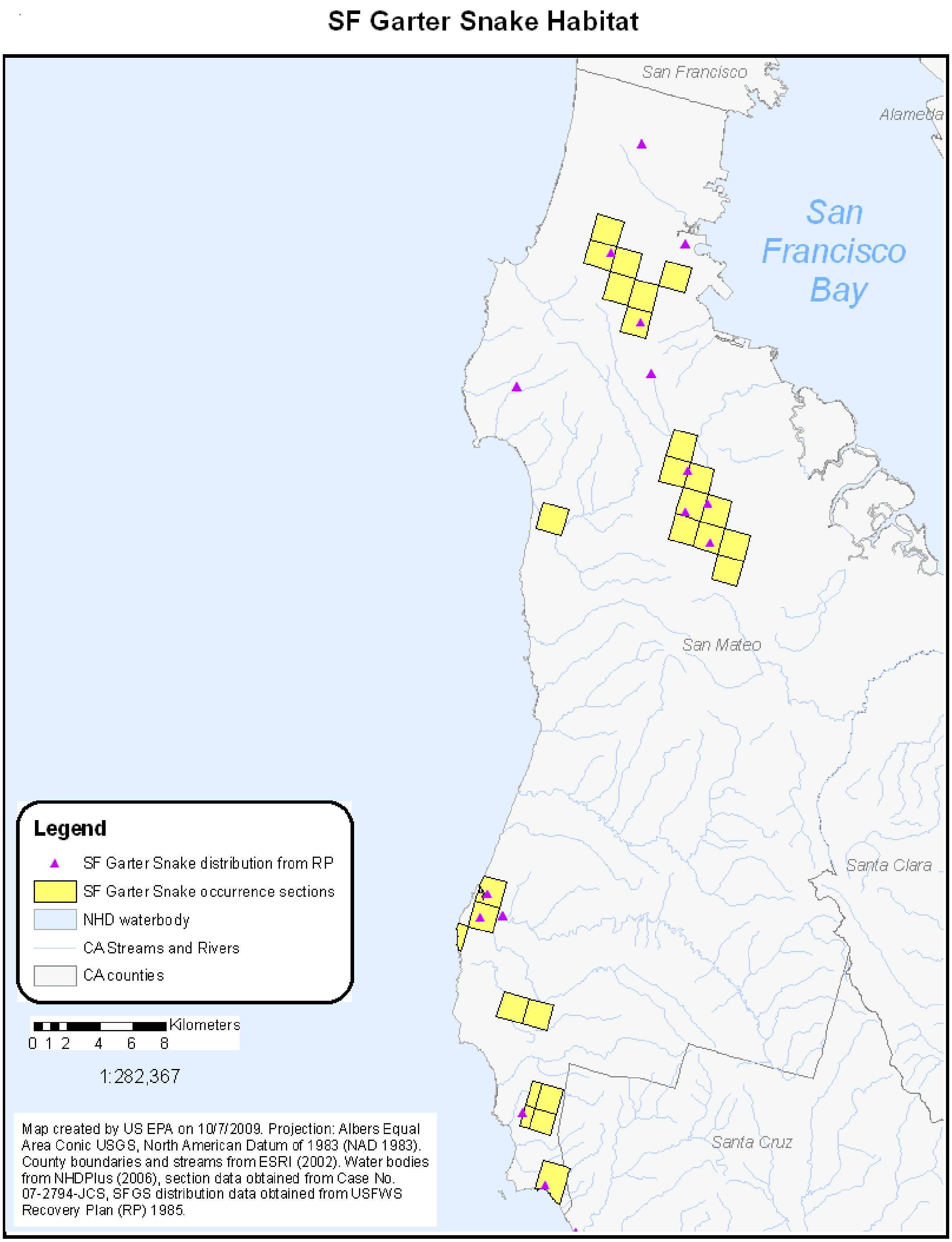

Figure 2-8. San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

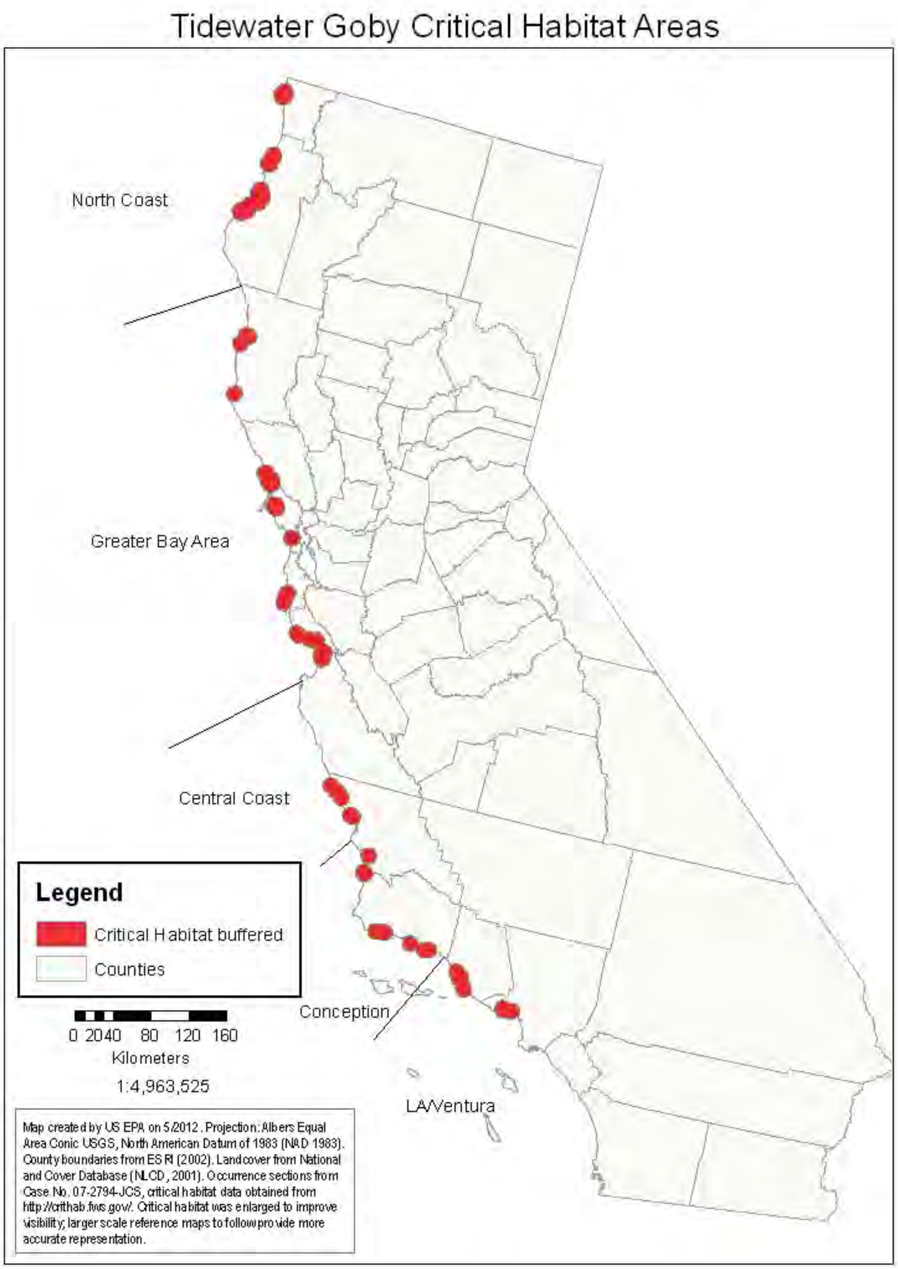

Figure 2-9. Tidewater Goby (TG) (*Eucyclogobius newberryi*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS. The critical habitat and sections were too small to portray at the state scale; as a result a buffer of approximately 10km was applied to the original habitat polygons. As a result, the map is not representative of the exact critical habitat area. Additional maps of the TG habitats and use footprint overlays are magnified to enable better visualization; these maps are available in Appendix M.

2.8. Designated Critical Habitat

Critical habitat has been designated for the BCB, CTS-CC DPS, DS, CTS-SB DPS, and TG. Risk to critical habitat is evaluated separately from risk to effects on the species. 'Critical habitat' is defined in the ESA as the geographic area occupied by the species at the time of the listing where the physical and biological features necessary for the conservation of the species exist, and there is a need for special management to protect the listed species. It may also include areas outside the occupied area at the time of listing if such areas are 'essential to the conservation of the species. Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas that provide essential life cycle needs of the species or areas that contain certain primary constituent elements (PCEs) (as defined in 50 CFR 414.12(b)). **Table 2-8** describes the PCEs for the critical habitats designated for the BCB, CTS-CC DPS, DS, CTS-SB DPS, and TG.

Table 2-8. Designated Critical Habitat PCEs for the BCB, CTS-CC DPS, DS, CTS-SB DPS, and TG Species[1]

Species	PCEs	Reference
California tiger salamander	Standing bodies of fresh water, including natural and man-made (*e.g.*, stock) ponds, vernal pools, and dune ponds, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a sufficient length of time (*i.e.*, 12 weeks) necessary for the species to complete the aquatic (egg and larval) portion of its life cycle[2]	FR Vol. 69 No. 226 CTS, 68584, 2004
	Barrier-free uplands adjacent to breeding ponds that contain small mammal burrows. Small mammals are essential in creating the underground habitat that juvenile and adult California tiger salamanders depend upon for food, shelter, and protection from the elements and predation	
	Upland areas between breeding locations (PCE 1) and areas with small mammal burrows (PCE 2) that allow for dispersal among such sites	
Bay Checkerspot Butterfly	The presence of annual or perennial grasslands with little to no overstory that provide north/south and east/west slopes with a tilt of more than 7 degrees for larval host plant survival during periods of atypical weather (*e.g.*, drought).	66 FR 21449 21489, 2001
	The presence of the primary larval host plant, dwarf plantain (*Plantago erecta*) (a dicot) and at least one of the secondary host plants, purple owl's-clover or exserted paintbrush, are required for reproduction, feeding, and larval development.	
	The presence of adult nectar sources for feeding.	
	Aquatic features such as wetlands, springs, seeps, streams, lakes, and ponds and their associated banks, that provide moisture during periods of spring drought; these features can be ephemeral, seasonal, or permanent.	
	Soils derived from serpentinite ultramafic rock (Montara, Climara, Henneke, Hentine, and Obispo soil series) or similar soils (Inks, Candlestick, Los Gatos, Fagan, and Barnabe soil series) that provide areas with fewer aggressive, nonnative plant species for larval host plant and adult nectar plant survival and reproduction.[2]	
	The presence of stable holes and cracks in the soil, and surface rock outcrops that provide shelter for the larval stage of the bay checkerspot butterfly during summer diapause.[2]	
Tidewater Goby	Persistent, shallow (in the range of about 0.1-2 m), still-to-slow-moving, aquatic habitat most commonly ranging in salinity from less than 0.5 ppt to about 10-12 ppt, which provides adequate space for normal behavior and individual and population growth	65 FR 69693 69717, 2000
	Substrates (*e.g.*, sand, silt, mud) suitable for the construction of	

Species	PCEs	Reference
	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 chlorothalonil that may alter the PCEs of the designated critical habitat for BCB, CTS-CC DPS, DS, CTS-SB DPS, and TG form the basis of the critical habitat impact analysis.

As previously noted in Section 2.1, the Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Because chlorothalonil is expected to directly impact living organisms within the action area, critical habitat analysis for chlorothalonil 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.

2.9. Action Area and LAA Effects Determination Area

2.9.1. 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 chlorothalonil 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, CTS, DS, CCR, CFWS, SFGS, and TG and their designated critical habitat within the state of California. For this assessment, the entire state of California is considered the action area. The purpose of defining the action area as the entire state of California is to ensure that the initial area of consideration encompasses all areas where the pesticide may be used now and in the future, including the potential for off-site transport via spray drift and downstream dilution that could influence the San Francisco Bay Species. Additionally, the concept of a state-wide action area takes into account the potential for direct and indirect effects and any potential modification to critical habitat based on ecological effect measures associated with reduction in survival, growth, and reproduction, as well as the full suite of sublethal effects available in the effects literature.

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

2.9.2. 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 chlorothalonil. An analysis of labeled uses and review of available product labels was completed. Labeled uses that are special local needs (SLN) uses not specified for use in California or are restricted to specific states and were 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 chlorothalonil, there is a multitude of agricultural, orchard, and non-agricultural uses that are considered as part of the federal action evaluated in this assessment. For a summary of uses, please see **Table 2-5**.

Following a determination of the assessed uses, an evaluation of the potential "footprint" of chlorothalonil 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 chlorothalonil, these land cover types include cultivated crops; developed high, low, medium intensity; developed open space; forest; open water; orchards; pasture/hay; and wetlands. Since there are a large number of uses covering a high number of land cover types, in this case, an initial area of concern map was not developed. Since the chemical may be used over a wide area, an initial area of concern map may under represent potential use.

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 2.01) 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 chlorothalonil uses the most sensitive endpoint for aquatic exposure, and terrestrial exposure. The terrestrial exposure spray drift analysis was further broken down into invertebrates versus vertebrates. The most sensitive endpoints for spray drift were: 3.6 μg a.i./L (acute invertebrate, aquatic assessment), 0.6 μg a.i./L (chronic invertebrate, aquatic assessment), 4640 mg/kg-bw (acute vertebrate, terrestrial assessment, toxicity value is non-definitive and expected to be conservative), 153 mg/kg-bw (chronic vertebrate, terrestrial assessment, toxicity value is non-definitive and may be conservative), 181μg a.i./bee (acute invertebrate, terrestrial assessment). Further details on the spray drift analysis are provided in **Section 5.2.11.a**.

In addition to the buffered area from the spray drift analysis, the Potential Area of LAA Effects area also considers the downstream extent of chlorothalonil that exceeds the LOC based on downstream dilution analysis (discussed in Section 5.2.11.b).

An evaluation of usage information was conducted to determine the area where use of chlorothalonil may impact the assessed species. This analysis is used to characterize where predicted exposures are most likely to occur, but does not preclude use in other portions of the action area. A more detailed review of the county-level use information was also completed. These data suggest that chlorothalonil has historically been used on a wide variety of agricultural and non-agricultural uses.

2.10. Assessment Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected."[18] Selection of the assessment endpoints is based on valued entities (*e.g.*, CTS, organisms important in the life cycle of the CTS, and the PCEs of its designated critical habitat), the ecosystems potentially at risk (*e.g*,. water bodies, riparian vegetation, and upland and dispersal habitats), the migration pathways of chlorothalonil (*e.g.*, runoff, spray drift, *etc*.), and the routes by which ecological receptors are exposed to chlorothalonil-related contamination (*e.g.*, direct contact, *etc*.).

2.10.1. 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 chlorothalonil 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 2-9. Taxa Used in the Analyses of Direct and Indirect Effects for the Assessed Listed Species

Listed Species	Birds	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Estuarine /Marine Fish	Estuarine/Marine Inverts.	Aquatic Plants
San Francisco garter snake**	Direct/ Indirect (prey) Acute: Mallard duck Chronic: Bobwhite quail	Indirect (prey/ habitat) Acute/ Chronic: Lab rat	Indirect (habitat) Onion/ cucumber	Indirect (prey) Acute only: Honey bee	Indirect (prey) Acute: Rainbow trout Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	n/a	n/a	Indirect (habitat) Duckweed; freshwater diatom
California clapper rail**	Direct/ Indirect (prey) Acute: Mallard duck Chronic: Bobwhite quail	Indirect (prey/ habitat) Acute/ Chronic: Lab rat	Indirect (habitat) Onion/ cucumber	Indirect (prey) Acute only: Honey bee	Indirect (prey) Acute: Rainbow trout Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	Indirect (prey) Acute/ Chronic: Sheepshead minnow	Indirect (prey) Acute: Oyster Chronic: penaeid shrimp	Indirect (habitat) Duckweed; freshwater diatom
Bay checkerspot butterfly	n/a	n/a	Indirect (food/ habitat)* Onion/ cucumber	Direct Acute only: Honey bee	n/a	n/a	n/a	n/a	n/a

[18] From U.S. EPA (1992). *Framework for Ecological Risk Assessment.* EPA/630/R-92/001.

Listed Species	Birds	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Estuarine /Marine Fish	Estuarine/Marine Inverts.	Aquatic Plants
California tiger salamander	Direct/ Indirect (prey) Acute: Mallard duck Chronic: Bobwhite quail	Indirect (prey/ habitat) Acute/ Chronic: Lab rat	Indirect (food/ habitat) Onion/ cucumber	Indirect (prey) Acute only: Honey bee	Direct/ Indirect (prey) Acute: Rainbow trout Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	n/a	n/a	Indirect (habitat) Duckweed; freshwater diatom
Tidewater goby	n/a	n/a	Indirect (food/ habitat) Onion/ cucumber	n/a	Direct*** Acute: Rainbow trout Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	Direct*** Acute/ Chronic: Sheepshead minnow	Indirect (prey) Acute: Oyster Chronic: penaeid shrimp	Indirect (habitat) Duckweed; freshwater diatom
Delta smelt	n/a	n/a	Indirect (food/ habitat) Onion/ cucumber	n/a	Direct*** Acute: Rainbow trout Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	Direct*** Acute/ Chronic: Sheepshead minnow	Indirect (prey) Acute: Oyster Chronic: penaeid shrimp	Indirect (habitat) Duckweed; freshwater diatom
California freshwater shrimp	n/a	n/a	Indirect (habitat) Onion/ cucumber	n/a	n/a	Direct/ Indirect (prey) Acute/ Chronic: Waterflea	n/a	n/a	Indirect (habitat) Duckweed; freshwater diatom

Abbreviations: n/a = Not applicable; Terr. = Terrestrial; Invert. = Invertebrate; FW = Freshwater
* obligate relationship
** Consumption of residues of chlorothalonil 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 2-10. Taxa and Assessment Endpoints Used to Evaluate the Potential for Use of Chlorothalonil 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. Most sensitive fish acute 96-hr LC_{50} 1b. Most sensitive fish chronic NOAEC
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail	Survival, growth, and reproduction of individuals or modification of critical	

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
	-CA Tiger Salamander	habitat/habitat (CTS-SB DPS) 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. Most sensitive freshwater invertebrate 48-hr EC_{50} 2b. Most sensitive freshwater invertebrate chronic NOAEC
	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 (CTS-SB DPS, TG, and DS) 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	1a. Most sensitive estuarine/marine fish 96-hr LC50 1b. A Chronic estuarine/marine fish data not available
	Indirect Effect (prey) -CA 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 (TG and DS) via indirect effects on aquatic prey food supply (*i.e.*, estuarine/marine invertebrates)	4a. Most sensitive estuarine/marine invertebrate 96-hr LC_{50} 4b. Acceptable estuarine/marine invertebrate chronic data not available.
5. Aquatic Plants (freshwater/marine)	Indirect Effect (food/habitat) -SF Garter Snake (fw) -CA Clapper Rail (fw) -CA Tiger Salamander (fw) -Tidewater Goby (fw/em) -Delta Smelt (fw/em) -CA FW Shrimp (fw)	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS, TG, DS) via indirect effects on habitat, cover, food supply, and/or primary productivity (*i.e.*, aquatic plant community)	5a. Vascular plant acute EC_{50} 5b. Non-vascular plant acute EC_{50}
6. Birds	Direct Effect -SF Garter Snake -CA Clapper Rail	Survival, growth, and reproduction of individuals via direct effects	6a. Most sensitive bird** or terrestrial-phase amphibian acute LC_{50} or LD_{50} 6b. Most sensitive bird** or terrestrial-

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
	-CA Tiger Salamander		phase amphibian chronic NOAEC
	Indirect Effect (prey/rearing sites) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS) via indirect effects on terrestrial prey (birds)	
7. Mammals	Direct Effect None.	Survival, growth, and reproduction of individuals via direct effects	7a. Most sensitive laboratory mammalian acute LC_{50} or LD_{50} 7b. Most sensitive laboratory mammalian chronic NOAEL
	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 (CTS-SB DPS) via indirect effects on terrestrial prey (mammals) and/or burrows/rearing sites	
8. Terrestrial Invertebrates	Direct Effect -Bay Checkerspot Butterfly	Survival, growth, and reproduction of individuals via direct effects	8a. Most sensitive terrestrial invertebrate acute contact LD_{50} 8b. Most sensitive terrestrial invertebrate chronic NOAEC not available
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS) via indirect effects on terrestrial prey (terrestrial invertebrates)	
9. Terrestrial Plants	Indirect Effect (food/habitat) (non-obligate relationship) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander -Tidewater Goby -Delta Smelt -CA Freshwater Shrimp	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS, TG, DS, BCB,) via indirect effects on food and habitat (*i.e.,* riparian and upland vegetation)	9a. Most sensitive for monocots seedling emergence EC_{25} and the no effect concentration 9b. Most sensitive for dicots vegetative vigor EC_{25} and the no effect concentration
	Indirect Effect (food/habitat) (obligate relationship) -Bay Checkerspot Butterfly		

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.

2.10.2. Assessment Endpoints for Designated Critical Habitat

As previously discussed, designated critical habitat is assessed to evaluate actions related to the use of chlorothalonil that may alter the PCEs of the assessed species' designated critical habitat. PCEs for the assessed species were previously described in Section 2.8. 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 chlorothalonil 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.

2.11. Conceptual Model

2.11.1. 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 chlorothalonil to the environment. The following risk hypotheses are presumed in this assessment:

The labeled use of chlorothalonil within the action area may:

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

2.11.2. Diagram

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

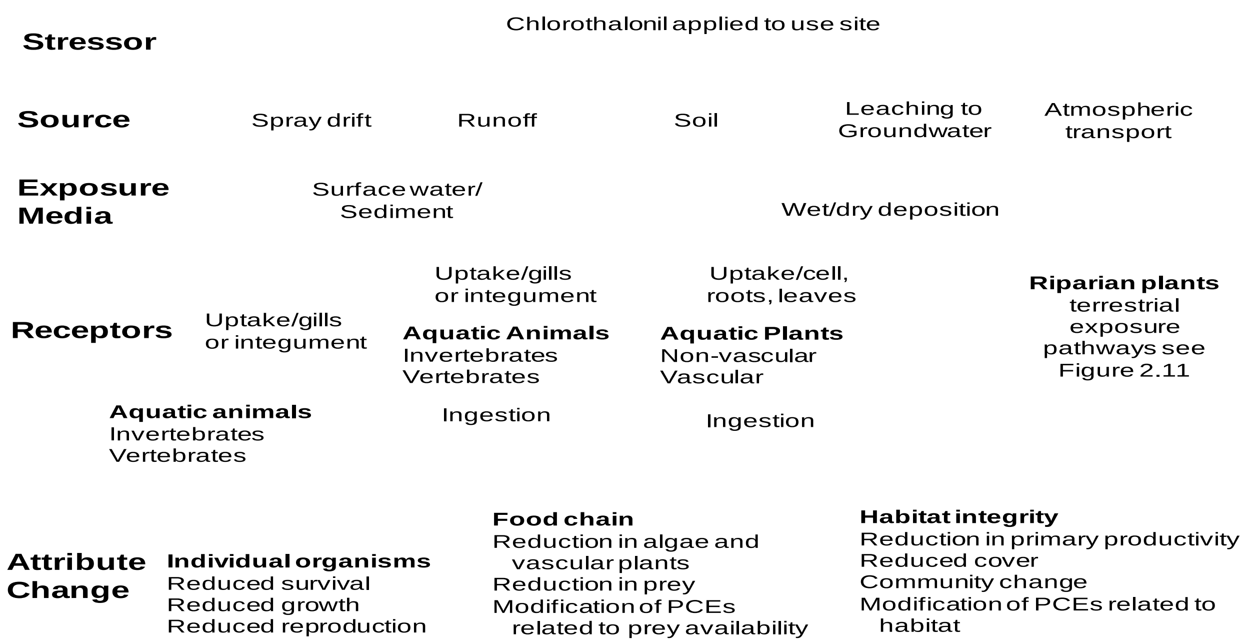

Figure 2-10. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Aquatic Organisms from Chlorothalonil Uses; Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk

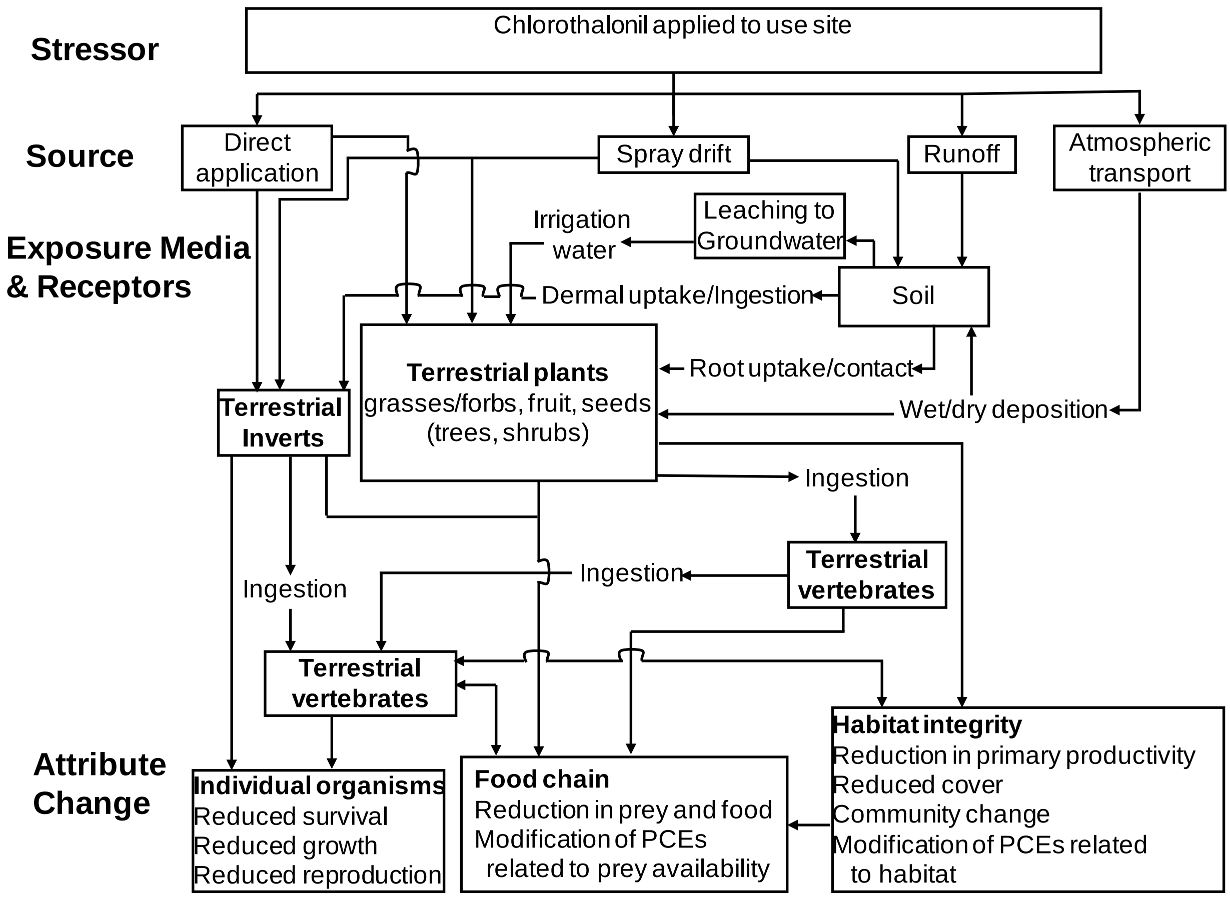

Figure 2-11. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Terrestrial Organisms from chlorothalonil Use

2.12. 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 chlorothalonil 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 chlorothalonil 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.

2.12.1. Measures of Exposure

Both parent chlorothalonil and SDS-3701 are evaluated for terrestrial animals, whereas only parent chlorothalonil is assessed for aquatic animals and plants

The environmental fate properties of chlorothalonil along with available monitoring data indicate that water and sediment runoff and spray drift are the principle potential transport mechanisms of chlorothalonil to the aquatic and terrestrial habitats. Chlorothalonil may leach to groundwater and has the potential to persist in pH's 7 and below.

Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EECs) of chlorothalonil 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 Terrestrial Residue Exposure (T-REX) model. The model T-HERPS (Terrestrial Herpetofaunal Exposure Residue Program Simulation) is used as a refinement to predict terrestrial EECs on food items for terrestrial-phase amphibian and reptiles. The model used to derive EECs relevant to terrestrial and wetland plants is TerrPlant. These models are parameterized using relevant reviewed registrant-submitted environmental fate data. More information on these models is available in **Attachment I**.

2.12.1.a. Estimating Exposure in the Aquatic Environment

The measure of exposure for aquatic species is the estimated environmental concentration (EEC) expected once every ten years based on 30 years of simulations. The 1-in-10 year peak concentration is used for estimating acute effects to aquatic vertebrate and invertebrate species; the 1-in-10 year 21-day mean concentration is used for assessing aquatic invertebrate chronic exposure; and the1-in-10 year 60-day mean concentration is used for assessing chronic exposure for fish (and aquatic-phase amphibians).

2.12.1.b. Estimating Exposure in the Terrestrial Environment

For the foliar uses, the terrestrial measure of exposure for vertebrate and invertebrate animals is based on the upper bound concentration of residues normalized for application rates on various dietary items.

2.12.2. Measures of Effect

Data identified in **Section 2.10** 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 are used in assessments is available in Attachment I.

2.12.3. 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 chlorothalonil, 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.

2.12.4. Data Gaps

The studies submitted to fulfill environmental fate data requirements for chlorothalonil are not sufficient for a full exposure assessment. Although the submitted studies provide supplemental data on the fate of chlorothalonil, data gaps and uncertainties exist. Data gaps include the following: hydrolysis (850.2120), air photolysis (835.2370), aqueous photolysis (835.2240), aerobic soil metabolism (835.4100), anaerobic soil metabolism (835.4200), aerobic aquatic metabolism (850.4300), anaerobic aquatic metabolism (835.4400), adsorption/desorption [(batch equilibrium); desorption only] (835.1230), terrestrial field dissipation (835.6100), and field volatility (835.8100).

The studies submitted to fulfill environmental effects data requirements for chlorothalonil are also not wholly sufficient. Although many submissions have been made to provide data on the effects of chlorothalonil to aquatic and terrestrial organisms, data gaps still exist. Data gaps include the following: avian acute oral toxicity (850.2100), avian reproduction (850.2300), terrestrial plant (850.4100, 850.4150), acute and chronic estuarine/marine fish (850.1075 and 850.1400), chronic estuarine/marine invertebrates (850.1350) and freshwater and estuarine/marine sediment (850.1735 and 1740) toxicity studies. In addition, an acute avian inhalation toxicity study was requested in the Registration Review Preliminary Problem Formulation based on the toxicity and fate properties of chlorothalonil.

The specific data gaps are described in full in Registration Review Preliminary Problem Formulation for Chlorothalonil (DP Barcode 394667, 394849).

3. Exposure Assessment

Chlorothalonil is formulated in solid form as dust, water dispersible granules, pellets, tablets, and as a wettable powder. In liquid form, chlorothalonil is available as an emulsifiable, flowable, and soluble concentrate as well as a ready-to-use solution. Application methods for the agricultural uses of chlorothalonil include aircraft, high and low volume ground sprayer, sprinkler irrigation and tank-type sprayers. 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 chlorothalonil due to generally higher spray drift levels.

3.1. Label Application Rates and Intervals

Chlorothalonil labels may be categorized into two types: labels for manufacturing uses (including technical grade chlorothalonil and its formulated products) and end-use products. While technical products, which contain chlorothalonil 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 fungal diseases. The formulated product labels legally limit chlorothalonil's potential use to only those sites that are specified on the labels.

Currently registered agricultural and non-agricultural uses of chlorothalonil within California include a multitude of agricultural and non-agricultural uses. Please see Section 2.4.3 for a full list of uses. The uses being assessed are summarized in **Table 3-1**. The uses modeled below encompass the range of uses; the highest, median, and lowest application rates; and the uses where chlorothalonil is applied the most, based on information provided by BEAD.

Table 3-1. Chlorothalonil Uses, Scenarios, and Application Information Used in Aquatic Model Simulations

Uses Represented by Scenario[1]	Scenario	Application Method/ Formulation	Application Rate (lb ai/A)[2]	Maximum Number of Applications[2]	Application Interval	Date of First Application
almond	CA almond STD	aerial and ground/ emulsifiable concentrate	3.0 0.8 **Total: 18.8**	6 1	3	March 1
apricot, nectarine, peach, plum, prune, stone fruits	CA fruit STD	aerial/ emulsifiable concentrate	3.1 **Total: 15.5**	5	10	March 1
asparagus	CA row crop RLF	aerial/ emulsifiable concentrate	3.0 **Total: 9.0**	3	14	March 1
beans, dried-type, peas, dried-type	CA row crop RLF	aerial/ emulsifiable concentrate	1.5 **Total: 6.0**	4	7	March 7 (early) October 1 (late)
beans, succulent (snap)	CA row crop RLF	aerial/ emulsifiable concentrate	2.3 2.1 **Total: 9.0**	3 1	7	March 7 (early) October 1 (late)
blueberry	CA wine grapes RLF	aerial/ emulsifiable concentrate	3.0 **Total: 9.0**	3	10	April 1
brassica	CA cole crop RLF	aerial/ emulsifiable concentrate	1.5 1.3 **Total:8.8**	5 1	7	February 1 (early) July 2 (late)
			1.1 0.6 **Total: 10.5**	9 1		
broccoli, Brussels sprouts, cabbage, cauliflower	CA cole crop RLF	aerial/ emulsifiable concentrate	1.5 **Total: 12.0**	8	7	February 1 (early) July 2 (late)
bulb vegetables	CA onion STD	aerial/ emulsifiable concentrate	1.5 **Total: 6.0**	4	7	February 1
carrot	CA row crop RLF	aerial/ emulsifiable concentrate	1.5 **Total: 15**	10	7	March 1 (early) September 15 (late)

Uses Represented by Scenario[1]	Scenario	Application Method/ Formulation	Application Rate (lb ai/A)[2]	Maximum Number of Applications[2]	Application Interval	Date of First Application
celery	CA row crop RLF	aerial/ emulsifiable concentrate	2.3 1.9 **Total: 18**	8 1	3	February 1 (early) July 2 (late)
cherry	CA fruit STD	aerial/ emulsifiable concentrate	3.2 **Total: 15.5**	5	10	March 1
christmas tree, conifers, forest trees	CA forestry RLF	aerial/ emulsifiable concentrate	4.5 3.0 **Total: 16.5**	3 1	3	October 1
cole crops	CA row crop RLF	aerial/ emulsifiable concentrate	1.0 Total: 12.0	12	14	February 1 (early) July 2 (late)
commercial/industrial laws	CA turf RLF	ground/ emulsifiable concentrate	11.0 4.0 **Total: 26.0**	2 1	14	January 3
corn	CA corn OP	aerial/ emulsifiable concentrate	1.5 **Total: 9.0**	6	7	May 1
			1.0 **Total:9.0**	9	4	May 1
cucumber, melon, pumpkin, squash	CA melons RLF	aerial/ emulsifiable concentrate	2.5 0.8 **Total: 15.8**	6 1	7	May 15
cucurbit vegetable	CA melons RLF	aerial/ emulsifiable concentrate	2.3 2.0 **Total: 15.8**	6 1	5	May 15
filbert (hazelnut)	CA almond STD	aerial/ emulsifiable concentrate	3.0 **Total: 9.0**	3	14	March 1
fruiting vegetables	CA row crop RLF CA tomato STD	aerial/ emulsifiable concentrate	1.2 0.6 **Total: 9.0**	7 1	7	July 24
garlic	CA garlic RLF	aerial/ emulsifiable concentrate	2.3 1.3 **Total: 15.1**	6 1	7	March 20
ginseng	CA row crop RLF	aerial/ emulsifiable concentrate	1.5 **Total: 21.0**	14	7	
golf course	CA turf RLF	ground/ emulsifiable concentrate	11.4 4.6 **Total: 73 (greens)**	6 1	14	January 3
			11.4 6.4 **Total: 52 (tees)**	4 1		
			11.4 3.2 **Total: 26 (fairways)**	2 1		

Uses Represented by Scenario[1]	Scenario	Application Method/ Formulation	Application Rate (lb ai/A)[2]	Maximum Number of Applications[2]	Application Interval	Date of First Application
grass forage, fodder, hay	CA rangeland hay RLF	aerial/ emulsifiable concentrate	1.6 1.3 **Total: 4.5**	2 1	14	January 3
grass grown for seed	CA turf RLF	aerial/ emulsifiable concentrate	1.5 **Total: 4.5**	3	14	January 3
green onion	CA onion STD	aerial/ emulsifiable concentrate	2.3 **Total: 6.8[3]**	3	7	February 1
horseradish	CA cole crop RLF	aerial/ emulsifiable concentrate	2.2 0.4 **Total: 4.5**	7 1	7	March 7
leek	CA garlic RLF	aerial/ emulsifiable concentrate	2.3 **Total: 6.8**	3	7	February 1
lupine, grain	CA alfalfa OP	aerial/ emulsifiable concentrate	1.1 0.5 **Total: 6.0**	5 1	7	March 7 (early) October 1 (late)
mango	CA citrus STD	aerial/ emulsifiable concentrate	2.6 0.6 **Total: 24**	9 1	7	February 15
onion	CA onion STD	aerial/ emulsifiable concentrate	2.2 1.8 **Total: 15.5**	6 1	7	February 1
ornamental (laws, turf, sod farms), recreation area lawns	CA turf RLF	aerial/ emulsifiable concentrate	11.4 3.2 **Total: 26.0**	2 1	7	November 1
ornamentals plants and trees	CA nursery	aerial/ emulsifiable concentrate	1.5 0.4 **Total: 36.4**	24 1	7	March 15
papaya	CA citrus STD	aerial/ emulsifiable concentrate	2.3 **Total: 6.8[3]**	3	14	February 15
parsnip	CA row crop RLF	aerial/ emulsifiable concentrate	1.6 1.2 **Total: 6.0**	3 1	7	March 1 (early) September 15 (late)
passion fruit	CA wine grapes RLF	aerial/ emulsifiable concentrate	1.7 0.7 **Total:7.5**	4 1	14	February 15
pistachio	CA almond STD	aerial/ emulsifiable concentrate	4.5 **Total: 22.5**	5	28	March 1
potato	CA potato RLF	aerial/ emulsifiable concentrate	1.4 **Total: 11.3**	8	5	February 17
rhubarb	CA row crop RLF	aerial/ emulsifiable concentrate	2.3 2.0 **Total: 13.5**	5 1	7	March 1

Uses Represented by Scenario[1]	Scenario	Application Method/ Formulation	Application Rate (lb ai/A)[2]	Maximum Number of Applications[2]	Application Interval	Date of First Application
rose	CA nursery	aerial/ emulsifiable concentrate	1.1 0.8 **Total: 36**	32 1	7	March 15
shallot	CA onion STD	aerial/ emulsifiable concentrate	2.2 **Total: 6.7**[3]	3	7	February 1 September 9
strawberry	CA strawberry (non plastic) RLF	aerial/ emulsifiable concentrate	1.1 0.7 **Total: 15**	13 1	10	January 3 (early) March 1 (mid-spring)
tomato	CA tomato STD	aerial/ emulsifiable concentrate	2.3 1.3 **Total: 15.1**	6 1	7	July 24
yam	CA potato RLF	aerial/ emulsifiable concentrate	0.94 0.9 **Total: 11.2**	11 1	10	February 17

1 Uses assessed based on memorandum from Pesticide Re-evaluation Division (PRD) dated May 31, 2012 and EFED Label Data report and associated Label Use Information Reports prepared on September 14, 2011 provided by BEAD.
2 Under application rate, the first number represents the maximum single application rate with the second number representing a single application that is possible after applying the maximum single application rate the maximum number of times without exceeding the total maximum pounds allowed either per crop season or per year. For example, for almonds, the single maximum application rate of 3.0 lb a.i./A can be applied 6 times with one additional application of 0.8 lb a.i./A to reach the total pounds allowed of 18.8 per acre.
3 Although, 3 applications at 2.3 or 2.2 lb a.i./A is slightly more than or less than the total allowed of 6.8 or 6.7 lbs,, a decrease of 0.1 lbs/A for one use or and addition single application of 0.1 lbs was not included. This inclusion or omission of 0.1 lb a.i. is not expected to influence the EECs.

3.2. Aquatic Exposure Assessment

3.2.1. Modeling Approach

The aquatic EECs are calculated using the EPA Tier II PRZM (Pesticide Root Zone Model) and EXAMS (Exposure Analysis Modeling System) with the EFED Standard Pond environment. PRZM is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field, and EXAMS estimates environmental fate and transport of pesticides in surface water. Aquatic exposure is modeled for the chlorothalonil only, as based on the available data, it appears that SDS-3701 is less toxic than parent chlorothalonil to aquatic organisms (data only available for freshwater organisms).

The most recent PRZM-EXAMS linkage program (PE5, PE Version 5, dated Nov. 15, 2006) was used for all surface water simulations. California-specific PRZM crop scenarios, which consist of location-specific soils, weather, and cropping practices were used in the simulations to represent labeled agricultural uses of chlorothalonil. These scenarios were developed to represent high-end exposure sites in terms of vulnerability to runoff and erosion and subsequent off-site transport of pesticide.

Chlorothalonil is registered on a wide variety of field, vegetable, and orchard crops as well as golf courses and turf (see **Table 2-5**). A summary of the output files used to estimate chlorothalonil concentrations in the aquatic systems for ecological risk assessment can be found in **APPENDIX D**.

PRZM-EXAMS modeling was completed using the maximum seasonal use pattern for each use. Chlorothalonil product labels, however, specify application rates on a per crop basis and not on a per annual basis. Since standard PRZM scenarios include only one crop per year, applications to only one crop per year were modeled (this is discussed further in **Section 2.4.3**). Even though laboratory studies indicate that chlorothalonil is short-lived in water, it is may be persistent in soils depending on the application rate applied (**Table 3-1**).

Use-specific management practices for all of the assessed uses of chlorothalonil were used for modeling, including application rates, number of applications per year, application intervals, buffer widths and resulting spray drift values and the first application date for each use. Application-specific and chemical-specific input parameters are listed in **Table 3-1** and **Table 3-2,** respectively. Modeling inputs were selected according to EFED's Input Parameter Guidance (USEPA 2009). Pesticide applications were simulated as aerial spray applications or ground spray as prescribed by product labels.

The date of first application was selected based on several sources of information including data provided by BEAD, a summary of individual applications from the CDPR PUR data, Crop Profiles (http://www.ipmcenters.org/CropProfiles/), California Red Legged Frog Assessment (EPA, 2007), and best professional judgement.

3.2.2. Model Inputs

The appropriate PRZM and EXAMS input parameters for chlorothalonil and total toxic chlorothalonil residues (chlorothalonil and SDS-3701) were selected from the environmental fate data submitted by the registrant and in accordance with US EPA-OPP EFED water model parameter selection guidelines, *Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1*, October 22, 2009 and *PE5 User's Manual. (P)RZM (E)XAMS Model Shell, Version (5)*, November 15, 2006. While a thorough review of the available environmental fate data, including additional kinetic analysis, was completed as part of the Registration Review Problem Formulation[19], including additional kinetic analysis, guidance on how to calculate model input values for the representative half-life values based on updated kinetics guidance is not currently available. Therefore, the modeling input values used in this assessment are the same as those used in the most recent chlorothalonil new use assessment.[20]

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[19] Registration Review – Preliminary Problem Formulation for the Ecological Risk Assessment and Drinking Water Exposure Assessment of Chlorothalonil **D394667, D394849**

[20] Ecological Assessment for the IR-4 Registration of Chlorothalonil (Bravo Weather Stick®/Bravo® 720, 54%; EPA Reg. 50534-188) and the Degradation Product, 4-Hydroxy-2,5,6-trichloro-1,3-dicyanobenzene (SDS-3701) for the New Uses On: Bulb Vegetables, Bushberries, and Low Growing Berries **D370488**

Input parameters are grouped by physical-chemical properties and other environmental fate data, application information, and use scenarios. Physical and chemical properties relevant for assessing the behavior of chlorothalonil in the environment are presented in **Table 3-2**. Application information, label rates taken from chlorothalonil labels and representative PRZM scenario used in modeling are presented in **Table 3-1**. **Appendix D** contains example model output files and tables showing the data used to calculate input values.

Table 3-2. Summary of PRZM-EXAMS Chemical and Environmental Fate Model Input Values Used for Modeling Chlorothalonil in this Endangered Species Assessment

Parameter	Chlorothalonil	Value Used in Current Assessment	
		Chlorothalonil	Chlorothalonil Source
Molecular Weight	265.9 g/mol	265.9 g/mol	Chlorothalonil: RED, EPA 738-R-99004, April, 1999 SDS-3701: ChemDraw Ultra calculation
Henry's Law Constant	2.6 x 10^{-7} atm - m^3/mol	2.6 x 10^{-7} atm - m^3/mol	Chlorothalonil: RED, EPA 738-R-99004, April, 1999
Vapor Pressure	5.72 x 10^{-7} torr	5.72 x 10^{-7} torr	MRID 00153732
Water Solubility (25 °C)	0.8 mg/L	0.8 mg/L	Chlorothalonil: RED, EPA 738-R-99004, April, 1999
Hydrolysis Half-life ($t_{1/2}$) pH 7	Stable, 0	stable, 0	MRID 0040539
Aquatic Photolysis Half-life ($t_{1/2}$) pH 7	10 hours	0.4 days	MRID 45710223
Soil Partition Coefficient (K_{oc})	6872, 2677, 1527, 5642, 5015, and 2505 mL/g	4040 mean value of 6872, 2677, 1527, 5642, 5015, and 2505 mL/g	Chlorothalonil: EPA Acc. 29406
Aerobic Soil Metabolism Half-life ($t_{1/2}$)	57, 22, 18, 15, 14, 10, 10, 5, 2, 1, 1, 1.0, 0.5, 0.3 days	16 days upper 90th percentile confidence bound on the mean value of 87, 57, 22,	MRIDs 00040547, 00087351, 43879601, 47207702, and 47207703

		18, 15, 14, 10, 10, 5, 2, 1, 1, 1, 0.5, 0.3 days; 11 + ((1.282 x 15)/ √14) = 16 days	
Aerobic Aquatic Metabolism Half-life ($t_{1/2}$)	2.6, 1.4, 0.8, 0.3, 0.1, and 0.1 days	1.5 days upper 90th percentile confidence bound on the mean value of 2.6, 1.4, 0.8, 0.3, 0.1, and 0.1 days; 0.88 + ((1.476 x 0.98)/ √6) = 1.5 days	MRIDs 42226101, 45908001, and 47207701
Anaerobic Aquatic Metabolism Half-life ($t_{1/2}$)	8.9 and 4.8 days	11.5 days upper 90th percentile confidence bound on mean value of 8.9 and 4.8 days; 6.9 + ((3.078 x 2.1)/√2) = 11.5 day.	MRID 00147975
Application Type and Depth of Incorporation	aerial, 0 ground, 0		EFED Guidance
Spray Drift Fraction[2]	0.05 (aerial) 0.01 (ground)		EFED Guidance
Application Efficiency	0.95 (aerial) 0.99 (ground)		EFED Guidance

1. Inputs determined in accordance with EFED "*Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1*" dated October 22, 2009.
2. Aerial applications provide the most conservative EEC; therefore, unless aerial applications are not permitted for a specific use or otherwise noted other types of applications were not modeled. For some use scenarios (orchards) ground applications were modeled in addition to aerial applications to provide a bounding estimate on the potential exposure. Orchard blast applications are expected to result in EECs between aerial and ground applications and were not specifically examined.

3.2.3. Results

The aquatic EECs of chlorothalonil for all modeled scenarios are presented in **Table 3-3**. An example output from PRZM-EXAMS is provided in **APPENDIX D**. The maximum peak, 21 day average, and 60 day average EECs results from chlorothalonil use on christmas trees (47.5 µg/L, 11.9 µg/L, and 6.8 µg/L respectively).

Table 3-3. Aquatic EECs for Chlorothalonil Uses in California

Uses Represented by Scenario	Scenario	Application Method/ Formulation	Application Rate (kg a.i./ha)	Maximum Number of Applications	Application Interval (days)	Date of First Application	Chlorothalonil		
							Peak EEC (µg/L)	21-day Average EEC (µg/L)	60-day Average EEC (µg/L)
almond	CA almond STD W23232	aerial/ emulsifiable concentrate	3.4	6	3	March 1	18.6	10.1	4.4
		ground/ emulsifiable	0.9	1			8.4	2.8	1.5
apricot, nectarine, peach, plum, prune, stone fruits	CA fruit STD W93193	aerial/ emulsifiable concentrate	3.5	5	10	March 1	10.8	4.2	3.1
asparagus	CA row crop RLF W23234	aerial/ emulsifiable concentrate	3.4	3	14	March 1	10.1	3.6	2.3
beans, dried-type, peas, dried-type	CA row crop RLF W23234	aerial/ emulsifiable concentrate	1.7	4	7	March 7 (early)	6.8	2.8	1.6
						October 1 (late)	6.4	2.2	1.3
beans, succulent (snap)	CA row crop RLF W23234	aerial/ emulsifiable concentrate	2.6 2.4	3 1	7	March 7 (early)	10.0	4.3	2.4
						October 1 (late)	9.8	3.4	1.9
blueberry	CA wine grapes RLF W23234	aerial/ emulsifiable concentrate	3.4	3	10	April 1	10.4	3.7	1.8

Uses Represented by Scenario	Scenario	Application Method/ Formulation	Application Rate (kg a.i./ha)	Maximum Number of Applications	Application Interval (days)	Date of First Application	Chlorothalonil		
							Peak EEC (µg/L)	21-day Average EEC (µg/L)	60-day Average EEC (µg/L)
brassica	CA cole crop RLF W23234	aerial/ emulsifiable concentrate	1.7 1.5	5 1	7	February 1 (early)	12.1	4.6	2.8
						July 2 (late)	4.8	2.0	1.4
			1.2 0.7	9 1		February 1 (early)	9.7	4.1	2.8
						July 2 (late)	3.4	1.4	1.4
broccoli, Brussels sprouts, cabbage, cauliflower	CA cole crop RLF W23234	aerial/ emulsifiable concentrate	1.7	8	7	February 1 (early)	13.0	9.0	3.7
						July 2 (late)	4.8	2.0	1.8
bulb vegetables	CA onion STD W23155	aerial/ emulsifiable concentrate	1.7	4	7	February 1	5.6	2.6	1.3
carrot	CA row crop RLF W23234	aerial/ emulsifiable concentrate	1.7	10	7	March 1 (early)	7.9	3.5	3.0
						September 15 (late)	10.6	3.8	2.8
celery	CA row crop RLF W23234	aerial/ emulsifiable concentrate	2.6 2.1	8 1	3	February 1 (early)	20.4	11.1	5.4
						July 2 (late)	10.8	6.9	3.2
cherry	CA fruit STD W93193	aerial/ emulsifiable concentrate	3.6	5	10	March 1	11.3	4.3	3.1
christmas tree, conifers, forest trees	CA forestry RLF W24283	aerial/ emulsifiable concentrate	5.0 3.4	3 1	3	October 1	47.5	11.9	6.8

Uses Represented by Scenario	Scenario	Application Method/ Formulation	Application Rate (kg a.i./ha)	Maximum Number of Applications	Application Interval (days)	Date of First Application	Chlorothalonil		
							Peak EEC (µg/L)	21-day Average EEC (µg/L)	60-day Average EEC (µg/L)
cole crops	CA row crop RLF W23234	aerial/ emulsifiable concentrate	1.1	12	14	February 1 (early)	5.3	2.2	1.5
						July 2 (late)	5.1	2.0	1.3
commercial/ industrial laws	CA turf RLF W23234	ground/ emulsifiable concentrate	12.3 4.5	2 1	14	January 3	11.7	3.5	1.9
corn	CA corn OP W23232	aerial/ emulsifiable concentrate	1.7	6	7	May 1	4.8	1.9	1.3
			1.1	9	4	May 1	3.9	2.2	1.3
cucumber, melon, pumpkin, squash	CA melons RLF W93193	aerial/ emulsifiable concentrate	2.8 0.9	6 1	7	May 15	7.8	2.7	1.7
cucurbit vegetable	CA melons RLF W93193	aerial/ emulsifiable concentrate	2.6 2.2	6 1	5	May 15	8.0	3.5	1.8
filbert (hazelnut)	CA almond STD W23232	aerial/ emulsifiable concentrate	3.4	3	14	March 1	9.3	3.4	2.0
fruiting vegetables	CA row crop RLF	aerial/ emulsifiable concentrate	1.3 0.7	7 1	7	July 24	3.7	1.5	1.3
	CA tomato STD W93193						3.6	0.9	0.8
garlic	CA garlic RLF W23188	aerial/ emulsifiable concentrate	2.6 1.5	6 1	7	March 20	12.8	4.6	3.6

Uses Represented by Scenario	Scenario	Application Method/ Formulation	Application Rate (kg a.i./ha)	Maximum Number of Applications	Application Interval (days)	Date of First Application	Chlorothalonil		
							Peak EEC (µg/L)	21-day Average EEC (µg/L)	60-day Average EEC (µg/L)
golf course	CA turf RLF w23234	aerial/ emulsifiable concentrate	12.8 5.2 **(greens)**[3]	6 1	14	January 3	**17.6**	**4.7**	**3.2**
			12.8 7.2 **(tees)**	4 1			12.5	3.6	2.5
			12.8 3.6 **(fairways/ roughs**[4]**)**	2 1			7.6	2.5	1.3
grass forage, fodder, hay	CA rangeland hay RLF w23232	aerial/ emulsifiable concentrate	1.8 1.5	2 1	14	January 3	11.3	3.9	2.2
grass grown for seed	CA turf RLF w23234	aerial/ emulsifiable concentrate	1.7	3	14	January 3	5.1	1.9	1.1
green onion	CA onion STD W23155	aerial/ emulsifiable concentrate	2.6	3	7	February 1	8.6	3.7	1.5
horseradish	CA cole crop RLF w23234	aerial/ emulsifiable concentrate	2.5 0.4	7 1	7	March 7	16.3	6.7	4.6
leek	CA garlic RLF W23188	aerial/ emulsifiable concentrate	2.6	3	7	February 1	9.5	3.7	1.7
lupine, grain	CA alfalfa OP W93193	aerial/ emulsifiable concentrate	1.2 0.6	5 1	7	March 7 (early)	4.0	1.8	1.2
						October 1 (late)	3.9	1.4	1.0
mango	CA citrus STD W23155	aerial/ emulsifiable concentrate	2.9 0.7	9 1	7	February 15	9.6	4.4	4.0

Uses Represented by Scenario	Scenario	Application Method/ Formulation	Application Rate (kg a.i./ha)	Maximum Number of Applications	Application Interval (days)	Date of First Application	Chlorothalonil		
							Peak EEC (µg/L)	21-day Average EEC (µg/L)	60-day Average EEC (µg/L)
onion	CA onion STD	aerial/ emulsifiable concentrate	2.5 2.1	6 1	7	February 1	9.0	3.9	3.0
ornamental (lawns, turf, sod farms), recreation area lawns	CA turf RLF w23234	aerial/ emulsifiable concentrate	12.8 3.6	2 1	3	November 1	37.1	13.5	5.3
ornamentals plants and trees	CA nursery w23188	aerial/ emulsifiable concentrate	1.7 0.4	24 1	7	March 15	31.1	7.5	3.4
papaya	CA citrus STD W23155	aerial/ emulsifiable concentrate	2.6	3	14	February 15	6.9	2.3	1.3
parsnip	CA row crop RLF w23234	aerial/ emulsifiable concentrate	1.8 1.3	3 1	7	March 1 (early)	6.4	2.7	1.5
						September 15 (late)	5.0	2.0	1.0
passion fruit	CA wine grapes RLF	aerial/ emulsifiable concentrate	1.9 0.8	4 1	14	February 15	6.4	2.6	1.8
pistachio	CA almond STD W23232	aerial/ emulsifiable concentrate	5.0	5	28	March 1	13.5	3.0	2.5
potato	CA potato RLF	aerial/ emulsifiable concentrate	1.6	8	5	February 17	7.9	3.7	2.3
rhubarb	CA row crop RLF w23234	aerial/ emulsifiable concentrate	2.6 2.2	5 1	7	March 1	12.1	5.1	3.3
rose	CA nursery W23188	aerial/ emulsifiable concentrate	1.2 0.9	26[2]	7	March 15	23.8	5.3	2.6

Uses Represented by Scenario	Scenario	Application Method/ Formulation	Application Rate (kg a.i./ha)	Maximum Number of Applications	Application Interval (days)	Date of First Application	Chlorothalonil		
							Peak EEC (µg/L)	21-day Average EEC (µg/L)	60-day Average EEC (µg/L)
shallot	CA onion STD	aerial/ emulsifiable concentrate	2.5	3	7	February 1 (early)	8.2	3.6	1.4
						September 9 (late)	6.5	1.9	0.7
strawberry	CA strawberry (non plastic) RLF w23234	aerial/ emulsifiable concentrate	1.2 0.8	13 1	10	January 3 (early)	19.4	6.6	4.9
						March 1 (mid-spring)	10.6	3.5	2.7
tomato	CA tomato STD W93193	aerial/ emulsifiable concentrate	2.6 1.5	6 1	7	July 24	6.6	1.8	1.4
yam	CA potato RLF W23155	aerial/ emulsifiable concentrate	1.1 1.0	11 1	10	February 17	5.3	1.9	1.6

1. Uses assessed based on memorandum from Pesticide Re-evaluation Division (PRD) dated May 31, 2012 and EFED Label Data report and associated Label Use Information Reports prepared on September 14, 2011 provided by BEAD.
2. PRZM can only run a maximum of 26 applications per year. Label permits 32 applications per year.
3. Golf course adjustment factor for tees, greens, fairways, and roughs is 1; therefore, highest EECs for golf course was assumed to be a reasonable upper bound estimate of exposure to chlorothalonil as a results of its use on golf courses.
4. "Other" turf uses are permitted on chlorothalonil labels; therefore, it is assumed that roughs can be treated as "other turf". The rates for "other turf" are the similar to fairways.

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 chlorothalonil data from the USGS NAWQA program (http://water.usgs.gov/nawqa) and data from the California Department of Pesticide Regulation (CDPR). In addition, air monitoring data for chlorothalonil is presented.

Several sources of surface water monitoring data were assessed including the USGS National Water Quality Assessment Data Warehouse (NAWQA[21]), California State Water Resources Control Board, Surface Water Ambient Monitoring Program (SWAMP) and California Department of Pesticide Regulation (CDPR) Surface Water Database. These sources indicate that chlorothalonil has been detected in surface water. Minimum reporting limit ranged from 0.01 to 4.1 µg/L. In general, for these datasets sample frequencies are sporadic and range from once per year to a few times per month depending on the site and year.

On a national basis, of the 7,214 NAWQA samples (951 sites) there are 29 reported detections (levels greater than the detection limit) of chlorothalonil. The highest detected concentration was 0.71µg/L in an urban location in New Jersey. The highest detection (0.68 µg/L) in an agricultural setting was observed in Georgia. Both detections were observed for filtered water (49306-chlorothalonil). Eight samples reported detection limits greater than 1 µg/L.

For California, approximately 370 samples collected from 11 counties between March 18, 1993 and December, 22, 2005 were analyzed for chlorothalonil. [22] Surface water samples were collected in counties (# of samples) including Alpine (4), Amador (6), Del Norte (1), El-Dorado (4), Merced (87), Nevada (4), Orange (10), Sacramento (109), San Bernardino (8), San Joaquin (61), and Stanislaus (74). The highest concentration detected in California is reported to be 0.29 µg/L from a sample collected in Merced County (USGS Station #1123500) on February 8, 1994. This specific sample is not included in the CalDPR dataset.

3.2.4.a. Atmospheric Monitoring Data

While evolution of volatile compounds was not significant in laboratory testing, ambient air monitoring from 7/5/89 to 8/3/89 for four sites in Fresno County,[23] California was targeted for chlorothalonil applications to tomatoes for control of black mold. All samples (n=92) were less than the minimum detection limit of 7.0 ng/m^3.

Ambient air monitoring conducted from 1/8/90 to 2/2/90 at three sites in Ventura County,[24] California was targeted to coincide with applications to celery. The distance from application site

[21] USGS National Water Quality Assessment Data Warehouse; 49306-chlorothalonil water filtered (7121); 65071-chlorothalonil water filtered (2); 70314-chlorothalonil water unfiltered (87); 62904-chlorothalonil bed sediment (4)
[22] As reported in the CalDPR database and includes SWAMP and NAWQA sampling sites.
[23] Kollman, W. S.. 2002. Summary of Assembly Bill 1807/3219: Pesticide Air Monitoring Results: Conducted by California Air Resources Board 1986-2000. California Department of Pesticide Regulation

was unknown. The maximum air concentration was 0.005 μg/m^3 at an air sampling site near the Animal Control Shelter in Camarillo, California. Five air samples were above the minimum detection limit of 4.0 ng/m^3, while 96% of the samples were below the minimum detection limit.

Ambient air monitoring was conducted during 2/92 for 72 hours immediately after chlorothalonil was aerially applied to celery in Ventura County,[25] California. The distance between the sampling location and application site was not reported. Chlorothalonil was aerially applied at a rate of 1 lb/acre. The maximum air concentration was 158 ng/m^3. A total of 75% of the samples had detections of chlorothalonil above 4 ng/m^3.

Ambient air samples were taken between 5/31/00 and 8/3/00. Sampling was 24 hour samples for 4 days a week during a 10 week period. Lompoc, California[26] was selected as a monitoring site because it is downwind from agricultural areas. Chlorothalonil was detected in trace quantities (at or below the detection limit). The percent of air samples with detectable levels of chlorothalonil was 17%. The estimated concentrations were 4.3 ng/m^3 for the highest 1 day concentration, 3.27 ng/m^3 for the highest 14 day air concentration, and 1.61 ng/m^3 for the highest 10 week air concentration.

Studies have documented atmospheric transport and redeposition of chlorothalonil, from the Central Valley to the Sierra Nevada Mountains.[27] This is likely the result of prevailing winds blowing across the Central Valley eastward to the Sierra Nevada Mountains transporting airborne pollutants such as chlorothalonil into the Sierra Nevada ecosystems. In addition, local ambient air monitoring data from a site in North Dakota and three sites in California, to list a few, indicate that chlorothalonil was present in the air at application sites and at locations up to a mile away from the application sites.[28] Data from the state of Montana show detections of chlorothalonil in precipitation. This indicates that chlorothalonil volatility or particle phase transport plays a role in the dissipation of chlorothalonil and that it is possible for chlorothalonil exposure to occur adjacent to application sites, as well as areas distant from application sites (long range transport). In this assessment, exposure from inhalation was not assessed and this uncertainty is discussed in Section 6.2.1.

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[24] Kollman, W. S.. 2002. Summary of Assembly Bill 1807/3219: Pesticide Air Monitoring Results: Conducted by California Air Resources Board 1986-2000. California Department of Pesticide Regulation

[25] Kollman, W. S.. 2002. Summary of Assembly Bill 1807/3219: Pesticide Air Monitoring Results: Conducted by California Air Resources Board 1986-2000. California Department of Pesticide Regulation

[26] Source: Wollford, Pamela, R. Segawa, M. Brattesani, J. Schreider, and S. Powell. 2003. Ambient Air Monitoring for Pesticides in Lompoc, California; Volume 3: Multiple Pesticides. California Department of Pesticide Regulation

[27] LeNoir, J.S., L.L. McConnell, G.M. Fellers, T.M. Cahill, J.N. Seiber. 1999. Summertime Transport of Current-use pesticides from California's Central Valley to the Sierra Nevada Mountain Range, USA. Environmental Toxicology & Chemistry 18(12): 2715-2722.

[28] **JOURNAL OF PESTICIDE REFORM/** WINTER 1997 • VOL.17, NO.
http://64.233.161.104/search?q=cache:0yXOLRyW_IUJ:www.pesticide.org/chlorothalonil.pdf+chlorothalonil+monitoring&hl=en&gl=us&ct=clnk&cd=5

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 chlorothalonil and SDS-3701 for birds (including terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. T-REX simulates a 1-year time period. T-HERPS is used as a refinement of dietary and dose-based EECs for snakes and amphibians when risk quotients from T-REX are higher than LOCs. T-HERPS was also set up to simulate a 1-year time period. Terrestrial EECs were derived for the uses previously summarized in Table 3-4. Exposure estimates generated using T-REX and T-HERPS are for the parent alone as well as for SDS-3701.

Terrestrial EECs for foliar formulations of chlorothalonil and SDS-3701 were derived for the uses summarized in Table 3-4. A foliar dissipation half-life of 35 days (T-REX default value) was used in this assessment. In the California red-legged frog risk assessment, a foliar dissipation half-life of 12.3 days was used. This value was based on multiplying the foliar dissipation half-life of 4.1 days (based on apples) reported by Willis and McDowell (1987) by 3; additionally, dislodgable residue studies report half lives that are equivalent to or less than 12 days (MRIDs 44868601, 44868602). In the 1999 RED assessment, a foliar half-life of 30 days was used, based on terrestrial field studies cited in Ware 1992; however, in some instances, because of the range of studies available, a lower-end value of 7 days was also utilized. In regards to the dislodgable residues, this dissipation rate does not necessarily consider residues that are not dislodgeable (bound to surface of plant) or those that were transported inside the plant material. As the log Kow for chlorothalonil is 3.8, it may be adsorbed across the plant membrane. Therefore, determining a foliar dissipation rate for dietary items based on only a dislodgable foliar rate may underestimate the rate for residues that may be more persistent than chemicals that are more readily dislodged from plant surface. Additionally, as the only value reported in Willis and McDowell (1987) was for apples, it may not be representative of other times of dietary items including grasses. While there are many studies that examined the magnitude of chlorothalonil residues in different crops post application, generally, these studies do not measure resides immediately after application which is important considering that a non-target bird or mammal may be feeding on the exposed plant material. Given that the initial residue concentration is not known, there is uncertainty associated with estimating an accurate dissipation rate. Therefore, the T-REX default value of 35 days was used in this assessment. This value is the highest reported dissipation rate reported in Willis and McDowell (1987) and generally correlates with the value used in the 1999 RED. Use specific input values, including number of applications, application rate, foliar half-life and application interval are provided in **Table 3-4**. An example output from T-REX and T-HERPS is available in **APPENDIX E**.

Table 3-4. Input Parameters for Foliar Applications Used to Derive Terrestrial EECs for Chlorothalonil with T-REX and T-HERPS

Uses[1]	Chlorothalonil Application Rate (lb ai/A)[2]	SDS-3701 Application Rate (lb ai/A)[3]	Maximum Number of Applications	Application Interval (days)	Foliar half-life (days)

Uses[1]	Chlorothalonil Application Rate (lb ai/A)[2]	SDS-3701 Application Rate (lb ai/A)[3]	Maximum Number of Applications	Application Interval (days)	Foliar half-life (days)
almond	3.0 0.8 **Total: 18.8[3]**	0.95 0.25	6 1	3	35
apricot, nectarine, peach, plum, prune, stone fruits	3.1 **Total: 15.5**	0.98	5	10	35
asparagus	3.0 **Total: 9.0**	0.95	3	14	35
beans, dried-type, peas, dried-type	1.5 **Total: 6.0**	0.48	4	7	35
beans, succulent (snap)	2.3 2.1 **Total: 9.0**	0.73 0.67	3 1	7	35
blueberry	3.0 **Total: 9.0**	0.95	3	10	35
brassica	1.5 1.3 **Total:8.8**	0.48 0.41	5 1	7	35
	1.1 0.6 **Total: 10.5**	0.35 0.19	9 1		
broccoli, Brussels sprouts, cabbage, cauliflower	1.5 **Total: 12.0**	0.48	8	7	35
bulb vegetables	1.5 **Total: 6.0**	0.48	4	7	35
carrot	1.5 **Total: 15**	0.48	10	7	35
celery	2.3 1.9 **Total: 18**	0.73 0.60	8 1	3	35
cherry	3.2 **Total: 15.5**	1.02	5	10	35
christmas tree, conifers, forest trees	4.5 3.0 **Total: 16.5**	1.43 0.95	3 1	3	35
cole crops	1.0 Total: 12.0	0.32	12	14	35
commercial/industrial laws	11.0 4.0 **Total: 26.0**	3.49 1.27	2 1	14	35
corn	1.5 **Total: 9.0**	0.48	6	7	35
	1.0 **Total:9.0**	0.32	9	4	35
cucumber, melon, pumpkin, squash	2.5 0.8 **Total: 15.8**	0.79 0.25	6 1	7	35

Uses[1]	Chlorothalonil Application Rate (lb ai/A)[2]	SDS-3701 Application Rate (lb ai/A)[3]	Maximum Number of Applications	Application Interval (days)	Foliar half-life (days)
cucurbit vegetable	2.3 2.0 **Total: 15.8**	0.73 0.64	6 1	5	35
filbert (hazelnut)	3.0 **Total: 9.0**	0.95	3	14	35
fruiting vegetables	1.2 0.6 **Total: 9.0**	0.38 0.19	7 1	7	35
garlic	2.3 1.3 **Total: 15.1**	0.73 0.41	6 1	7	35
ginseng	1.5 **Total: 21.0**	0.48	14	7	35
golf course	11.4 4.6 **Total: 73 (greens)**	3.62 1.46	6 1	14	35
grass forage, fodder, hay	1.6 1.3 **Total: 4.5**	0.51 0.41	2 1	14	35
grass grown for seed	1.5 **Total: 4.5**	0.48	3	14	35
green onion	2.3 **Total: 6.8[1]**	0.73	3	7	35
horseradish	2.2 0.4 **Total: 4.5**	0.70 0.13	7 1	7	35
leek	2.3 **Total: 6.8**	0.73	3	7	35
lupine, grain	1.1 0.5 **Total: 6.0**	0.35 0.16	5 1	7	35
mango	2.6 0.6 **Total: 24**	0.83 0.19	9 1	7	35
onion	2.2 1.8 **Total: 15.5**	0.70 0.57	6 1	7	35
ornamental (laws, turf, sod farms), recreation area lawns	11.4 3.2 **Total: 26.0**	3.62 1.02	2 1	7	35
ornamentals plants and trees	1.5 0.4 **Total: 36.4**	0.48 0.13	24 1	7	35
papaya	2.3 **Total: 6.8[1]**	0.73	3	14	35

Uses[1]	Chlorothalonil Application Rate (lb ai/A)[2]	SDS-3701 Application Rate (lb ai/A)[3]	Maximum Number of Applications	Application Interval (days)	Foliar half-life (days)
parsnip	1.6 1.2 **Total: 6.0**	0.51 0.38	3 1	7	35
passion fruit	1.7 0.7 **Total:7.5**	0.54	4 1	14	35
pistachio	4.5 **Total: 22.5**	0.22	5	28	35
potato	1.4 **Total: 11.3**	0.44	8	5	35
rhubarb	2.3 2.0 **Total: 13.5**	0.73 0.64	5 1	7	35
rose	1.1 0.8 **Total: 36**	0.35 0.25	32	7	35
shallot	2.2 **Total: 6.7[1]**	0.70	3	7	35
strawberry	1.1 0.7 **Total: 15**	0.35 0.22	13 1	10	35
tomato	2.3 1.3 **Total: 15.1**	0.73 0.41	6 1	7	35
yam	0.94 0.9 **Total: 11.2**	0.30 0.29	11 1	10	35

1 Uses assessed based on memorandum from Pesticide Re-evaluation Division (PRD) dated May 31, 2012 and EFED Label Data report and associated Label Use Information Reports prepared on September 14, 2011 provided by BEAD.
2 Under application rate, the first number represents the maximum single application rate with the second number representing a single application that is possible after applying the maximum single application rate the maximum number of times without exceeding the total maximum pounds allowed either per crop season or per year. For example, for almonds, the single maximum application rate of 3.0 lb a.i./A can be applied 6 times with one additional application of 0.8 lb a.i./A to reach the total pounds allowed of 18.8 per acre. Total lb amount based on EFED Label Data report
3 SDS rates based on multiplying the chlorothalonil maximum formation observed in fate studies (34%) and the molecular weight ratio of SDS-3701 and chlorothalonil.[(247.5/265.9)*.341 = 0.3174]

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

For foliar applications of liquid formulations, T-HERPS estimates exposure for the following dietary items: broadleaf plants/small insects, fruits/pods/seeds/large insects, small herbivore mammals, small insectivore mammals, and small amphibians. Snakes and amphibians may consume all of these items. The default size classes of amphibians represented in T-HERPS are small (2 g), medium (20 g), and large (200 g). The default vertebrate prey size that the medium and large amphibians can consume is 13 g and 133 g, respectively (small amphibians are not expected to eat vertebrate prey). The default size classes for snakes are small (2 g), medium (20 g), and large (800 g). The default vertebrate prey size that medium and large snakes can consume is 25 g and 1286 g, respectively (small snakes are not expected to eat vertebrate prey). EECs are calculated for the most sensitive dietary item and size class for amphibians and snakes. For both amphibians and reptiles, the most sensitive EECs and RQs are for a 20-gram animal that consumes small herbivore mammals. If dietary RQs are more sensitive than acute dose based RQs for acute exposures they are shown as well. Dietary based EECs and RQs are used to characterize risk from chronic exposure. The percentages of the EECs for the different dietary items are discussed in the discussion on uncertainties (see Section 6.1.3.b).

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

For the foliar uses, upper-bound Kenaga nomogram values reported by T-REX are used for derivation of dietary EECs for the CTS, CCR, SFGS, and their potential prey (Table 3-5 for chlorothalonil and for SDS-3701).

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 conservative EEC for the CCR is for the small bird consuming short grass. However, EECs for small birds consuming arthropods is also a relevant dietary item and as such are included in the assessment. 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[29]. If the LC_{50} is lower than the LD_{50}, the highest acute dietary EECs are shown as well. For mammals, EECs for acute and chronic dose-based exposure are calculated as these are typically the most conservative values.

Table 3-5. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Birds and Mammals Derived Using T-REX for Chlorothalonil: Accounting for direct effects with most sensitive size classes for acute exposure

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

Use(s), Type of Application[a]	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds of 20g consuming short grass & arthropods)[1]				EECs for Mammals (small mammals of 15 g consuming short grass)	
	Dietary-based EEC (mg/kg-diet)		Dose-based EEC (mg/kg-bw)		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
	Short grass	Arthropod	Short grass	Arthropod		
almond	3742.92	1465.98	4262.81	1669.60	3742.92	3568.59
apricot, nectarine, peach, plum, prune, stone fruits	2602.65	1019.37	2964.16	1160.96	2602.65	2481.43
asparagus	1679.19	657.68	1912.43	749.03	1679.19	1600.98
beans, dried-type, peas, dried-type	1183.74	463.63	1348.16	528.03	1183.74	1128.60
beans, succulent (snap)	1767.07	692.10	2012.51	788.23	1767.07	1684.76
blueberry	1795.17	703.11	2044.51	800.77	1795.17	1711.55
brassica	1522.50	596.31	1733.98	679.14	1522.50	1451.59
	1453.74	569.38	1655.67	648.47	1453.74	1386.03
broccoli, Brussels sprouts, cabbage, cauliflower	1863.62	729.92	2122.47	831.30	1863.62	1776.82
bulb vegetables	1183.74	463.63	1348.16	528.03	1183.74	1128.60
carrot	2085.76	816.92	2375.47	930.39	2085.76	1988.61
celery	3867.41	1514.74	4404.59	1725.13	3867.41	3687.28
cherry	2686.61	1052.26	3059.78	1198.41	2686.61	2561.48
christmas tree, conifers, forest trees	3600.39	1410.15	4100.48	1606.02	3600.39	3432.69
cole crops	955.58	374.27	1088.31	426.25	955.58	911.07
commercial/industrial laws	5791.94	2268.51	6596.44	2583.61	5791.94	5522.17
corn	1570.50	615.11	1788.65	700.55	1570.50	1497.36
	1606.52	629.22	1829.66	716.62	1606.52	1531.69
cucumber, melon, pumpkin, squash	2617.51	1025.19	2981.08	1167.59	2617.51	2495.59
cucurbit vegetable	2855.56	1118.43	3252.20	1273.78	2855.56	2722.56
filbert (hazelnut)	1679.19	657.68	1912.43	749.03	1679.19	1600.98
fruiting vegetables	1381.76	541.19	1573.69	616.36	1381.76	1317.40
garlic	2408.38	943.28	2742.90	1074.30	2408.38	2296.20

Use(s), Type of Application[a]	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds of 20g consuming short grass & arthropods)[1]				EECs for Mammals (small mammals of 15 g consuming short grass)	
	Dietary-based EEC (mg/kg-diet)		Dose-based EEC (mg/kg-bw)		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
	Short grass	Arthropod	Short grass	Arthropod		
ginseng	2381.69	932.83	2712.51	1062.40	2381.69	2270.76
golf course	9158.38	3587.03	10430.47	4085.27	9158.38	8731.81
	7571.83	2965.63	8623.56	3377.56	7571.83	7219.16
	4809.50	1883.72	5477.54	2145.37	4809.50	4585.49
grass forage, fodder, hay	823.57	322.56	937.96	367.37	823.57	785.21
grass grown for seed	839.59	328.84	956.21	374.52	839.59	800.49
green onion	1450.88	568.26	1652.41	647.19	1450.88	1383.30
horseradish	2533.23	992.18	2885.10	1130.00	2533.23	2415.24
leek	1450.88	568.26	1652.41	647.19	1450.88	1383.30
lupine, grain	1019.70	399.38	1161.34	454.86	1019.70	972.21
mango	3436.11	1345.81	3913.39	1532.74	3436.11	3276.07
onion	2437.23	954.58	2775.76	1087.17	2437.23	2323.71
ornamental (laws, turf, sod farms), recreation area lawns	5775.65	2262.13	6577.89	2576.34	5775.65	5506.64
ornamentals plants and trees	2681.18	1050.13	3053.59	1195.99	2681.18	2556.30
papaya	1287.38	504.22	1466.20	574.26	1287.38	1227.42
parsnip	1166.65	456.94	1328.70	520.41	1166.65	1112.32
passion fruit	1129.13	442.24	1285.97	503.67	1129.13	1076.54
pistachio	2378.71	931.66	2709.11	1061.07	2378.71	2267.92
potato	1950.00	763.75	2220.85	869.83	1950.00	1859.17
rhubarb	2336.11	914.98	2660.59	1042.07	2336.11	2227.30
rose	2007.54	786.29	2286.39	895.50	2007.54	1914.04
shallot	1494.39	585.30	1701.96	666.60	1494.39	1424.78
strawberry	1357.45	531.67	1546.00	605.52	1357.45	1294.23
tomato	2408.38	943.28	2742.90	1074.30	2408.38	2742.90
yam	1082.38	423.93	1232.72	482.82	1082.38	1031.97

[1] While multiple application scenarios were presented for some crops, in this table, generally only the scenario with the highest EECs are presented.
NA= not applicable

Table 3-6. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Birds and Mammals Derived Using T-REX for SDS-3701: Accounting for direct effects with most sensitive size classes for acute exposure

Use(s), Type of Application[a]	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds of 20g consuming short grass & arthropods)				EECs for Mammals (small mammals of 15 g consuming short grass)	
	Dietary-based EEC (mg/kg-diet)		Dose-based EEC (mg/kg-bw)		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
	Short grass	Arthropod	Short grass	Arthropod		
almond	1185.26	464.23	1349.89	528.71	1185.26	1130.05
apricot, nectarine, peach, plum, prune, stone fruits	822.77	322.25	937.06	367.01	822.77	784.45
asparagus	531.74	208.27	605.60	237.19	531.74	506.98
beans, dried-type, peas, dried-type	378.80	148.36	431.41	168.97	378.80	361.15
beans, succulent (snap)	561.69	219.99	639.70	250.55	561.69	535.52
blueberry	568.47	222.65	647.43	253.58	568.47	541.99
brassica	462.55	181.17	526.80	206.33	462.55	441.01
	485.76	190.26	553.23	216.68	485.76	463.14
broccoli, Brussels sprouts, cabbage, cauliflower	596.36	233.57	679.19	266.02	596.36	568.58
bulb vegetables	378.80	148.36	431.41	168.97	378.80	361.15
carrot	667.44	261.41	760.15	297.73	667.44	636.35
celery	1226.75	480.48	1397.15	547.22	1226.75	1169.61
cherry	839.57	328.83	956.18	374.50	839.57	800.46
christmas tree, conifers, forest trees	1124.12	440.28	1280.26	501.44	1124.12	1071.76
cole crops	305.78	119.77	348.26	136.40	305.78	291.54
commercial/industrial laws	1849.44	724.36	2106.32	824.98	1849.44	1763.30
corn	502.56	196.84	572.37	224.18	502.56	479.15
	514.09	201.35	585.49	229.32	514.09	490.14
cucumber, melon, pumpkin, squash	827.13	323.96	942.02	368.96	827.13	788.61
cucurbit vegetable	810.87	317.59	923.49	361.70	810.87	773.10
filbert (hazelnut)	531.74	208.27	605.60	237.19	531.74	506.98
fruiting vegetables	437.56	171.38	498.33	195.18	437.56	417.18
garlic	764.31	299.36	870.47	340.94	764.31	728.71

ginseng	762.14	298.51	868.00	339.97	762.14	726.64
golf course	2892.12	1132.75	3293.83	1290.08	2892.12	2757.41
	2391.11	936.52	2723.23	1066.60	2391.11	2279.74
	1527.23	598.16	1739.36	681.25	1527.23	1456.09
grass forage, fodder, hay	261.46	102.41	297.78	116.63	261.46	249.28
grass grown for seed	268.67	105.23	305.99	119.85	268.67	256.16
green onion	460.50	180.36	524.46	205.41	460.50	439.05
horseradish	806.03	315.69	917.99	359.54	806.03	768.49
leek	460.50	180.36	524.46	205.41	460.50	439.05
lupine, grain	324.45	127.08	369.52	144.73	324.45	309.34
mango	1096.91	429.62	1249.27	489.30	1096.91	1045.82
onion	774.83	303.47	882.45	345.63	774.83	738.74
ornamental (laws, turf, sod farms), recreation area lawns	1821.36	713.37	2074.35	812.45	1821.36	1736.53
ornamentals plants and trees	857.98	336.04	977.15	382.72	857.98	818.02
papaya	408.60	160.04	465.36	182.27	408.60	389.57
parsnip	371.27	145.41	422.84	165.61	371.27	353.98
passion fruit	358.67	140.48	408.48	159.99	358.67	341.96
pistachio	740.04	289.85	842.84	330.11	740.04	705.57
potato	612.86	240.04	697.98	273.38	612.86	584.31
rhubarb	742.71	290.90	845.87	331.30	742.71	708.12
rose	638.76	250.18	727.49	284.93	638.76	609.01
shallot	441.57	172.95	502.91	196.97	441.57	421.01
strawberry	431.92	169.17	491.91	192.66	431.92	411.80
tomato	764.31	299.36	870.47	340.94	764.31	728.71
yam	361.13	141.44	411.29	161.09	361.13	344.31

3.3.2. Exposure to Terrestrial Invertebrates Derived Using T-REX

T-REX is also used to calculate EECs for terrestrial invertebrates exposed to chlorothalonil from foliar uses. Available acute contact toxicity data for bees exposed to chlorothalonil (in units of µg a.i./bee), are converted to µg a.i./g (of bee) by multiplying 1 bee by 0.128 g (the average weight on an adult honey bee). In this case, the acute contact LD_{50} is >181 µg a.i./bee for the honey bee (*Apis mellifera*, MRID 00077759), which results in an adjusted toxicity value of >1414 µg a.i./g of bee. Dietary-based EECs calculated by T-REX for arthropods (units of µg a.i./g of bee) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. However, as the acute toxicity value for chlorothalonil is a non-definitive value (greater than), RQ values cannot be calculated, so a comparison of the non-definitive value to the EECs was conducted

The exposure values are applicable to direct effects to the BCB and in estimating indirect effects based on reduction in prey to the CCR, SFGS, and CTS. An example output from T-REX v. 1.5.1 is available in **APPENDIX E**.

Table 3-7. Summary EECs Used for Estimating Risk to Terrestrial Invertebrates and Derived Using T-REX ver. 1.5. for Chlorothalonil

Use, Method of Application[a]	Arthropod EEC (in μg a.i./g of bee, or ppm)
almond	1465.98
apricot, nectarine, peach, plum, prune, stone fruits	1019.37
asparagus	657.68
beans, dried-type, peas, dried-type	463.63
beans, succulent (snap)	692.10
blueberry	703.11
brassica	596.31
	569.38
broccoli, Brussels sprouts, cabbage, cauliflower	729.92
bulb vegetables	692.10
carrot	816.92
celery	1514.74
cherry	1052.26
christmas tree, conifers, forest trees	1410.15
cole crops	374.27
commercial/industrial laws	2268.51
corn	615.11
	629.22
cucumber, melon, pumpkin, squash	1025.19
cucurbit vegetable	1118.43
filbert (hazelnut)	657.68
fruiting vegetables	541.19
garlic	943.28
ginseng	932.83
golf course	3587.03
	2965.63
	1883.72
grass forage, fodder, hay	322.56
grass grown for seed	328.84
green onion	568.26
horseradish	992.18
leek	568.26
lupine, grain	399.38
mango	1345.81
onion	954.58

ornamental (laws, turf, sod farms), recreation area lawns	2262.13
ornamentals plants and trees	1050.13
papaya	504.22
parsnip	456.94
passion fruit	442.24
pistachio	931.66
potato	763.75
rhubarb	914.98
rose	786.29
shallot	585.30
strawberry	531.67
tomato	943.28
yam	423.93

Table 3-8. Summary EECs Used for Estimating Risk to Terrestrial Invertebrates and Derived Using T-REX ver. 1.5. for SDS-3701

Use, Method of Application[a]	Arthropod EEC (in μg a.i./g of bee, or ppm)
almond	464.23
apricot, nectarine, peach, plum, prune, stone fruits	322.25
asparagus	208.27
beans, dried-type, peas, dried-type	148.36
beans, succulent (snap)	219.99
blueberry	222.65
brassica	181.17
	190.26
broccoli, Brussels sprouts, cabbage, cauliflower	233.57
bulb vegetables	148.36
carrot	261.41
celery	480.48
cherry	328.83
christmas tree, conifers, forest trees	440.28
cole crops	119.77
commercial/industrial laws	724.36
corn	196.84
	201.35
cucumber, melon, pumpkin, squash	323.96
cucurbit vegetable	317.59
filbert (hazelnut)	208.27
fruiting vegetables	171.38
garlic	299.36
ginseng	298.51
golf course	1132.75
	936.52
	598.16
grass forage, fodder, hay	102.41
grass grown for seed	105.23
green onion	180.36
horseradish	315.69
leek	180.36
lupine, grain	127.08
mango	429.62
onion	303.47
ornamental (laws, turf, sod farms), recreation area lawns	713.37
ornamentals plants and trees	336.04
papaya	160.04
parsnip	145.41

passion fruit	140.48
pistachio	289.85
potato	240.04
rhubarb	290.90
rose	250.18
shallot	172.95
strawberry	169.17
tomato	299.36
yam	141.44

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

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

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

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

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

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

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

Table 3-9. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians and Reptiles Derived Using T-HERPS for Chlorothalonil and SDS-3701: CTS specific

Use(s), Type of Application[a]	App Rate (lb a.i./A), # App, Interval (days)	EEC for Small CTS (2g) (small amphibian 2g consuming small insects)		EEC for Medium CTS (20g) (medium amphibian 20g consuming small/medium herbivorous mammals of 1.33g/13.33)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)[b]	Dose-based EEC (mg/kg-bw)
Chlorothalonil					
grass grown for seed[c]	1.5,3,14	472.27	26.23	2299.63 / 842.67	561.78
golf course (greens)	11.4,6,14; 4.6, 1, NA[d]	5151.59	286.10	25084.58 / 9191.93	6127.95
SDS-3701					
grass grown for seed	0.48,3,14	151.13	8.39	735.88 / 269.65	179.77
golf course (greens)	3.6,6,14; 1.5, 1, NA[d]	1635.85	90.85	7921.45 / 2902.72	1935.14

[a] See Table 3-4 for details on the uses.
[b] First EEC is for small-sized herbivorous mammal (of 1.33g) and the second EEC is for medium-sized herbivorous mammal (of 13.33g)
[c] The use on grass forage, fodder and hay resulted in the lowest EECs, slightly less than grass grown for seed. As T-HERPS cannot model different application rates, grass grown for seed was reported. If the RQ values are manually calculated for grass forage, fodder and hay using the maximum allowable rates, it results in the same RQs as grass for seed use.
[d] T-HERPS cannot model different application rates, therefore, for the golf course scenario, the last application of 4.6 or 1.5 lb a.i./A was not included. This exclusion of the last 4.6 or 1.5 lb a.i./A will not affect the risk conclusions.

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.[30] 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).

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

[30] 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.

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

EECs in T-HERPS that are applicable to the SFGS are small (2 g, juveniles) snakes consuming small and large insects and medium (20 g) snakes consuming small and large insects, small herbivorous and insectivorous mammals, and amphibians. The most sensitive EECs and RQs for SFGS are for the medium animal consuming small herbivorous mammals. EECs calculated using T-HERPS for the SFGS are shown in Table 3-10.

Table 3-10. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians and Reptiles Derived Using T-HERPS for Chlorothalonil and SDS-3701: SFGS specific

Use(s), Type of Application[a]	App Rate (lb a.i./A), # App, Interval (days)	EEC for Small SFGS (2g) (small reptile 2g consuming small insects)		EEC for Medium SFGS (20g) (medium reptile 20g consuming small/medium herbivorous mammals of 2.10g/24.74g)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)[b]	Dose-based EEC (mg/kg-bw)
Chlorothalonil					
grass grown for seed[c]	1.5,3,14	472.27	26.23	1886.09 / 643.59	796.12
golf course (greens)	11.4,6,14; 4.6, 1, NA[d]	5151.59	286.10	20573.70 / 7020.31	8684.19
SDS-3701					
grass grown for seed[c]	0.48,3,14	151.13	8.39	603.55 / 205.95	254.76
golf course (greens)	3.6,6,14; 1.5, 1, NA[d]	1635.85	90.85	6496.96 / 2216.94	2742.38

[a] See Table 3-4 for details on the uses.
[b] First EEC is for small-sized herbivorous mammal (of 2.10g) and the second EEC is for medium-sized herbivorous mammal (of 24.74g)
[c] The use on grass forage, fodder and hay resulted in the lowest EECs, slightly less than grass grown for seed. As T-HERPS cannot model different application rates, grass grown for seed was reported. If the RQ values are manually calculated for grass forage, fodder and hay using the maximum allowable rates, it results in the same RQs as grass for seed use.
[d] T-HERPS cannot model different application rates, therefore, for the golf course scenario, the last application of 4.6 or 1.5 lb a.i./A was not included. This exclusion of the last 4.6 or 1.5 lb a.i./A will not affect the risk conclusions.

3.4. Terrestrial Plant Exposure Assessment

TerrPlant (Version 1.1.2) is used to calculate EECs for non-target plant species inhabiting dry and semi-aquatic areas. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method (**Table 3-4**). A runoff value of 0.01 is utilized based on chlorothalonil's solubility, which is classified by TerrPlant as <10 mg/L. For aerial and ground application methods, drift is assumed to be 5% and 1%, respectively. EECs relevant to terrestrial plants consider pesticide concentrations in drift and in runoff. EECs for the uses with the highest and lowest EECs are presented in **Table 3-11**. An example output from TerrPlant v.1.2.2 is available in **Appendix F**.

Table 3-11. TerrPlant Inputs and Resulting EECs for Plants Inhabiting Dry and Semi-aquatic Areas Exposed to Chlorothalonil and SDS-3701 via Runoff and Drift

Use (Formulation)	Application rate (lbs a.i./A)	Application method	Drift Value (%)	Spray drift EEC (lbs a.i./A)	Dry area EEC (lbs a.i./A)	Semi-aquatic area EEC (lbs a.i./A)
Chlorothalonil						
Yam (liquid)	0.94	Foliar – aerial	5	0.047	0.0564	0.141
ornamental (laws, turf, sod farms), recreation area lawns (liquid)	11.4	Foliar – aerial	5	0.57	0.684	1.71
SDS-3701						
Yam (liquid)	0.30	Foliar – aerial	5	0.015	0.018	0.045
ornamental (laws, turf, sod farms), recreation area lawns (liquid)	3.6	Foliar – aerial	5	0.18	0.216	0.54

4. Effects Assessment

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

As described in the Agency's Overview Document (USEPA, 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include freshwater fish (used as a surrogate for aquatic-phase amphibians), freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrates, 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 open literature (where available) on chlorothalonil.

This section summarizes the ecotoxicity data available on chlorothalonil and SDS-3701. Chlorothalonil is very highly toxic to freshwater and estuarine/marine fish; it is very highly toxic to freshwater and marine/estuarine invertebrates on an acute exposure basis. The compound has effects on a chronic basis as well for freshwater fish and invertebrates (effects are observed at concentrations 0.6- 1.3 µg a.i./L). The 5-day EC_{50} and NOAEC values for the aquatic non-vascular plants (*Navicula pelliculosa*) are 12 and 3.9 µg a.i./L, respectively. The aquatic vascular plant 7-day EC_{50} and NOAEC values are 640 and 290 µg a.i./L. Acceptable chronic toxicity tests are not available for estuarine/marine invertebrates and a chronic toxicity study for estuarine/marine fish is not available. Chlorothalonil is practically non-toxic on an acute oral and subacute dietary exposure basis, respectively, to birds. It is also practically non-toxic to mammals on an acute oral exposure basis. Chlorothalonil has reproductive effects on birds and mammals, affecting number of eggs produced as well as pup body weight in subsequent generations at 153 (bird) and 1500 (rat) mg a.i./kg-diet concentrations, respectively. Chlorothalonil is classified as practically non-toxic to honey bees on an acute contact exposure basis. The EC_{25} for terrestrial plants for both seedling emergence and vegetative vigor was > 16 lb a.i./A, the only concentration tested. However, the NOAEC for both the seedling emergence and vegetative vigor is <16 lb a.i./A. There was a 26% inhibition in growth for onion in the seedling emergence study and a 26% inhibition in growth for cucumber in the vegetative vigor study at 16 lb a.i./A when compared to the negative control.

SDS-3701 is the major degradate product of chlorothalonil, and toxicity data are available for some taxa. Acute toxicity data indicate that SDS-3701 is moderately toxic to very highly toxic (more toxic than parent) to small mammals (oral LD_{50} = 242 mg/kg-bw, rat acute) and is slightly toxic to moderately toxic (more toxic than parent) to birds (LD_{50} = 158 mg/kg-bw, mallard duck acute oral toxicity; 1746 ppm, bobwhite quail sub-acute dietary toxicity). For the aquatic data available, SDS-3701 is sightly toxic to moderately toxic (less toxic than parent) to aquatic organisms (96-hr LC_{50} = 9.2 ppm, bluegill sunfish; 48-h EC_{50} = 26 mg/L, daphnia) and less toxic than parent to algae (EC_{50} = 33.7 mg/L). Chronic reproduction data for SDS-3701 are available for birds (NOAEC = 50 mg a.i./kg-diet, mallard duck, based on reduced egg-shell thickness) and mammals (NOAEC = 6 mg/kg-bw, rat, no effects at highest concentration tested).

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 originally compiled during several searches (*i.e.,* March 2004, April 2006, June 2007 and 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.

The ECOTOX open literature summary table is provided in **APPENDIX I**. The list of citations including toxicological and/or efficacy data on target species (*e.g.,* fungal plant pathogens) not considered in this assessment is provided in **Appendix H**.

Data that pass the ECOTOX screen are evaluated along with the registrant-submitted data, and may be incorporated qualitatively or quantitatively into this endangered species assessment. In general, effects data in the open literature that are more conservative than the registrant-submitted data are considered. The degree to which open literature data are quantitatively or qualitatively characterized for the effects determination is dependent on whether the information is relevant to the assessment endpoints (*i.e.*, survival, reproduction, and growth) identified in Section 2.10. For example, endpoints such as behavior modifications are likely to be qualitatively evaluated, because quantitative relationships between modifications and reduction in species survival, reproduction, and/or growth are not available. Although the effects determination relies on endpoints that are relevant to the assessment endpoints of survival, growth, or reproduction, it is important to note that the full suite of sublethal endpoints potentially available in the effects literature (regardless of their significance to the assessment endpoints) are considered, as they are relevant to the understanding of the area with potential effects, as defined for the action area.

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

A detailed spreadsheet of the available ECOTOX open literature data, including the full suite of lethal and sublethal endpoints is presented in **APPENDIX I**. Human health data are presented in **Appendix K**.

In addition to registrant-submitted and open literature toxicity information, other sources of information, including use of the acute probit dose response relationship to establish the probability of an individual effect and reviews of ecological incident data, are considered to further refine the characterization of potential ecological effects associated with exposure to chlorothalonil. A summary of the available aquatic and terrestrial ecotoxicity information and the incident information for chlorothalonil are provided in Sections 4.1 through 4.4.

4.2. Toxicity of Chlorothalonil and SDS-3701 to Aquatic Organisms

Table 4-1 summarizes the most sensitive aquatic toxicity endpoints used in the assessment, 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 SFGS, CCR, CTS, DS, CFWS, and TG is presented below. Additional information is provided in **APPENDIX G**.

Table 4-1. Aquatic Toxicity Profile for Chlorothalonil (Most Sensitive Endpoints)

Species	Taxa Represented	Toxicity Value	MRID # / ECOTOX #	Classification	Comment
Rainbow trout *Oncorhynchus*	Freshwater fish and aquatic-phase	96-hr LC_{50} = 18 µg a.i./L	45710219	Acceptable	Slope = 5.58 (2.79 – 8.37)

mykiss	amphibians	96-hr LC50 = 10.5 µg a.i./L	Ecotox 87454;7055	Qualitative	Co-stressor of reduced dissolved oxygen present
Fathead minnow *Pimephales promelas*		NOAEC = 1.3 µg a.i./L	00030391	Supplemental	
Daphnid (*Daphnia magna*)	Freshwater invertebrates	48-hr EC_{50} = 54 µg a.i./L	45710221	Acceptable	Slope = 4.57 (3.12 – 6.02)
		NOAEC = 0.6 µg a.i./L	45710222	Supplemental	The LOAEC is 0.002 mg a.i./L based reduced survival.
Zebra mussel (*Dreissena polymorpha*)	Freshwater invertebrates	48-hr EC_{50} = 0.97 µg a.i./L	E156417 (Faria *et al.* 2010)	Qualitative	Based on embryonic development [1]
Sheepshead minnow (*Cyprinodon variegatus*)	Estuarine/marine fish	No acceptable study available[2]			
		No data available[3]			
Eastern oyster (*Crassostrea virginica*)	Estuarine/marine invertebrates	96-hr EC_{50} = 3.6 µg a.i./L	00138143	Acceptable	Shell deposition study
Northern pink shrimp (*Penaeus duorarum*)		96-hr LC_{50} = 154 µg a.i./L	00127864	Supplemental	A slope could not be determined
		NOAEC = 1.7 µg a.i./L	N/A	N/A	Based an acute to chronic ratio (ACR) using acute and chronic data from Daphnia and acute data from the Northern pink shrimp
Grass shrimp (*Palamonetes pugio*)		96-hr LC_{50} = 49.5 µg a.i./L	E101032; (Key *et al.* 2003)	Qualitative	Open-literature study[4]
Non-vascular aquatic plants (*Navicula pelliculosa*)		5-dayEC_{50} = 12 µg a.i./L NOAEC = 3.9 µg a.i./L	44908105	Acceptable	Based on area under curve
(*Thalassiosira pseudonana*)		96-hr EC_{50} = 4.4 µg a.i./L	E156339 (Bao *et al.* 2011)	Qualitative	Based on growth rate; Open-literature study[5]
Vascular aquatic plants (*Lemna gibba*)		7-d EC_{50} = 640 µg ai/L NOAEC = 290 µg ai/L	44908102	Acceptable	(based on dry wt)
(*Elodea nuttallii*)		21-day EC50 = 94 µg a.i./L	E108046 (Belgers *et al.* 2009)	Qualitative	Based on length of new shoots[6]

[1] Open literature study, for qualitative use only due to: 1) raw data not provided; unclear about sample size used to calculate EC50.
[2]A study with sheepshead minnow was available (MRID 00127863) however, the endpoint value is for qualitative use only.
[3] An early life-stage toxicity study with estuarine/marine fish is not available. Therefore, a chronic NOAEC was calculated using freshwater fish data. The calculated chronic NOAEC for sheepshead minnow was 2.7 µg a.i./L
[4] Open literature study, for qualitative use only due to: 1) raw data not provided; 2) no negative control group only solvent (acetone,0.1%); control performance difficult to interpret. Additional studies conducted with (*P. pugio*), whereas salinity and temperature were increases as co-stressor for larval shrimp and 96-hr LC50 values were 39.4 µg/L and higher with 95% confidence intervals overlapping value above (E1202220); higher temperatures also resulted in higher control mortality.
[5] Open literature study, for qualitative use only due to: 1) raw data not provided; 2) DMSO (<1%) used as a solvent carrier; 3) test volumes of 5mL used; 4) nominal test concentrations used. 96% CI's overlap *Navicula* value.
[6] Several submerged macrophytes were tested for 21-day exposed to a chlorothalonil formulation and analyzed for several growth endpoints whereas several species reported EC50 values for relative growth lower than the 7-day Lemna value. The most sensitive species and endpoint is reported in table. If comparing based on biomass (dry weight), all the test species 21-day EC50 were greater than Lemna. For qualitative use due to: 1) raw data not reported; 2) only initial measured concentrations available for one series of tests (which include the most sensitive endpoint);3) it is not known if formulation tested (study conducted in Europe) accurately reflects a U.S. formulation.

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

SDS-3701 is the major degradate product of chlorothalonil and toxicity data are available for some taxa. For the aquatic data available, SDS-3701 is sightly toxic to moderately toxic (less toxic than parent) to aquatic organisms (96-hr LC_{50} = 9.2 mg/L, bluegill sunfish; 48-h EC_{50} = 26 mg/L, daphnia) and less toxic than parent to algae (EC_{50} = 33.7 mg/L). Chronic reproduction data for SDS-3701 are not available for aquatic organisms.

4.2.1. Fish Toxicity Data

There are several acute freshwater fish toxicity studies available. The reported 96-h LC_{50} values for freshwater fish range from 10.5 to 120 µg a.i./L. For the study with the most sensitive 96-h LC_{50} value of 10.5 µg a.i./L using rainbow trout, a co-stressor of reduced oxygen (*ca*. 50% of saturation) was used in the study (Ecotox 87454;7055); therefore, this study was deemed not appropriate for use in the risk estimation (risk quotient) evaluation. However, it will be used during the risk description/characterization of chlorothalonil for freshwater fish. The second most sensitive study, which also used rainbow trout, reported a 96-h LC_{50} value of 18 µg a.i./L and this value will be used to calculate the risk quotient (MRID 45710219). In this study, swimming and/or hanging at the surface, lethargy, loss of equilibrium, and/or moribundity were observed in surviving fish from the ≥17.7 µg a.i./L groups; effects were first observed within 6 hours of exposure and continued through 96 hours in groups with surviving fish. The observed NOEC (for mortality and sub-lethal effects) was 8.5 µg a.i./L. A 96-hour LC_{50} value was determined during the chronic fathead minnow study discussed below, and was determined to be 16 µg a.i./L, however due to uncertainties regarding actual exposure as measurements were not collected during the in-life phase of the study it was not used in the acute RQ calculation. The use of an acute LC_{50} value between 10.5-18 µg a.i./L is not anticipated to influence the overall conclusions on potential acute risk to freshwater fish.

Regarding chronic exposure, toxicity data are available for freshwater fish. No toxicity data from chronic exposure to chlorothalonil are available for the most acutely sensitive freshwater fish species, rainbow trout (*Oncorhynchus mykiss*) (LC_{50} = 18 µg a.i./L) (MRID 45710219). Therefore, an acute-to-chronic ratio (ACR) is used to calculate a chronic freshwater fish endpoint using acute and chronic data from the fathead minnow (for which both acute and chronic toxicity data are available). The most sensitive no observed adverse effect concentration (NOAEC) for freshwater fish [fathead minnows (*Pimephales promelas*)] is 1.3 µg a.i./L (MRID 00030391), based on a reduction in fecundity; this study is classified as Supplemental due to replicate size and solvent control mortality. The ACR for fathead minnow, *i.e.* ACR = 12.3, results in a NOAEC of 1.5 µg a.i./L for rainbow trout [(18)/(12.3) = 1.5]. Therefore, the chronic NOAEC value of 1.3 µg a.i./L for the fathead minnow is used in this assessment to evaluate chronic risk.

For estuarine/marine fish, an acute toxicity study is available for sheepshead minnow (*Cyprinodon variegates*) with a reported 96-hour LC_{50} of 33 µg a.i./L conducted under static conditions; however, this value was used qualitatively given uncertainties regarding actual exposure concentrations as test concentrations were not measured in the study (MRID 00127863). Additionally, an early life-stage toxicity study with estuarine/marine fish is not available. As such, a chronic NOAEC value was determined using the fathead minnow data and the qualitative LC_{50} value, but this value is also only for qualitative use. The calculated chronic NOAEC for sheepshead minnow was 2.7 µg a.i./L.

Fish were used as surrogates for aquatic-phase CTS to evaluate acute and chronic direct effects from exposure to chlorothalonil. A study that examined lethality for three species of amphibians for 10 days exposed to chlorothalonil under semi-static conditions was available (McMahon et al., 2012, ECOTOX # E156144). Amphibian species, *Rana sphenocephala*, *Osteopilus septentrionalis*, and *Hyla cinerea* (Gosner stage 25) were exposed to nominal technical chlorothalonil concentrations ranging from 0.0164, 0.164, 1.64, 16.4, 82.0, or 164µg/L in addition to negative and solvent (acetone) controls for 10-days in which the test solutions were changed on day 7. The concentration of the stock used to prepare the test solutions was measured in a previous study; however, the test solutions were not measured in the study. At the highest treatment group, 164 µg/L, 100% of the tadpoles were dead by Day 10. The mortality response in *R. sphenocephala* and *H. cinerea* was not monotonic with significantly more mortality exhibited for *R. sphenocephala* and *H. cinerea* at respective treatment levels of 0.164 µg/L or 0.0164 µg/L exhibited significantly more mortality than adjacent concentrations. Based on the figures provided in the study, after 10 days of exposure, it appears that control survival was 80% or greater, and that the survival in the treatment groups for *R. sphenocephala*, *O.*

septentrionalis, and *H. cinerea* ranged from 0-55%, 0-90%, and 0-70%, respectively. For *O. septentrionalis*, and *H. cinerea*, the use of the acute 96-hr toxicity value for rainbow trout appears to be protective; however, this may not be true for *R. sphenocephala*. Given the reported variation in response in this study around the 100 hour timepoint, there is uncertainty in this comparison. The study also examined amphibian mortality under a mesocosm scenario at chlorothalonil levels of 164 µg/L and 328 µg/L, and mortality was significantly greater at both concentrations compared to the control. As this study evaluated mortality over a 10-day exposure, and did not evaluate other sublethal endpoints (*i.e*., growth) and the study was not conducted over chronic exposure duration (*i.e*., such as the early-life stage toxicity test with fish), there is uncertainty in whether the chronic toxicity value for fish is conservative for aquatic-phase amphibians.

4.2.2. Aquatic Invertebrate Toxicity Data

In the most sensitive acute endpoint acceptable for RQ calculation, exposure to chlorothalonil for the water flea (MRID 45710221) indicated a 48-hour EC_{50} of 54 µg a.i./L based on immobility of the test organisms. Cumulative immobility was 0% in the negative and solvent control groups, and 0, 0, 5, 5, 40, 100, 95, 100, and 100% in the mean-measured concentration 5.1, 9.3, 16.9, 31.6, 51.5, 95.2, 169.5, 286.7, and 491.6 µg a.i./L test groups.

A paper by Faria *et al*., 2010, (E156417) reported an estimated 48-hour EC_{50} of 0.97 µg/L for chlorothalonil for zebra mussels (*Dreissena polymorpha*) based on embryonic development; however, raw data were not available and there was uncertainty in the reported sample size used in the EC_{50} calculation. This reported 48-hr EC_{50} is lower than the EECs for all uses.

There were also additional acute toxicity data available for freshwater invertebrates. Some of these studies are discussed in the Risk Description section (5.2) and are presented in **Appendix G**.

A 21-day life-cycle toxicity study of *Daphnia magna* resulted in a NOAEC of 0.6 µg. a.i./L and a LOAEC of 1.8 µg a.i./L based on reduced survival (MRID 45710222). There was a significant Inhibitory effect on reproduction (number of live young/adult) at the 75 µg a.i./L test level. Terminal growth measurements were not performed. No other sub-lethal effects were noted at any other concentration. This study is classified as Supplemental based on instability of the test substance as measured concentrations were below detection for several concentrations at the end of a renewal period. Given that the study was conducted as a static renewal, non-detection levels were accounted for in the concentration estimates by using a value of zero for the non-detects [i.e., the compound was unstable between media renewal intervals, and the shape of the decline curve for the chemical is unknown].

For estuarine/marine invertebrates, the most acutely sensitive species tested is the Eastern oyster (*Crassostrea virginica*, MRID 00138143) based on a reduction in shell deposition (96-hour IC_{50} = 3.6 µg a.i./L).

Acceptable chronic toxicity data are not available for estuarine/marine invertebrates, and therefore an ACR was used to determine a chronic NOAEC using toxicity data from the *Daphnia magna*. Since it is not appropriate to apply an ACR that was derived using acute mortality data to acute toxicity data on shell growth, the ACR approach was applied using acute data from the penaeid shrimp (*Penaeus duorarum*) with an 96-hour LC_{50} value of 154 µg a.i./L (MRID 00127864). The most sensitive no observed adverse effect concentration (NOAEC) and acute EC_{50} value for *Daphnia magna* is 0.6 and 54 µg a.i./L, respectively. The ACR for *Daphnia magna*, *i.e*. ACR = 90, results in a NOAEC of 1.7 µg a.i./L for the penaeid shrimp [(154)/(90) = 1.7].

4.2.3. Aquatic Plant Toxicity Data

A chlorothalonil toxicity test with the aquatic vascular plant, *Lemna gibba*, is available and the 7-day EC_{50} value is 640 µg a.i./L, based on dry weight (MRID 44908102). The NOAEC is 290 µg a.i./L. In addition, the study authors reported toxic symptoms, such as discolored leaves, reduced root growth, and small frond size in concentrations of 71 µg/L and higher from Day 2 onward. By the end of the experiment, similar symptoms were observed at the two lowest concentrations, 17 µg/L and 35 µg/L.

The most sensitive 5-day EC_{50} endpoint values for the freshwater (*Navicula pelliculosa*) and marine diatom (*Skeletonema costatum*) were similar with values of 12 µg a.i./L and 14 µg a.i./L, respectively, with a NOAEC value of 3.9 µg a.i./L for the marine diatom (MRID 44908105; 44908103).

4.2.4. Cosm Toxicity Data

In the paper by Ernst, 1991 (MRID 44286001), spraying of ponds at 875 g a.i./ha (0.78 lb a.i./A) resulted in mortality of caged water boatmen (*Sigara alternate*) and threespine stickleback (*Gasterosteus aculeatus*) which could be related to chlorothalonil exposure. However, caddisfly larvae (*Limnephilus* spp.), freshwater clams (*Psidium* spp.), water beetles (*Haliplus* spp.), scud (*Gramarus* spp.) and midge larvae (Chironomidae) did not suffer substantial chlorothalonil induced mortality. Changes in endemic benthic invertebrate abundance after sprays were not remarkable or related to treatment. Faunal impacts on the pond were generally of smaller magnitude than were predicted by bioassay results. Factors such as dilution, adsorption to suspended particles and microbial degradation are thought to have attenuated the initial pond concentrations of chlorothalonil, thereby reducing the toxicity.

4.3. Toxicity of Chlorothalonil and SDS-3701 to Terrestrial Organisms

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

Table 4-3. Terrestrial Toxicity Profile for Chlorothalonil and SDS-3701

Species	Taxa Represented	Toxicity Value	MRID #	Classification	Comment
Chlorothalonil					
Bobwhite quail (*Colinus virginianus*)	Birds, reptiles, and terrestrial-phase amphibians	LC_{50} > 10,000 mg/kg-diet	00039146	Acceptable	
		NOAEC = 153 mg a.i./kg-diet	45710218	Acceptable	LOAEC = 624 mg a.i./kg-diet, based on reduction in number of eggs produced
Mallard duck (Anas platyrhynchos)		LD_{50} >4640 mg/kg-diet	00068753	Acceptable	
Laboratory rat (*Rattus norvegicus*)	Mammals	LD_{50} >10,000 mg a.i./kg-bw	00094941	Acceptable	
Laboratory rat		NOAEL = 1,200 mg a.i./kg-diet (92.5 mg a.i/kg-bw) LOAEL = 3,000 mg a.i./kg-diet	45710209	Acceptable	NOAEL based on decreases in pups body weights
Honey bee (*Apis mellifera*)	Terrestrial invertebrates	LD_{50} >181 µg a.i./bee	00077759	Acceptable	No mention of mortality or sublethal effects in report
Terrestrial Plants					
Seed germination/seedling emergence–Tier 1 (10 species)		EC_{25} = >16 lb a.i./A[1] NOAEL < 16 lb a.i./acre (for onion and soybean)	42433808	Acceptable	26% inhibition (growth) for onion compared to control
Vegetative vigor–Tier 1 (10 species)		EC_{25} = >16 lb a.i./A[1] NOAEL < 16 lb a.i./acre (for cucumber and oat)	42433809	Acceptable	26% inhibition (growth) for cucumber compared to control
SDS-3701					
Bobwhite quail (*Colinus virginianus*)	Birds, reptiles, and terrestrial-phase amphibians	LC_{50} = 1746 mg/kg-diet	00115109	Acceptable	
Mallard duck (*Anas platyrhynchos*)		LD_{50} = 158 mg/kg-diet	00030395	Acceptable	
		NOAEC = 153 mg a.i./kg-diet	40729402	Acceptable	Based on reduced egg-shell thickness
Laboratory rat (*Rattus norvegicus*)	Mammals	LD_{50} =242 mg a.i./kg-bw	00001098	Acceptable	
Laboratory rat		1-generation NOAEL = 6 mg/kg-bw (120 mg a.i./kg-diet) **SDS-3701** No LOAEL	40729402	Acceptable	No effect at highest concentration tested

Species	Taxa Represented	Toxicity Value	MRID #	Classification	Comment
Chlorothalonil					
		3-generation NOAEL = 6.25 mg/kg-bw (125 mg a.i./kg-diet) **SDS-3701** No LOAEL			
bw = body weight [1] EC_{25} >16 lb a.i./A for all species except for potentially one each for seedling emergence and vegetative vigor as a 26% decrease in growth was observed in one species for each test. As study was conducted as a limit test, with only one concentration tested, a calculated dose-response EC_{25} could not be derived for the onion and cucumber.					

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

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

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

Chlorothalonil is classified as practically non-toxic to birds, mammals, and honey bees on an acute exposure basis. Chlorothalonil has reproductive effects on birds and mammals, affecting number of eggs produced as well as pup body weight in subsequent generations at 153 (bird) mg a.i./kg-diet and 1200 (rat) mg a.i./kg-diet concentrations, respectively. Chlorothalonil is classified as practically non-toxic to honey bees on an acute contact exposure basis. The EC_{25} for terrestrial plants for the majority of species tested in both seedling emergence and vegetative vigor was > 16 lb a.i./A, the only concentration tested, with the following exceptions, there was a 26% inhibition in growth for onion in the seedling emergence study and a 26% inhibition in growth for cucumber in the vegetative vigor study at 16 lb a.i./A when compared to the negative control. Additionally, there was a significant difference in growth between the limit concentration and the control for soybean in the seedling emergence study and for oat in the vegetative vigor study. As such, the NOAEC for both the seedling emergence and vegetative vigor is <16 lb a.i./A.

For SDS-3701, acute toxicity data indicate that it is moderately toxic to very highly toxic (more toxic than parent) to small mammals (oral LD_{50} = 242 mg/kg-bw, rat acute) and is slightly toxic to moderately toxic (more toxic than parent) to birds (LD_{50} = 158 mg/kg-bw, mallard duck acute oral toxicity; 1746 ppm, bobwhite quail sub-acute dietary toxicity). Chronic reproduction data for SDS-3701 are available for birds (NOAEC = 50 mg a.i./kg-diet, mallard duck, based on reduced egg-shell thickness) and mammals (NOAEC = 6 mg/kg-bw, rat, no effects at highest concentration tested).

4.4. 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. 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 (U.S., EPA 2004; USFWS/NMFS 2004).

Chlorothalonil has registered products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **APPENDIX A**. The results of this analysis show that an assessment based on the toxicity of the single active ingredient of chlorothalonil is appropriate; the analysis indicated that the available data was insufficient to establish a difference in toxicity between the parent and the multiple active ingredient formulations. Therefore, there is uncertainty regarding the extent to which the multiple active ingredient formulations may be more toxic than parent chlorothalonil.

In addition, aquatic toxicity data was available for some of the multiple active ingredient formulations for chlorothalonil (*e.g.,* propiconazole and azoxystrobin). The remaining chlorothalonil formulations only contain a single active ingredient (*i.e*., chlorothalonil). Available toxicity data for aquatic freshwater animals did not show any significant differences between formulated commercial products and the technical active ingredient. For species in which comparative data are available, the confidence intervals of the toxicity endpoints for freshwater fish and invertebrates exposed to the TGAI and formulated chlorothalonil overlap, thereby toxicity differences between chlorothalonil TGAI and formulated chlorothalonil could not be distinguished, for freshwater animals (see **APPENDICES G, I, and J**). Toxicity data for birds are only available for the TGAI. For a study conducted using marine phytoplankton, *Dunaliella tertiolecta*, it was reported that a mixture of chlorothalonil and atrazine (1:1 ratio) were 1.83 times more toxic (based on growth rate) than in the individual toxicity tests using the Additive Index and Magnification Factor methodology (DeLorenzo and Serrano, 2003; E92068); a negative control group was not used in the study, only a solvent control (acetone, 0.1%), therefore, there is uncertainty in whether the solvent influenced the response. Additionally, brine shrimp, *Artemia salina*, were exposed to chlorothalonil and mixtures for 24-hours (using the Artoxkit M and DMSO (0.5%) as a co-solvent), and it was reported that a tertiary mixture of chlorothalonil, zinc pyrithione, and copper pyrithione exhibited synergism as well as a mixture of the previous three as well as diurnon as calculated using the mixture toxicity index and/or toxic unit summation methodology (Koutsaftis and Aoyama, 2007; E101947); however, binary mixtures of chlorothalonil and the above mentioned chemicals and other tertiary mixtures resulted in less than additive or antagonist results. As a result, the risk analyses were conducted using the most sensitive endpoint determined from toxicity studies using technical active ingredient.

4.5. Incident Database Review

Reviews of the Ecological Incident Information System (EIIS, version 2.1) and the Avian Incident Monitoring System (AIMS)[31] were conducted on November 5, 2012. There are 36 chlorothalonil incidents reported in the EIIS (see Table 4-5). The reported incidents occurred between 1976 and 2003. In three of the incidents, chlorothalonil was reported as "unlikely" in the cause of the incident. Six of the incidents involved misuses or spills. In the remaining 27 incidents, the legality of use was either a registered use (5) or undetermined (21) and the certainty index was possible (24) or highly probable (2). Of these 27 incidents, 8 involved aquatic animals, 4 involved terrestrial animals, and 15 involved plant damage. There were no additional incidents identified in the AIMS database for chlorothalonil.

Due to limitations with data in the EIIS, a low number or lack of reported incidents in the database cannot be construed as evidence that additional incidents have not occurred. Incident reports for non-target plants and animals typically provide information on mortality events only. Reports for other adverse effects, such as reduced growth or impaired reproduction, are rarely received. EPA's changes in the registrant reporting requirements of incidents may also account for the reduced number of reported incidents. Registrants are now only required to submit detailed information on 'major' incidents. Minor incidents are generally reported aggregately and are not included in EIIS. In addition, there have been reductions in state monitoring efforts due to lack of resources.

Table 4-5. Summary of Incidents Reported in EIIS

Type	Incident ID	Year	Legality	Certainty
AQUATIC	B000637-001	1976	Undetermined	Highly Probable
AQUATIC	I000636-014	1984	Undetermined	Possible
AQUATIC	B0000-500-15	1989	Registered use	Possible
TERRESTRIAL	I000103-008	1990	Undetermined	Unlikely
PLANTS	I003377-013	1993	Misuse (accidental)	Highly Probable
AQUATIC	I002200-001	1994	Registered use	Possible
AQUATIC	I003596-001	1994	Undetermined	Possible
PLANTS	I014406-002	1996	Misuse	Possible
AQUATIC	I012265-006	1996	Undetermined	Possible
AQUATIC	I007372-007	1997	Misuse (accidental)	Probable
PLANTS	I014597-011	1998	Registered use	Possible
PLANTS	I007340-625	1998	Undetermined	Possible
PLANTS	I007340-629	1998	Undetermined	Possible
PLANTS	I007340-631	1998	Undetermined	Possible
PLANTS	I007340-628	1998	Undetermined	Possible
PLANTS	I007340-630	1998	Undetermined	Possible
PLANTS	I007340-632	1998	Undetermined	Possible
PLANTS	I014597-010	1998	Registered use	Possible
PLANTS	I007340-638	1998	Undetermined	Possible
PLANTS	I007340-686	1998	Undetermined	Possible
PLANTS	I007340-693	1998	Misuse (intentional)	Possible
PLANTS	I007340-712	1998	Undetermined	Possible
TERRESTRIAL	I013884-010	1998	Undetermined	Highly Probable
TERRESTRIAL	I014341-034	1999	Undetermined	Possible

[31] http://www.abcbirds.org/abcprograms/policy/pesticides/aims/aims/index.cfm

TERRESTRIAL	I014341-033	1999	Undetermined	Possible
TERRESTRIAL	I013587-012	1999	Undetermined	Possible
PLANTS	I009262-115	1999	Undetermined	Possible
AQUATIC	I017028-001	2000	Undetermined	Possible
PLANTS	I011838-111	2001	Undetermined	Possible
PLANTS	I011942-002	2001	Undetermined	Possible
PLANTS	I013550-002	2001	Registered use	Possible
TERRESTRIAL/AQUATIC	I011988-008	2001	Misuse (accidental)	Possible
AQUATIC	I014538-013	2003	Spill	Possible
AQUATIC	I022024-001	2010	Undetermined	Possible
The shaded incidents will not be considered in the risk assessment because they involve misuses or incidents unlikely caused by chlorothalonil.				

In addition to the incidents recorded in EIIS and AIMS, additional incidents have been reported to the Agency in aggregated incident reports, within the US EPA Office of Pesticide Programs Incident Data System. Pesticide registrants report certain types of incidents to the Agency as aggregate counts of incidents occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as 'minor fish and wildlife' (W-B), 'minor plant' (P-B), and 'other non-target' (ONT) incidents. 'Other non-target' incidents include reports of adverse effects to insects and other terrestrial invertebrates. For chlorothalonil, as of November 5, 2012 registrants have reported 6 minor fish and wildlife incidents and 406 minor plant incidents, all of which occurred between 1995 and 2012, most of which have reported dates of 1995. The number of individual organisms affected in these incidents was not specified. Unless additional information on these aggregated incidents becomes available, they are assumed to be representative of registered uses of chlorothalonil in the risk assessment.

4.5.1. Terrestrial Incidents

All four of the terrestrial incidents involved honeybees; however it was undetermined whether the exposure resulted from a registered use of chlorothalonil. The use site was not reported in three of the incidents and was reported as alfalfa in the other (I03587-012). In I013884-010, it was reported that 500 colonies in the vicinity were affected (based on mortality) based on spray drift and that it was highly probable that it was due to chlorothalonil. For the other three reported incidents (I014341-033, I014341-034 and I03587-012), the certainty was reported as possible and the effects were also reported as mortality and ranged from 30 hives to 200 hives affected.

4.5.2. Plant Incidents

In 12 of the reported 15 plant incidents, it was undetermined whether the incidents were from a registered use, and the level of certainty was reported as "possible" for all 15 plant incidents. In nine of the 15 incidents, the use was reported as direct treatment of home lawn or trees, and the response was reported as mortality and/or plant damage. An additional incident was reported for residential use in which plant damage was reported for ornamentals that were treated directly (I007340-686). All of the plant incidents were reported in 1998 and 1999. An incident on conifers (I014597-011, 1998) was reported as a registered use which was treated directly and reported plant damage to 80 acres. Two incidents on peanuts were reported in 2001 (I011838-111, I011942-002), in which one was for a registered use and one was undetermined with plant damage reported after direct treatment and a magnitude of 26 acres. The final incident was for potatoes treated directly with associated plant damage reported on 65 acres (I013550-002).

4.5.3. Aquatic Incidents

For the aquatic incidents, two of the eight were reported as from a registered use with the remaining six as undetermined. Two incidences were reported from use on a golf course in which the fish in a nearby pond or stream/river were reported as dead; one incident reported 200-300 dead carp, some dead shad and a few dead catfish with an unknown magnitude and species reported in the other. Mortality to trout and/or salmon were reported for five incidents after use on potato, cucumber or an unreported use site (B0000-500-15, I002200-001, I003596-001, I012265-006, I017028-001); three were reported as undetermined and two as from a registered use on potato or cucumber. In three of the incidents, mortality in the thousands up to 40,000 was reported; in the forth incident, the mortality rate was reported as >50. Stickleback mortality was also reported for one of these incidents (I017028-001). For a use site on sugarcane (undetermined if from registered use), mortality to 50 kg of tilapia and other fish were reported (I022024-001); it was reported that the site contained domestic and agricultural waste and had low dissolved oxygen.

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 SFGS, CCR, BCB, CTS, DS, CFWS, and TG or for modification to their designated critical habitat from the use of chlorothalonil in CA. The risk characterization provides an estimation (Section 5.1) and a description (Section 5.2) of the likelihood of adverse effects; articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the likelihood of adverse effects to the assessed species or their designated critical habitat (*i.e.*, "no effect," "likely to adversely affect," or "may affect, but not likely to adversely affect"). In the risk estimation section, risk quotients are calculated using standard EFED procedures and models. In the risk description section, additional analyses may be conducted to help characterize the potential for risk.

5.1. Risk Estimation

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

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

5.1.1. Exposures in the Aquatic Habitat

5.1.1.a. Freshwater Fish and Aquatic-phase Amphibians

Acute risk to fish and aquatic-phase amphibians and reptiles is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value for freshwater fish. Chronic risk is based on the 1 in 10 year 60-day EECs and the lowest chronic toxicity value for freshwater fish. While risk quotients for freshwater fish were calculated for all assessed used, for ease of reading, the uses with some of the lowest and highest EECs and subsequently the lowest and highest RQ values are shown in Table 5-1.

Table 5-1. Acute and Chronic RQs for Freshwater Fish and/or Aquatic-Phase Amphibians and Reptiles (Surrogate: Rainbow trout (acute); Fathead minnow (chronic))

Use(s)	App Rate (lb a.i./A, # Apps, Interval in days)	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
almond	3.0, 6, 3; 0.8, 1, NA	18.6	4.4	**<u>1.03</u>**	**3.4**
beans, dried-type, peas, dried-type	1.5, 4, 7 (early plant)	6.8	1.6	**0.378**	**1.2**
	1.5, 4, 7 (late plant)	6.4	1.3	**0.356**	**1.0**
broccoli, Brussel sprout, cabbage, cauliflower	1.5, 8, 7	13	3.7	**<u>0.722</u>**	**2.8**
bulb vegetables	1.5, 4, 7	5.6	1.3	**0.311**	**1.0**
celery	2.3,8,3; 1.9,1,NA	20.4	5.4	**<u>1.13</u>**	**4.2**
christmas tree, conifers, forest trees	4.5, 3, 3; 3.0, 1, NA	47.5	6.8	**<u>2.64</u>**	**5.2**
commercial/industrial lawns	11.0, 2, 14; 4.0, 1, NA	11.7	1.9	**<u>0.650</u>**	**1.5**
corn	1.5, 6,7	4.8	1.3	**0.267**	**1.0**
	1.0, 9, 4	3.9	1.3	**0.217**	**1.0**
Fruiting vegetables	1.2,7,7;0.6,1,NA (early plant)	3.7	1.3	**0.206**	**1.0**
	1.2,7,7;0.6,1,NA (late plant)	3.6	0.8	**0.200**	0.6
garlic	2.3, 6, 7; 1.3, 1, NA	12.8	3.6	**<u>0.711</u>**	**2.8**
golf course, greens	11.4,6,14; 4.6, 1, NA	17.6	3.2	**<u>0.978</u>**	**2.5**
grass grown for seed	1.5,3,14	5.1	1.1	**0.283**	0.8

horseradish	2.2, 7, 7; 0.4, 1, NA	16.3	4.6	**<u>0.906</u>**	**3.5**
lupine, grain	1.1, 5,7 ; 0.5, 1, NA (early plant)	4	1.2	**0.222**	0.9
	1.1, 5,7 ; 0.5, 1, NA (late plant)	3.9	1	**0.217**	0.8
ornamental (lawns, turf, sod farms), recreation area lawns	11.4, 2, 7; 3.2, 1, NA	37.1	5.3	**<u>2.06</u>**	**4.1**
ornamentals plants and trees	1.5, 24, 7; 0.4, 1, NA	31.1	3.4	**<u>1.73</u>**	**2.6**
pistachio	4.5, 5, 28	13.5	2.5	**<u>0.750</u>**	**1.9**
rhubarb	2.3, 5, 7; 2.0, 1, NA	12.1	3.3	**<u>0.672</u>**	**2.5**
rose	1.1, 32, 7; 0.8, 1, NA	23.8	2.6	**<u>1.32</u>**	**2.0**
strawberry	1.1, 13, 10; 0.7, 1, NA	19.4	4.9	**<u>1.08</u>**	**3.8**

* = LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded. Acute RQs > 0.5 are bolded and underlined.
Acute RQ = use-specific peak EEC /LC_{50}, where LC_{50} = 18 µg a.i./L (MRID 45710219)
Chronic RQ = use-specific 60-day EEC /NOAEC, where NOAEC = 1.3 µg a.i./L

Based on the acute and chronic RQs calculated for freshwater fish (and/or aquatic-phase amphibians), chlorothalonil has the potential to <u>directly</u> affect the CTS, DS, and TG for all registered uses. Additionally, as the chronic LOC is exceeded for all registered uses except for grass grown as seed and lupine as well acute LOC exceedances for non-listed fish for all uses (RQs>0.1) for restricted use and RQs >0.5 for many uses (*i.e.,* almonds, stone fruits, asparagus, succulent beans, blueberry, brassica, broccoli, Brussels sprouts, cabbage, cauliflower, carrot, celery, cherry, christmas trees, turf uses, filberts, garlic, grass forage, horseradish, leek, mango, onion, ornamentals, pistachio, rhubarb, and strawberry), there is also potential for <u>indirect</u> 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, CTS).

5.1.1.b. Freshwater Invertebrates

Acute risk to freshwater invertebrates is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value for freshwater invertebrates. Chronic risk is based on 1 in 10 year 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates. Again, risk quotients for freshwater invertebrates were calculated for all uses, however, the uses with the lowest and highest EECs and subsequently the highest and lowest RQ values are shown in Table 5-2.

Table 5-2. Summary of Acute and Chronic RQs for Freshwater Invertebrates. (Surrogate: *Daphnia magna*)

Use(s)	App Rate (lb a.i./A, # Apps, Interval in days)	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
almond	3.0, 6, 3; 0.8, 1, NA	18.6	10.1	**0.344**	**16.8**
beans, dried-type, peas, dried-type	1.5, 4, 7 (early plant)	6.8	2.8	**0.126**	**4.7**
	1.5, 4, 7 (late plant)	6.4	2.2	**0.119**	**3.7**
broccoli, Brussels sprout, cabbage, cauliflower	1.5, 8, 7	13	9.0	**0.241**	**15**
bulb vegetables	1.5, 4, 7	5.6	2.6	**0.104**	**4.3**
celery	2.3,8,3;1.9,1,NA	20.4	11.1	**0.378**	**18.5**
christmas tree, conifers, forest trees	4.5, 3, 3; 3.0, 1, NA	47.5	11.9	**<u>0.880</u>**	**19.8**
commercial/industrial lawns	11.0, 2, 14; 4.0, 1, NA	11.7	3.5	**0.217**	**5.8**
corn	1.5, 6,7	4.8	1.9	**0.089**	**3.2**
	1.0, 9, 4	3.9	2.2	**0.072**	**3.7**
fruiting vegetables	1.2,7,7;0.6,1,NA (early plant)	3.7	1.5	**0.069**	**2.5**
	1.2,7,7;0.6,1,NA (late plant)	3.6	0.9	**0.067**	**1.5**
garlic	2.3, 6, 7; 1.3, 1, NA	12.8	4.6	**0.237**	**7.7**
golf course	11.4,6,14; 4.6, 1, NA	17.6	4.7	**0.326**	**7.8**
grass grown for seed	1.5,3,14	5.1	1.9	**0.094**	**3.2**
horseradish	2.2, 7, 7; 0.4, 1, NA	16.3	6.7	**0.302**	**11.2**
lupine, grain	1.1, 5,7 ; 0.5, 1, NA (early plant)	4	1.8	**0.074**	**3.0**
	1.1, 5,7 ; 0.5, 1, NA (late plant)	3.9	1.4	**0.072**	**2.3**
ornamental (lawns, turf, sod farms), recreation area lawns	11.4, 2, 7; 3.2, 1, NA	37.1	13.5	**<u>0.687</u>**	**22.5**
ornamentals plants and trees	1.5, 24, 7; 0.4, 1, NA	31.1	7.5	**<u>0.576</u>**	**12.5**
pistachio	4.5, 5, 28	13.5	3.0	**0.250**	**5.0**
rhubarb	2.3, 5, 7; 2.0, 1, NA	12.1	5.1	**0.224**	**8.5**

rose	1.1, 32, 7; 0.8, 1, NA	23.8	5.3	**0.441**	**8.8**
strawberry	1.1, 13, 10; 0.7, 1, NA	19.4	6.6	**0.196**	**5.8**
* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded and shaded. Acute RQs > 0.5 (non-listed) are bolded and underlined. Acute RQ = use-specific peak EEC /LC_{50}, where LC_{50} = 54 µg a.i./L Chronic RQ = use-specific 21-day EEC /NOAEC, where NOAEC = 0.6 µg a.i./L					

Based on the acute and chronic RQs calculated for freshwater invertebrates, chlorothalonil (all uses) has the potential to directly affect the CFWS. Additionally, since chronic LOCs are exceeded for all uses and there are acute LOC exceedances for non-listed species based on RQs > 0.1 for all uses except for cole crops, corn, fruiting vegetables, grain grown for seed, lupine, and yam, there is also potential for indirect effects to those listed species that rely on freshwater invertebrates during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, DS, CFWS, and TG). The RQ value also exceeded the non-listed acute LOC of 0.5 for use on Christmas trees and ornamentals.

5.1.1.c. Estuarine/Marine Fish

Acute risk to estuarine/marine fish is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine fish. Chronic risk is based on 1 in 10 year 60-day EECs and the lowest chronic toxicity value for estuarine/marine fish is used. However, as quantitative acute and chronic toxicity values were not available for estuarine/marine fish, RQ values were not calculated. Direct effects to DS and TG as well as indirect effects to other species (i.e., CCR) are evaluated in the Risk Description section (5.2.3).

5.1.1.d. Estuarine/Marine Invertebrates

Acute risk to estuarine/marine invertebrates is based on peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine invertebrates. Chronic risk is based on 21-day EECs and the lowest chronic toxicity value for estuarine/marine invertebrates. Risk quotients were calculated for all uses, however, uses with the lowest and highest EECs and subsequently the highest and lowest RQ values are shown in **Table 5-3**.

Table 5-3. Summary of Acute and Chronic RQs for Estuarine/Marine Invertebrates [Surrogate: Eastern oyster (acute), Northern pink shrimp (chronic)]

Use(s)	App Rate (lb a.i./A, # Apps, Interval in days)	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
almond	3.0, 6, 3; 0.8, 1, NA	18.6	10.1	**5.2**	**10.9**
beans, dried-type, peas, dried-type	1.5, 4, 7 (early plant)	6.8	2.8	**1.9**	**4.0**
	1.5, 4, 7 (late plant)	6.4	2.2	**1.8**	**3.8**
broccoli, Brussel sprout, cabbage, cauliflower	1.5, 8, 7	13	9.0	**3.6**	**7.6**

bulb vegetables	1.5, 4, 7	5.6	2.6	**1.6**	**3.3**
celery	2.3,8,3;1.9,1,NA	20.4	11.1	**3.0**	**6.4**
christmas tree, conifers, forest trees	4.5, 3, 3; 3.0, 1, NA	47.5	11.9	**13.2**	**27.9**
commercial/industrial lawns	11.0, 2, 14; 4.0, 1, NA	11.7	3.5	**3.3**	**6.9**
corn	1.5, 6,7	4.8	1.9	**1.3**	**2.8**
	1.0, 9, 4	3.9	2.2	**1.1**	**2.3**
fruiting vegetables	1.2,7,7;0.6,1,NA (early plant)	3.7	1.5	**1.0**	**2.2**
	1.2,7,7;0.6,1,NA (late plant)	3.6	0.9	**1.0**	**2.1**
garlic	2.3, 6, 7; 1.3, 1, NA	12.8	4.6	**3.6**	**7.5**
golf course	11.4,6,14; 4.6, 1, NA	17.6	4.7	**4.9**	**10.4**
grass grown for seed	1.5,3,14	5.1	1.9	**1.4**	**3.0**
horseradish	2.2, 7, 7; 0.4, 1, NA	16.3	6.7	**4.5**	**9.6**
lupine, grain	1.1, 5,7 ; 0.5, 1, NA (early plant)	4	1.8	**1.1**	**2.4**
	1.1, 5,7 ; 0.5, 1, NA (late plant)	3.9	1.4	**1.1**	**2.3**
ornamental (lawns, turf, sod farms), recreation area lawns	11.4, 2, 7; 3.2, 1, NA	37.1	13.5	**10.3**	**21.8**
ornamentals plants and trees	1.5, 24, 7; 0.4, 1, NA	31.1	7.5	**8.6**	**18.3**
pistachio	4.5, 5, 28	13.5	3.0	**3.8**	**7.9**
rhubarb	2.3, 5, 7; 2.0, 1, NA	12.1	5.1	**3.4**	**7.1**
rose	1.1, 32, 7; 0.8, 1, NA	23.8	5.3	**6.6**	**14**
strawberry	1.1, 13, 10; 0.7, 1, NA	19.4	6.6	**5.4**	**11**

* = LOC exceedances (acute RQ $\geq$ 0.05 and 0.5; chronic RQ $\geq$ 1.0) are bolded.
Acute RQ = use-specific peak EEC /LC_{50}, where IC_{50} = 3.6 µg a.i./L
Chronic RQ = use-specific 21-day EEC /NOAEC, where NOAEC = 1.7 µg a.i./L

Based on the acute and chronic RQs calculated for estuarine/marine invertebrates, chlorothalonil (all uses) has the potential to indirectly effects to those listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, DS, and TG).

5.1.1.e. Non-vascular Aquatic Plants

Acute risk to aquatic non-vascular plants is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value. Risk quotients with some of the lowest and highest EECs and all uses in which the RQ value exceeded the LOC are shown in Table 5-4 uses (RQs for all assessed uses were calculated).

Table 5-4. Summary of Acute RQs for Non-Vascular Aquatic Plants

Use(s)	App Rate (lb a.i./A, # Apps, Interval in days)	Peak EEC (µg/L)	RQ*
almond	3.0, 6, 3; 0.8, 1, NA	18.6	**1.6**
beans, dried-type, peas, dried-type	1.5, 4, 7 (early plant)	6.8	0.6
	1.5, 4, 7 (late plant)	6.4	0.5
broccoli, Brussel sprout, cabbage, cauliflower	1.5, 8, 7	13	**1.1**
bulb vegetables	1.5, 4, 7	5.6	0.5
celery	2.3, 8,3; 1.9, 1,NA	20.4	**1.7**
christmas tree, conifers, forest trees	4.5, 3, 3; 3.0, 1, NA	47.5	**4.0**
commercial/industrial lawns	11.0, 2, 14; 4.0, 1, NA	11.7	**1.0**
garlic	2.3, 6, 7; 1.3, 1, NA	12.8	**1.1**
golf course	11.4,6,14; 4.6, 1, NA	17.6	**1.5**
grass grown for seed	1.5,3,14	5.1	0.4
horseradish	2.2, 7, 7; 0.4, 1, NA	16.3	**1.4**
lupine, grain	1.1, 5,7 ; 0.5, 1, NA (early plant)	4	0.3
	1.1, 5,7 ; 0.5, 1, NA (late plant)	3.9	0.3
ornamental (lawns, turf, sod farms), recreation area lawns	11.4, 2, 7; 3.2, 1, NA	37.1	**3.1**
ornamentals plants and trees	1.5, 24, 7; 0.4, 1, NA	31.1	**2.6**
pistachio	4.5, 5, 28	13.5	**1.1**
rhubarb	2.3, 5, 7; 2.0, 1, NA	12.1	**1.0**
rose	1.1, 32, 7; 0.8, 1, NA	23.8	**2.0**

strawberry	1.1, 13, 10; 0.7, 1, NA	19.4	**1.6**
* LOC exceedances (RQ ≥ 1) are bolded. RQ = use-specific peak EEC /IC_{50}, where IC_{50} is 12 µg a.i./L .			

Since the RQs are exceeded for the majority of registered uses (, there is a potential for indirect effects to those listed species that rely on non-vascular aquatic plants during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, DS, CFWS, and TG).

5.1.1.f. Aquatic Vascular Plants

Acute risk to aquatic vascular plants is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value. Risk quotients are shown in Table 5-5 for some of the uses with the highest and lowest EECs (RQs were calculated for all uses).

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

Use(s)	App Rate (lb a.i./A, # Apps, Interval in days)	Peak EEC (µg/L)	RQ*
almond	3.0, 6, 3; 0.8, 1, NA	18.6	0.03
beans, dried-type, peas, dried-type	1.5, 4, 7 (early plant)	6.8	0.01
	1.5, 4, 7 (late plant)	6.4	0.01
broccoli, Brussel sprout, cabbage, cauliflower	1.5, 8, 7	13	0.02
bulb vegetables	1.5, 4, 7	5.6	0.01
celery	2.3, 8,3; 1.9, 1,NA	20.4	0.03
christmas tree, conifers, forest trees	4.5, 3, 3; 3.0, 1, NA	47.5	0.07
commercial/industrial lawns	11.0, 2, 14; 4.0, 1, NA	11.7	0.02
garlic	2.3, 6, 7; 1.3, 1, NA	12.8	0.02
golf course	11.4,6,14; 4.6, 1, NA	17.6	0.03
grass grown for seed	1.5,3,14	5.1	0.01
horseradish	2.2, 7, 7; 0.4, 1, NA	16.3	0.03
lupine, grain	1.1, 5,7 ; 0.5, 1, NA (early plant)	4	0.01
	1.1, 5,7 ; 0.5, 1, NA (late plant)	3.9	0.01

ornamental (lawns, turf, sod farms), recreation area lawns	11.4, 2, 7; 3.2, 1, NA	37.1	0.06
ornamentals plants and trees	1.5, 24, 7; 0.4, 1, NA	31.1	0.05
pistachio	4.5, 5, 28	13.5	0.02
rhubarb	2.3, 5, 7; 2.0, 1, NA	12.1	0.02
rose	1.1, 32, 7; 0.8, 1, NA	23.8	0.04
strawberry	1.1, 13, 10; 0.7, 1, NA	19.4	0.03
* RQ = use-specific peak EEC /IC_{50}, where IC_{50} is 640 µg a.i./L .			

Since the RQs are not exceeded, indirect effects to those listed species that rely on vascular aquatic plants during at least some portion of their life-cycle are not likely based on lack of LOC exceedances (*i.e*., SFGS, CCR, CTS, DS, CFWS, and TG)).

5.1.2. Exposures in the Terrestrial Habitat

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

As previously discussed in Section 3.3, potential direct effects to terrestrial species are based on foliar applications of chlorothalonil as well as exposure to the degradate SDS-3701 after foliar application of chlorothalonil to dietary items.

Potential risks to birds and, thus, terrestrial-phase amphibians and reptiles are evaluated using T-REX, acute and chronic toxicity data for the most sensitive bird species for which data are available, and the most sensitive dietary item and size class for that species. The most conservative avian RQ in T-REX is for the small bird consuming short grass. However, consumption of arthropods is a relevant dietary item and therefore RQs for this item were also calculated.

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

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

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

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; however, the indirect effect RQs are compared to the non-listed LOC (acute and acute restricted use LOCs, 0.5 and 0.2, respectively). The most conservative EEC calculated in T-REX is for small birds consuming short grass.

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

Chronic RQs for the birds (including CCR), CTS (all DPS), and SFGS derived using T-REX are shown in **Table 5-6**. As acute toxicity values for birds for chlorothalonil resulted in a non-definitive value (LC/LD50 > highest concentration tested), RQ values were not calculated for chlorothalonil. Acute risk to birds, CTS and SFGS from exposure to chlorothalonil are evaluated further as part of the Risk Description (Section 5.2.6). However, definitive acute toxicity values were available for SDS-3701, and therefore, RQ values are calculated. RQ values presented represent the registered uses with the highest and lowest EECs and therefore, the highest and lowest RQ values.

Table 5-6. Chronic RQs Derived Using T-REX for Chlorothalonil and SDS-3701 and Acute RQs for SDS-3701: Birds (including CCR), CTS (all DPS), and SFGS consuming short grass

Use Type	RQs for Birds (including CCR), CTS (all DPS) and SFGS (small bird 20g consuming short grass)		
	Acute Dose-Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]
Chlorothalonil			
Grass forage, fodder, hay	N/A[4]	N/A[4]	**5.38**
Golf courses, greens	N/A[4]	N/A[4]	**59.9**
SDS-3701			
Grass forage, fodder, hay	**3.63**	**0.15**	**5.23**
Golf courses, greens	**40.2**	**1.66**	**57.8**

LOC exceedances (acute RQ ≥ 0.1 and chronic RQ ≥ 1.0) are **bolded**.
[1]Based on SDS-3701 dose-based EEC and mallard duck acute oral LD_{50} = 158 mg/kg-bw
[2]Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 1,746 mg/kg-diet.
[3] Chlorothalonil: Based on dietary-based EEC and Northern bobwhite quail NOAEC = 153 mg/kg-diet; for SDS-3701 based on mallard duck NOAEC of 50 mg/kg-diet.
[4] As the acute toxicity values for birds for chlorothalonil resulted in non-definitive values (LC/LD50 > highest concentration tested), RQ values not calculated.

Table 5-8. Acute and Chronic RQs Derived Using T-REX for Chlorothalonil: Birds (including CCR), CTS (all DPS), and SFGS consuming arthropods

Use Type	RQs for Birds (including CCR), CTS (all DPS) and SFGS (small bird 20g consuming arthropods)		
	Acute Dose-Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]
Chlorothalonil			
Grass forage, fodder, hay	N/A[4]	N/A[4]	**2.11**
Golf courses, greens	N/A[4]	N/A[4]	**24.0**
SDS-3701			
Grass forage, fodder, hay	**1.42**	0.06	**2.05**
Golf courses, greens	**15.7**	**0.65**	**22.7**

LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are **bolded**.
[1]Based on SDS-3701 dose-based EEC and mallard duck acute oral LD_{50} = 158 mg/kg-bw
[2]Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 1,746 mg/kg-diet.
[3] Chlorothalonil: Based on dietary-based EEC and Northern bobwhite quail NOAEC = 153 mg/kg-diet; for SDS-3701 based on mallard duck NOAEC of 50 mg/kg-diet.
[4] As the acute toxicity values for birds for chlorothalonil resulted in non-definitive values (LC/LD50 > highest concentration tested), RQ values not calculated.

For chlorothalonil, based on the calculated chronic RQs for 20g birds consuming short grass and arthropods, chlorothalonil has the potential to directly affect the CCR, CTS (all DPS), and the SFGS for all uses. For SDS-3701, the acute (dose-based) and chronic RQs exceeded the appropriate LOC for all uses and therefore has the potential to directly affect the CCR, CTS (all DPS), and the SFGS; acute dietary based RQs exceeded the listed LOC for most of the uses (exceptions are: dried beans and bulb vegetables, cole crops, grass forage, fodder, grass for seed, lupine, papaya, parsnip, passion fruit and yam). Additionally, since the chronic RQs are exceeded for all uses for both chlorothalonil and SDS-3701, and the acute dose-based RQ exceeded the non-listed LOC for SDS-3701 for all uses, there is a potential for indirect effects to those listed species that rely on birds (and, thus, reptiles and/or terrestrial-phase amphibians) during at least some portion of their life-cycle (*i.e.*, CCR, CTS (all DPS), and the SFGS).

A refinement of the RQs for the CTS and SFGS using T-HERPS is provided below **Table 5-9** and **Table 5-10**. The amphibian CTS default weights are 2, 20, and 200g; the reptile SFGS default weights are 2, 20, and 800g. The maximum size mammal that can be consumed by the three amphibian size classes are 1.33, 13.33, and 133.33g, respectively [based on the default assumption that an amphibian can eat 2/3 of its body weight, Cook 1997]; the maximum size amphibian/reptile that can be consumed by the three reptile size classes are 2.10, 24.74, and 1285.91g, respectively [based on the equation: BW of assessed species$^{1.071}$, King 2002]. The percent water content for all herptile size classes was assumed to be 80%. As mentioned above, acute toxicity values for birds for chlorothalonil resulted in a non-definitive value (LC/LD50 > highest concentration tested); therefore RQ values were not calculated for chlorothalonil. Characterization of acute risk is discussed in the Risk Description section.

Table 5-9. Acute and Chronic RQs Derived Using T-HERPS for Chlorothalonil and SDS-3701: CTS (all DPS) consuming small insects and herbivorous mammals

Use Type	RQs for Small CTS (2g) (small amphibian 2g consuming small insects)			RQs for Medium CTS (20g) (medium amphibian 20g consuming small/medium herbivorous mammals of 1.33g/13.33g)		
	Acute Dose-Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]	Acute Dose-Based[1]	Acute Dietary Based[2,a]	Chronic Dietary Based[3,a]
Chlorothalonil						
Grass grown for seed[5]	N/A[4]	N/A[4]	**3.09**	N/A[4]	N/A[4]	**5.51**
Golf courses, greens	N/A[4]	N/A[4]	**33.7**	N/A[4]	N/A[4]	**60.1**
SDS-3701						
Grass grown for seed	0.05	0.09	**3.02**	**1.14**	0.09	**5.39**
Cole crops	0.06	**0.10**	**3.44**	**1.29**	**0.10**	**6.14**
Golf courses, greens	**0.57**	**0.94**	**32.7**	**12.3**	**1.67**	**58.4**

LOC exceedances (acute RQ ≥ 0.1 and chronic RQ ≥ 1.0) are **bolded**.
[1]Based on SDS-3701 dose-based EEC and mallard duck acute oral LD_{50} = 158 mg/kg-bw
[2]Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 1,746 mg/kg-diet.
[3] Chlorothalonil: Based on dietary-based EEC and Northern bobwhite quail NOAEC = 153 mg/kg-diet; for SDS-3701 based on mallard duck NOAEC of 50 mg/kg-diet.
[4] As the acute toxicity values for birds for chlorothalonil resulted in non-definitive values (LC/LD50 > highest concentration tested), RQ values not calculated.
[5] EECs for grass forage, fodder and hay uses results in slightly lower EECs than for grass grown for seed use. However, T-HERPS cannot model different application rates, therefore RQs for the grass seed use are shown. Manual calculations of RQs for grass forage, fodder and hay resulted in almost identical or identical EECs as shown for grass seed and the risk conclusions for this use are the same.
[a]RQ for medium-sized herbivorous mammal (of 13.33g)

Table 5-10. Acute and Chronic RQs Derived Using T-HERPS for Chlorothalonil and SDS-3701: SFGS consuming small insects and herbivorous mammals

Use Type	RQs for Small SFGS (2g) (small reptile 2g consuming small insects)			RQs for Medium SFGS (20g) (medium reptile 20g consuming small/medium herbivorous mammals of 2.10g/24.74g)		
	Acute Dose-Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]	Acute Dose-Based[1]	Acute Dietary Based[2,a]	Chronic Dietary Based[3,a]
Chlorothalonil						
Grass grown for seed[5]	N/A[4]	N/A[4]	**3.09**	N/A[4]	N/A[4]	**4.21**
Golf courses, greens	N/A[4]	N/A[4]	**33.7**	N/A[4]	N/A[4]	**45.9**
SDS-3701						
Grass grown for seed[5]	0.05	0.09	**3.02**	**1.61**	**0.12**	**4.12**
Cole crops	0.06	**0.10**	**3.44**	**1.84**	**0.13**	**4.69**
Golf courses, greens	**0.57**	**0.94**	**32.7**	**17.5**	**1.28**	**44.6**

LOC exceedances (acute RQ ≥ 0.1 and chronic RQ ≥ 1.0) are **bolded**.
[1]Based on SDS-3701 dose-based EEC and mallard duck acute oral LD_{50} = 158 mg/kg-bw
[2]Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 1,746 mg/kg-diet.
[3] Chlorothalonil: Based on dietary-based EEC and Northern bobwhite quail NOAEC = 153 mg/kg-diet; for SDS-3701 based on mallard duck NOAEC of 50 mg/kg-diet.
[4] As the acute toxicity values for birds for chlorothalonil resulted in non-definitive values (LC/LD50 > highest concentration tested), RQ values not calculated.
[5] EECs for grass forage, fodder and hay uses results in slightly lower EECs than for grass grown for seed use. However, T-HERPS cannot model different application rates, therefore RQs for the grass seed use are shown.

Manual calculations of RQs for grass forage, fodder and hay resulted in almost identical or identical EECs as shown for grass seed and the risk conclusions for this use are the same. [a]RQ for medium-sized herbivorous mammal (of 24.74g)

For chlorothalonil, based on the calculated chronic RQs for small 2g CTS/SFGS and medium 20g CTS/SFGS consuming small insects and herbivorous mammals, T-HERPS calculations further confirm that chlorothalonil has the potential to directly affect the CTS (all DPS) and the SFGS for all assessed uses. For SDS-370, based on the calculated acute and chronic RQs for small 2g CTS/SFGS and medium 20g CTS/SFGS consuming small insects and herbivorous mammals, T-HERPS calculations also confirm that chlorothalonil has the potential to directly affect the CTS (all DPS) and the SFGS for all assessed uses, except for acute exposure from use on grass seed and grass forage, fodder and hay for the 2g amphibian or reptile consuming small insects. Additionally, since the chronic RQs exceeded the LOC for all uses for both chlorothalonil and SDS-3701, as well as acute non-listed LOC exceedances (RQs>0.5) for SDS-3701 all uses for the medium amphibian/reptile consuming herbivore mammals and for golf courses and ornamental lawn uses for the 2 g amphibian/reptile consuming small insects, there is a potential for indirect effects to those listed species that rely on reptiles and terrestrial-phase amphibians during at least some portion of their life-cycle (*i.e.*, CTS (all DPS), and the SFGS).

5.1.2.b. Mammals

Potential risks to mammals are evaluated using T-REX, acute and chronic mammalian toxicity data, and a variety of body-size and dietary categories. As previously discussed, potential direct effects to terrestrial species are based on foliar applications of chlorothalonil.

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 effects to habitat or a reduction in rearing sites. RQs for indirect effects are calculated in the same manner as those for direct effects. The most sensitive EECs calculated in T-REX are for small mammals consuming short grass.

Potential direct chronic effects to the mammals are evaluated by considering dietary-based EECs modeled in T-REX consuming a variety of dietary items. The specific EECs for each species are for the same size mammals and same dietary items as those considered for acute exposure. Chronic effects are estimated using the lowest available NOAEC from a chronic reproductive study for mammals. Dietary-based EECs are divided by toxicity values to estimate chronic dietary-based RQs. Acute and chronic RQs are presented in Table 5-7 for the uses with the highest and lowest EECs. As with the birds, the acute toxicity value for mammals was non-definitive for chlorothalonil, therefore, RQ values were not calculated; characterization of acute risk to mammals is discussed in the Risk Description Section 5.2.7. For the chronic SDS-3701 study, a LOAEL was not available as there were no effects observed at the highest concentration tested.

Table 5-7. Acute and Chronic RQs Derived Using T-REX for Chlorothalonil and SDS-3701 and Mammals

Use Type	RQs for Small Mammals (15g) (small mammals consuming short grass)			RQs for Medium Mammals (35g) (medium mammal consuming short grass)		
	Acute Dose-Based[1]	**Chronic Dietary Based [2]**	**Chronic Dose Based[3]**	**Acute Dose-Based[1]**	**Chronic Dietary Based[2]**	**Chronic Dose Based[3]**
Chlorothalonil						
Grass forage, fodder, hay	N/A[4]	0.69	**3.86**	N/A[4]	0.69	**3.30**
Beans, dried; bulb vegetable	N/A[4]	0.99	**5.55**	N/A[4]	0.99	**4.74**
Golf courses, greens	N/A[4]	**7.63**	**43.0**	N/A[4]	**7.63**	**36.7**
SDS-3701						
Grass forage, fodder, hay	**0.47**	N/A[4]	N/A[4]	**0.40**	N/A[4]	N/A[4]
Cole crops	**0.55**	N/A[4]	N/A[4]	**0.47**	N/A[4]	N/A[4]
Golf courses, greens	**5.18**	N/A[4]	N/A[4]	**4.43**	N/A[4]	N/A[4]

LOC exceedances (acute RQ ≥ 0.1 and chronic RQ ≥ 1.0) are **bolded**.
[1]For SDS-3701 based on dose-based EEC and laboratory rat acute oral LD_{50} = 242 mg/kg-bw
[2]Based on dietary-based EEC and laboratory rat NOAEL =120 mg a.i./kg-diet
[3]Based on dose-based EEC and laboratory rat NOAEL =120 mg a.i./kg-diet
[4] As the acute toxicity values for mammals for chlorothalonil resulted in non-definitive values (LD50 > highest concentration tested), RQ values not calculated; additionally for the chronic toxicity test, there were no effects observed at the highest concentration tested, therefore, RQs were not calculated.

Based on calculated chronic RQs for 15g and 35g mammals consuming short grass, chlorothalonil has the potential to directly affect listed mammals of the sizes modeled given all the uses assessed. In addition, based on acute RQs for SDS-3701, there is also the potential to directly affect small and medium mammals for all uses. Additionally, since the acute and chronic RQs are exceeded, there is potential for indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle (*i.e.*, CCR, CTS (all DPS), and the SFGS).

5.1.2.c. Terrestrial Invertebrates

In order to assess the risks of chlorothalonil to terrestrial invertebrates, the honey bee (acute contact LD_{50} of >181 µg a.i./bee; MRID 00077759) 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 >181 µg a.i./bee by 1 bee/0.128g, which is based on the weight of an adult honey bee. EECs (µg a.i./g of bee) calculated by T-REX for arthropods are typically divided by the calculated toxicity value for terrestrial invertebrates, which is >1414 µg a.i./g of bee. As the acute toxicity value for the honeybee is a non-definitive value, RQs were not calculated. Evaluation of direct effects to terrestrial invertebrates is discussed in the Risk Description section (5.2.8.a). Toxicity data for SDS-3701 for honeybees are not available.

5.1.2.d. Terrestrial Plants

Generally, for indirect effects, potential effects on terrestrial vegetation are assessed using RQs from terrestrial plant seedling emergence and vegetative vigor EC_{25} data as a screen. Since the BCB has an obligate relationship with specific dicot plant species, the seedling emergence and vegetative vigor EC_{05} or the NOAEC for dicots are used to calculate RQs for indirect effects to these species via potential effects to dicots. Toxicity testing with terrestrial plants for chlorothalonil was conducted using a limit concentration of 16 lb a.i./A. For all but one species for seedling emergence and vegetative vigor, the observed effect was <25% compared to the negative control, and as such the EC_{25} is >16 lb a.i./A. For two species (onion and cucumber), a 26% decrease in growth was observed in either the seedling emergence or vegetative vigor, suggesting that the EC_{25} is <16 lb a.i./A. However, as only one concentration was tested, a reliable EC_{25} cannot be calculated. Additionally the overall NOAEC for both the seedling emergence and vegetative vigor is <16 lb a.i./A as there was a significant difference in growth for soybean in the seedling emergence study and for oat in the vegetative vigor study when compared to the negative control. Due to testing one concentration, an EC_{05} for these species could not be determined, which could have been used in lieu of a NOAEC. As such, RQ values were not calculated and an evaluation of toxicity to terrestrial plants is described in the Risk Description section (5.2.9). Toxicity data for SDS-3701 for terrestrial plants are not available.

5.1. 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 chlorothalonil on par with the acute toxicity endpoint selected for RQ calculation. To accomplish this interpretation, the Agency uses the slope of the dose response relationship available from the toxicity study used to establish the acute toxicity measures of effect for each taxonomic group that is relevant to this assessment. The individual effects probability associated with the acute RQ is based on the mean estimate of the slope and an assumption of a probit dose response relationship. In addition to a single effects probability estimate based on the mean, upper and lower estimates of the effects probability are also provided to account for variance in the slope, if available.

Individual effect probabilities are calculated based on an Excel spreadsheet tool IEC v1.1 (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 5-8. IEC for Taxa for Use of Chlorothalonil and RQs

Taxa represented	Surrogate species (most sensitive)	Endpoint (LC_{50} or LD_{50})	MRID	Uses[1] (RQ)	Slope[2]	Chance of Individual effect (~1 in…) for Min RQ[3]	Chance of Individual effect (~1 in…) for Max RQ[3]	SF Bay Species (direct effect)	SF Bay Species (indirect effect)
Freshwater fish and aquatic-phase amphibians	Rainbow trout *Oncorhynchus mykiss*	Chlrothalonil 96-hr LC_{50} = 18 µg a.i./L	40098001	Brassica (0.189), christmas trees (2.63)	5.58	37000	1	TG, DS, CTS	SFGS, CCR, CTS
					2.79	46	1		
					8.37	1.43 x 10^{9}	1		
Freshwater invertebrates	Daphnid (*Daphnia magna*)	Chlorothalonil 48-hr EC_{50} = 54 µg a.i./L	45710221	Brassica (0.063), christmas trees (0.88)	4.57	4.89 x 10^{7}	2.5	CFWS	CFWS, SFGS, CCR, CTS, TG, DS
					3.12	11,100	2.3		
					6.02	4.08 x10^{12}	2.7		
Estuarine/marine fish	Sheepshead minnow (*Cyprinodon variegatus*)	Chlorothalonil 96-hr LC_{50} = 33 µg a.i./L	00127863	LC50 value for qualitative use only, so IECs not calculated	--	--	--	TG, DS	CCR
Estuarine/marine invertebrates	Eastern oyster (*Crassostrea virginica*)	Chlorothalonil 96-hr EC_{50} = 3.6 µg a.i./L	00138143	Brassica (0.9), christmas trees (13.2); This endpoint based on growth, so IEC calculations not appropriate for this endpoint	--	--	--	---	CCR, TG, DS
Birds, Reptiles, and Terrestrial-Phase Amphibians (T-REX, 20g bird consuming short grass)	Mallard duck (*Anas platyrhynchos*	SDS-3701 LD_{50} =153 mg/kg-bw; Chlorothalonil[4]	0030395	Grass forage, fodder, hay (3.63); golf course, greens (40.2) Dose-based	6.5	1	1	SFGS, CCR, CTS	SFGS, CCR, CTS
					2.6	1	1		
					10.3	1	1		
Birds, Reptiles, and Terrestrial-Phase Amphibians (T-REX, 20g bird consuming arthropods)	Mallard duck (*Anas platyrhynchos*	SDS-3701 LD_{50} =153 mg/kg-bw; Chlorothalonil[4]	0030395	Grass forage, fodder, hay (1.42); golf course, greens (15.7) dose-based	6.5	1	1	SFGS, CCR, CTS	SFGS, CCR, CTS
					2.6	1	1		
					10.3	1	1		

Birds, Reptiles, and Terrestrial-Phase Amphibians (T-HERPS, 20g)	Mallard duck (*Anas platyrhynchos*	SDS-3701 LD_{50} =153 mg/kg-bw; Chlorothalonil[4]	0030395	Grass grown for seed (1.14); golf course, greens (12.3) dose-based	6.5 2.6 10.3	1 1 1	1 1 1	CTS [refinement]	CTS [refinement]
Birds, Reptiles, and Terrestrial-Phase Amphibians (T-HERPS, 20g)	Mallard duck (*Anas platyrhynchos*	SDS-3701 LD_{50} =153 mg/kg-bw; Chlorothalonil[4]	0030395	Grass grown for seed (1.61); golf course, greens (17.5) dose-based	6.5 2.6 10.3	1 1 1	1 1 1	SFGS [refinement]	SFGS [refinement]
Mammals (T-REX, 15g)	Laboratory rat (*Rattus norvegicus*)	SDS-3701 LD_{50} = 242 mg a.i./kg-bw; Chlorothalonil[4]	00001098	Grass forage, fodder, hay (0.47); golf course, greens (5.18)	4.5 2 9	14 4 632	1 1 1	---	SFGS, CCR, CTS
Terrestrial Invertebrates	Honey bee (*Apis mellifera*)	Chlorothalonil LD_{50} >181 µg a.i./bee; RQs not calculated	00077759	As RQs not calculated, IECs not calculated	--	--	--	BCB	SFGS, CCR, CTS

Uses for which the acute RQ exceeds the listed species LOC for the given taxon category. The lowest exceeded RQ and the highest exceeded RQ is in brackets.

[2] Default value for slope is 4.5, with upper and lower bounds of 2 and 9

[3] Acute RQs provide a min/max range and depend on uses that exceeded acute listed species LOC of 0.05 for aquatic organisms and terrestrial invertebrates and 0.1 for terrestrial birds and mammals.

[4] Non-definitive acute LD/LC50 values were reported for birds and mammals (LC50 greater than highest dose tested). Therefore, RQs were not calculated, and as such neither were IECs.

5.1.1. Primary Constituent Elements of Designated Critical Habitat

For chlorothalonil 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.

5.2. 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 Level of Concern. The final No Effect/May Affect determination is made after the spatial analysis is completed at the end of the risk description, Section 5.2.11. In Section 5.2.11, a discussion of any potential overlap between areas where potential usage may result in LAA effects and areas where species are expected to occur (including any designated critical habitat) is presented. If there is no overlap of the species habitat and occurrence sections with the Potential Area of LAA Effects a No Effect determination is made.

If the RQs presented in the Risk Estimation (Section 5.1) show no direct or indirect effects for the assessed species, and no modification to PCEs of the designated critical habitat, a preliminary "no effect" determination is made, based on chlorothalonil'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 chlorothalonil. A summary of the risk estimation results (a preliminary effects determination of "no effect" or "may affect") are provided in **Table 5-9** for direct and indirect effects to the listed species assessed here and in **Table 5-10** for the PCEs of their designated critical habitat.

Table 5-9. Risk Estimation Summary for Chlorothalonil - Direct and Indirect Effects

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
Freshwater Fish and Aquatic-phase Amphibians	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses Chronic: RQs >1 for all assessed uses	Indirect Effects: SFGS, CCR, CTS
	Listed Species (Yes)	Acute: RQs ≥ 0.05 for all assessed uses. Chronic: RQs >1 for all assessed uses	Direct Effects: CTS, DS, TG
Freshwater Invertebrates	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses except cole crops, corn, fruiting vegs., grass seed, lupine, yam Chronic: RQs >1 for all assessed uses	Indirect Effects: SFGS, CCR, CTS, DS, CFWS, TG
	Listed Species (Yes)	Acute: RQs > 0.05 for all assessed uses	Direct Effects: CFWS

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
		Chronic: RQs >1 for all assessed uses	
Estuarine/Marine Fish	Non-listed Species (N/A)	RQs were not calculated because acute toxicity for quantitative use were not available and chronic toxicity data were not available	Indirect Effects: None expected.
	Listed Species (N/A)	RQs were not calculated because acute toxicity for quantitative use were not available and chronic toxicity data were not available	Direct Effects: None expected.
Estuarine/Marine Invertebrates	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses Chronic: RQs >1 for all assessed uses	Indirect Effects: CCR, DS, TG
	Listed Species (Yes)	Acute: RQs > 0.05 for all assessed uses Chronic: RQs >1 for all assessed uses	Direct Effects: None expected as none of the assessed SF Bay species is an estuarine/marine invertebrate.
Vascular Aquatic Plants	Non-listed Species (No)	RQs < 1 for all assessed uses	Indirect Effects: None expected
Non-Vascular Aquatic Plants	Non-listed Species (No)	RQs > 1 for some uses including almond, brassica, cabbage, broccoli, celery, turf uses, ornamentals, garlic, horseradish, pistachio, rhubarb and strawberry	Indirect Effects: SFGS, CCR, CTS, DS, CFWS, TG
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes)	Chlorothalonil: acute RQs not calculated based on non-definitive LD/LC50 values SDS-3701: Acute: dose-based RQs >0.5 for all assessed uses for small birds consuming short grass, arthropods/small insects, and herbivorous mammals Chlorothalonil and SDS-3701: Chronic: dietary-based RQs >1 for all assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals	Indirect Effects: CCR, CTS, SFGS
	Listed Species (Yes)	Chlorothalonil: acute RQs not calculated based on non-definitive LD/LC50 values SDS-3701: Acute: dose based RQs >0.1 for all assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals Chlorothalonil and SDS-3701 Chronic: Same as for non-listed (above cell)	Direct Effects: CCR, CTS, SFGS
Mammals	Non-listed Species (Yes)	Chlorothalonil: acute RQs not calculated based on non-definitive LD/LC50 values	Indirect Effects: CCR, CTS,

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
		SDS-3701: Acute: dose-based RQs >0.5 for most assessed uses. Chlorothalonil - Chronic: dose-based RQs>1 for all assessed uses and diet-based for most uses SDS-3701 – Chronic dose and dietary-based RQs>1 for all assessed uses	SFGS
	Listed Species (Yes)	Chlorothalonil: acute RQs not calculated based on non-definitive LD/LC50 values SDS-3701: Acute: dose-based RQs >0.1 for all assessed uses. Chlorothalonil and SDS-3701 Chronic: Same as for non-listed (above cell)	Direct Effects: None as no SF Bay species for this assessment is a mammal
Terrestrial Invertebrates	Listed Species (N/A)	RQs were not calculated as acute toxicity value was non-definitive (LD50> highest conc. tested)	Direct/Indirect Effects: BCB (direct); CCR, CTS, SFGS (indirect)
Terrestrial Plants - Monocots	Non-listed Species (N/A)	RQs were not calculated as EC25 value was non-definitive (EC25 > limit concentration or could not be calculated)	Indirect Effects: BCB, SFGS, CCR, CTS, DS, CFWS, and TG
Terrestrial Plants - Dicots	Non-listed Species (N/A)	RQs were not calculated as EC25 value was non-definitive (EC25 > limit concentration or could not be calculated)	Indirect Effects: BCB, SFGS, CCR, CTS, DS, CFWS, and TG
	Listed Species (N/A)	RQs were not calculated as NOAEC value was non-definitive (NOAEC < limit concentration and EC05 could not be calculated)	Indirect Effects: BCB, SFGS, CCR, CTS, DS, CFWS, and TG

N/A = not applicable

Table 5-10. Risk Estimation Summary for Chlorothalonil – Effects to Designated Critical Habitat (PCEs)

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
Freshwater Fish and Aquatic-phase Amphibians	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses Chronic: RQs >1 for all assessed uses	CTS (SB-DPS & CC DPS), DS, TG
	Listed Species (Yes)	Acute: RQs ≥ 0.05 for all assessed uses. Chronic: RQs >1 for all assessed uses	
Freshwater Invertebrates	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses except cole crops, corn, fruiting vegs., grass seed, lupine,	CTS (SB-DPS & CC DPS),

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
		yam Chronic: RQs >1 for all assessed uses	DS, TG
Estuarine/Marine Fish	Non-listed Species (N/A)	RQs were not calculated because acute toxicity for quantitative use were not available and chronic toxicity data were not available	CTS (SB-DPS & CC DPS), DS, TG
	Listed Species (N/A)	RQs were not calculated because acute toxicity for quantitative use were not available and chronic toxicity data were not available	
Estuarine/Marine Invertebrates	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses Chronic: RQs >1 for all assessed uses	CTS (SB-DPS & CC DPS), DS, TG
Vascular Aquatic Plants	Non-listed Species (No)	RQs < 1 for all assessed uses	None expected
Non-Vascular Aquatic Plants	Non-listed Species (No)	RQs > 1 for some uses including almond, brassica, cabbage, broccoli, celery, turf uses, ornamentals, garlic, horseradish, pistachio, rhubarb and strawberry	CTS (SB-DPS & CC DPS), DS, TG
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes)	Chlorothalonil: acute RQs not calculated based on non-definitive LD/LC50 values SDS-3701: Acute: dose-based RQs >0.5 for all assessed uses for small birds consuming short grass, arthropods/small insects, and herbivorous mammals Chlorothalonil and SDS-3701: Chronic: dietary-based RQs >1 for all assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals	CTS (SB-DPS & CC DPS)
	Listed Species (Yes)	Chlorothalonil: acute RQs not calculated based on non-definitive LD/LC50 values SDS-3701: Acute: dose based RQs >0.1 for all assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals Chlorothalonil and SDS-3701 Chronic: Same as for non-listed (above cell)	CTS (SB-DPS & CC DPS)
Mammals	Non-listed Species (Yes)	Chlorothalonil: acute RQs not calculated based on non-definitive LD/LC50 values SDS-3701: Acute: dose-based RQs >0.5 for most assessed uses. Chlorothalonil - Chronic: dose-based RQs>1 for all assessed uses	CTS (SB-DPS & CC DPS)

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
		and diet-based for most uses SDS-3701 – Chronic dose and dietary-based RQs>1 for all assessed uses	
Terrestrial Invertebrates	Listed Species (N/A)	RQs were not calculated as acute toxicity value was non-definitive (LD50> highest conc. tested)	BCB, CTS (SB-DPS & CC DPS)
Terrestrial Plants - Monocots	Non-listed Species (N/A)	RQs were not calculated as EC25 value was non-definitive (EC25 > limit concentration or could not be calculated)	BCB,CTS (SB-DPS & CC DPS), DS, and TG
Terrestrial Plants - Dicots	Non-listed Species (N/A)	RQs were not calculated as EC25 value was non-definitive (EC25 > limit concentration or could not be calculated)	BCB, CTS (SB-DPS & CC DPS), DS, and TG
	Listed Species (N/A)	RQs were not calculated as NOAEC value was non-definitive (NOAEC < limit concentration and EC05 could not be calculated)	BCB

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

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

- Significance of Effect: Insignificant effects are those that cannot be meaningfully measured, detected, or evaluated in the context of a level of effect where "take" occurs for even a single individual. "Take" in this context means to harass or harm, defined as the following:
  - Harm includes significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.
  - Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.
- Likelihood of the Effect Occurring: Discountable effects are those that are extremely unlikely to occur.
- Adverse Nature of Effect: Effects that are wholly beneficial without any adverse effects are not considered adverse.

A description of the risk and effects determination for each of the established assessment endpoints for the assessed species and their designated critical habitat is provided in Sections **5.2.1** through **5.2.11**. 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. In the instance where a direct effect is not supported by the evidence, but indirect effects are, then the indirect effects will be described in the direct effects section (where appropriate). Additional indirect effects are enumerated in the indirect effects section. 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 chlorothalonil. Finally, in Section 5.2.11, 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. Freshwater Fish and Aquatic-phase Amphibians

5.2.1.a. Direct Effects

The acute RQs (0.189-2.63) and chronic RQs (1.00-5.23) for freshwater fish and aquatic-phase amphibians exceed listed species LOCs (acute: 0.05; chronic: 1). The peak model-estimated environmental concentrations resulting from different chlorothalonil uses range from 3.4 μg/L (brassica, one modeled scenario) to 47.5 μg/L (christmas trees). The maximum concentration reported from the USDA NAWQA database for surface water was 0.71 μg/L. The maximum concentration of chlorothalonil reported by the CDPR surface water database was 0.29 μg/L and is roughly 164 times *lower* than the highest peak model-estimated environmental concentration. As a result, it is believed that PRZM/EXAMS EECs provide a conservative measure of exposure. However, there were eight aquatic incidences that reported large fish kills including trout, salmon, tilapia, carp as well as other species. These incidences were classified as possible from chlorothalonil use.

There was an open literature study that reported an acute 96-hr LC_{50} value than the value used in this assessment for the RQ calculations (Davies and White, 1985; Ecotox 87454;7055). This study reported an LC_{50} value of 10.5 μg a.i./L using rainbow trout which included a co-stressor of reduced oxygen (*ca*. 50% of saturation). While this toxicity value is slightly lower than the 18 μg a.i./L value used in this assessment, given the EECs and that chlorothalonil is very highly toxic to freshwater fish, the use of either value will not modify the overall risk conclusion.

Fish were used as surrogates for aquatic-phase CTS to evaluate acute and chronic direct effects from exposure to chlorothalonil. Lethality was examined in three species of amphibians (*Rana sphenocephala*, *Osteopilus septentrionalis*, and *Hyla cinerea*) (McMahon et al., 2012; E156144). For *O. septentrionalis*, and *H. cinerea*, the use of the acute 96-hours toxicity value for rainbow trout appear to be protective, however, this may not be true for *R. sphenocephala*, but there is uncertainty in this comparison given the results of the amphibian test. As this study did not evaluate other sublethal endpoints (*i.e.*, growth) and the study was not conducted over chronic exposure duration (*i.e.*, such as the early-life stage toxicity test with fish), there is uncertainty in whether the chronic toxicity value for fish is conservative or not for aquatic-phase amphibians.

Lastly, because freshwater fish are being used as surrogates for aquatic-phase CTS and the most sensitive acute toxicity value for chlorothalonil is being used, an analysis of the sensitivity of freshwater fish to chlorothalonil on an acute exposure basis was completed. Therefore, a species sensitivity distribution (SSD) for the eight freshwater fish for which acute toxicity data are available was calculated. The eight genus mean 96-h LC_{50} values used to calculate the acute SSD for freshwater fish are listed in **Table 5-11**. This calculation is consistent with the Office of Water's approach for generating SSDs for Ambient Water Quality Criteria (AWQC). For a specific species with multiple tests available, the geometric species mean LC_{50} value for the specific species was calculated first, and then the genus mean LC_{50} was calculated.

Table 5-11. Freshwater Fish Genus and Species Mean Acute 96-Hr LC_{50} Values

GENUS MEAN ACUTE VALUE (µg/L)	SPECIES	NUMBER OF ACUTE VALUES USED TO CALCULATE THE SPECIES MEAN VALUE
23	*Pimephales promelas* Fathead minnow	1
17	*Galaxias maculatus* Jollytail	1
17	*Galaxias olidus* Spotted mountain	1
20	*Oncorhynchus mykiss* Rainbow trout	3
100	*Tilapia nilotica* Tilapia	1
69	*Gasterosteus* Stickleback	1
64	*Lepomis macrochirus* Bluegill sunfish	3
48	*Ictalurus punctatus* Channel catfish	1

The genus log LC_{50} values are used to calculate a SSD using the US EPA species sensitivity distribution generator which is part of CADDIS (Causal Analysis/Diagnosis Decision Information System)[32]. It was used for extrapolating 5th, 50th, and 95th percentile LC_{50} values for freshwater fish. Using this approach, the 5th percentile LC_{50} is 10.5 µg/L, the 50th or median percentile LC_{50} value is 36.1 µg/L, and the 95th is 125 µg/L (**Figure 5-1**). Assuming that the genera tested represent the full range of freshwater fish sensitivity to chlorothalonil, these results

[32] http://www.epa.gov/caddis/da_software_ssdmacro.html

indicate that 5% of freshwater fish will have an LC_{50} value less than or equal to 10.5 µg/L, 50% less than or equal to 36.1 µg/L, and 95% less than or equal to 125 µg/L. Relative to this sensitivity distribution, the rainbow trout LC_{50} value (18 µg/L) is a conservative estimate with over 95% of the fish being less sensitive.

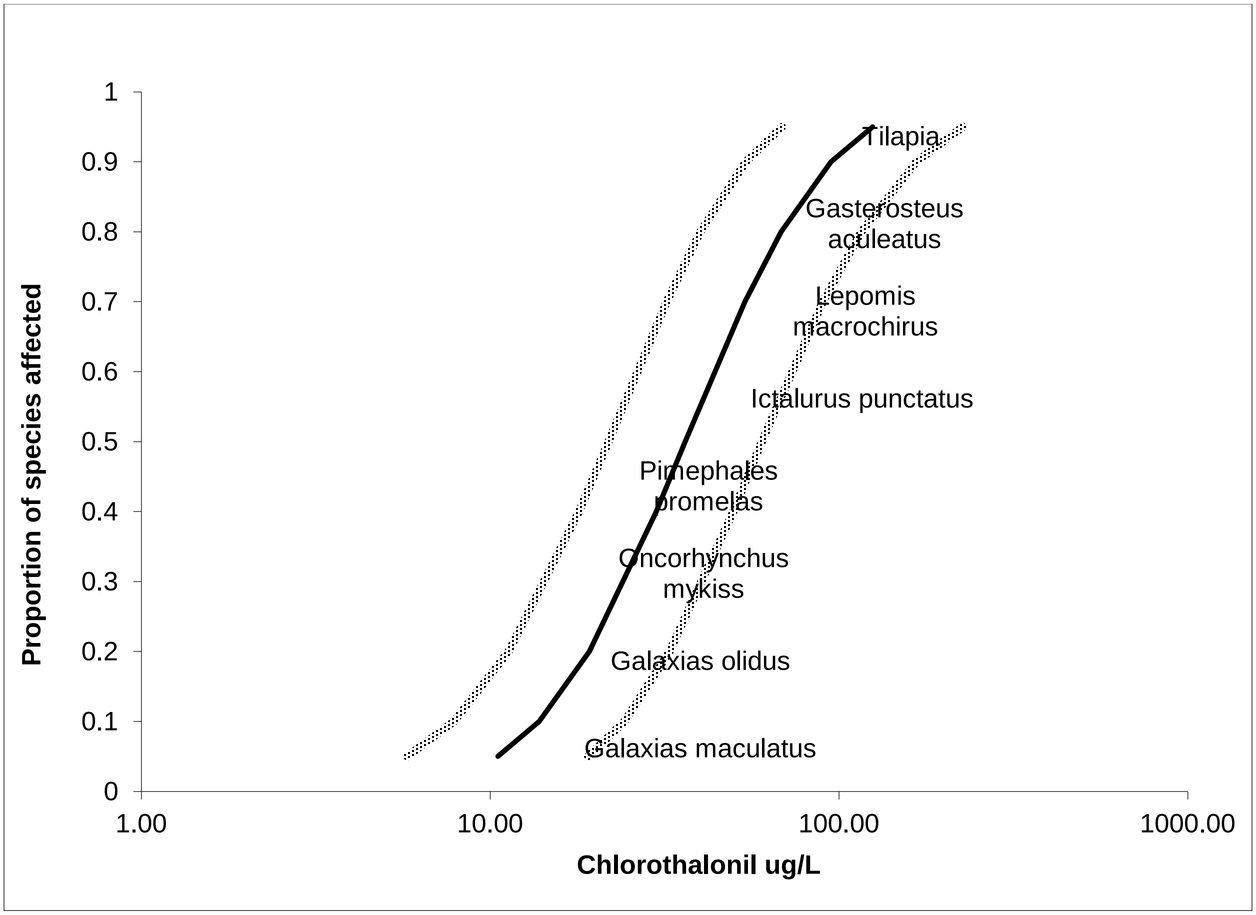

Figure 5-1. SSD for Freshwater Fish for Chlorothalonil

Using the lowest and highest RQs (0.189-2.63) that exceed the acute listed LOC for aquatic animals (0.05), the chance of an individual mortality for freshwater fish and aquatic phase amphibians is 1 in 37,000 to 1 in 1 for slope of 5.58 and ranges from 1 in 46 to 1 in 1 and 1 in 1.43×10^9 to 1 for the 95% confidence limits of 2.79 and 8.37, respectively. Furthermore, spatial distribution maps for freshwater dwelling species indicates overlap between habitat and the chlorothalonil use footprint (see map 1, **APPENDIX L**).

Based on the above analyses, there is the **potential for risk of <u>direct effects</u> to aquatic-phase CTS, the DS, and TG from acute and/or chronic exposure to chlorothalonil** from all registered agricultural uses of chlorothalonil.

5.2.2. Freshwater Invertebrates

5.2.2.a. Direct Effects

The acute RQs (0.063-0.88) and chronic RQs (2.3-19.8) for freshwater invertebrates exceed listed species LOCs (acute: 0.05; chronic: 1) for all assessed uses. Aquatic incident data are not available for freshwater invertebrates; however, invertebrate incident data are rarely reported.

A study which evaluated acute toxicity to many different species of freshwater invertebrates (Multiple spp.- crustacea, insecta, gastropoda spp., *Planaria* sp., *Brachionus calyciflorus*, and *Erpobdella* sp.) was submitted by the registrants (MRID 4341601). The 24-96-hr LC/EC50 values (value depends on species) ranged from 19.5 - >1,60 µg/L. However, there were uncertainties in this study as the following occurred in some tests: negative control not used, unacceptable control mortality; prior exposure to field collected organisms unknown (acclimation unknown); and potential cannibalism.

There were several open literature studies for acute toxicity for freshwater invertebrates. A paper by Faria *et al*., 2010, (E156417) reported an estimated 48-hour EC_{50} of 0.97 µg/L for chlorothalonil for zebra mussels (*Dreissena polymorpha*) based on embryonic development; however, raw data were not available and there was uncertainty in the reported sample size used in the EC_{50} calculation. This reported 48-hr EC_{50} is lower than the EECs for all uses.

In addition, an open literature study (Davies *et al*., 1994; E4442) reported 96-hour LC_{50} values for two invertebrate species that were more sensitive to chlorothalonil than daphnids (48-h EC_{50} of 54 µg a.i./L). 96-hour LC_{50} values for the giant freshwater crayfish (*Astacopsis gouldi*) and the freshwater atyid shrimp (*Paratya australiensis*) were 12 µg a.i./L and 16 µg a.i./L, respectively. Details of the study were not reported in the article such as potential prior pesticide exposure of the wild caught *P. australiensis*, the five test concentration levels, and control survival performance. Finally, the invertebrates in the study were fed crumbled commercial salmon food which may be an adequate substrate for chlorothalonil to bind (log K_{ow} 3.8); therefore, the bioavailability of the test compound is an uncertainty. The reported 48-hr EC50's for these studies are lower than many of the EECs and if compared to the EECs, the ratio would be greater than 0.2 for all uses.

There was an additional chronic toxicity study with *Daphnia magna* in which the NOAEC was 39 µg a.i./L based on survival and reproduction (MRID 00115107). All of the assessed 21-day EECs are less than this value. While there is a large difference between the two chronic *Daphnia magna* studies, the toxicity observed in the lower toxicity value study is believed to be due to exposure to chlorothalonil. Therefore, while there is an observed difference in the LOC exceedances depending on which value is chosen which introduces some uncertainty, the overall conclusions on chronic toxicity to freshwater invertebrates, based on the available data are believed to be appropriate.

Using the lowest and highest RQs (0.063-0.88) that exceed the acute listed LOC for aquatic animals (0.05), the chance of an individual mortality for freshwater invertebrates is 1 in 4.89 x 10^9 to 1 in 2.5 for slope of 4.57 and ranges from 1 in 11,100 to 1 in 2.3 and 1 in 4.08 x 10^{12} to 1 in 2.7 for the 95% confidence limits of 3.12 and 6.02, respectively. Furthermore, spatial distribution maps for freshwater dwelling species indicates overlap between habitat and the chlorothalonil use footprint (see map 2, **APPENDIX L**).

Based on the above analyses, there is the **potential for risk of direct effects to the CFWS from acute and chronic exposure to chlorothalonil** from all registered uses assessed for chlorothalonil.

5.2.3. Estuarine/Marine Fish

5.2.3.a. Direct Effects

Acute and chronic toxicity data for estuarine/marine fish available for use in a RQ calculation were not available. A study with sheepshead minnow was available (MRID 00127863) with a 96-hr LC_{50} of 33 µg a.i./L; however, given the uncertainties in the exposure concentrations (nominal concentrations in a static system which may underestimate the actual exposure concentrations), the endpoint value is for qualitative use only. An early life-stage toxicity study with estuarine/marine fish is not available. As such, a chronic NOAEC value was determined using the fathead minnow data and the qualitative LC_{50} value; however, the estimated chronic NOAEC of 2.7 µg a.i./L for sheepshead minnow was considered only qualitatively.

One acute estuarine/marine study was reported in the open literature (Bao *et al.*, 2011; E156339). In this study, marine medaka (*Oryzias melastigma*) were exposed as larvae (<24 hrs old) to chlorothalonil under static-renewal conditions for 96 hours (48-hr renewal). The fish were not fed during the study. The reported 96-hr LC_{50} was 110 µg/L (100-110 95% CI) based on nominal concentrations. In this study, DMSO was used as a co-solvent carrier (<1%), and the actual test concentrations were uncertain. Control mortality may have been as high as 20% (mortality not specified but not greater than 20%), and newly-hatched larvae were not fed, potentially confounding the results. As such this study is for qualitative use only.

To evaluate acute and chronic risk to estuarine/marine fish, the qualitative acute LC_{50} value and chronic NOAEC value were compared to the EECs. The peak model-estimated environmental concentrations resulting from different chlorothalonil uses range from 3.4 µg/L (brassica) to 47.5 µg/L (Christmas trees). To evaluate listed (LOC of 0.05) and non-listed species (LOCs of 0.1 and 0.5), 1/20th, 1/10th, and 1/2 the qualitative LC50 value (which correlate to the LOCs listed above) were derived as follows: 1/20th = 1.65, 1/10th = 3.3, ½ = 16.5. These modified values were compared to the peak EECs. The peak EECs exceeds both the 1/20th and 1/10th values for all uses. The peak EECs exceed ½ the LC_{50} value for the following uses: almonds, celery, Christmas trees, golf courses, ornamental lawns and plants, and strawberries. To evaluate chronic exposure, the qualitative NOAEC was compared to the 60-day EECs, and the EECs were greater than the NOAEC for the following uses: almonds, stone fruits, brassica, broccoli, cabbage, Brussels sprouts, cauliflower, carrot, celery, cherry, Christmas trees, garlic, golf courses, horseradish, mango, onion, ornamental lawns and plants, rhubarb, and strawberry.

Aquatic incident data were not submitted and are not available for estuarine/marine fish. This does not mean, however, that an estuarine/marine fish kill did not occur, but that it was potentially not reported.

Spatial distribution maps for marine/estuarine dwelling species cannot clearly indicate spatial overlap between estuarine/marine habitat and the chlorothalonil use footprint (see Delta Smelt map in **Appendix L** and Tidewater Goby maps in **Appendix M**). Nevertheless, given all lines of evidence including that the EECs are greater than the qualitative acute and chronic toxicity values**, chlorothalonil <u>does have the potential to directly</u> affect the DS and TG via the marine environment.**

5.2.4. Estuarine/Marine Invertebrates

5.2.4.a. Direct Effects

The acute RQs (0.9-13.2) and chronic RQs (2.0-27.9) for estuarine/marine invertebrates exceed listed species LOCs (acute: 0.05; chronic: 1) for all assessed uses. The peak model-estimated environmental concentrations resulting from different chlorothalonil uses range from 3.4 µg/L (brassica) to 47.5 µg/L (Christmas tree). The maximum concentration reported from the USDA NAWQA database for surface water was 0.71 µg/L. The maximum concentration of chlorothalonil reported by the CDPR surface water database was 0.29 µg/L and is roughly 164 times *lower* than the highest peak model-estimated environmental concentration. As a result, it is believed that PRZM/EXAMS EECs provide a conservative measure of exposure. Aquatic incident data were not submitted for estuarine/marine invertebrates. This does not mean, however, that an invertebrate kill did not occur, but that it was potentially not reported.

While the acute RQs were based on shell growth for the Eastern Oyster, the chronic RQs were based on an ACR derived using the Northern pink shrimp acute toxicity value of 154 µg/L. In Key *et al*., 2003 (ECOTOX # 101032), a 96-hr LC50 value of 49.5 µg/L was reported for another estuarine/marine invertebrate, grass shrimp (*Palamonetes pugio*) during the larval stage. The 96-hr LC50 for the adult stage was reported as 153 µg/L, which is the same stage as the submitted study. However, this study is classified as qualitative due to: 1) raw data were not provided; 2) no negative control group only solvent (acetone, 0.1%); control performance difficult to interpret. This reported toxicity value with another shrimp species, gives further evidence in the level of toxicity of chlorothalonil to estuarine/marine invertebrates. Also, in this study, a chronic life-cycle study was conducted for 50-days where the shrimp were exposed to chlorothalonil in a pulsed exposure (6-hr exposures every day). The study authors reported that there was a significant increase in the number of molts to post-larvae for treatment groups 31.5-125 µg/L compared to the control; higher doses had complete mortality by test termination. However, the time to post-larvae stage or dry weight was not significantly different. Based on the figure in the study, it appears that there was substantial control mortality shortly after Day 25 with an overall control survival of 38%. Additional open literature acute toxicity studies with the grass shrimp were available (ECOTOX 120220), with similar 96-hr LC50 values as reported by Key *et al*. 2003, whereas the 95% confidence intervals overlap.

The most-sensitive acute toxicity value for estuarine/marine invertebrates is for the Eastern oyster for shell deposition. As this is based on a growth endpoint, evaluating the chance of an individual mortality using these RQs is not appropriate. As discussed for estuarine/marine fish, spatial distribution maps for marine/estuarine dwelling species cannot clearly indicate spatial overlap between habitat and the chlorothalonil use footprint. However, should modeled concentrations reach the estuarine/marine environment **there is potential for <u>indirect effects</u> to the CCR, DS, and TG** from all registered uses assessed for chlorothalonil**; <u>no direct effects</u> are expected to the SF Bay species as none are a marine/estuarine invertebrate.**

5.2.5. Aquatic vascular/non-vascular plants

5.2.5.a. Direct Effects

There are no LOC exceedances for aquatic vascular plants for any of the assessed uses (RQs<1). However, for aquatic non-vascular plants, RQs exceed the LOC (of 1) for the following uses: almond, brassica, cabbage, broccoli, celery, turf uses, ornamentals, garlic, horseradish, pistachio, rhubarb and strawberry (RQs 1.0-4.0). The peak model-estimated environmental concentrations resulting from different chlorothalonil uses range from 3.4 µg/L (brassica) to 47.5 µg/L (Christmas tree). The maximum concentration reported from the USDA NAWQA database for surface water was 0.67 µg/L. The maximum concentration of chlorothalonil reported by the CDPR surface water database was 5.4 µg/L and is roughly 11.6 times *lower* than the highest peak model-estimated environmental concentration. As a result, it is believed that PRZM/EXAMS EECs provide a conservative measure of exposure. Aquatic incident data were not reported for aquatic vascular or non-vascular plants. This does not mean, however, that plant damage did not occur, but that it was potentially not reported.

Open literature studies were available for both aquatic non-vascular and vascular plants. For the non-vascular plant, *Thalassiosira pseudonana,* a 96-hr EC_{50} (based on growth rate) of 4.4 µg/L was reported (Bao *et al.,* 2011; E156339). This study was deemed qualitative as: 1) raw data not provided; 2) DMSO (<1%) used as a solvent carrier; 3) test volumes of 5mL used; 4) nominal test concentrations used. The reported 95% confidence intervals in this study overlap with the Navicula *pelliculosa* EC_{50} value that was used to calculate the RQs, and this study gives further information on the toxicity of chlorothalonil to non-vascular plants. For vascular plants, Belgers *et al.,* 2009, (E108046) evaluated growth for several aquatic vascular plant species using chlorothalonil. The study examined several species and many growth endpoints, and for several species and endpoints, the reported toxicity was less than the *Lemna gibba* value used in the RQ calculations. However, the most sensitive endpoint reported was for *Elodea nuttallii* with a reported 21-day EC_{50} of 94 µg a.i./L based on length of new shoots. This study was deemed for qualitative use due to: 1) raw data not reported; 2) only initial measured concentrations available for one series of tests (which include the most sensitive endpoint); 3) it is not known if formulation tested (study conducted in Europe) accurately reflects a U.S. formulation. The highest EEC is 47.5 µg/L (Christmas trees), and therefore, even with this lower toxicity value, the EECs are still below the toxicity value. A NOAEC was not reported in this study.

Spatial distribution maps for SFGS, CCR, CTS, DS, CFWS, TG indicate overlap between habitat and the chlorothalonil use footprint. Since the LOC is exceeded for aquatic non-vascular plants and these species rely on plants for shelter and/or food, **there is potential for <u>indirect effects</u> to the SFGS, CCR, CTS, DS, CFWS, and TG** presumably from almond, brassica, cabbage, broccoli, celery, turf uses, ornamentals, garlic, horseradish, pistachio, rhubarb and strawberry **.**

5.2.6. Birds, reptiles, and terrestrial-phase amphibians

5.2.6.a. Direct Effects

T-REX

Chlorothalonil

Chronic RQ values for birds consuming short grass and arthropods exceeded the LOC for all assessed uses (RQs 5.23-59.9 for short grass; 2.11-23.4 for arthropods). Acute RQ values could not be calculated due to non-definitive acute toxicity values for birds (LC/LD_{50} greater than highest concentration tested). Therefore, the $1/10^{th}$ and ½ of the highest test concentrations in the acute and sub-acute avian studies were compared to the EECs. The acute dose-based LD_{50} was >4,640 mg/kg-bw (mallard duck) and $1/10^{th}$ and ½ of the adjusted acute dose-based values were compared to dose-based EECs; these toxicity values were modified to account for food consumption requirements based on body size. The acute dietary-based LC_{50} value was >10,000 mg/kg-diet (bobwhite quail) and >21,500 mg/kg-diet (mallard) which corresponds to 1,000 and 5,000 mg/kg-diet and 2,150 and 10,750 mg/kg-diet for $1/10^{th}$ and 1/2, respectively. In comparing these values to the EECs for small birds consuming short grass (both dietary and dose-based), the EECs are greater than $1/10^{th}$ and $1/5^{th}$ the highest concentration tested for all assessed uses. The acute (dose-based) EECs were greater than ½ the highest concentration tested for all uses except, grass forage, fodder, hay, grass seed, lupine, and cole crops, and were greater (dietary-based) for some uses (*i.e.,* almond, stone fruit, carrot, celery, Christmas trees, turf, cucurbit, melons, garlic, ginseng, horseradish, mango, onion, ornamentals, pistachio, rhubarb, and tomato). In the acute oral toxicity study with mallard duck, the LOAEC was determined to be 2,150 mg a.i./kg-bw based on reduced body weight. In the acute dietary studies, in the bobwhite quail study, there was a slight reduction in body weight at the highest concentration tested (10,000 mg a.i./kg-diet) and in the mallard study there was reduced weight gain starting at the 4,600 mg a.i./kg-diet concentration. As the EECs overlap with the modified highest concentration tested and the observation of reduced body weight in the studies, there is a concern for potential effects to listed birds (surrogates for reptiles and terrestrial-phase amphibians). The same approach was used for small birds consuming arthropods. In comparing $1/10^{th}$ the highest concentration tested, for the acute (dose-based) EECs, all were greater than the highest concentration for all crops, but for acute dietary, only the turf, mango, and ornamental EECs were greater. In comparing ½ the highest concentration, the EEC for some uses (i.e., almond, celery, Christmas trees, turf, cucurbit, garlic, horseradish, mango, ornamentals, pistachio), was greater using the acute dose-based EEC.

SDS-3701

The acute RQs (dose based: 3.63-40.2; dietary based: 0.15-1.66) and chronic RQs (dietary based: 5.23-57.8) for birds, reptiles, and terrestrial-phase amphibians exceed listed species LOCs (acute: 0.1; chronic: 1) for all uses when modeling is based on consumption of short grass. The acute RQs (dose based: 1.42-15.7; dietary based: 0.10-0.65) and chronic RQs (dietary based: 2.05-22.7) for birds, reptiles, and terrestrial-phase amphibians exceed listed species LOCs (acute: 0.1; chronic: 1) for all uses when modeling is based on consumption of arthropods. In either case,

there is potential for <u>direct effects</u> to the CCR, CTS (all DPS), and SFGS from all assessed uses of chlorothalonil and when modeling the major degradate, SDS-3701.

T-HERPS

A refinement of the RQs for the CTS and SFGS using T-HERPS indicates LOC exceedances for all uses.

Chlorothalonil

Chronic RQs (dietary based: 3.09-33.7) for a <u>small 2g bird (surrogate for small CTS)</u> consuming small insects exceed listed species LOCs (chronic: 1). The chronic RQs (dietary based: 5.51-60.1) for a <u>medium 20g bird (surrogate for CTS)</u> consuming herbivorous mammals of 1.33 to 13.3g exceed listed species LOCs (chronic: 1). The chronic RQs (dietary based: 3.09-33.7) for a <u>small 2g bird (surrogate for small SFGS)</u> consuming small insects exceed listed species LOCs (acute: 0.1; chronic: 1). The chronic RQs (dietary based: 4.21-45.9) for a <u>medium 20g bird (surrogate for SFGS)</u> consuming herbivorous mammals of 2.10 to 24.7g exceed listed species LOCs (chronic: 1). Again, acute RQ values were not calculated. If the same approach is used as described above, for a <u>small 2g bird (surrogate for small CTS and SFGS)</u> consuming small insects the EECs for all uses are less the 1/10th the highest concentration tested using acute dose-based EECs; however, if using the acute dietary-based EECs, these EECs are greater than 1/10th the highest concentration for a majority of the uses. For a <u>medium 20g bird (surrogate for CTS and SFGS)</u> consuming herbivorous mammals, the EECs (acute dose-based) are greater than 1/10th the highest concentration tested for all uses, and are greater than 1/5th the highest concentration for all uses, expect grass fodder, hay; grass seed; lupine; parsnip; beans dried; bulb vegetables, and are greater based on acute dietary-based EECs for almost all uses.

SDS-3701

The acute RQs (dose based: 0.1-0.57; dietary-based: 0.1-0.94) and chronic RQs (dietary based: 3.02-32.7) for a <u>small 2g bird (surrogate for small CTS)</u> consuming small insects exceed listed species LOCs (acute: 0.1; chronic: 1). The acute RQs (dose based: 1.14-12.3; dietary-based: 0.10-1.67) and chronic RQs (dietary based: 5.39-58.4) for a <u>medium 20g bird (surrogate for CTS)</u> consuming herbivorous mammals of 1.33 to 13.3g exceed listed species LOCs (acute: 0.1; chronic: 1). The acute RQs (dose based: 0.1-0.57; dietary-based: 0.1-0.94) and chronic RQs (dietary based: 3.02-32.7) for a <u>small 2g bird (surrogate for small SFGS)</u> consuming small insects exceed listed species LOCs (acute: 0.1; chronic: 1). The acute RQs (dose based: 1.61-17.5; dietary-based: 0.12-1.28) and chronic RQs (dietary based: 4.12-44.6) for a <u>medium 20g bird (surrogate for SFGS)</u> consuming herbivorous mammals of 2.10 to 24.7g exceed listed species LOCs (acute: 0.1; chronic: 1). **T-HERPS calculations further confirm that chlorothalonil has the potential to <u>directly affect</u> the CTS (all DPS) and the SFGS** from all assessed agricultural uses of chlorothalonil and when modeling the major degradate, SDS-3701.

Avian incident data were not submitted. This does not mean, however, that effects did not occur, but that it was potentially not reported.

As acute RQ values were not calculated for chlorothalonil, the calculations of an individual chance of mortality were not appropriate with the available data. However, using the lowest and highest RQs (1.14-17.5) for SDS-3701 that exceed the acute listed LOC for terrestrial animals (0.10), the chance of an individual mortality for birds, reptiles, and terrestrial-phase amphibians is 1 in 1 to 1 in 1 for the default slope of 4.5 and ranges from 1 in 1 to 1 in 1 for the default 95% confidence limits of 2 and 9, respectively. Furthermore, spatial distribution maps for CCR, CTS, and SFGS species indicates overlap between habitat and the chlorothalonil use footprint.

5.2.7. Mammals

5.2.7.a. Direct Effects

Chlorothalonil

The chronic RQs (dietary based: 1.0-7.63; dose based: 3.86-43.0) for small 15g mammals consuming short grass exceed listed species LOCs (chronic: 1) for all uses. The chronic RQs (dietary based: 1.0-7.63; dose based: 3.30-36.7) for 35g medium mammals consuming short grass exceed listed species LOCs (chronic: 1) for all uses. As with the birds, the acute oral LD_{50} toxicity value for mammals is a non-definitive value (LD_{50}>10,000 mg/kg-bw) and therefore RQs were not calculated. Using the same approach as was done with the birds, none of the EECs (acute dose-based) were greater than ½ the highest concentration tested when evaluating small mammals consuming short grass. For small mammals consuming short grass, the EECs for garlic, mango, ornamentals and turf were greater than $1/10^{th}$ the highest test concentration, and only ornamental plant and turf EECs were greater than $1/10^{th}$ of the highest test concentration for medium mammals consuming short grass. In comparing $1/5^{th}$ the value, only turf uses (golf courses, ornamentals) uses exceed. However, another acute oral toxicity study with rats was available in which the LD_{50} was greater than 16,240 mg/kg (MRID 00094728). When comparing $1/10^{th}$ this value to the EECs, only the turf uses (golf courses and ornamentals) exceeded, but only golf courses when comparing 1/5th. Therefore, it is anticipated that only for golf course uses, the potential for direct acute effects to mammals may occur.

SDS-3701

The acute RQs (dose based: 0.47-5.18) for small 15g mammals consuming short grass exceed listed species LOC and restricted-use LOC (acute: 0.1 or 0.2) for all uses. The acute RQs (dose based: 0.40-4.43) for 35g medium mammals consuming short grass exceed listed species or restricted LOCs (acute: 0.1 or 0.2) for all uses. As there were no observed effects at the highest concentration test in the chronic mammalian test with SDS-3701(NOAEC = 6 mg/kg-bw), RQ values were not calculated. However, when this highest dose tested was compared to the EECs, the EECs were greater for all uses.

Based on calculated acute and chronic RQs for 15g and 35g mammals consuming short grass, chlorothalonil and its major degradate SDS-3701 has the potential to directly affect listed mammals of the sizes modeled given the modeled uses.

As acute RQ values were not calculated for chlorothalonil, the calculations of an individual chance of mortality were not appropriate with the available data. For SDS-3701, using the lowest and highest RQs (0.47-5.18) that exceed the acute listed LOC for terrestrial animals (0.10), the chance of an individual mortality for mammals is 1 in 14 to 1 in 1 for the default slope of 4.5 and ranges from 1 in 4 to 1 in 1 and 1 in 632 and 1 in 1 (for low and high RQ range) for the default 95% confidence limits of 2 and 9, respectively. Mammalian incident data was not available.

Potential for direct effects to the seven species assessed for chlorothalonil does not apply as none of the SF Bay species for this assessment is a mammal. However, **since the acute and chronic RQs are exceeded, there is potential for <u>indirect effects</u> to those listed species that rely on mammals during at least some portion of their life-cycle (*i.e.*, CCR, CTS (all DPS), and the SFGS)** from all assessed uses of chlorothalonil.

5.2.8. Terrestrial invertebrates

5.2.8.a. Direct Effects

As the acute contact LD_{50} value for the honeybee resulted in a non-definitive value (LD_{50} is greater than the highest concentration tested, >181 µg a.i./bee or 1414 µg a.i./g), RQs were not calculated. Mortality or other sublethal effects were also not reported at this concentration. Toxicity data for SDS-3701 was not available. However, the arthropod EECs were compared to $1/20^{th}$ of this highest concentration which corresponds to the LOC of 0.05. The EECs for almond, celery and the turf uses (golf courses and ornamental lawns) were greater than this modified value.

As the arthropod EECs were greater than $1/20^{th}$ of the highest concentration for a few uses, there is uncertainty in whether effects would occur. However, there were four reported incidences for honeybees, in which mortality was reported ranging from 30 to 200 hives up to 500 colonies in the vicinity affected. Of the four reported incidents, one was associated with alfalfa use, while the use sites for other three incidents were not reported. The routes of exposure were reported as spray drift for two incidents, ingestion for one incident, and the route for the forth was not reported; the certainty were reported as possible for three and highly possible for the other.

Spatial distribution maps for BCB species indicates overlap between habitat and the chlorothalonil use footprint.

As there are reported honeybee incidents for chlorothalonil, it is assumed that **chlorothalonil has the potential to <u>directly affect</u> the BCB** from the assessed uses of chlorothalonil**.** While RQs were not calculated as the acute contact toxicity value for honeybees was a non-definitive value, calculated EECs did exceed this limit dose ($1/20^{th}$ of the limit dose), there is a potential for indirect effects to those listed species that rely on terrestrial invertebrates during at least some portion of their life-cycle (*i.e*., CCR, CTS (all DPS), and the SFGS).

5.2.9. Terrestrial plants

5.2.9.a. Direct Effects

RQ values were not calculated for terrestrial plants as the EC_{25} and overall no effect concentrations were both non-definitive (EC_{25} > 16 lb a.i./A; no effect concentration < 16 lb a.i./A). The EC_{25} value is used to evaluate potential risk to non-listed plants and the NOAEC for listed plants. Toxicity data for SDS-3701 for terrestrial plants are not available. A 26% effect on growth compared to the control was observed for one species (either onion or cucumber) out of 10 tested in both the seedling emergence and vegetative vigor studies; however, the overall no effect concentration for those studies is < 16 lb a.i./A. Additionally, the study was not conducted using a typical end-use product (TEP) but rather with technical chlorothalonil with an acetone co-solvent. Therefore, there is additional uncertainty in whether the other components in a TEP would affect the plants. Based on a comparison between this limit concentration (16 lb a.i./A) and the EECs for the highest single application using aerial application, the EECs (spray drift: 0.047-0.57; dry: 0.0564-0.684; semi-aquatic: 0.141-1.71) are approximately 10 times lower than the limit concentration. These EECs reflect only a single application, and are based on the label rates for chlorothalonil, although repeated applications may occur and the minimum re-application interval for ornamental lawns is 3 days. The limit concentration, which resulted in a non-defined NOAEC, was for 16 lb a.i./A, which is greater than the highest label single application rates whereas, except for turf uses, the typical maximum application rate on the label is 1-3 lb a.i./A. However, because multiple applications are allowed, the total a.i. allowed per year approaches or exceeds 16 lb a.i./A for several uses.

Additionally, 15 major plant incidents were reported; for all but three, it was reported that it was undetermined whether the incident was from a registered use, and the level of certainty was reported as “possible” for all incidences. Nine of the incidents were reported damage to home lawn or home trees. There were also incidents reported on conifers, peanuts and potatoes. For all incidents, the exposure route was reported as treated directly. Therefore, given the uncertainty in the toxicity value along with the reported plant incidents which were reported as direct application, there is uncertainty in whether chlorothalonil may affect non-target terrestrial plants. Additionally, there were over 400 minor plant incidents reported, but the details on these reports are minimal, and most of these incidents were reported in 1995. It is not known if there were changes to application methods or uses that may have contributed to the decrease in reported incidents.

Based on the information above, it is presumed that effects to non-target terrestrial plants may occur.

Furthermore, spatial distribution maps for BCB, SFGS, CCR, CTS, DS, CFWS, and TG indicate overlap between habitat and the chlorothalonil use footprint. Based on the available information, and these species rely on plants for shelter and/or food, it was assumed that **there is a potential for <u>indirect effects</u> to those listed species that rely on terrestrial plants for food, habitat, etc. during at least some portion of their life-cycle (*i.e.*, BCB, SFGS, CCR, CTS, DS, CFWS, and TG).**

5.2.9.b. Indirect Effects

i. Potential Loss of Prey

For indirect effects, since RQs exceed the non-listed species LOC(s) including the acute and acute restricted use LOCs, then chlorothalonil is likely to indirectly affect the SFGS, CCR, CTS, DS, CFWS, and TG for all uses. For specific uses that exceed the acute LOC (0.5) or the acute restricted use LOC (0.1 for aquatic organisms, 0.2 for terrestrial animals), see the Risk Estimation section. Risk quotients were not calculated for terrestrial plants and invertebrates given the lack of defined endpoints, however, risk was assumed for terrestrial plants for some uses and for terrestrial invertebrates. Therefore, indirect effects to the BCB are expected.

Table 5-12 Range of Acute[1] and Chronic RQs That Exceed Non-listed Species LOCs for Prey of Each SF Bay Species

SF Bay Species	Aquatic Organisms	Aquatic RQs	Terrestrial Organisms	Terrestrial RQs
SFGS* (eats invertebrates, fish, small mammals, reptiles, amphibians)	Freshwater fish	Acute: 0.189-2.64 Chronic: 1.1-5.2	Mammals[2]	Chlorothalonil: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, EECs for golf courses greater than modified toxicity when evaluating LOC of 0.2 Chronic: (sm): 1.0-43.0; (med): 1.0-36.7) SDS-3701 Acute (sm): 0.47-5.18 Acute (med): 0.40-4.43 Chronic: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, all EECs greater than modified toxicity when evaluating LOC of 1
	Freshwater inverts.	Acute: 0.104-0.88 Chronic: 2.3-19.8	Birds / Terrestrial-phase Amphibians	Chlorothalonil: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, all EECs for all uses greater than modified toxicity when evaluating LOC of 0.2 Chronic: 5.38-59.9 (birds); 4.21- 45.9 (SFGS) SDS-3701 Acute (birds): 0.20-

				40.2 Acute (SFGS):0.20-17.5 Chronic: 5.23-57.8 (birds); 4.12-44.6 (SFGS)
	Aquatic plants	Non-vascular: 1.0-4.0 Vascular: <1	Terrestrial inverts.	RQs not calculated due to lack of definitive data, comparison of EECs and toxicity, EECs greater for almond, celery, turf coupled with bee incidences, presumed risk.
			Terrestrial plants	No definitive data, comparison of toxicity data and EECs, presumed risk for plants
CCR (eats dead fish, frogs, aquatic inverts., aquatic plants, seeds, worms, spiders, small birds and mammals, terrestrial plants)	Freshwater fish	Acute: 0.189-2.64 Chronic: 1.1-5.2	Mammals[2]	Chlorothalonil: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, EECs for golf courses greater than modified toxicity when evaluating LOC of 0.2 Chronic: (sm): 1.0-43.0; (med): 1.0-36.7) SDS-3701 Acute (sm): 0.47-5.18 Acute (med): 0.40-4.43 Chronic: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, all EECs greater than modified toxicity when evaluating LOC of 1
	Freshwater inverts.	Acute: 0.104-0.88 Chronic: 2.3-19.8	Birds	Chlorothalonil: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, all EECs for all uses greater than modified toxicity when evaluating

				LOC of 0.2 Chronic: 5.38-59.9 SDS-3701 Acute (birds): 0.20-40.2 Chronic: 5.23-57.8
	E/M fish	RQs not calculated, given lack of quantitative data. Comparison of data to EECs, all EECs greater than toxicity data modified to assess LOC of 0.1 and some greater than when evaluating LOC of 0.5	Terrestrial inverts.	RQs not calculated due to lack of definitive data, comparison of EECs and toxicity, EECs greater for almond, celery, turf coupled with bee incidences, presumed risk.
	E/M inverts.	Acute: 0.9-13.2 Chronic: 2.0-27.9	Terrestrial plants	No definitive data, comparison of toxicity data and EECs, presumed risk for plants
	Aquatic plants	Non-vascular: 1.0-4.0 Vascular: <1		
CTS* (eats freshwater snails, aquatic invertebrates, fish, frogs, algae, zooplankton, terrestrial invertebrates, worms, small mammals)	Freshwater fish	Acute: 0.189-2.64 Chronic: 1.1-5.2	Mammals[2]	Chlorothalonil: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, EECs for golf courses greater than modified toxicity when evaluating LOC of 0.2 Chronic: (sm): 1.0-43.0; (med): 1.0-36.7) SDS-3701 Acute (sm): 0.47-5.18 Acute (med): 0.40-4.43 Chronic: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, all EECs greater than modified toxicity when evaluating LOC of 1
	Freshwater inverts.	Acute: 0.104-0.88 Chronic: 2.3-19.8	Birds / Terrestrial-phase amphibians	Chlorothalonil: RQs not calculated, given lack of quantitative data. Comparison of data to EECs, all EECs for all uses

				greater than modified toxicity when evaluating LOC of 0.2 Chronic: 5.38-59.9 (birds); 4.21- 45.9 (SFGS) SDS-3701 Acute (birds): 0.20-40.2 Acute (SFGS):0.20-17.5 Chronic: 5.23-57.8 (birds); 4.12-44.6 (SFGS)
	Aquatic plants	Non-vascular: 1.0-4.0 Vascular: <1	Terrestrial inverts.	RQs not calculated due to lack of definitive data, comparison of EECs and toxicity, EECs greater for almond, celery, turf coupled with bee incidences, presumed risk.
			Terrestrial plants	No definitive data, comparison of toxicity data and EECs, presumed risk for plants
DS (eats primarily planktonic copepods, cladocerans, amphipods, and insect larval; larvae feed on phytoplankton; juveniles on zooplankton)	Freshwater inverts.	Acute: 0.104-0.88 Chronic: 2.3-19.8	Terrestrial plants	No definitive data, comparison of toxicity data and EECs, presumed risk for plants
	E/M inverts.	Acute: 0.9-13.2 Chronic: 2.0-27.9		
	Aquatic plants	Non-vascular: 1.0-4.0 Vascular: <1		
CFWS (eats detritus – algae, aquatic macrophyte fragments, zooplankton, aufwuchs)	Freshwater inverts.	Acute: 0.104-0.88 Chronic: 2.3-19.8	Terrestrial plants	No definitive data, comparison of toxicity data and EECs, presumed risk for plants
	Aquatic plants	Non-vascular: 1.0-4.0 Vascular: <1		
TG (eats small benthic invertebrates, crustaceans, snails, mysids, aquatic insect larvae; juveniles may feed on unicellular phytoplankton or	Freshwater inverts.	Acute: 0.104-0.88 Chronic: 2.3-19.8	Terrestrial plants	No definitive data, comparison of toxicity data and EECs, presumed risk for plants
	E/M inverts.	Acute: 0.9-13.2 Chronic: 2.0-27.9		
	Aquatic plants	Non-vascular: 1.0-4.0 Vascular: <1		

zooplankton)				
BCB	N/A	N/A	Terrestrial plants	No definitive data, comparison of toxicity data and EECs, presumed risk for plants
E/M = estuarine/marine; N/A = not applicable *T-HERPS was run for this SF Bay species [1]Acute restricted use LOC (0.1) and Acute LOC (0.5) were both considered as non-listed LOCs for aquatic organisms. Acute restricted use LOC (0.2) and Acute LOC (0.5) were both considered as non-listed LOCs for terrestrial organisms. [2] Acute and chronic values for small 15g mammals (sm); acute and chronic values for large 35g mammals (med); chronic values include both dose-based and dietary based RQs. All values are based on consumption of short grass. [3]Acute values include both dose-based and dietary based RQs based on consumption of short grass [4] Acute values include both dose-based and dietary based RQs, and both acute and chronic RQ values are based on medium sized SFGS (20g) consuming small/medium herbivorous mammals of 2.10 to 24.74g [5] Acute values include both dose-based and dietary based RQs, and both acute and chronic RQ values are based on medium sized CTS (20g) consuming small/medium herbivorous mammals of 1.33 to 13.3g				

ii. Potential Modification of Habitat

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

The PRZM/EXAMS modeled peak EECs range from 3.4-47.5 µg a.i./L, which overlaps with the concentrations at which the growth inhibition effect on the non-vascular plants was observed in the open literature study (i.e., 96-hr EC_{50} 12 µg a.i./L). For the vascular aquatic plants, the EC_{50} value was 640 µg/L (94 µg/L for open literature study) and the peak EECs are at least approximately one order of magnitude lower.

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

Definitive toxicity data for terrestrial plants are not available. As discussed above, based on the available information, it was presumed that the potential for risk may occur. Furthermore, spatial distribution maps for BCB,SFGS, CCR, CTS, DS, CFWS, and TG indicate overlap between habitat and the chlorothalonil use footprint. Since effects to terrestrial plants are assumed and these species rely on plants for shelter and/or food, **there is a potential for <u>indirect effects</u> to those listed species that rely on terrestrial plants (for food, habitat, etc.)**

during at least some portion of their life-cycle (*i.e.*, BCB, , SFGS, CCR, CTS, DS, CFWS, and TG).

5.2.10. Modification of Designated Critical Habitat

Based on the weight-of-evidence and particularly the output of the RQ calculations whereby direct and indirect effects are expected for certain species (see the table above), **there is a potential for the modification designated critical habitat** (*i.e.,* particularly in reference to the species with a designated critical habitat designation including BCB, CTS (CC DPS & SB DPS), DS, and TG.)

5.2.11. 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 SFGS, CCR, BCB, CTS, DS, CFWS, and TG 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 the SFGS, CCR, BCB, CTS, DS, CFWS, and TG habitat and areas of occurrence and/or critical habitat do not overlap, a no effect determination is made.

To determine this area, the footprint of the chlorothalonil use pattern is identified, using corresponding land cover data, see Section 2.9. The land cover classes used to determine the use footprint include cultivated, orchard/ vineyard, pasture/ hay, and residential NLCD categories based on potential uses on numerous agricultural crops, fruit trees, ornamentals, golf courses and ornamental lawns. No representative land cover was available for the Christmas tree/conifer plantations and nurseries use. Actual usage is expected to occur in a smaller area as the chemical is only expected to be used on a portion of the identified area. The spatial extent of the effects determination also includes areas beyond the initial area of concern that may be impacted by runoff and/or spray drift (Use Footprint + distance down stream or down wind from use sites where organisms relevant to the assessed species may be affected). The determination of the buffer distance and downstream dilution for spatial extent of the effects determination is described below.

5.2.11.a. Spray Drift

In order to determine terrestrial and aquatic habitats of concern due to chlorothalonil exposures through spray drift, it is necessary to estimate the distance that spray applications can drift from the treated area and still be present at concentrations that exceed levels of concern. A quantitative analysis of spray drift distances was completed using AgDRIFT (v. 2.01) using default inputs for aerial applications (*i.e*., ASABE Fine to Medium). The most sensitive acute and chronic endpoints for aquatic and terrestrial exposure were looked at. For terrestrial exposure, a buffer was determined for invertebrates as well as vertebrates.

Table 5-13. Buffers for Most Sensitive Aquatic and Terrestrial Species using AgDRIFT

Endpoint	Species	Max Application Rate	Fraction of Applied	Type of Assessment	Buffer[1]
Acute: EC50 (at 96 hrs) = 3.6 µg a.i./L	Eastern oyster (MRID 00138143)	11.4 lb a.i./A	NA	Aquatic (Tier I)	>1000 feet
Chronic: NOAEC = 0.0006 mg a.i./L	Daphnia Magna (MRID 45710222)	11.4 lb a.i./A	NA	Aquatic (Tier I)	>1000 feet
Acute: LD50 = 158 mg/kg-bw[2]	Mallard duck (MRID 00030395) (vertebrate)	3.6 lb a.i./A	LOC/RQ = 0.019	Terrestrial (Tier 1)	505 feet
Chronic: NOAEL = 153mg a.i./kg-diet[2]	Mallard duck (MRID 40729402) (vertebrate)	3.6 lb a.i./A	LOC/RQ = 0.041	Terrestrial (Tier 1)	230 feet
Acute: LD50 > 181 ug a.i./bee[3]	Honey Bee (acute contact study - MRID 00077759) (Invertebrate)	11.4 lb a.i./A	LOC/RQ = 0.020	Terrestrial (Tier 1)	479 feet

[1] All applications already have a 150 foot buffer for estuarine/marine areas taken into account and was added to the buffer values determined by AgDRIFT. Therefore, the values seen in the table is the total buffer distance including the 150 foot buffer that is already on the label.
[2] Based on toxicity for SDS-3701, application rate is also for SDS-3701
[3] As value is non-definitive RQs were not calculated therefore, RQ is represented by highest EEC divided by the non-definitive toxicity value, value is expected to be conservative

5.2.11.b. Downstream Dilution Analysis

The downstream extent of exposure in streams and rivers where the EEC could potentially be above levels that would exceed the most sensitive LOC is calculated using the downstream dilution model. To complete this assessment, the greatest ratio of aquatic RQ to LOC was estimated. Using an assumption of uniform runoff across the landscape, it is assumed that streams flowing through treated areas (*i.e.*, the Initial Area of Concern) are represented by the modeled EECs; as those waters move downstream, it is assumed that the influx of non-impacted water will dilute the concentrations of chlorothalonil present. The highest RQ/LOC ratio and the land cover class are used as inputs into the downstream dilution model.

Using a 48-hr LC_{50} value of 3.6 µg/L for Eastern oyster, an LOC of 0.05, and a maximum peak EEC of 47.5 µg/L for Christmas trees from the Tier II PE5 model yields an RQ/LOC ratio of 264

((47.5/3.6)/0.05). The downstream dilution approach is described in more detail in **Appendix** L. This value has been input into the downstream dilution model and results in a distance of 258.5 kilometers which represents the maximum continuous distance of downstream dilution from the edge of the Initial Area of Concern where LOCs may be exceeded in the aquatic environment. It is also important to note that this chemical has wide usage (*e.g*., applied in almost all land classes, showing that the chemical can be used practically everywhere.). As a result, giving a distance may result in a limitation since it does not capture the likelihood that the stream reaches will run into adjacent land cover classes that may also have usage.

5.2.11.c. Overlap of Potential Areas of LAA Effect and Habitat and Occurrence of SFGS, CCR, BCB, CTS, DS, CFWS, and TG

The spray drift and downstream dilution analyses help to identify areas of potential effect to the SFGS, CCR, BCB, CTS, DS, CFWS, and TG from registered uses of chlorothalonil. The Potential Area of LAA Effects on survival, growth, and reproduction for the SFGS, CCR, BCB, CTS, DS, CFWS, and TG from chlorothalonil spray drift extend from the site of application to 148 feet or greater than 1000 feet from the site of application. For exposure to runoff and spray drift, the area of potential LAA effects extends up to 258.5 km downstream from the site of application. The maps presented in **APPENDIX L** indicate overlap between the habitat space in all SF Bay species assessed and the use footprint area without the downstream dilution distance incorporated into the use footprint space. However, should these distances be added to the footprint of the Initial Area of Concern (which represents potential chlorothalonil use sites) and compared to SFGS, CCR, BCB, CTS, DS, CFWS, and TG habitat, it is likely that the area of overlap will increase. The overlap between the areas of LAA effect and SFGS, CCR, BCB, CTS, DS, CFWS, and TG habitat, including designated critical habitat, indicates that chlorothalonil use in California has the potential to affect the SFGS, CCR, BCB, CTS, DS, CFWS, and TG. More information on the spatial analysis is available in **APPENDIX L**.

5.3. Effects Determinations

5.3.1. Assessed Species

Overall, each species includes a habitat location that overlaps with the chlorothalonil area of effects (*i.e.*, a combination of chlorothalonil uses assessed in this risk assessment that is represented by the 2001 NLCD data). All listed species (SFGS, CCR, BCB, CTS, DS, CFWS, and TG) have the potential for direct and indirect effects as a result of chlorothalonil exposure at the registered use rates.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the all species (SFGS, CCR, BCB, CTS, DS, CFWS, and TG) and a **habitat modification determination** for their designated critical habitat (*i.e.,* particularly in reference to the species with a designated critical habitat designation including BCB, CTS (CC DPS & SB DPS), DS, and TG.) based on the potential for direct and indirect effects and effects to the PCEs of critical habitat.

5.3.2. Addressing the Risk Hypotheses

In order to conclude this risk assessment, it is necessary to address the risk hypotheses defined in Section 2.11.1. Based on the conclusions of this assessment, none of the hypotheses can be rejected, meaning that the stated hypotheses represent concerns in terms of direct and indirect effects of chlorothalonil the SFGS, CCR, BCB, CTS, DS, CFWS, and TG and their designated critical habitat (*i.e.,* that of BCB, CTS (CC DPS & SB DPS), DS, and TG.)

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 chlorothalonil to the environment. The following risk hypotheses are confirmed in this assessment:

The labeled use of chlorothalonil within the action area may:

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

6. Uncertainties

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

6.1. Exposure Assessment Uncertainties

6.1.1. Data Gaps and Uncertainties

The available fate dataset has major deficiencies and are not sufficient for a full exposure assessment as identified after a thorough review of the available environmental fate data, including additional kinetic analysis, as part of the Registration Review Preliminary Problem

Formulation for Chlorothalonil (DP Barcode 394667,394849, 2012). Although the submitted studies provide supplemental data on the fate of chlorothalonil, data gaps and uncertainties exist. Data gaps include the following: hydrolysis (850.2120), air photolysis (835.2370), aqueous photolysis (835.2240), aerobic soil metabolism (835.4100), anaerobic soil metabolism (835.4200), aerobic aquatic metabolism (850.4300), anaerobic aquatic metabolism (835.4400), adsorption/desorption [(batch equilibrium); desorption only] (835.1230), terrestrial field dissipation (835.6100), and field volatility (835.8100). The specific data gaps are described in full in Registration Review Preliminary Problem Formulation for Chlorothalonil. Despite these data gaps and uncertainties, the appropriate PRZM and EXAMS input parameters for chlorothalonil and total toxic chlorothalonil residues (chlorothalonil and SDS-3701) were selected from the available environmental fate data. While additional kinetic analysis were completed, guidance on how to calculate model input values for the representative half-life values based on the updated kinetics guidance was not available at the time this assessment was completed. Therefore, the modeling input values used in this assessment are the same as those used in the most recent chlorothalonil new use assessment.

6.1.2. Scope of Uses Assessed

Chlorothalonil is a broad spectrum, non-systemic pesticide, mainly used as a fungicide to control fungal foliar diseases of vegetable, field, and ornamental crops, as well as non-agricultural use sites include golf courses, lawns around commercial and industrial buildings, and other turfgrass areas such as professional and collegiate athletic fields. Chlorothalonil is also used in residential settings. Chlorothalonil is also registered for antimicrobial uses as an industrial and consumer wood preservative, a fungicidal/mildewcidal/algicidal paint, stain, and coating film preservative, and a material preservative for paper and paperboard (non-food contact) and for the "in-service" life of caulks and sealants, adhesives, grouts and joint compounds, wallboard, stucco. A quantitative ecological risk assessment was not performed for antimicrobial chlorothalonil uses at the time of the RED because the Agency did not anticipate any exposure of concern to fish, wildlife, and/or endangered species based on the registered use patterns; furthermore, discharge to the environment complied with all Federal disposal laws and NPDES. For registration review, the Agency anticipates the need to conduct a comprehensive ecological risk assessment for both conventional and antimicrobial uses of chlorothalonil. This assessment considers only the currently registered conventional uses of chlorothalonil, as the Agency intends to evaluate the antimicrobial uses in the Preliminary Risk Assessment as part of the Registration Review process, in order to evaluate all registered chlorothalonil uses for potential exposure to fish, wildlife, and/or endangered species.

6.1.3. Terrestrial Exposure Assessment Uncertainties

6.1.3.a. T-REX

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

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

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

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

[2] Percentages for dose-based chronic EECs and RQs for mammals are equivalent to the acute dose-based EECs and RQs.

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

6.1.3.b. T-HERPS

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

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

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

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.

6.1.3.c. SDS-3701 Application Rates

A formation rate of 34% of SDS-3701 was assumed based on formation observed in soil metabolism studies (MRIDs 00040547 and 00087351). A discussion about the formation of SDS-3701 on avian and mammalian food items is presented in the 1999 RED and 2007 CRLF risk assessment. Studies that evaluated the amount of SDS-3701 that may form after chlorothalonil application to peanut hay, turf, and grass grown for seed are available. In a peanut hay study (MRID 43843601), SDS-3701 residues were reported at a maximum of 24% of the parent chlorothalonil residues. The 1999 RED reported that use of a 10% formation rate would be conservative, however, it also stated that due to the observed formation of 24% in the peanut hay study, it is conceivable that under different conditions, residues of SDS-3701 could reach higher levels.

As previously stated in these documents, there are insufficient residue study data to characterize with certainty how much SDS-3701 will form on avian and mammalian food items. Most of the available residue studies were designed to measure the amount of SDS-3701 that is taken up by crops and how much accumulates in vegetable items associated with human consumption such as beans and fruits. Unfortunately, most of these studies do not provide a dependable basis for estimating how much SDS-3701 will form on avian and mammalian food items in the days immediately following treatment with chlorothalonil, as measurement of chlorothalonil and its degradates generally occur days up to months after the last chlorothalonil application (RED, EPA 1999). Typically, a minimum of three reliable residue studies which measure residues immediately after application are needed to adequately evaluate potential magnitude of formation.

As the residue data was deemed to not be sufficient, the available laboratory data were used to estimate the amount of SDS-3701 that may form on terrestrial organism food items. Soil metabolism studies suggest that SDS-3701 could form at levels of approximately 34% of applied parent material. SDS-3701 was observed in several of the submitted aerobic soil metabolism studies (MRIDs 00087351/00040547, 4387960, 47207702, and 47207703. The maximum concentration ranged from <10% to 34.1% (n=14) in various soils and time points. In four of the test systems the concentration of SDS-3701 was >20%. The second highest concentration of

SDS-3701 observed was 28.4%, thereby, suggesting that 34% is an appropriate maximum formation value

6.1.3.d. Foliar Dissipation Half-life

Based on the data available, a default foliar dissipation half-life of 35 days was used in this assessment. However, based on the available information, the T-REX default value of 35 days was used in this assessment which is the highest reported dissipation rate reported in Willis and McDowell (1987) and this value generally correlates with the value used in the 1999 RED. If the foliar dissipation rate was lower, it may make a difference in some of the EECs as many crops have multiple applications with application intervals of 7-14 days. However, given the large number of exceedances and their associated RQs, it is anticipated that there would still be LOC exceedances from chlorothalonil use.

6.1.4. Exposure in Estuarine/marine Environments

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

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

6.1.5. 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 NAWQA and CDPR for chlorothalonil concentrations measured in surface waters receiving runoff from agricultural areas. The specific use patterns (*e.g.*, application rates and timing, crops) associated with the agricultural areas are unknown, however, they are assumed to be representative of potential chlorothalonil use areas. The peak model-estimated environmental concentrations resulting from different chlorothalonil uses range from 3.4 µg/L (brassica) to 47.5 µg/L (Christmas trees). The maximum concentration reported from the USGA NAWQA database for surface water was 0.71 µg/L. The maximum concentration of chlorothalonil reported by the CDPR surface water database was 0.29 µg/L and is roughly 164 times *lower* than the highest peak model-estimated environmental concentration. As a result, it is believed that PRZM/EXAMS EECs provide a conservative measure of exposure.

6.2. Effects Assessment Uncertainties

6.2.1. Data Gaps and Uncertainties

Although many submissions have been made to provide data on the effects of chlorothalonil to aquatic and terrestrial organisms, data gaps still exist. Data gaps include the following: avian acute oral toxicity study (850.2100), terrestrial plant study (850.4100, 850.4150), estuarine/marine fish acute (850.1075) and chronic studies (850.1400), estuarine/marine invertebrate chronic study (850.1350), freshwater and estuarine/marine sediment organism studies (850.1735 and 850.1740) and a special study (acute avian inhalation) toxicity studies. The specific data gaps are described in full in Registration Review Preliminary Problem Formulation for Chlorothalonil (DP Barcode 394667,394849, 2012).

Avian Acute Oral Toxicity

Acceptable acute avian oral toxicity data were submitted for exposures of mallard duck to chlorothalonil; however, data are not available for passerines, which are required under the 40 CFR Part 158 (Oct. 26, 2007) data requirements for conventional pesticides (72 FR 60934; USEPA 2007*d*). The Part 158 data requirements specify that acute avian oral toxicity data be submitted for either a mallard duck or bobwhite quail and a passerine species. Therefore, an avian oral toxicity test (OCSPP Guideline 850.2100) is needed for passerine birds, as specified in 40 CFR Part 158 (Oct. 26, 2007).

Although, there were no mortalities observed during the acute oral study available for mallard ducks and the LD_{50} value was determined to be greater than 4,640 mg/kg-bw (the highest concentration tested), the LOAEC in this study was determined to be 2,150 mg a.i./kg-bw based on reduced body weight. Weight loss was also noted in the available avian sub-acute dietary studies, indicating potential toxicity of chlorothalonil to birds. Therefore, this indicates that chlorothalonil may be toxic to birds. In this assessment, evaluation of risk to birds (surrogates for reptiles and terrestrial-phase amphibian), was conducted using the data available (mallard duck acute oral).

Avian Acute Inhalation Toxicity

Acceptable acute avian toxicity data were submitted for oral exposures of mallard duck (*Anas platyrhynchos*) to chlorothalonil; however, data are not available for inhalation toxicity. Acute toxicity data using rats indicate that mammals are much more sensitive to chlorothalonil when exposed via the inhalation route compared to the oral route. Furthermore, an evaluation of inhalation as a route of exposure using the Screening Tool for Inhalation Risk (STIR, v. 1.0) model suggests that inhalation exposure is a pathway of concern for avian wildlife due to vapor-phase pesticide. In addition, the available air monitoring data suggests that chlorothalonil volatility and/or particle phase transport plays a role in the dissipation of chlorothalonil and that it is possible for chlorothalonil exposure to occur adjacent to application sites, as well as areas distant from application sites (long range transport). The study being requested will aid in evaluating this pathway of concern for avian taxa. In this assessment, avian inhalation toxicity was not assessed.

Terrestrial Plant Studies

Terrestrial plant toxicity studies using TEP(s) and associated risk analysis of plants are required for registration of conventional pesticides with outdoor uses (CFR Part 158). For terrestrial plants, Tier II studies are required when potential concerns are triggered (*i.e*., when there is some indication that there may be significant toxicity to plants). These indicators may be an herbicidal mode of action, statements on the label indicating toxicity to plants, or ≥ 25% effect levels in the Tier I studies.

Tier I seedling emergence and vegetative vigor studies are available for chlorothalonil using 16 lb a.i./acre test concentrations (MRIDs 42433808 and 42433809). These studies were not conducted with a typical end-use product (TEP), but were instead conducted using chlorothalonil mixed with a solvent (100% acetone). When the results are compared to the negative (and not the pooled) control, onion shows an inhibition in growth of 26% in the seedling emergence study and cucumber shows a 26% inhibition in growth in the vegetative vigor study at the 16 lbs a.i./acre concentration. Additionally, there were significant effects on growth for soybean in the seedling emergence study and for oat in the vegetative vigor study when compared to the control at this limit concentration. In this assessment, evaluation of risk to terrestrial plants was conducted using the data available.

Acute and Chronic Estuarine-marine Fish Studies

The available acute sheepshead study was conducted as a static study and the test concentrations were not measured. Given the difficulties in maintaining test concentrations observed in other aquatic fish toxicity studies, there is substantial uncertainty in the actual exposure concentrations in the acute sheepshead study. As chlorothalonil is very highly toxic to fish, the use of nominal test concentrations is probably underestimating risk to estuarine-marine fish.

A chronic toxicity test with chlorothalonil for estuarine-marine fish is not available. In this assessment, the acute toxicity study was used qualitatively and was used to derive a chronic NOAEC value that was also used qualitatively.

Chronic Estuarine-marine Invertebrate Study

There were no acceptable chronic data conducted on estuarine/marine invertebrates. In this assessment, a chronic NOAEC value was derived using acute toxicity data for penaeid shrimp data and data from *Daphnia magna*.

Freshwater and Estuarine-marine Sediment Studies

Based on it use pattern and fate properties, chlorothalonil has the potential to reach freshwater and estuarine-marine aquatic environments and bind to sediment. In addition, a 28-day study, in which chlorothalonil was applied to water, provided evidence that chlorothalonil is toxic to sediment-dwelling organisms in a water-sediment system. Since chlorothalonil may be persistent in terrestrial environments, based on the aerobic soil metabolism, and is expected to enter aquatic environments through runoff, this runoff may provide a more chronic or pulsed exposure to sediment organisms. In this assessment, evaluation of sediment-dwelling organisms was not directly evaluated.

6.2.2. Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on chlorothalonil are not available for aquatic-phase amphibians; therefore, freshwater fish are used as surrogate species for aquatic-phase amphibians and the CTS. Endpoints based on freshwater fish ecotoxicity data are assumed to be protective of potential direct effects to aquatic-phase amphibians including the CTS. 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. Aquatic-phase Amphibian Toxicity Data

Fish were used as surrogates for aquatic-phase CTS to evaluate acute and chronic direct effects from exposure to chlorothalonil. A study that examined lethality for three species of amphibians (for 10 days exposed to chlorothalonil under semi-static conditions was available (McMahon et al., 2012; E156144). While there were uncertainties associated with the open literature study, it is uncertain at least for one reported amphibian species, if using the acute fish toxicity data was protective. Additionally, there is uncertainty in chronic exposure as the published paper did not examine chronic exposures. However, as chlorothalonil is very highly toxic to fish, acute and chronic risks were assumed for fish and thereby aquatic-phase amphibians.

6.2.4. Chronic Avian Reproduction Endpoint for SDS-3701

The most sensitive chronic NOAEC endpoint for the avian mallard SDS-3701 reproduction study (MRID 40729402) was 50 mg/kg-diet based on a reduction in eggshell thickness at 100 mg/kg-diet. At 250 mg/kg-diet, affects were observed on adult body weight, food consumption, and gonad development affected, as well as effects on numbers of eggs laid, embryonic development, eggshell thickness, hatchability, and hatching survival. As birds are a surrogate for the terrestrial phase amphibian there is some uncertainty in the relevance of the eggshell thickness endpoint for the salamander. As there were many other effects observed at 250 mg/kg-diet, a NOAEC of 100 mg/kg-diet may have been used as the NOAEC level. If this value is used in T-REX, the LOC for birds consuming short grass is exceeded for all uses and most uses for birds consuming arthropods. If used in T-HERPS, the RQs are greater than the LOC for all uses for amphibians consuming small insects or herbivore mammals.

6.2.5. Exposure from Groundwater Containing Chlorothalonil

Based on available data [small-scale prospective groundwater study in which the final report has not been submitted; MRIDs 43959401 (1996), 43959402 (1996), and 44254801 (1997)], the data suggest that chlorothalonil and some of its environmental transformation products can leach to groundwater. Therefore, there may be a potential for non-target organisms to be exposed to chlorothalonil-containing groundwater that is used to irrigate crops for re-charge surface water. However, in this assessment, evaluation of exposure via this route was not assessed. In this assessment, it is anticipated that the EECs from foliar applications will be greater than the EECs from groundwater containing chlorothalonil dissipation products that is used as irrigation water. This irrigation water may pose as an exposure route for terrestrial plants and terrestrial animals that consume plants treated with contaminated irrigation water. However, this is an uncertainty.

6.2.6. 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.

In a study by Teather *et al.,* 2003, (E60156), the activity level in Japanese medaka (Oryzias latipes) fry, measured by the distance swam in two minutes were reported to be significantly less ($p<0.05$) when compared to the control at a chlorothalonil concentration of 0.06 µg/L (the only concentration tested) using a formulation (purity and brand not reported, and the reviewer assumed that the reported concentration was for technical chlorothalonil). However, based on the information presented in the study, there is a discrepancy in the text and figure representing activity level whereas in the figure the activity level for chlorothalonil is not significantly different than the control; therefore, there is uncertainty in this effect. In addition, after five months (it appears that the fish were only exposed to chlorothalonil for 7-days post-hatch), the sex ratio in fish exposed to 0.06µg/L was reported to be altered and biased toward females by departing significantly from an even sex ratio, although the mechanism for this change is not known. Chlorothalonil was reported to not affect survival, hatching time, or foraging ability. Based on the study, survival rates by 7 days post-hatch in this study ranged from 61-69%, and appear to range from approximately 33-50% after five months.

A study that examined chlorothalonil exposure to larval honeybee (*Apis mellifera L.*) and apoptosis in the midgut, salivary glands and ovaries was available (Gregorc and Ellis, 2011; E156418). In this study, honeybee larvae were exposed to 400 ppm chlorothalonil via diet for 6 days after which larvae tissue was examined for signs of apoptosis. According to the report, there were elevated levels of apoptosis in the larvae midgut tissue treated with chlorothalonil compared to the control. According to the authors, it is not known if the type of injury observed in the midgut may have been a reversible process or not. In terms of chlorothalonil exposure to honeybees, chlorothalonil has been detected in entombed pollen inside honeybee hives (vanEngelsdorp *et al.* 2009).

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 chlorothalonil to SFGS, CCR, BCB, CTS, DS, CFWS, and TG and the designated critical habitat of BCB, CTS (CC DPS & SB DPS), DS, and TG.

Based on the best available information, the Agency makes a May Affect, Likely to Adversely Affect determination for the SFGS, CCR, BCB, CTS, DS, CFWS, and TG. Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, CTS (CC DPS & SB DPS), DS, and TG from the use of the chemical. Given the LAA determination for SFGS, CCR, BCB, CTS, DS, CFWS, and TG and potential modification of designated critical habitat for BCB, CTS (CC DPS & SB DPS), 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 SFGS, CCR, BCB, CTS, DS, CFWS, and TG and 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 Chlorothalonil on the SFGS, CCR, BCB, CTS, DS, CFWS, and TG

Species	Effects Determination	Basis for Determination
		Potential for Direct Effects

San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	• Acute: Chlorothalonil: dose and dietary-based RQs not calculated1 however EECs overlap with 1/10th highest tested concentration or dose for all assessed uses for small and medium-sized reptiles (based on toxicity data for birds); SDS-3701- dose and dietary-based RQs>0.1 for all assessed uses for small and medium-sized reptiles (based on toxicity data for birds) consuming arthropods and herbivorous mammals • Chronic: chlorothalonil and SDS-3701 - dietary-based RQs >1 for all assessed uses for small and medium-sized reptiles (based on toxicity data for birds) consuming arthropods and herbivorous mammals • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird toxicity data for SDS-3701) is 1 in 1, at a slope of 2.6 for SDS-3701
		Potential for Indirect Effects
		• SFGS prey base is affected based on LOC exceedances; SFGS feeds on invertebrates (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2); fish (fw fish RQs: acute: 0.19-2.64, chronic: 0.5-5.2), terrestrial invertebrates (RQs not calculated but EECs overlap with 1/20th highest tested dose for a few uses), small mammals (SDS-3701-15g mammal RQs: acute: 0.47-5.18; chronic: not calculated2 however EECs overlap with highest concentration tested; chlorothalonil acute RQs not calculated but EECs overlap with 1/5th highest dose tested; chronic 0.69-36.7), reptiles and amphibians (birds RQs: SDS-3701 acute: 0.06-40.2; chronic: 2.05-57.8; chlorothalonil- acute RQs not calculated but EECs overlap with 1/5th highest tested dose; chronic: 2.11-59.9, 20g reptile: SDS-3701-acute: 0.10-17.5; chronic:4.12-44.6; chlorothalonil-acute: RQs not calculated but EECs overlap with 1/5th highest dose, chronic:4.21-45.9) • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: lab rat, bird, freshwater invertebrate/fish) ranges from 1 in x 4.08 1012 to 1 in 1
California Clapper Rail (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	Potential for Direct Effects
		• Acute: chlorothalonil- acute RQs not calculated1 but EECs greater than 1/10th highest dose or concentration tested for all assessed uses; SDS-3701-dose- based RQs >0.1 for all assessed uses and dietary-based RQs>0.1 for all uses for small and medium-sized birds consuming arthropods and short grasses • Chronic: chlorothalonil and SDS-3701 - dietary-based RQs >1 for all assessed uses for small and medium-sized birds consuming arthropods and short grasses • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird toxicity data) is 1 in 1 at the slope of 2.6 for SDS-3701
		Potential for Indirect Effects

		• CCR prey base is affected; CCR feeds on aquatic invertebrates, worms, spiders (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2; terrestrial invert RQs not calculated but EECs greater than 1/20th highest dose tested; e/m invert: acute: 0.9-13.2; chronic: 2.0-27.9), dead fish (fw fish RQs: acute: 0.19-2.64; chronic: 0.5-5.2), small mammals (SDS-3701- 15g mammal RQs: acute: 0.47-5.18; chronic: not calculated2 however EECs overlap with highest concentration tested; chlorothalonil acute RQs not calculated but EECs overlap with 1/5th highest dose tested; chronic 0.69-36.7), small birds and amphibians/frogs (Acute: chlorothalonil- acute RQs not calculated1 but EECs greater than 1/10th highest dose or concentration tested for most assessed uses; SDS-3701- dose- based RQs >0.2 for all assessed uses and dietary-based RQs>0.2 for all uses for small and medium-sized birds consuming arthropods and short grasses and Chronic: chlorothalonil and SDS-3701 - dietary-based RQs >1 for all assessed uses for small and medium-sized birds consuming arthropods and short grasses • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: lab rat, bird, freshwater invertebrate/fish, estuarine/marine invertebrate) ranges from 1 in 4.08 x 1012 to 1 in 1
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	Potential for Direct Effects • Based on parent chlorothalonil only • Terrestrial invertebrate/ arthropod RQs not calculated1 but EECs exceed 1/20th the highest concentration tested for use on golf courses (LOC of 0.05, the interim terrestrial invertebrate LOC). • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect not calculated due to RQs not calculated Potential for Indirect Effects • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint.
California Tiger	May Affect,	Potential for Direct Effects

Salamander (*Ambystoma californiense*)	Likely to Adversely Affect (LAA)	• Acute: Chlorothalonil- RQs not calculated1 but EECs exceed 1/10th the highest dose and concentration tested for all uses; SDS-3701-dose and dietary-based RQs >0.1 for all assessed uses (except for grass for seed and grass forage, fodder and hay) for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Chronic: dietary-based RQs >1 all assessed uses for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Acute: RQs ≥ 0.05 for all uses assessed with respect to freshwater fish (which are a surrogate for aquatic-phase amphibians) • Chronic: RQs >1 for most uses, except grass grown for seed and lupine, with respect to freshwater fish (which are a surrogate for aquatic-phase amphibians) • Several fish kills reported which were attributed possibly to chlorothalonil use • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird and freshwater fish toxicity data) ranges from 1 in 4.08 x 1012 to 1 in 1
		Potential for Indirect Effects
		• CTS prey base is affected; CTS feeds on algae, aquatic invertebrates/ zooplankton, freshwater snails, terrestrial invertebrates, worms (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2; terrestrial invert RQs not calculated1 but EECs exceed 1/20th the highest dose tested; e/m invert: acute: 0.9-13.2; chronic: 2.0-27.9), fish (fw fish RQs: acute: 0.19-2.64; chronic: 0.5-5.2), small mammals (SDS-3701-15g mammal RQs: acute: 0.47-5.18; chronic: not calculated2 however EECs overlap with highest concentration tested; chlorothalonil acute RQs not calculated but EECs overlap with 1/5th highest dose tested; chronic 0.69-36.7), amphibians and frogs (birds RQs: SDS-3701 acute: 0.06-40.2; chronic: 2.05-57.8; chlorothalonil- acute RQs not calculated but EECs overlap with 1/5th highest tested dose; chronic: 2.11-59.9, amphibian: acute: Acute: Chlorothalonil- RQs not calculated1 but EECs exceed 1/5th the highest dose and concentration tested for most uses; SDS-3701-dose and dietary-based RQs >0.1 for all assessed uses (e.g., except for grass for seed and grass forage, fodder and hay) and RQs >0.2 for most assessed used for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Chronic: dietary-based RQs >1 all assessed uses for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals) • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: lab rat, bird, freshwater invertebrate/fish) ranges from 1 in 4.08 x 1012 to 1 in 1
Delta Smelt	May Affect,	Potential for Direct Effects

(*Hypomesus transpacificus*)	Likely to Adversely Affect (LAA)	• Acute: RQs ≥ 0.05 for all uses assessed, with respect to freshwater fish; RQs not calculated for estuarine/marine fish , but EECs greater than 1/20th the LC50 value for all uses • Chronic: RQs >1 all uses except for grass grown for seed and lupine using freshwater fish data; RQs not calculated for estuarine/marine fish, but EECs greater than NOAEC for many uses • Four fish kills incidences were reported possibly due to chlorothalonil • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on freshwater fish toxicity data) ranges from 1 in 1.43 x 109 to 1 in 1
		Potential for Indirect Effects
		• DS prey base is affected; adult DS feeds on planktonic copepods, cladocerans, amphipods and insect larvae and juvenile DS feed on zooplankton (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2; e/m invert: acute: 0.9-13.2; chronic: 2.0-27.9); the DS larvae feed on phytoplankton (non-vascular RQs: 0.3-4.0) • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: freshwater invertebrates) ranges from 1 in 4.08 x 1012 to 1 in 2.3
California Freshwater Shrimp (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	Potential for Direct Effects
		• Acute: RQs > 0.05 for all assessed uses using freshwater invertebrate data • Chronic: RQs > 1 for all assessed uses using freshwater invertebrate data • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on freshwater invertebrate toxicity data) ranges from 1 in 4.08 x 1012 to 1 in 2.3
		Potential for Indirect Effects
		• CFWS prey base is affected; CFWS feeds on zooplankton (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2), detritus, algae, aquatic macrophyte fragments, aufwuchs. • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: freshwater invertebrates) ranges 1 in 4.08 x 1012 to 1 in 2.3
Tidewater Goby	May Affect,	Potential for Direct Effects

(*Eucyclogobius newberryi*)	Likely to Adversely Affect (LAA)	• Acute: RQs ≥ 0.05 for all uses with respect to freshwater fish; RQs not calculated for estuarine/marine fish , but EECs greater than 1/20th the 96-hr LC50 for all uses • Chronic: RQs >1 for all uses except grass grown for seed and lupine using freshwater fish data, with respect to freshwater fish; chronic RQs not calculated for estuarine/marine fish but EECs greater than chronic NOAEC for many uses • Four fish kills incidences were reported possibly due to chlorothalonil • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on freshwater fish toxicity data) ranges from 1 in 1.43 x 109 to 1 in 1
		Potential for Indirect Effects
		• TG prey base is affected; adult TG feeds on small benthic invertebrates, crustaceans, snails, mysids, aquatic insect larvae, juvenile TG feeds on unicellular zooplankton (fw invert RQs: acute: 0.063-0.88; chronic: 1.5-13.2; e/m invert: acute: 0.9-13.2; chronic: 2.0-27.9) or phytoplankton (non-vascular RQs:0.3-4.0). • Habitat modification (terrestrial plant toxicity data resulted in non-definitive EC25 and NOAEC values (based on limit concentration of 16 lb a.i./A), and adverse effects are presumed for uses. Hundreds of incident data for terrestrial plants reported for different use patterns. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: freshwater invertebrates) ranges from 1 in 4.08 x 1012 to 1 in 2.3
FW = freshwater; EM = estuarine/marine [1] Acute RQ values were not calculated because the acute toxicity values resulted in non-definitive values (LD/LC50 value greater than highest concentration tested) [2] No effects observed at highest dose tested in chronic mammalian study, therefore, RQs not calculated.		

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

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (Euphydryas editha bayensis)	Habitat Modification	• Risk to terrestrial plants and thus BCB habitat (esp. dwarf plantain, purple owl's clover, exserted paintbrush) was assumed. (RQs were not calculated given due to non-definitive values; however based on data available, risk to listed terrestrial plants was assumed.) • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint
California Tiger Salamander (Ambystoma californiense) [Central CA, Santa Barbara County]	Habitat Modification	• Terrestrial arthropod RQs not calculated due to non-definitive value, however EECs were greater than 1/20th the highest dose tested for use on turf (LOC 0.05, the interim terrestrial invertebrate LOC). • Risk to terrestrial plants was assumed. (RQs were not calculated given due to non-definitive values; however based on data available, risk to listed terrestrial plants was assumed.) • RQs for aquatic vascular plants were all <1; RQs for non-vascular aquatic plants >1 for several uses • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Mammal acute dose-based RQs >0.5 for most assessed uses; chronic: dose- and/or dietary-based RQs>1 for all assessed uses. • Bird (surrogate for terrestrial-phase amphibians) acute dose and dietary-based RQs >0.1 (listed sp.) and 0.2 (restricted use) for most assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals; chronic dietary-based RQs >1 for all assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals • Fish (surrogate for aquatic-phase amphibians) acute RQs ≥ 0.2 for all uses; chronic RQs >1 for all uses except grass grown for seed and lupine • Freshwater invertebrate acute RQs > 0.1 and 0.2 for most uses; chronic RQs >1 for all assessed uses
Delta Smelt (Hypomesus transpacificus)	Habitat Modification	• Risk to listed terrestrial plants was assumed. (RQs were not calculated given due to non-definitive values; however based on data available, risk to listed terrestrial plants was assumed.) • RQs for aquatic vascular plants were all <1; RQs for non-vascular aquatic plants >1 for several uses • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Freshwater invertebrate acute RQs > 0.1 and 0.2 for most uses; chronic RQs >1 for all assessed uses • Estuarine/marine invertebrate acute RQs > 0.5 for all assessed uses; chronic RQs >1 for all assessed use
Tidewater Goby (Eucyclogobius newberryi)	Habitat Modification	• Risk to listed terrestrial plants was assumed. (RQs were not calculated given due to non-definitive values; however based on data available, risk to listed terrestrial plants was assumed.) • RQs for aquatic vascular plants were all <1; RQs for non-vascular aquatic plants >1 for several uses • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Freshwater invertebrate acute RQs > 0.1 and 0.2 for most uses; chronic RQs >1 for all assessed uses Estuarine/marine invertebrate acute RQs > 0.5 for all assessed uses; chronic RQs >1 for all assessed use •

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

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment									
	DS, TG and Estuarine/Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Estuarine/Marine Invertebrates[4]		Vascular Plants[5]	Non-vascular Plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic		
almond	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
apricot, nectarine, peach, plum, prune, stone fruits	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
asparagus	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
beans, dried-type, peas, dried-type	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
beans, succulent (snap)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
blueberry	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
brassica	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
broccoli, Brussel sprouts, cabbage, cauliflower	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
bulb vegetables	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
carrot	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
celery	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
cherry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
christmas tree, conifers, forest trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
cole crops	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
commercial/i	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

ndustrial laws										
corn	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
cucumber, melon, pumpkin, squash	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
cucurbit vegetable	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
filbert (hazelnut)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
fruiting vegetables	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
garlic	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
ginseng	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
golf course	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
grass forage, fodder, hay	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
grass grown for seed	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	No
green onion	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
horseradish	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
leek	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
lupine, grain	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	No
mango	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
onion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
ornamental (laws, turf, sod farms), recreation area lawns	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
ornamentals plants and trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
papaya	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
parsnip	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
passion fruit	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
pistachio	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
potato	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No

rhubarb	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
rose	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
shallot	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
strawberry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
tomato	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
yam	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No

1 A yes in this column indicates a potential for direct effects to DS and TG and indirect effects to CCR, TG, and DS as a result of an effect to estuarine/marine fish.
2 A yes in this column indicates a potential for direct effects to DS, TG and indirect effects to SFGS, CCR, TG, and DS. A yes also indicates a potential for direct and indirect effects for the CTS-CC, CTS-SC, and CTS-SB as a result of an effect to freshwater fish.
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 as a result of an effect to freshwater invertebrates.
4 A yes in this column indicates a potential for indirect effects to CCR, TG, and DS as a result of an effect to estuarine/marine invertebrates.
5 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS.

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

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
almond	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
apricot, nectarine, peach, plum, prune, stone fruits	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
asparagus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
beans, dried-type, peas, dried-type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
beans, succulent (snap)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
blueberry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
brassica	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
broccoli, Brussel sprouts, cabbage, cauliflower	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
bulb vegetables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

carrot	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
celery	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
cherry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
christmas tree, conifers, forest trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
cole crops	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
commercial/industrial laws	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
corn	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
cucumber, melon, pumpkin, squash	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
cucurbit vegetable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
filbert (hazelnut)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
fruiting vegetables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
garlic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
ginseng	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
golf course	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
grass forage, fodder, hay	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
grass grown for seed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
green onion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
horseradish	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
leek	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
lupine, grain	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
mango	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
onion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
ornamental (laws, turf, sod farms), recreation area lawns	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ornamentals plants and trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
papaya	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
parsnip	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
passion fruit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
pistachio	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
potato	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
rhubarb	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
rose	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
shallot	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

strawberry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
tomato	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
yam	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

1 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS, and CTS-SB as a result of an effect to small mammals.

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 as a result of an effect to small birds.

3 A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS-CC, CTS-SC, CTS-SB, SFGS, CCR as a result of an effect to terrestrial-phase amphibians (for which birds serve as surrogate).

4 A yes in this column indicates the potential for direct and indirect effects to SFGS and other reptiles as a result of an effect to reptiles (for which birds serve as a surrogate).

5 This value is based on a non-definitive acute toxicity and is expected to be conservative. A yes in this column indicates a potential for direct effect to BCB and indirect effects to SFGS, CCR, CTS-CC, CTS-SC, and CTS-SB as a result of an effect to terrestrial invertebrates.

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

8. References

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

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9. MRID List

71-1 Avian Single Dose Oral Toxicity

MRID	Citation Reference
30395	Beavers, J.B.; Fink, R.; Brown, R. (1978) Final Report: Acute Oral LD50--Mallard Duck: Project No. 111-110. (Unpublished study including submitter summary, received Feb 19, 1980 under 677- 313; prepared by Wildlife International, Ltd. in cooperation with Washington College, submitted by Diamond Shamrock Agricul- tural Chemicals, Cleveland, Ohio; CDL:099247-N)
68753	Fink, R.; Beavers, J.B.; Brown, R. (1977) Final Report: Acute Oral LD50--Mallard Duck: Project No. 111-109. (Unpublished study, including submitter summary, received Jan 19, 1978 under 677- 229; prepared by Wildlife International Ltd. and Washington College, submitted by Diamond Shamrock Agricultural Chemicals, Cleveland, Ohio; CDL:232729-A)
40964105	Shults, S.; Wilson, N.; Killeen, J. (1987) Acute Oral Toxicity (LD50) Study in Japanese Quail with Technical Chlorothalonil: Ricerca--Document No. 1582-87-0041-TX-002. Unpublished study prepared by Wildlife International Ltd. 54 p.

71-2 Avian Dietary Toxicity

MRID	Citation Reference
30388	Shults, S.K.; Killeen, J.C., Jr.; Heilman, R.D. (1979) Chlorothalo- nil (Technical) Eight-Day Dietary (LCI50^) Study in Bobwhite Quail. (Unpublished study received Feb 19, 1980 under 677- 313; prepared in cooperation with Wildlife International, Ltd., submitted by Diamond Shamrock Agricultural Chemicals, Cleveland Ohio; CDL:099247-A)
30389	Shults, S.K.; Killeen, J.C., Jr.; Heilman, R.D. (1979) Chlorothalonil (Technical) Eight-Day Dietary (LC50) Study in Mallard Ducks. (Unpublished study received Feb 19, 1980 under 677- 313; prepared in cooperation with Wildlife International, Ltd., submitted by Diamond Shamrock Agricultural Chemicals, Cleveland, Ohio; CDL:099247-B)
39146	Dieterich, W.H. (1965) Acute Dietary Administration--Wildfowl: Project No.

200-163. (Unpublished study received Feb 25, 1976 under 6F1749; prepared by Hazleton Laboratories, Inc., submitted by Diamond Shamrock Agricultural Chemicals, Cleveland, Ohio; CDL:096459-B)

115108	Beavers, J. and R. Fink (1981) Nine-day Dietary LC50 Mallard Duck. T-114-2. Final Report. Unpublished Study Submitted to Diamond Shamrock Corp., Plainesville, Ohio by Wildlife International Ltd., St. Michael's MD. Registration No. 677-313. Accession No. 071097.
115109	Beavers, J. and R. Fink (1981) Eight-day Dietary LC50 Bobwhite Quail. T-114-2. Final Report. Unpublished Study Submitted to Diamond Shamrock Corp., Plainesville, Ohio by Wildlife International Ltd., St. Michael's MD. Registration No. 677-313. Accession No. 071097.

71-4 Avian Reproduction

MRID	Citation Reference
41440	Fink, R. (1976) Final Report: One-Generation Reproduction Study--Bobwhite Quail: Project No. 111-107. (Unpublished study in- cluding submitter summary, received Feb 19, 1980 under 677-313; prepared by Wildlife International, Ltd., submitted by Diamond Shamrock Agricultural Chemicals, Cleveland, Ohio; CDL:099247-F)
41441	Fink, R. (1976) Final Report: One-Generation Reproduction Study-- Mallard Duck: Project No. 111-108. (Unpublished study including submitter summary, received Feb 19, 1980 under 677-313; pre- pared by Wildlife International, Ltd., submitted by Diamond Shamrock Agricultural Chemicals, Cleveland, Ohio; CDL:099247-G)
40729401	Shults, S.; Wilson, N.; Killeen, J. (1988) Pilot Reproduction Study in Mallard Ducks with 4-Hydroxy-2,5,6-trichloroisophthalonitrile Project ID. 230-102. Unpublished study prepared by Wildlife International Ltd. and Ricerca, Inc. 134 p.
40729402	Shults, S.; Wilson, N.; Killeen, J. (1988) Reproduction Study in Mallard Ducks with 4-Hudroxy-2,5,6-trichloroisophthalonitrile: Project ID. 230-106. Unpublished study prepared by Wildlife International Ltd. and Ricerca, Inc. 193.
40729403	Shults, S.; Wilson, N.; Killeen, J. (1988) Pilot Reproduction Study in Bobwhite Quail with 4-Hydroxy-2,5,6-trichloroisophthaloni- trile: Project ID. 230-101. Unpublished study prepared by Wild- life International Ltd. and Ricerca, Inc. 131 p.
40729404	Shults, S.; Wilson, N.; Killeen, J. (1988) Reproduction Study in Bobwhite Quail with 4-Hydroxy-2,5,6-trichloroisophthalonitrile: Project Id. 230-105. Unpublished study prepared by Wildlife International Ltd. and Ricerca, Inc. 195 p.
40964101	Shults, S.; Wilson, N.; Killeen, J. (1988) Pilot Reproduction Study in Mallard Ducks with Technical Chlorothalonil: Document No. 1469-87-0003-TX-002. Unpublished study prepared by Wildlife In- ternational Ltd. in cooperation with Ricerca, Inc. 138 p.
40964102	Shults, S.; Wilson, N.; Killeen, J. (1988) Reproduction Study in Mallard Ducks with Technical Chlorothalonil: Ricerca--Document No. 1469-87-0004-TX-002. Unpublished study prepared by Wild- life International Ltd. in

cooperation with Ricerca, Inc. 196 p.

40964103	Shults, S.; Wilson, N.; Killeen, J. (1988) Pilot Reproduction Study in Bobwhite Quail with Technical Chlorothalonil: Ricerca--Docu- ment No. 1469-87-0005-TX-002. Unpublished study prepared by Wildlife International Ltd. in cooperation with Ricerca, Inc. 136 p.
40964104	Shults, S.; Wilson, N.; Killeen, J. (1988) Reproduction Study in Bobwhite Quail with Technical Chlorothalonil: Ricerca--Document No. 1469-87/-0006-TX-002. Unpublished study prepared by Wild- life International Ltd. in cooperation with Ricerca, Inc. 185 p.
45710218	Redgrave, V. (1993) Chlorothalonil: Bobwhite Quail Dietary Reproduction and Tolerance Studies: Lab Project Number: VCM 11/930496. Unpublished study prepared by Huntingdon Research Centre Ltd. 314 p. {OPPTS 850.2300}
43890602	Habig, C.; Leyes, G. (1995) Chlorothalonil: Chronic Avian Risk Evaluation: Lab Project Number: 6287-95-0264-EF-001. Unpublished study prepared by Ricerca, Inc. and Jellinek, Schwartz & Connolly, Inc. 35 p.

72-1 850.1075 Acute Toxicity to Freshwater Fish

MRID	Citation Reference
87258	McCann, J.A.; Pitcher, F. (1973) ?Bravo TM W-75: Bluegill (?~Lepomis macrochirus?~)|: Test No. 548. (U.S. Environmental Protection Agency, Pesticide Regulation Div., Agricultural Research Center, Animal Biology Laboratory and Fish Toxicity Laboratory; unpublished study; CDL:128550-A)
87303	Pitcher, F. (1972) ?Tetrachloroisophthalonitrile: Rainbow Trout (?~Salmo gairdneri~?)|: Test No. 503. (U.S. Agricultural Re- search Service, Pesticides Regulation Div., Animal Biology Lab- oratory; unpublished study; CDL:130256-A)
87304	Pitcher, F. (1972) ?Tetrachloroisophthalonitrile: Rainbow Trout (?~Salmo gairdneri~?)|: Test No. 504. (U.S.Agricultural Re- search Service, Pesticides Regulation Div., Animal Biology Labo- ratory; unpublished study; CDL:130254-A)
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