Potential Risks of Labeled Chlorothalonil Uses to the Federally Listed California Red Legged Frog

(*Rana aurora draytonii*)

Pesticide Effects Determination

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1. Executive Summary

The purpose of this assessment is to evaluate potential direct and indirect effects on the California red-legged frog *(Rana aurora draytonii*) (CRLF) arising from FIFRA regulatory actions regarding labeled uses of chlorothalonil on agricultural and non-agricultural sites. In addition, this assessment evaluates whether these actions can be expected to result in modification of the species' designated critical habitat. This assessment was completed in accordance with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998) and procedures outlined in the Agency's Overview Document (U.S. EPA, 2004).

The CRLF was listed as a threatened species by USFWS in 1996. The species is endemic to California and Baja California (Mexico) and inhabits both coastal and interior mountain ranges. A total of 243 streams or drainages are believed to be currently occupied by the species, with the greatest numbers in Monterey, San Luis Obispo, and Santa Barbara counties (USFWS 1996) in California.

Chlorothalonil is a broad spectrum, non-systemic pesticide used mainly as a foliar fungicide for vegetable, field, and ornamental crops. Assessed uses within California include: asparagus, beans (snap and dry), blueberries, carrots, celery, cole crops, corn, cucurbits, filberts, almonds, pistachios, conifers, onions (bulb, green shallot, and grown for seed), garlic, mangos, passion fruit, peanuts, potatoes, stone fruit, cherries, tomatoes, ornamentals, sod farms, golf courses, and general turf. Application methods include aerial and ground spray and chemigation.

Chlorothalonil is expected to be slightly to moderately mobile in the open environment and can degrade by both biotic and abiotic processes. It is stable to hydrolysis, but may degrade rapidly in clear, shallow water through aqueous photolysis. Chlorothalonil is more persistent under terrestrial aerobic conditions than under aerobic aquatic and anaerobic conditions. Biotic degradation rates for chlorothalonil are sensitive to the biogeochemical environment and ambient conditions, and may depart from first-order kinetics. Half-lives range from a few hours to several weeks. A major metabolite identified to be of concern in terrestrial conditions, SDS-3701 (4-hydroxy-2,5,6-trichloro-1,3-dicyanobenzene), forms under differing test conditions, and appears to be persistent. Both chlorothalonil and SDS-3701 exhibit a degree of persistence sufficient to allow their appearance in ground water.

Since CRLFs exist within aquatic and terrestrial habitats, exposures of the CRLF, its prey, and its habitats to chlorothalonil were assessed separately for the two habitats. In accordance with the methodology specified in the Agency's Overview Document (U.S. EPA, 2004), screening level aquatic estimated environmental concentrations (EECs) based on the PRZM/EXAMS static water body scenario were used to derive risk quotients (RQs) for aquatic animals and plants for all relevant chlorothalonil uses within the action area. It is acknowledged that screening level EECs based on the static water body may not be representative of all waters where the CRLF and designated critical habitat occur.

The T-REX model (Version 1.3.1.) was used to estimate exposure to terrestrial phase CRLFs and to its terrestrial prey. The T-HERPS (version 1.0) model was used to allow for further characterization of dietary exposures of terrestrial-phase CRLFs relative to birds. AgDRIFT was also used to estimate deposition of chlorothalonil as a function of distance on terrestrial habitats from spray drift.

The assessment endpoints for the CRLF include direct toxic effects on the survival, reproduction, and growth of the CRLF itself, as well as indirect effects, such as reduction of the prey base or modification of its habitat. Direct effects to the CRLF in the aquatic habitat are based on toxicity information for freshwater fish, which are used as a surrogate for aquatic-phase amphibians. In the terrestrial habitat, direct effects are based on toxicity information for birds, which are used as a surrogate for terrestrial-phase amphibians. Given that the presence of food for the CRLF and designated critical habitat requirements in the aquatic habitat are dependant on the availability of freshwater aquatic invertebrates, fish, and aquatic plants, toxicity information for these taxonomic groups is also discussed. In the terrestrial habitat, indirect effects due to depletion of prey are assessed by considering effects to terrestrial invertebrates, small terrestrial mammals and amphibians. Indirect effects due to modification of the terrestrial habitat are characterized by available data for terrestrial plants.

A degradate of chlorothalonil (SDS-3701) was also assessed because it was shown to be more toxic to terrestrial animals than chlorothalonil. This degradate was not assessed for aquatic species because it was orders of magnitude less toxic than chlorothalonil to aquatic organisms. There is considerable uncertainty in estimating the amount of SDS-3701 that may form on CRLF food items. SDS-3701 has been shown to form at up to 40% of initial chlorothalonil levels in a soil metabolism study. Therefore, RQs were calculated assuming that SDS-3701 levels were 40% of chlorothalonil levels, although an alternative assumption of 10% was also used.

RQs based on screening level EECs were used to distinguish "no effect" from "may affect" determinations for direct and indirect effects to the CRLF and the critical habitat impact analysis. All "may affect" determinations were further refined using best available evidence to determine whether they are "not likely to adversely affect" (NLAA) or "likely to adversely affect" (LAA). Additional evidence included dose-response analysis, biology and habitat of the assessed species relative to risk assessment assumptions, and consideration of species sensitivity distributions. Risk conclusions and effects determinations for the CRLF based on direct effects for the assessed chlorothalonil uses are summarized in Table 1.1. Use-specific determinations based on indirect effects due to effects to prey in aquatic and terrestrial habitats are noted in Table 1.2. Effects determinations summarized by assessment endpoint are in Table 1.3. Determinations for effects to critical habitat are summarized in Table 1.4. The overall determination for direct and indirect effects to the CRLF in aquatic and terrestrial habitats is LAA. Of the uses listed in Tables 1.1 and 1.2, the mass of chlorothalonil applied in

California from 2002 – 2005 was predominantly on tomatoes (945,000 lbs), followed by landscape maintenance (373,000 lbs), onions (266,000 lbs), potatoes (220,000 lbs), celery (196,000 lbs), and almonds (109,000 lbs). Approximately 80% of the total mass of chlorothalonil reportedly applied from 2002 – 2005 was applied to these six use sites (see Table 2.4.4).

Table 1.1. Chlorothalonil and SDS-3701 use-specific direct effects determinations for the CRLF[1,2]

Use	Aquatic-phase		Terrestrial-phase	
	Acute	Chronic	Acute[3]	Chronic[4]
Peanuts	LAA	LAA	LAA	LAA
Passion fruit	LAA	NE	LAA	LAA
Onions (green, seed)	LAA	LAA	LAA	LAA
Shallots	LAA	LAA	LAA	LAA
Conifers	LAA	LAA	LAA	LAA
Potatoes	LAA	LAA	LAA	LAA
Dry beans	LAA	LAA	LAA	LAA
Corn	LAA	LAA	LAA	LAA
Blueberries	LAA	LAA	LAA	LAA
Grass grown for seed or hay	LAA	LAA	LAA	LAA
Cucurbits	LAA	LAA	LAA	LAA
Filberts, almonds, pistachios	LAA	LAA	LAA	LAA
Asparagus	LAA	LAA	LAA	LAA
Bulb onions	LAA	LAA	LAA	LAA
Stone fruits and cherries	LAA	LAA	LAA	LAA
Snap beans	LAA	LAA	LAA	LAA
Carrots	LAA	LAA	LAA	LAA
Garlic	LAA	LAA	LAA	LAA
Tomatoes	LAA	LAA	LAA	LAA
Cole crops	LAA	LAA	LAA	LAA
Celery	LAA	LAA	LAA	LAA
Roses	LAA	LAA	LAA	LAA
Turf	LAA	LAA	LAA	LAA
Pachysandra	LAA	LAA	LAA	LAA
Ornamentals	LAA	LAA	LAA	LAA
Sod farms	LAA	LAA	LAA	LAA
Golf courses	LAA	LAA	LAA	LAA

1 LAA = likely to adversely affect; NE = no effect; NLAA = not likely to adversely affect
2 Effects determinations include chlorothalonil and SDS-3701
3 Acute risks to CRLF from exposure to chlorothalonil were below the endangered species concern level; LAA determination was based on potential risk to SDS-3701, assuming 40% formation rate.
4 Chronic LOC was exceeded for both chlorothalonil and SDS-3701

Table 1.2. Chlorothalonil and SDS-3701 use-specific indirect effects determinations[1] based on effects to prey

Use	Non-vascular plant	Aquatic Invertebrates		Terrest. Invert. (Acute)	Aquatic phase amphibians and fish		Terrestrial-phase frogs		Small Mammals	
		Acute	Chronic		Acute	Chronic	Acute[2]	Chronic[3]	Acute[2]	Chronic[3]
Peanuts	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	NLAA	LAA
Passion fruit	NE	LAA	LAA	NLAA	NLAA	NE	NLAA	LAA	NLAA	LAA
Onions (green, seed)	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Shallots	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Conifers	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Potatoes	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Dry beans	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Corn	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Blueberries	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Grass grown for seed or hay	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	NLAA	LAA
Cucurbits	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Filberts, almonds, pistachios	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Asparagus	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Bulb onions	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Stone fruits and cherries	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Snap beans	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Carrots	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Garlic	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Tomatoes	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Cole crops	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Celery	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Roses	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Turf	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Pachysandra	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Ornamentals	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Sod farms	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Golf courses	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA

[1] LAA = likely to adversely affect; NLAA = not likely to adversely affect; NE = no effect
[2] Effects determination for chlorothalonil was "no effect"; LAA and NLAA determination is for SDS-3701.
[3] Chronic LOC was exceeded for both chlorothalonil and SDS-3701

Table 1.3. Chlorothalonil Effects Determination Summary for the CRLF (Direct and Indirect Effects)

Assessment Endpoint	Effects	NLAA/LAA Discrimination[1]	Basis
Aquatic Phase			
1. Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases (eggs, larvae, tadpoles, juveniles and adults)	Acute direct effects	LAA	RQs exceeded the endangered species LOC for all uses. EECs exceeded the most sensitive LC_{50} for all uses except passion fruit and peanuts.
	Chronic direct effects	LAA	The chronic LOC was exceeded for all uses except passion fruit. The 60-day EEC exceeded the LOAEC (level at which 12% reduction in number of eggs per spawn relative to controls occurred) for all uses except passion fruit and peanuts.
2. Survival, growth, and reproduction of CRLF individuals via indirect effects to prey (freshwater invertebrates)	Acute direct effects to freshwater invertebrates	LAA	RQs ranged from 0.72 to 78. The peak EEC exceeded the most sensitive LC_{50} for all uses except passion fruit. RQs based on 50th percentile LC_{50} of approximately 40 µg/L would be 0.5 or higher for all uses except passion fruit and peanuts.
	Chronic direct effects to freshwater invertebrates	LAA	The lowest RQ was 3.7 (passion fruit); the highest RQ was >400 (golf course).
3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat and/or primary productivity (i.e. aquatic plant community)	Direct effects to aquatic non-vascular plants	LAA	RQs for green algae exceeded the LOC for all uses except passion fruit; RQs for diatoms exceed the LOC for all uses except passion fruit and peanuts.
	Direct effects to aquatic vascular plants	NE	No LOCs were exceeded for vascular plants.
	Direct effects to aquatic emergent vascular plants	NE	No LOCs were exceeded for aquatic vascular plants or for terrestrial plants.
Terrestrial Phase			
4. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	Acute direct effects	LAA (SDS-3701 only)	The endangered species LOC was exceeded for conifers, bulb onions, stone fruits, garlic, tomatoes, celery, pachysandra, and golf courses.
	Chronic direct effects	LAA	LOCs were exceeded for all uses for chlorothalonil and SDS-3701
5. Survival, growth, and reproduction of CRLF individuals via indirect effects on prey (i.e., terrestrial invertebrates, small terrestrial vertebrates)	Acute direct effects to most sensitive prey	LAA	Potential effect to mammals and terrestrial invertebrates could be of sufficient magnitude to adversely affect CRLFs for a number of uses.
	Chronic direct effects to most sensitive prey	LAA	Both chlorothalonil and SDS-3701 could affect small vertebrates to an extent that could adversely affect the CRLF for all uses.
6. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (i.e. riparian vegetation)	Direct effects to monocots	NE	No LOCs were exceeded.
	Direct effects to dicots	NE	No LOCs were exceeded.

[1] Potential effects to CRLFs will be influenced by many factors, and potential exposures and risks are not expected to be uniformly distributed in the environment

Table 1.4. Effects Determination Summary for the Critical Habitat Impact Analysis

Assessment Endpoint	Effects Determination	Basis
Aquatic Phase Primary Constituent Elements (PCEs) (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)		
Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.	No effect	Chlorothalonil did not affect terrestrial plants at levels that exceed the maximum labeled application rate.
Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source. [1]	Habitat modification	Aquatic non-vascular plant LOCs were exceeded for green algae and diatoms.
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	Habitat modification	RQs exceeded for acute and chronic effects to prey items (invertebrates, fish, aquatic phase amphibians)
Reduction and/or modification of aquatic-based food sources for pre-metamorphose (*e.g.*, algae)	Habitat modification	Non-vascular plant LOCs were exceeded
Terrestrial Phase PCEs (Upland Habitat and Dispersal Habitat)		
Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or drip line surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance	No effect	Chlorothalonil did not affect terrestrial plants at levels that exceed the maximum labeled application rate.
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal	No effect	
Reduction and/or modification of food sources for terrestrial phase juveniles and adults	Habitat modification	Chlorothalonil and/or its degradate could affect prey items of the CRLF (terrestrial invertebrates, terrestrial vertebrates, terrestrial-phase amphibians).
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	Habitat modification	Chlorothalonil poses acute and chronic risk to prey items of the CRLF (terrestrial invertebrates, mice, terrestrial-phase frogs).

[1] Physico-chemical water quality parameters such as salinity, pH, and hardness are not evaluated because these processes are not biologically mediated and, therefore, are not relevant to the endpoints included in this assessment.

When evaluating the significance of this risk assessment's direct and indirect effects and habitat modification determinations, it is important to note that pesticide exposures and predicted risks to the 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 CRLF life stages within specific recovery units and/or designated critical habitat within the action area. 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 species.

- Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase frogs. While existing information provides a preliminary picture of the types of food sources utilized by the frog, 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 frogs and potential modification to critical habitat.

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

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

2.1 Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the federally threatened California red-legged frog *(Rana aurora draytonii*) (CRLF) arising from FIFRA regulatory actions regarding use of the fungicide chlorothalonil on a number of agricultural commodities and non-agricultural uses (see Section 2.4 for the use profile of chlorothalonil). In addition, this assessment evaluates whether these actions can be expected to result in modification of the species' critical habitat. Key biological information for the CRLF is included in Section 2.5, and designated critical habitat information for the species is provided in Section 2.6 of this assessment. This ecological risk assessment has been prepared as part of the *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 02-1580-JSW(JL)) settlement entered in the Federal District Court for the Northern District of California on October 20, 2006.

2.2 Scope

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 in portions of the action area that are reasonably assumed to be biologically relevant to the CRLF and its designated critical habitat. Further discussion of the action area for the CRLF and its critical habitat is provided in Section 2.7.

Degradates are discussed in detail in section 2.4. One degradate, 4-hydroxy-2,5,6-trichloro-1,3-dicyanobenzene (SDS-3701), has been identified as a degradate of concern for terrestrial organisms due to its elevated toxicity and persistence relative to chlorothalonil. Therefore, SDS-3701 is quantitatively evaluated as part of the terrestrial phase CRLF assessment. However, SDS-3701 was not quantitatively evaluated as part of the aquatic organism risk assessment because it is orders of magnitude less toxic to aquatic animals than chlorothalonil (see Section 4).

This assessment evaluates potential effects resulting from exposure to chlorothalonil and the degradate SDS-3701. In the environment, multiple chemical stressors may co-occur. Exposure to pesticide or other chemical mixtures may result in increased, decreased, or no effect on toxicity relative to effects from exposure to each individual chemical. The chemical interactions can be a function of many factors including but not necessarily limited to (1) the exposed species, (2) the co-contaminants in the mixture, (3) the ratio of chlorothalonil and the co-contaminant concentrations, (4) differences in the pattern and duration of exposure among contaminants, and (5) the differential effects of other physical/chemical characteristics of the receiving waters (e.g. organic matter present in sediment and suspended water). Quantitatively predicting the combined effects of all these variables on mixture toxicity to any given taxa with confidence is beyond the scope of this assessment. However, a qualitative discussion of implications of the available pesticide mixture effects data involving chlorothalonil on the confidence of risk assessment conclusions is addressed as part of the uncertainty analysis for this effects determination.

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 LD50 data for multiple active ingredient products relative to the single active ingredient is provided in Appendix I. The results of this analysis show that an assessment based on the toxicity of the single active ingredient of chlorothalonil is appropriate for most products; however, it is not possible to conclude that acute oral mammalian toxicity data from four formulations reflect an independent additive toxicity response and not an interactive effect in mammals. A discussion of these data as they relate to risk conclusions presented in this assessment is in Section 6.3.

2.3 Previous Assessments

Chlorothalonil has a long regulatory history, and a number of risk assessments have been conducted. Chlorothalonil was subjected to re-registration in April, 1999. LOC exceedances reported in the 1999 Re-registration Eligibility Decision (RED) document included exceedances for birds, mammals, fish, aquatic invertebrates, and aquatic plants.

Since the writing of the 1999 RED, no new uses with dramatically different use patterns have been approved for use by the Agency. However, as part of a recent "me-too" registration[1], new data were submitted that indicated greater toxicity of chlorothalonil to birds and daphnids than data used in the 1999 RED. Therefore, potential risks identified in this assessment may be different than potential risks identified in previous assessments including the 1999 RED. Also, the current assessment is a species specific assessment; therefore, some assumptions may be different than those used in the 1999 RED document for a national scope ecological risk assessment.

2.4 Stressor Source and Distribution

2.4.1 Environmental Fate Assessment

Chlorothalonil is expected to possess some degree of mobility in the open environment. It degrades through both photolytic ($t_{1/2}$ = 10 hr) and microbial processes ($t_{1/2}$ = 7 – 68 days). Chlorothalonil degrades rapidly in clear, shallow water through aqueous photolysis. It is not susceptible to hydrolysis in waters below pH 9, but does hydrolyze in waters at or above pH 9 ($t_{1/2}$ = 40-60 days). Although photolytic transformation of chlorothalonil is more rapid than biotic metabolism, aqueous photolysis is limited to environmental compartments where clear, shallow waters are exposed to direct sunlight. Therefore, the main route of dissipation for chlorothalonil in the environment is expected to be through aqueous, biotic degradation ($t_{1/2}$ = 7-29 days). Chlorothalonil degrades under both aerobic aquatic conditions ($t_{1/2}$ = 7-16 days), and aerobic terrestrial conditions ($t_{1/2}$ = 22-68 days), and through anaerobic degradation ($t_{1/2}$ = 21-29 days). Structures of chlorothalonil and SDS-3701 are presented in Figures 2.4.1.a and 2.4.1.b. Additional environmental fate discussion is included in Appendix A.

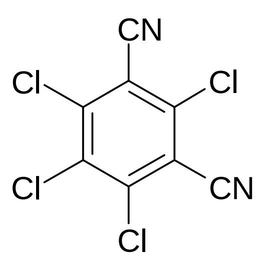
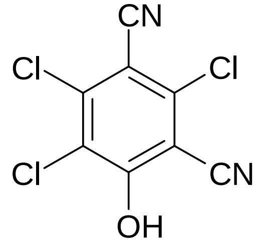


Figure 2.4.1.a Chemical Structure of Chlorothalonil



[1] New registrant petitioning for authorization to produce currently registered active ingredient.

Figure 2.4.1.b Chemical Structure of SDS-3701
(4-Hydroxy-2,5,6-trichloro-1,3-dicyanobenzene)

The major metabolite considered in this assessment, SDS-3701 (4-hydroxy-2,5,6-trichloro-1,3-dicyanobenzene), forms under differing test conditions, and appears to be more mobile and more persistent than chlorothalonil. In the submitted aerobic soil metabolism study[2] conducted with chlorothalonil, up to 32% of the applied radiation was present as SDS-3701. In the submitted anaerobic metabolism study[3] conducted with chlorothalonil, up to 43% of the applied radiation was present as SDS-3701. Only 4% of SDS-3701 formed in the submitted aqueous photolysis[4] study while chlorothalonil dissipated rapidly. Therefore, in clear shallow waters exposed to direct sunlight, the degradate SDS-3701 is not expected to form in significant amounts. In an aquatic metabolism study[5] conducted with chlorothalonil, a comparison of the ratio of residues reported in water and sediment for chlorothalonil and SDS-3701 indicated that a greater percentage of the degradate was present in the water compartment than for chlorothalonil.

Chlorothalonil (or its degradates) bioconcentrated[6] in oysters (BCF = 2660X) and bluegill sunfish (BCF = 2700X). Residues reported as recalcitrant metabolites that bioconcentrated were slow to be eliminated. Evolution of volatile compounds, including carbon dioxide, was not significant in laboratory testing. However, local ambient air monitoring data demonstrated that trace amounts of chlorothalonil were present in the air at locations up to a mile away from the application sites. The levels detected were low enough that long-range transport is not expected to contribute to potential risks to any measurable extent relative to risks presented in this assessment.

[2] MRID 001372-32
[3] MRID 001479-75
[4] MRID 457102-23
[5] MRID 459080-01
[6] MRID 457102-24

Table 2.4.1 Physical, Chemical and Environmental Fate Properties of Chlorothalonil

Physical and Chemical Properties	
Chemical Name (common)	chlorothalonil
Chemical Name (CAS)	2,4,5,6-tetrachloroisophthalonitrile
Chemical Abstract Number (CAS Number)	1897-45-6
Chemical Class	polychlorinated aromatic
Molecular Weight	265.91
Aqueous Solubility (25° C)	0.8 mg/L
pKa	Not determined
Vapor Pressure (26° C)	5.7 x 10^{-7} torr
Henry's Law Constant (20 ° C)	2.6 x 10^{-7} atm – m^3/mole
Octanol/water Partition Coefficient (K_{ow})	6277 (log K_{ow} = 3.8)
Environmental Fate Properties	
Hydrolysis Half-life (pH 5, 7)	$t_{1/2}$ = stable
Aqueous Photolysis Half-life	$t_{1/2}$ = 10 hours
Aerobic Metabolism Half-lives (total system)	$t_{1/2}$ = 7 – 68 days
Anaerobic Metabolism Half-lives (total system)	$t_{1/2}$ = 5 – 15 days
Soil-Water Distribution Coefficients (K_d)	3 – 29
Bioaccumulation in Fish	300 X (edible tissue) 2700 X (whole fish)
Bioaccumulation in Bivalves	2660 X
Terrestrial Field Dissipation (total system)	$t_{1/2}$ = 1 – 2 months

2.4.2 Environmental Transport Assessment

Volatility

The vapor pressure (5.7 x 10^{-7} torr) and Henry's Law Constant (2.6 x 10^{-7} atm - m^3/mole) values for chlorothalonil indicate some degree of volatility from both soil and water. However, inhalation exposure is not expected to be a predominant exposure route.

Aquatic Transport

Chlorothalonil is expected to vary in mobility in ground water and surface water for different soil types found in the open environment (K_d = 3-30; K_{oc} values not available for chlorothalonil). As a result, under some conditions, concentrations of chlorothalonil in benthic sediments could exceed concentrations found in runoff waters. Aquatic mobility data for SDS-3701 demonstrated that the degradate of concern is expected to be more mobile than the parent compound.

Long Range Atmospheric Transport

In addition to surface water runoff, potential transport mechanisms also include pesticide spray drift and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. The magnitude of pesticide transport via secondary drift depends on the pesticide's ability to be mobilized into air and its eventual removal through wet and dry deposition of gases/ particles and photochemical reactions in the atmosphere. A number of studies have documented atmospheric transport and redeposition of various pesticides, including chlorothalonil, from the Central Valley to the Sierra Nevada Mountains (Fellers *et al*., 2004, Sparling *et al*., 2001, LeNoir *et al*., 1999, and McConnell *et al*., 1998). Prevailing winds blow across the Central Valley eastward to the Sierra Nevada Mountains transporting airborne industrial and agricultural pollutants into the Sierra Nevada ecosystems (Fellers *et al*., 2004, LeNoir *et al*., 1999, and McConnell *et al*., 1998). Therefore, physicochemical properties of the pesticide (e.g., Henry's Law constant), pesticide use, modeled estimated concentrations in water and air, and available air monitoring data from Central Valley and Sierra Nevada are considered in evaluating the potential for atmospheric transport of chlorothalonil to habitat for the red-legged frog.

In general, deposition of drifting or volatilized pesticides is expected to be greatest close to the site of application. Computer models of spray drift (AgDRIFT) are used to determine distance from treated field exposures to aquatic and terrestrial organisms are below the Agency's Levels of Concern (LOCs). In addition to the use of spray drift models to determine potential off-site transport of pesticides, other factors such as available air monitoring data and the physicochemical properties of the chemical were also be considered.

2.4.3 Mechanism of Action

The open literature indicates that the chlorothalonil molecule combines with glutathione within the fungus cell, tying up the available glutathione. Glutathione dependent enzymes are then left unable to function in aiding cellular respiration[7].

2.4.4 Use Characterization

Chlorothalonil is a broad spectrum, non-systemic pesticide used mainly as a foliar fungicide for vegetable, field, and ornamental crops. It is also used as a wood protectant, antimold and antimildew agent, bactericide, microbiocide, algicide, insecticide and acaricide. The Agency's Biological and Economic Analysis Division (BEAD) provided an analysis of county-level usage information using the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database.[8] Usage data are averaged together over the years 2000 to 2005 to calculate average annual usage statistics by county and crop for chlorothalonil, including pounds of active ingredient applied and base acres treated. California state law requires that most pesticide applications be

[7] http://www.pesticide.org/chlorothalonil.pdf

[8] 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.html

reported to the state and made available to the public. A summary of the amount of chlorothalonil applied to various use sites is provided below in Table 2.4.4.

Table 2.4.4 Summary of CDPR PUR Usage Data from 2002 to 2005 for Chlorothalonil

Use site	Sum of pounds of chlorothalonil applied from 2002 – 2005[a]
Tomatoes	945,000
Landscape maintenance	373,000
Onions	266,000
Potatoes	220,000
Celery	196,000
Almonds	109,000
Carrots	95,000
Brussels Sprouts	56,000
Nursery	47,000
Prunes	32,000
Pistachio	32,000
Broccoli	29,000
Peaches	26,000
Turf/Sod	26,000

a Chlorothalonil was applied to other use sites in CA during 2002 – 2005, but only uses that comprised >1% of the total were included in Table 2.4.4. See Appendix K and L for additional information.

2.5 Assessed Species

The CRLF was federally listed as a threatened species by USFWS effective June 24, 1996 (USFWS 1996). It is one of two subspecies of the red-legged frog and is the largest native frog in the western United States (USFWS 2002). A brief summary of information regarding CRLF distribution, reproduction, diet, and habitat requirements is provided in Sections 2.5.1 through 2.5.4, respectively. Further information on the status, distribution, and life history of and specific threats to the CRLF is provided in Attachment 1.

Final critical habitat for the CRLF was designated by USFWS on April 13, 2006 (USFWS 2006; 71 FR 19244-19346). Further information on designated critical habitat for the CRLF is provided in Section 2.6.

2.5.1 Distribution

The CRLF is endemic to California and Baja California (Mexico) and historically inhabited 46 counties in California including the Central Valley and both coastal and interior mountain ranges (USFWS 1996). Its range has been reduced by about 70%, and the species currently resides in 22 counties in California (USFWS 1996). The species has an elevational range of near sea level to 1,500 meters (5,200 feet) (Jennings and Hayes 1994); however, nearly all of the known CRLF populations have been documented below 1,050 meters (3,500 feet) (USFWS 2002).

Populations currently exist along the northern California coast, northern Transverse Ranges (USFWS 2002), foothills of the Sierra Nevada (5-6 populations), and in southern California south of Santa Barbara (two populations) (Fellers 2005a). Relatively larger numbers of CRLFs are located between Marin and Santa Barbara Counties (Jennings and Hayes 1994). A total of 243 streams or drainages are believed to be currently occupied by the species, with the greatest numbers in Monterey, San Luis Obispo, and Santa Barbara counties (USFWS 1996). Occupied drainages or watersheds include all bodies of water that support CRLFs (i.e., streams, creeks, tributaries, associated natural and artificial ponds, and adjacent drainages), and habitats through which CRLFs can move (i.e., riparian vegetation, uplands) (USFWS 2002).

The distribution of CRLFs within California is addressed in this assessment using four categories of location including recovery units, core areas, designated critical habitat, and known occurrences of the CRLF reported in the California Natural Diversity Database (CNDDB) that are not included within core areas and/or designated critical habitat (see Figure 2.5.1). Recovery units, core areas, and other known occurrences of the CRLF from the CNDDB are described in further detail in this section, and designated critical habitat is addressed in Section 2.6. Recovery units are large areas defined at the watershed level that have similar conservation needs and management strategies. The recovery unit is primarily an administrative designation, and land area within the recovery unit boundary is not exclusively CRLF habitat. Core areas are smaller areas within the recovery units that comprise portions of the species' historic and current range and have been determined by USFWS to be important in the preservation of the species. Designated critical habitat is generally contained within the core areas, although a number of critical habitat units are outside the boundaries of core areas, but within the boundaries of the recovery units. Additional information on CRLF occurrences from the CNDDB is used to cover the current range of the species not included in core areas and/or designated critical habitat, but within the recovery units.

Recovery Units

Eight recovery units have been established by USFWS for the CRLF. These areas are considered essential to the recovery of the species, and the status of the CRLF "may be considered within the smaller scale of the recovery units, as opposed to the statewide range" (USFWS 2002). Recovery units reflect areas with similar conservation needs and population statuses, and therefore, similar recovery goals. The eight units described for the CRLF are delineated by watershed boundaries defined by US Geological Survey hydrologic units and are limited to the elevational maximum for the species of 1,500 m above sea level. The eight recovery units for the CRLF are listed in Table 2.5.1 and shown in Figure 2.5.1.

Core Areas

USFWS has designated 35 core areas across the eight recovery units to focus their recovery efforts for the CRLF (see Figure 2.a). Table 2.5.1 summarizes the geographical relationship among recovery units, core areas, and designated critical habitat. The core areas, which are distributed throughout portions of the historic and current range of the species, represent areas that allow for long-term viability of existing populations and reestablishment of populations within historic range. These areas were selected because they: 1) contain existing viable populations; or 2) they contribute to the connectivity of other habitat areas (USFWS 2002). Core area protection and enhancement are vital for maintenance and expansion of the CRLF's distribution and population throughout its range.

For purposes of this assessment, designated critical habitat, currently occupied (post-1985) core areas, and additional known occurrences of the CRLF from the CNDDB are considered. Each type of locational information is evaluated within the broader context of recovery units. For example, if no labeled uses of chlorothalonil occur (or if labeled uses occur at predicted exposures less than the Agency's LOCs) within an entire recovery unit, a "no effect" determination would be made for all designated critical habitat, currently occupied core areas, and other known CNDDB occurrences within that recovery unit. Historically occupied sections of the core areas are not evaluated as part of this assessment because the USFWS Recovery Plan (USFWS 2002) indicates that CRLFs are extirpated from these areas. A summary of currently and historically occupied core areas is provided in Table 2.5.1 (currently occupied core areas are bolded). While core areas are considered essential for recovery of the CRLF, core areas are not federally-designated critical habitat, although designated critical habitat is generally contained within these core recovery areas. It should be noted, however, that several critical habitat units are located outside of the core areas, but within the recovery units. The focus of this assessment is currently occupied core areas, designated critical habitat, and other known CNDDB CRLF occurrences within the recovery units. Federally-designated critical habitat for the CRLF is further explained in Section 2.6.

Table 2.5.1. California Red-legged Frog Recovery Units with Overlapping Core Areas and Designated Critical Habitat

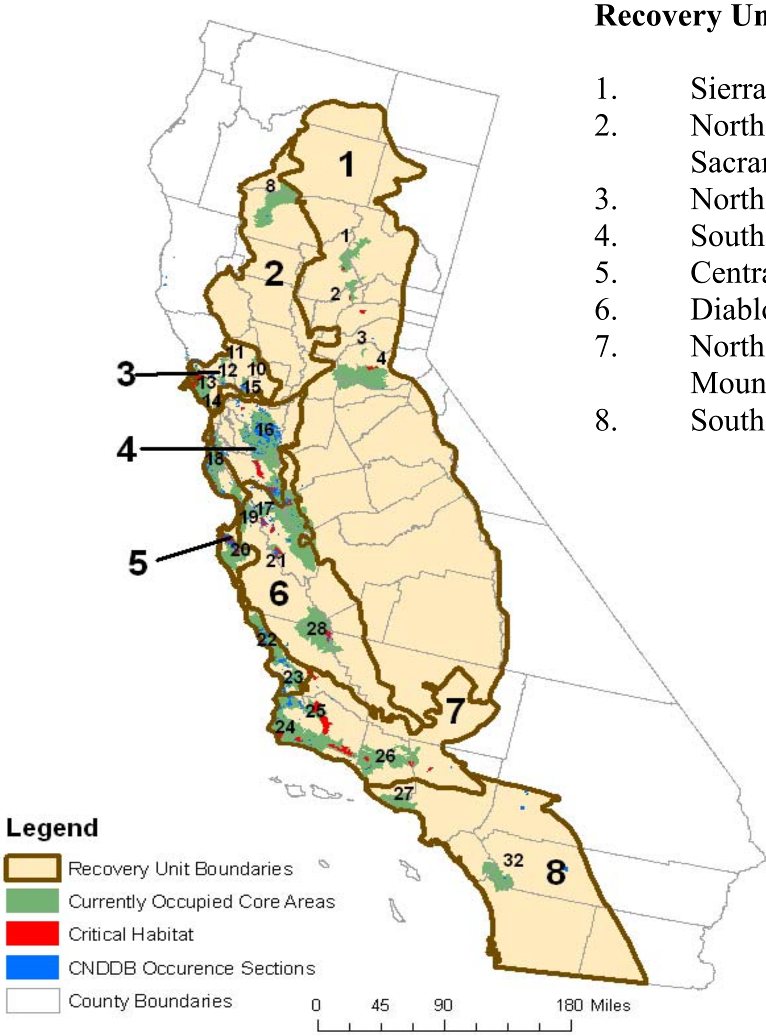
Recovery Unit [1] (Figure 2.5.1)	**Core Areas [2,7] (Figure 2.5.1)**	**Critical Habitat Units [3]**	**Currently Occupied (post-1985) [4]**	**Historically Occupied [4]**
Sierra Nevada Foothills and Central Valley (1) (eastern boundary is the 1,500m elevation line)	**Cottonwood Creek (partial) (8)**	--	✓	
	Feather River (1)	BUT-1A-B	✓	
	Yuba River-S. Fork Feather River (2)	YUB-1	✓	
	--	NEV-1[6]		
	Traverse Creek/Middle Fork American River/Rubicon (3)	--	✓	
	Consumnes River (4)	ELD-1	✓	
	S. Fork Calaveras River (5)	--		✓
	Tuolumne River (6)	--		✓
	Piney Creek (7)	--		✓
	East San Francisco Bay (partial)(16)	--	✓	
North Coast Range Foothills and Western Sacramento River Valley (2)	**Cottonwood Creek (8)**	--	✓	
	Putah Creek-Cache Creek (9)	--		✓
	Jameson Canyon – Lower Napa Valley (partial) (15)	--	✓	
	Belvedere Lagoon (partial) (14)	--	✓	
	Pt. Reyes Peninsula (partial) (13)	--	✓	
North Coast and North San Francisco Bay (3)	Putah Creek-Cache Creek (partial) (9)	--		✓
	Lake Berryessa Tributaries (10)	NAP-1	✓	
	Upper Sonoma Creek (11)	--	✓	
	Petaluma Creek-Sonoma Creek (12)	--	✓	
	Pt. Reyes Peninsula (13)	MRN-1, MRN-2	✓	
	Belvedere Lagoon (14)	--	✓	
	Jameson Canyon-Lower Napa River (15)	SOL-1	✓	
South and East San Francisco Bay (4)	--	CCS-1A[6]		
	East San Francisco Bay (partial) (16)	ALA-1A, ALA-1B, STC-1B	✓	
	--	STC-1A[6]		
	South San Francisco Bay (partial) (18)	SNM-1A	✓	
Central Coast (5)	**South San Francisco Bay (partial) (18)**	SNM-1A, SNM-2C, SCZ-1	✓	
	Watsonville Slough- Elkhorn Slough (partial) (19)	SCZ-2 [5]	✓	
	Carmel River-Santa Lucia (20)	MNT-2	✓	
	Estero Bay (22)	--	✓	

Recovery Unit [1] (Figure 2.5.1)	Core Areas [2,7] (Figure 2.5.1)	Critical Habitat Units [3]	Currently Occupied (post-1985) [4]	Historically Occupied [4]
	--	SLO-8[6]		
	Arroyo Grande Creek (23)	--	✓	
	Santa Maria River-Santa Ynez River (24)	--	✓	
Diablo Range and Salinas Valley (6)	**East San Francisco Bay (partial) (16)**	MER-1A-B, STC-1B	✓	
	--	SNB-1[6], SNB-2[6]		
	Santa Clara Valley (17)	--	✓	
	Watsonville Slough- Elkhorn Slough (partial)(19)	MNT-1	✓	
	Carmel River-Santa Lucia (partial)(20)	--	✓	
	Gablan Range (21)	SNB-3	✓	
	Estrella River (28)	SLO-1A-B	✓	
Northern Transverse Ranges and Tehachapi Mountains (7)	--	SLO-8[6]		
	Santa Maria River-Santa Ynez River (24)	STB-4, STB-5, STB-7	✓	
	Sisquoc River (25)	STB-1, STB-3	✓	
	Ventura River-Santa Clara River (26)	VEN-1, VEN-2, VEN-3	✓	
	--	LOS-1[6]		
Southern Transverse and Peninsular Ranges (8)	**Santa Monica Bay-Ventura Coastal Streams (27)**	--	✓	
	San Gabriel Mountain (29)	--		✓
	Forks of the Mojave (30)	--		✓
	Santa Ana Mountain (31)	--		✓
	Santa Rosa Plateau (32)	--	✓	
	San Luis Rey (33)	--		✓
	Sweetwater (34)	--		✓
	Laguna Mountain (35)	--		✓

[1] Recovery units designated by the USFWS (USFWS 2000, pg 49).
[2] Core areas designated by the USFWS (USFWS 2000, pg 51).
[3] Critical habitat units designated by the USFWS on April 13, 2006 (USFWS 2006, 71 FR 19244-19346).
[4] Currently occupied (post-1985) and historically occupied core areas as designated by the USFWS (USFWS 2002, pg 54).
[5] Critical habitat unit where identified threats specifically included pesticides or agricultural runoff (USFWS 2002).
[6] Critical habitat units that are outside of core areas, but within recovery units.
[7] Currently occupied core areas that are included in this effects determination are bolded.

Recovery Units

1. Sierra Nevada Foothills and Central Valley
2. North Coast Range Foothills and Western Sacramento River Valley
3. North Coast and North San Francisco Bay
4. South and East San Francisco Bay
5. Central Coast
6. Diablo Range and Salinas Valley
7. Northern Transverse Ranges and Tehachapi Mountains
8. Southern Transverse and Peninsular Ranges



1. **Core Areas***
2. Feather River
3. Yuba River- S. Fork Feather River
4. Traverse Creek/ Middle Fork/ American R. Rubicon
5. Cosumnes River
6. South Fork Calaveras River*
7. Tuolumne River*
8. Piney Creek*
9. Cottonwood Creek
10. Putah Creek – Cache Creek*
11. Lake Berryessa Tributaries
12. Upper Sonoma Creek
13. Petaluma Creek – Sonoma Creek
14. Pt. Reyes Peninsula
15. Belvedere Lagoon
16. Jameson Canyon – Lower Napa River
17. East San Francisco Bay
18. Santa Clara Valley
19. South San Francisco Bay
20. Watsonville Slough-Elkhorn Slough
21. Carmel River – Santa Lucia
22. Gablan Range
23. Estero Bay
24. Arroyo Grange River
25. Santa Maria River – Santa Ynez River
26. Sisquoc River
27. Ventura River – Santa Clara River
28. Santa Monica Bay – Venura Coastal Streams
29. Estrella River
30. San Gabriel Mountain*
31. Forks of the Mojave*
32. Santa Ana Mountain*
33. Santa Rosa Plateau
34. San Luis Ray*
35. Sweetwater*
36. Laguna Mountain*

* Core areas that were historically occupied by the California red-legged frog are not included in the map

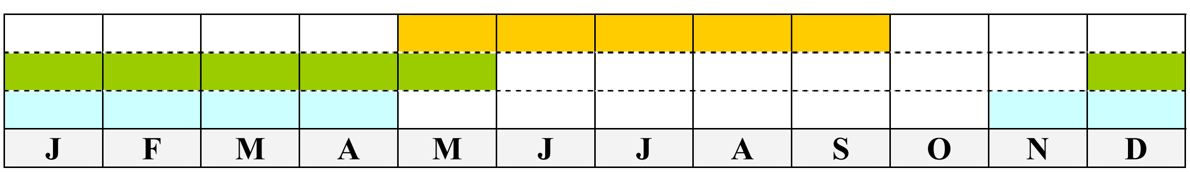
Figure 2.5.1. Recovery Unit, Core Area, Critical Habitat, and Occurrence Designations

Other Known Occurrences from the CNDDB

The CNDDB provides location and natural history information on species found in California. The CNDDB serves as a repository for historical and current species location sightings. Information regarding known occurrences of CRLFs outside of the currently occupied core areas and designated critical habitat is considered in defining the current range of the CRLF. See: http://www.dfg.ca.gov/bdb/html/cnddb_info.html for additional information on the CNDDB.

2.5.2 Reproduction

CRLFs breed primarily in ponds; however, they may also breed in quiescent streams, marshes, and lagoons (Fellers 2005a). According to the Recovery Plan (USFWS 2002), CRLFs breed from November through late April. Peaks in spawning activity vary geographically; Fellers (2005b) reports peak spawning as early as January in parts of coastal central California. Eggs are fertilized as they are being laid. Egg masses are typically attached to emergent vegetation, such as bulrushes (*Scirpus* spp.) and cattails (*Typha* spp.) or roots and twigs, and float on or near the surface of the water (Hayes and Miyamoto 1984). Egg masses contain approximately 2000 to 6000 eggs ranging in size between 2 and 2.8 mm (Jennings and Hayes 1994). Embryos hatch 10 to 14 days after fertilization (Fellers 2005a) depending on water temperature. Egg predation is reported to be infrequent and most mortality is associated with the larval stage (particularly through predation by fish); however, predation on eggs by newts has also been reported (Rathburn 1998). Tadpoles require 11 to 28 weeks to metamorphose into juveniles (terrestrial-phase), typically between May and September (Jennings and Hayes 1994, USFWS 2002); tadpoles have been observed to over-winter (delay metamorphosis until the following year) (Fellers 2005b, USFWS 2002). Males reach sexual maturity at 2 years, and females reach sexual maturity at 3 years of age; adults have been reported to live 8 to 10 years (USFWS 2002). Figure 2.5.2 depicts CRLF annual reproductive timing.



Light Blue = **Breeding/Egg Masses**
Green = **Tadpoles (except those that over-winter)**
Orange = **Young Juveniles**
Adults and juveniles can be present all year

Figure 2.5.2 – CRLF Reproductive Events by Month

2.5.3 Diet

Although the diet of CRLF aquatic-phase larvae (tadpoles) has not been studied specifically, it is assumed that their diet is similar to that of other frog species, with the aquatic phase feeding exclusively in water and consuming diatoms, algae, and detritus (USFWS 2002). Tadpoles filter and entrap suspended algae (Seale and Beckvar, 1980) via mouthparts designed for effective grazing of periphyton (Wassersug, 1984, Kupferberg *et al.*; 1994; Kupferberg, 1997; Altig and McDiarmid, 1999).

Juvenile and adult CRLFs forage in aquatic and terrestrial habitats, and their diet differs greatly from that of larvae. The main food source for juvenile aquatic- and terrestrial-phase CRLFs is thought to be aquatic and terrestrial invertebrates found along the shoreline and on the water surface. Hayes and Tennant (1985) report, based on a study examining the gut content of 35 juvenile and adult CRLFs, that the species feeds on as many as 42 different invertebrate taxa, including Arachnida, Amphipoda, Isopoda, Insecta, and Mollusca. The most commonly observed prey species were larval alderflies (*Sialis* cf. *californica*), pillbugs (*Armadilliadrium vulgare*), and water striders (*Gerris* sp). The preferred prey species, however, was the sowbug (Hayes and Tennant, 1985). This study suggests that CRLFs forage primarily above water, although the authors note other data reporting that adults also feed under water, are cannibalistic, and consume fish. For larger CRLFs, over 50% of the prey mass may consists of vertebrates such as mice, frogs, and fish, although aquatic and terrestrial invertebrates were the most numerous food items (Hayes and Tennant 1985). For adults, feeding activity takes place primarily at night; for juveniles feeding occurs during the day and at night (Hayes and Tennant 1985).

2.5.4 Habitat

CRLFs require aquatic habitat for breeding, but also use other habitat types including riparian and upland areas throughout their life cycle. CRLF use of their environment varies; they may complete their entire life cycle in a particular habitat or they may utilize multiple habitat types. Overall, populations are most likely to exist where multiple breeding areas are embedded within varying habitats used for dispersal (USFWS 2002). Generally, CRLFs utilize habitat with perennial or near-perennial water (Jennings *et al*. 1997). Dense vegetation close to water, shading, and water of moderate depth are habitat features that appear especially important for CRLF (Hayes and Jennings 1988). Breeding sites include streams, deep pools, backwaters within streams and creeks, ponds, marshes, sag ponds (land depressions between fault zones that have filled with water), dune ponds, and lagoons. Breeding adults have been found near deep (0.7 m) still or slow moving water surrounded by dense vegetation (USFWS 2002); however, the largest number of tadpoles have been found in shallower pools (0.26 – 0.5 m) (Reis, 1999). Data indicate that CRLFs do not frequently inhabit vernal pools, as conditions in these habitats generally are not suitable (Hayes and Jennings 1988).

CRLFs also frequently breed in artificial impoundments such as stock ponds, although additional research is needed to identify habitat requirements within artificial ponds

(USFWS 2002). Adult CRLFs use dense, shrubby, or emergent vegetation closely associated with deep-water pools bordered with cattails and dense stands of overhanging vegetation (http://www.fws.gov/endangered/features/rl_frog/rlfrog.html#where).

In general, dispersal and habitat use depends on climatic conditions, habitat suitability, and life stage. Adults rely on riparian vegetation for resting, feeding, and dispersal. The foraging quality of the riparian habitat depends on moisture, composition of the plant community, and presence of pools and backwater aquatic areas for breeding. CRLFs can be found living within streams at distances up to 3 km (2 miles) from their breeding site and have been found up to 30 m (100 feet) from water in dense riparian vegetation for up to 77 days (USFWS 2002).

During dry periods, the CRLF is rarely found far from water, although it will sometimes disperse from its breeding habitat to forage and seek other suitable habitat under downed trees or logs, industrial debris, and agricultural features (UWFWS 2002). According to Jennings and Hayes (1994), CRLFs also use small mammal burrows and moist leaf litter as habitat. In addition, CRLFs may also use large cracks in the bottom of dried ponds as refugia; these cracks may provide moisture for individuals avoiding predation and solar exposure (Alvarez 2000).

2.6 Designated Critical Habitat

In a final rule published on April 13, 2006, 34 separate units of critical habitat were designated for the CRLF by USFWS (USFWS 2006; FR 51 19244-19346). A summary of the 34 critical habitat units relative to USFWS-designated recovery units and core areas (previously discussed in Section 2.5.1) is provided in Table 2.5.1.

'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.' All designated critical habitat for the CRLF was occupied at the time of listing. Critical habitat receives protection under Section 7 of the ESA through prohibition against destruction or adverse modification with regard to actions carried out, funded, or authorized by a federal Agency. Section 7 requires consultation on federal actions that are likely to result in modification of critical habitat.

To be included in a critical habitat designation, the habitat must be '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)). PCEs include, but are not limited to, 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. The designated critical habitat areas for the CRLF are considered to have the following PCEs that justify critical habitat designation:

- Breeding aquatic habitat;
- Non-breeding aquatic habitat;
- Upland habitat; and
- Dispersal habitat.

Please note that a more complete description of these habitat types is provided in Attachment 1.

Occupied habitat may be included in the critical habitat only if essential features within the habitat may require special management or protection. Therefore, USFWS does not include areas where existing management is sufficient to conserve the species. Critical habitat is designated outside the geographic area presently occupied by the species only when a designation limited to its present range would be inadequate to ensure the conservation of the species. For the CRLF, all designated critical habitat units contain all four of the PCEs, and were occupied by the CRLF at the time of FR listing notice in April 2006. The FR notice designating critical habitat for the CRLF includes a special rule exempting routine ranching activities associated with livestock ranching from incidental take prohibitions. The purpose of this exemption is to promote the conservation of rangelands, which could be beneficial to the CRLF, and to reduce the rate of conversion to other land uses that are incompatible with CRLF conservation. Please see Attachment 1 for a full explanation on this special rule.

USFWS has established adverse modification standards for designated critical habitat (USFWS 2006). 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 CRLF's critical habitat form the basis of the critical habitat impact analysis. According to USFWS (2006), activities that may affect critical habitat and therefore result in adverse effects to the CRLF include, but are not limited to the following:

(1) Significant alteration of water chemistry or temperature to levels beyond the tolerances of the CRLF that result in direct or cumulative adverse effects to individuals and their life-cycles.
(2) Significant increase in sediment deposition within the stream channel or pond or disturbance of upland foraging and dispersal habitat that could result in elimination or reduction of habitat necessary for the growth and reproduction of the CRLF by increasing the sediment deposition to levels that would adversely affect their ability to complete their life cycles.
(3) Significant alteration of channel/pond morphology or geometry that may lead to changes to the hydrologic functioning of the stream or pond and alter the timing,

duration, water flows, and levels that would degrade or eliminate the CRLF and/or its habitat. Such an effect could also lead to increased sedimentation and degradation in water quality to levels that are beyond the CRLF's tolerances.
(4) Elimination of upland foraging and/or aestivating habitat or dispersal habitat.
(5) Introduction, spread, or augmentation of non-native aquatic species in stream segments or ponds used by the CRLF.
(6) Alteration or elimination of the CRLF's food sources or prey base (also evaluated as indirect effects to the CRLF).

As previously noted in Section 2.1, 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.

2.7 Action Area

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). It is recognized that the overall action area for the national registration of chlorothalonil uses is likely to encompass considerable portions of the United States based on the large array of both 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 RLF and its designated critical habitat within the state of California. Deriving the geographical extent of this portion of the action area is the product of consideration of the types of effects that chlorothalonil may be expected to have on the environment, the exposure levels to chlorothalonil that are associated with those effects, and the best available information concerning the use of chlorothalonil and its fate and transport within the state of California.

The definition of action area requires a stepwise approach that begins with an understanding of 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. This analysis indicates that, for chlorothalonil, the following uses are considered as part of the federal action evaluated in this assessment: asparagus, beans (snap and dry), blueberries, carrots, celery, cole crops, corn, cucurbits, filberts, almonds, pistachios, conifers, onions (bulb, green shallot, and onions grown for seed), garlic, mangos, passion fruit, peanuts, potatoes, stone fruit, cherries, tomatoes, ornamentals, sod farms, golf courses, and general turf. Chlorothalonil is also labeled for use on cranberries, soybeans, parsnip, and papaya, but these uses were not directly assessed because acreage used for production of these commodities is minimal. However, based on their use patterns (*e.g.,* application rates, intervals) risks from these uses would be expected to be bounded by risks from uses described in this assessment. In addition, chlorothalonil is used in industrial applications to make materials such as caulk, adhesives, and paint. These uses were not assessed because environmental exposures from these uses are assumed to be negligible and warrant a determination of no effect.

After determination of which uses will be assessed, an evaluation of the potential "footprint" of the use pattern is determined. This "footprint" represents the initial area of concern and is based on available land cover data. Local land cover data available for the state of California were analyzed to refine the understanding of potential chlorothalonil use. The initial area of concern is defined as all land cover types that represent the labeled uses described above. The initial area of concern is represented by (1) agricultural landcovers, which are assumed to represent vegetable and non-orchard fruit crops as well as ornamental crops and 2) orchard and vineyard landcovers which are assumed to be representative of tree fruit and almond crops. Chlorothalonil uses also include turf, residential, and open areas. Maps representing the land cover types that make up the initial areas of concern for agricultural and orchard crops are presented in Figure 2.7.1. These maps represent the areas that could be directly impacted by the federal action.

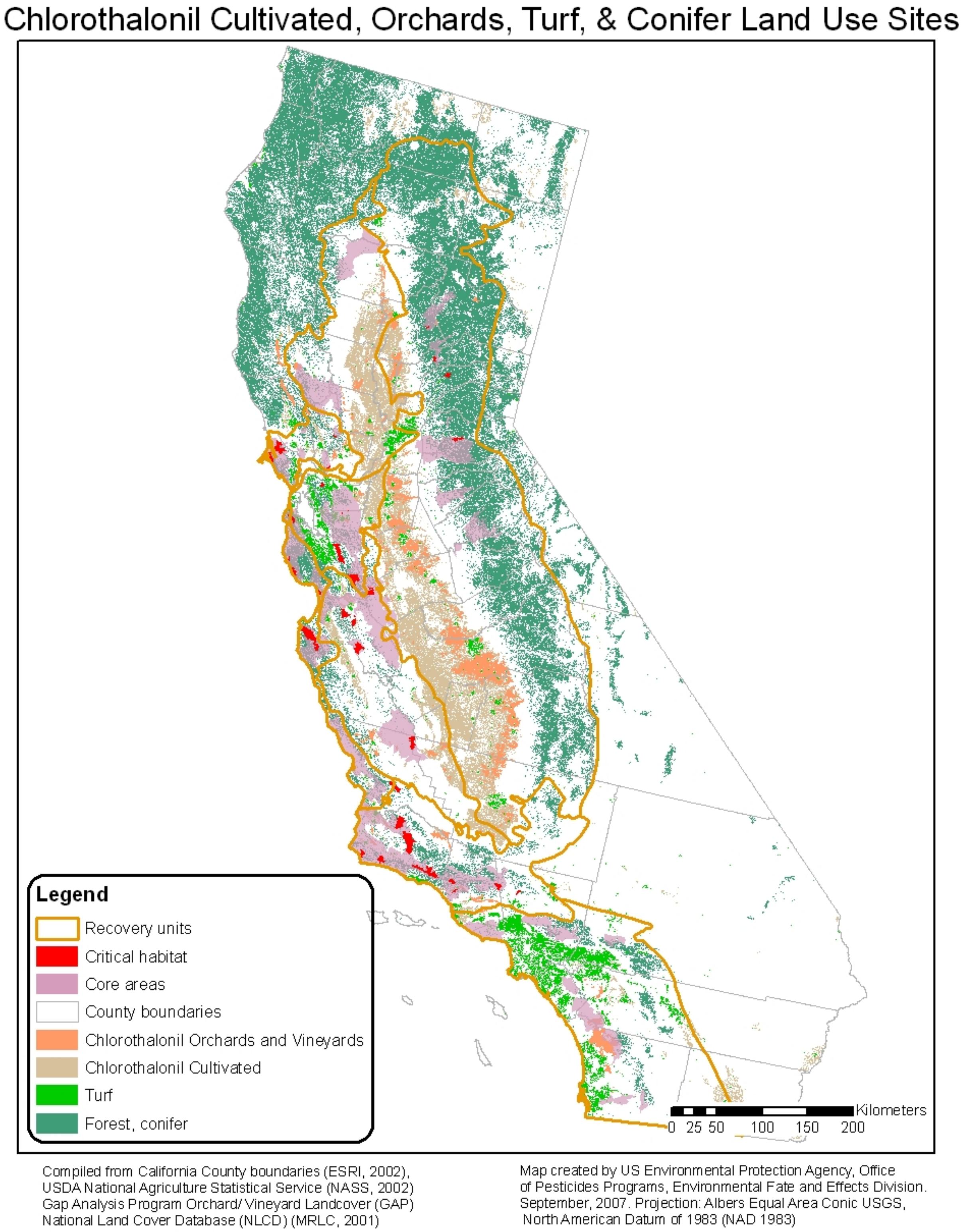


Figure 2.7.1. Initial Area of Concern

Once the initial area of concern is defined, the next step is to compare the extent of that area with the results of the screening level risk assessment. The environmental fate properties indicate that runoff and spray drift represent significant potential transport mechanisms of chlorothalonil to the aquatic and terrestrial habitats of the CRLF. Therefore, there is potential for chlorothalonil to be transported outside of the area where it is directly applied. In this assessment, transport of chlorothalonil through runoff and spray drift is considered in deriving quantitative estimates of chlorothalonil exposure to CRLF, its prey, and its habitats. Therefore, consideration of influences of runoff and spray drift in expanding the action area to include areas potentially affected by drift is used in the derivation of the final action area.

Since this screening level risk assessment defines taxa that are predicted to be exposed through runoff and drift to chlorothalonil at concentrations above the Agency's Levels of Concern (LOC), there is need to expand the action area to include all areas potentially impacted by this federal action. Two methods are used to define these areas and thus, the total action area: (1) the down stream dilution assessment for determining the extent of the affected lotic aquatic habitats (flowing water); and (2) the spray drift assessment for determining the extent of potentially affected terrestrial habitats. In order to define the final action areas relevant to uses of chlorothalonil, it is necessary to combine areas directly affected, as well as aquatic and terrestrial habitats indirectly affected by the federal action. It is assumed that lentic (standing water) aquatic habitats (*e.g.* ponds, pools, marshes) overlapping with the terrestrial areas are also indirectly affected by the federal action.

In order to determine the extent of the action area in lotic (flowing) aquatic habitats, the agricultural uses resulting in the greatest ratios of the RQ to the LOC for any endpoint for aquatic organisms is used to determine the distance downstream for concentrations to be diluted below levels that would be of concern (*i.e*. result in RQs above the LOC). This analysis is in Table 2.7.1 below. For this assessment, the greatest ratio was 1560 (the highest acute aquatic invertebrate RQ = 78; LOC = 0.05; 78 / 0.05 = 1560 – See Table 2.7.1) for indirect effects to the CRLF through acute effects to aquatic invertebrates exposed to chlorothalonil from runoff and drift (golf course uses). The areas potentially affected by the federal action due to runoff of chlorothalonil to aquatic habitats are depicted in **Figure 2.7.2**. The action area includes approximately 83,000 stream miles within California as described further in Appendix C.

Table 2.7.1. RQ/LOC Ratio for Various Landcover Classes for Aquatic Organisms[a,b]

Direct/Indirect Effects to CRLF	Exposure	Cropland[c]		Turf/Golf Course[d]		Conifers/Forest[e]	
		Highest RQ	RQ/LOC Ratio	Highest RQ	RQ/LOC Ratio	Highest RQ	RQ/LOC Ratio
Direct and Indirect - Fish and Aquatic Amphibians	**Acute**	13	260	27	540	1.8	2.8
	Chronic	24	24	49	49	4.0	4.0
Indirect- Aquatic Invertebrates[f]	**Acute**	39	780	78	1560	5.2	104
	Chronic	190	190	437	437	27	27

a RQ Calculations are presented in Section 5.
b RQs were not derived for SDS-3701 because of its low toxicity relative to chlorothalonil.
c Based on highest cropland RQs (stone fruits)
d Based on golf course RQs
e Based on Conifer RQs
f Aquatic plant RQs were similar to aquatic invertebrate RQs. The aquatic plant LOC of 1 is 20-fold higher than the aquatic invertebrate LOC of 0.05. Therefore, with similar RQs, the LOC:RQ ratio for aquatic invertebrates would be considerably higher than the ratio for aquatic plants. Therefore, aquatic plant RQ:LOC ratios are not presented in Tabe 2.7.1.

When considering the terrestrial habitats of the CRLF, spray drift from use sites onto non-target areas could potentially result in exposures of the CRLF, its prey and its habitat to chlorothalonil or SDS-3701 residues. As discussed in Section 4, SDS-3701 has been shown to be more toxic than chlorothalonil to birds and mammals and, therefore, potential risks from SDS-3701 were also assessed. Therefore, it is necessary to estimate the distance from the application site where spray drift exposures do not result in LOC exceedances for organisms within the terrestrial habitat. To account for this, first, the chlorothalonil application rate which does not result in an LOC exceedance is calculated for each terrestrial taxa of concern. The fraction of the application rate needed to reduce exposures to levels below LOCs was then calculated (1 / (RQ / LOC)), and AgDRIFT (Version 2.0, http://www.AgDRIFT.com/) was used to estimate the distance from the treated site associated with the spray drift fraction needed to reduce RQs to <LOC. LOCs used in the analysis were the endangered species LOC for acute effects (0.05 for aquatic animals; 0.1 for terrestrial animals) and the chronic LOC (1 for aquatic and terrestrial animals).

Table 2.7.2. Spraydrift Fraction Resulting in no LOC Exceedance for Terrestrial Animals for Chlorothalonil and SDS-3701

Direct/Indirect Effects to CRLF	Exposure	Cropland		Turf/Golf Course		Conifers/Forest	
		Highest RQ[a]	Fraction	Highest RQ[b]	Fraction	Highest RQ	Fraction
Direct (avian RQs)	**Acute** Chlorothalonil SDS-3701	N/A 5.1	N/A 2.0%	N/A 14	N/A 0.70%	N/A 7.5	N/A 1.3%
	Chronic Chlorothalonil SDS-3701	6.0 3.6	17% 28%	17 10	5.9% 10%	8.8 5.4	11% 19%
Indirect-mammals	**Acute** Chlorothalonil SDS-3701	N/A 1.2	N/A 8.3%	N/A 3.2	N/A 3.1	N/A 1.7	N/A 5.9
	Chronic Chlorothalonil SDS-3701	6.1 45	17% 2.2%	17 127	5.0% 0.78%	8.5 66	11% 1.5%
Indirect-Terrestrial Invertebrates	Acute Contact Exposures (**small insect**)	0.7	7.1%	2.1	2.4%	1.0	5%
	Acute Contact Exposures (**large insect**)	0.07	71%	0.23	22%	0.11	45%

N/A: Not applicable because RQs were not calculated
[a] RQ Calculations are presented in Section 5.
[b] Turf/golf course analysis was based on the sod farm RQ because the RQ for sod farms and golf courses were similar, but aerial applications for golf courses are unlikely to occur. Golf course EECs and RQs were approximately 15% higher than those for sod farms.

Table 2.7.2 indicates that the percent reduction needed to reduce EECs to levels below the LOC is greatest for the turf/golf course use (99.3%) followed by conifers/forest (98.7%), then cropland (98%). Distances from the treated site estimated using AgDRIFT associated with these reductions are in Table 2.7.3 below.

Table 2.7.3. Distances from the treated site estimated to result in no LOC exceedance

Use Site	Method of Application	Spray Drift Fraction Reduction	Distance Associated with Spray Drift Fraction (feet)
Cropland	Aerial	2%	480
Turf	Aerial	0.7%	2100
Conifers/Forest	Aerial	1.3%	830

The highest RQs used to define the distance from the treated site that resulted in LOC exceedance for terrestrial organisms were based on mammalian dose-based RQs for SDS-3701. There is considerable uncertainty in the SDS-3701 RQs due to uncertainties in the amount of this degradate that may form on food items of the CRLF. Therefore, there is considerable uncertainty in defining the action area. As indicated in Tables 2.7.2 and 2.7.3, spray drift deposition <0.7% would result in no LOC exceedance. AgDRIFT analysis indicated that distances of 2100 feet or greater would result in deposition <0.7%, resulting in no LOC exceedances. AgDRIFT was run using the Tier 3 aerial settings because the Tier 1 and Tier 2 settings do not allow for drift deposition estimates that exceed 1000 feet.

To understand the area potentially affected by the federal action due to spray drift from application areas, the landcovers where use sites occur are considered potential application areas. These areas are "buffered" using ArcGIS 9.1. In this process, the original landcover is modified by expanding the border of each polygon representing a field out to a designated distance, which in this case, is the distance estimated where chlorothalonil in spray drift does not exceed any LOCs. This effectively expands the action area relevant to terrestrial habitats so that it includes the area where direct or indirect effects could occur. For all chlorothalonil uses, the use areas were buffered using a distance of 2100 feet (Figure 2.7.2). Use of the 2100 foot buffer for all uses results in a conservative action area. For example, the highest RQ for agricultural cropland was 45 (chronic mammalian RQ for SDS-3701); therefore, LOCs would not be exceeded when distance from the treated area is sufficient to result in <2% spray drift deposition (approximately 480 feet). In addition, the EECs include spray drift for multiple applications. The spray drift buffer calculations assume that the wind direction and speed is the same for each application. Therefore, these buffers are considered to be somewhat conservative.

It is likely that exposure concentrations predicted with modeling are not uniform throughout the watershed, and portions of the action area may be below levels of concern. However, these areas cannot be definitively drawn on a map; therefore, the entire area described above includes all watersheds that drain to the action area.

Given the physico-chemical profile for chlorothalonil, the potential for long range transport outside of the defined action area cannot be precluded. However, these exposure concentrations are not expected to approach those predicted by modeling or levels expected to result in potential risks to non-target organisms (Section 3.2).

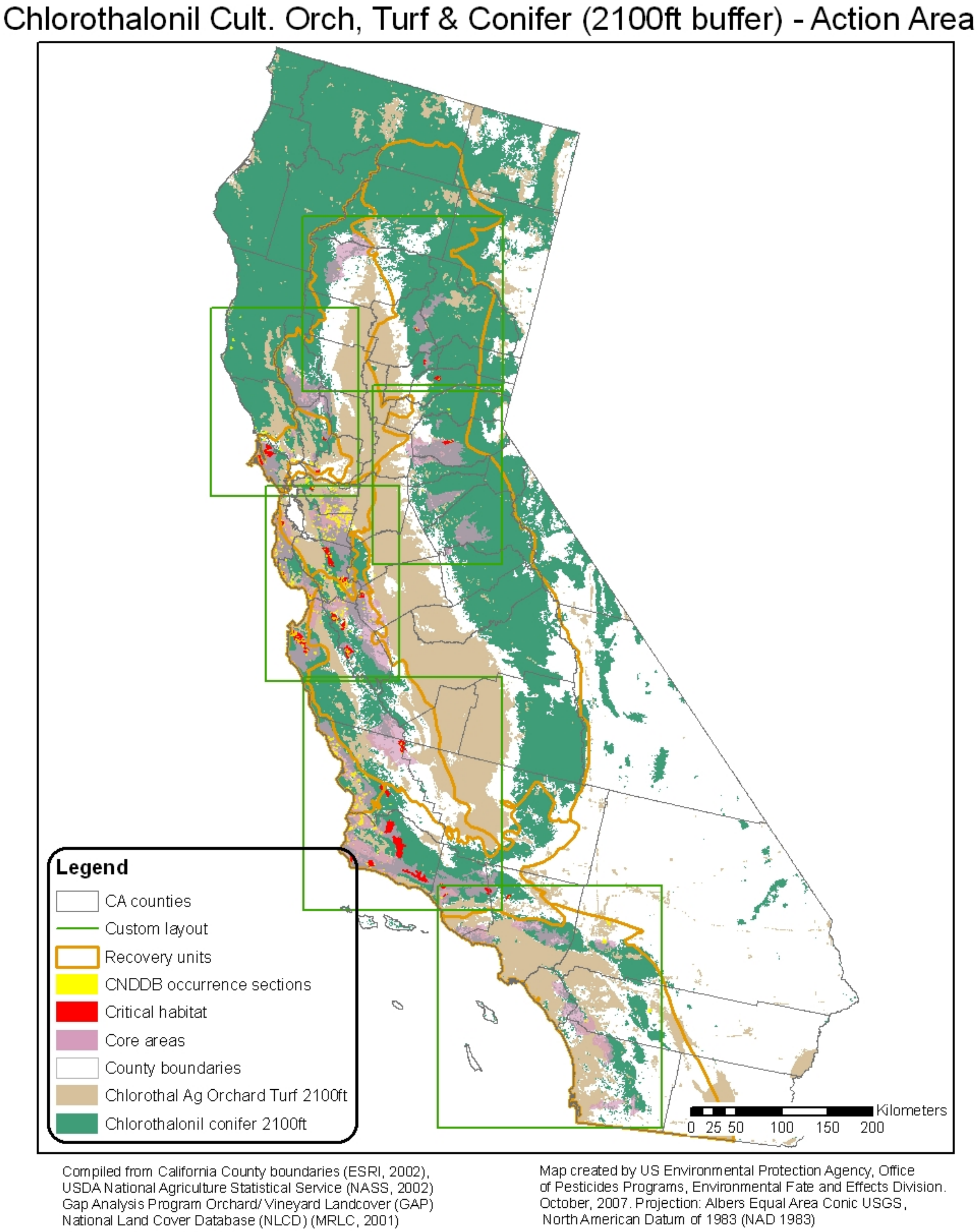


Figure 2.7.2. Action Area Map

2.8 Assessment Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected."[9] Selection of the assessment endpoints is based on valued entities (e.g., CRLF, organisms important in the life cycle of the CRLF, and the primary constituent elements (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).

2.8.1 Assessment Endpoints for the CRLF

Assessment endpoints for the CRLF include direct toxic effects on the survival, reproduction, and growth of the CRLF, as well as indirect effects, such as reduction of the prey base and/or modification of its habitat. In addition, potential modification of critical habitat is assessed by evaluating potential effects to PCEs, which are components of the habitat areas that provide essential life cycle needs of the CRLF. Each assessment endpoint requires one or more "measures of ecological effect," defined as changes in the attributes of an assessment endpoint or changes in a surrogate entity or attribute in response to exposure to a pesticide. Specific measures of ecological effect are generally evaluated based on acute and chronic toxicity information from registrant-submitted guideline tests that are performed on a limited number of organisms. Additional ecological effects data from the open literature are also considered.

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. A summary of the assessment endpoints and measures of ecological effect selected to characterize potential assessed direct and indirect CRLF risks associated with exposure to chlorothalonil is provided in Table 2.8.1.

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

Table 2.8.1 Summary of Assessment Endpoints and Measures of Ecological Effects for Direct and Indirect Effects of Chlorothalonil on the California Red-legged Frog

Assessment Endpoint	**Measures of Ecological Effects**[10]
Aquatic Phase (eggs, larvae, tadpoles, juveniles, and adults)[a]	
1. Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases	1a. Most sensitive fish acute LC_{50} 1b. Most sensitive fish chronic NOAEC
2. Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, fish, freshwater invertebrates, non-vascular plants)	2a. Most sensitive fish, aquatic invertebrate, and aquatic plant EC_{50} or LC_{50} 2b. Most sensitive aquatic invertebrate and fish chronic NOAEC
3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community)	3a. Vascular plant acute EC_{50} 3b. Non-vascular plant acute EC_{50}
4. Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation, required to maintain acceptable water quality and habitat in ponds and streams comprising the species' current range.	4a. Tier I seedling emergence and vegetative vigor EC_{25}[11]
Terrestrial Phase (Juveniles and adults)	
5. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles[d]	5a. Most sensitive bird[b] LC_{50} and LD_{50} 5b. Most sensitive bird[b] reproduction NOAEC
6. Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial vertebrates - including mammals and terrestrial phase amphibians) [d]	6a. Most sensitive terrestrial invertebrate and vertebrate acute LD_{50}, EC_{50} and LC_{50}[c] 6b. Most sensitive terrestrial invertebrate and vertebrate chronic NOAEC (guideline or ECOTOX)
7. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian vegetation)	7a. Tier I seedling emergence and vegetative vigor EC_{25}

[a] Adult frogs are no longer in the "aquatic phase" of the amphibian life cycle; however, submerged adult frogs are considered "aquatic" for the purposes of this assessment because exposure pathways in the water are considerably different that exposure pathways on land.
[b] Birds are used as surrogates for terrestrial phase amphibians.
[c] Although the most sensitive toxicity value is initially used to evaluate potential indirect effects, sensitivity distribution is used (if sufficient data are available) to evaluate the potential impact to food items of the CRLF.
[d] Potential risks from chlorothalonil and SDS-3701 were evaluated for mammals and terrestrial amphibians given the elevated toxicity of SDS-3701 relative to chlorothalonil.

[10] All registrant-submitted and open literature toxicity data reviewed for this assessment are included in Appendix B. Effects data used in risk estimation are included in Section 4.

[11] The available information indicates that the California red-legged frog does not have any obligate relationships with any particular plant species; therefore, EC25 values were used to evaluate potential indirect effects resulting from potential impacts to aquatic or terrestrial plants.

2.8.2 Assessment Endpoints for Designated Critical Habitat

As previously discussed, designated critical habitat is assessed to evaluate actions related to the use of chlorothalonil that may alter the PCEs of the CRLF's critical habitat. PCEs for the CRLF were previously described in Section 2.6. Actions that may destroy or adversely modify critical habitat are those that alter the PCEs. 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 and measures of ecological effect selected to characterize potential modification to designated critical habitat associated with exposure to chlorothalonil are provided in Table 2.8.2. Adverse modification to the critical habitat of the CRLF includes the following, as specified by USFWS (2006) and previously discussed in Section 2.6:

1. Alteration of water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs.
2. Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs.
3. Significant increase in sediment deposition within the stream channel or pond or disturbance of upland foraging and dispersal habitat.
4. Significant alteration of channel/pond morphology or geometry.
5. Elimination of upland foraging and/or aestivating habitat, as well as dispersal habitat.
6. Introduction, spread, or augmentation of non-native aquatic species in stream segments or ponds used by the CRLF.
7. Alteration or elimination of the CRLF's food sources or prey base.

Measures of such possible effects by labeled use of chlorothalonil on critical habitat of the CRLF are described in Table 2.8.2. 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. Assessment endpoints used for the analysis of designated critical habitat are based on the adverse modification standards established by USFWS (2006).

Table 2.8.2 Summary of Assessment Endpoints and Measures of Ecological Effect for Primary Constituent Elements of Designated Critical Habitat

<table>
<tr><th>Assessment Endpoint</th><th>Measures of Ecological Effect[12]</th></tr>
<tr><td colspan="2">Aquatic Phase PCEs
(Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)</td></tr>
<tr><td>Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.</td><td>a. Most sensitive aquatic plant EC_{50}
b. Tier I seedling emergence and vegetative vigor EC_{25}</td></tr>
<tr><td>Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.</td><td>a. Most sensitive EC_{50} values for aquatic plants
b. Tier I seedling emergence and vegetative vigor EC_{25}</td></tr>
<tr><td>Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.</td><td>a. Most sensitive fish, plant, and aquatic invertebrateEC_{50} and LC_{50} values
b. Most sensitive NOAEC values for fish and aquatic invertebrates</td></tr>
<tr><td>Reduction and/or modification of aquatic-based food sources for pre-metamorphose (e.g., algae)</td><td>a. Most sensitive aquatic plant EC_{50}</td></tr>
<tr><td colspan="2">Terrestrial Phase PCEs
(Upland Habitat and Dispersal Habitat)</td></tr>
<tr><td>Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance</td><td rowspan="4">a. Tier I seedling emergence and vegetative vigor EC_{25} for monocots and dicots.

b. Most sensitive direct effects (bird) LC_{50}, LD_{50}, and NOAEC and most sensitive food source EC_{50}/LC_{50} and NOAEC values (terrestrial vertebrates (mammals), invertebrates, and birds (surrogate for terrestrial amphibian food items).</td></tr>
<tr><td>Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal</td></tr>
<tr><td>Reduction and/or modification of food sources for terrestrial phase juveniles and adults</td></tr>
<tr><td>Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.</td></tr>
</table>

[12] All toxicity data reviewed for this assessment are included in Appendix B.

2.9 Conceptual Model

2.9.1 Risk Hypotheses

Risk hypotheses are specific assumptions about potential adverse effects (i.e., changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (U.S. EPA, 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 for this endangered species assessment:

- Labeled uses of chlorothalonil within the action area may directly affect the CRLF by causing mortality or by adversely affecting growth or fecundity;
- Labeled uses of chlorothalonil within the action area may indirectly affect the CRLF by reducing or changing the composition of food supply;
- Labeled uses of chlorothalonil within the action area may indirectly affect the CRLF or modify designated critical habitat by reducing or changing the composition of the aquatic plant community in the ponds and streams comprising the species' current range and designated critical habitat, thus affecting primary productivity and/or cover;
- Labeled uses of chlorothalonil within the action area may indirectly affect the CRLF or modify designated critical habitat by reducing or changing the composition of the terrestrial plant community (i.e., riparian habitat) required to maintain acceptable water quality and habitat in the ponds and streams comprising the species' current range and designated critical habitat;
- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by reducing or changing breeding and non-breeding aquatic habitat (via modification of water quality parameters, habitat morphology, and/or sedimentation);
- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by reducing the food supply required for normal growth and viability of juvenile and adult CRLFs;
- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by reducing or changing upland habitat within 200 ft of the edge of the riparian vegetation necessary for shelter, foraging, and predator avoidance.
- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by reducing or changing dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.
- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by altering chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs.

2.9.2 Diagram

The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the stressor (chlorothalonil), release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for aquatic and terrestrial phases of the CRLF are shown in Figures 2.9.1 and 2.9.2, and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in Figures 2.9.3 and 2.9.4. Exposure routes shown in dashed lines are not quantitatively considered because the resulting exposures are expected to be low such that they are not expected to measurably contribute to potential adverse effects to the CRLF.

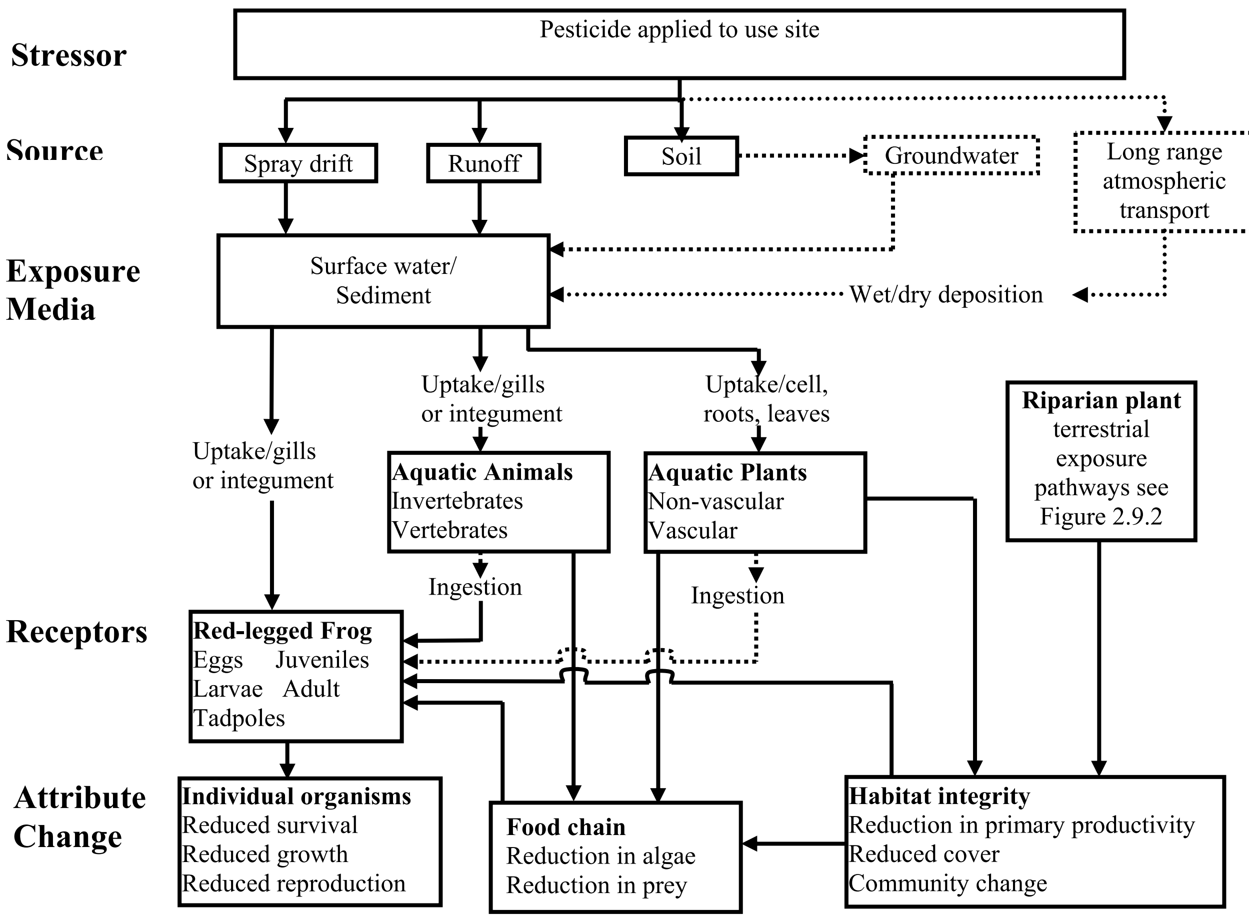


Figure 2.9.1. Conceptual model for chlorothalonil effects on aquatic phase of the red-legged frog.

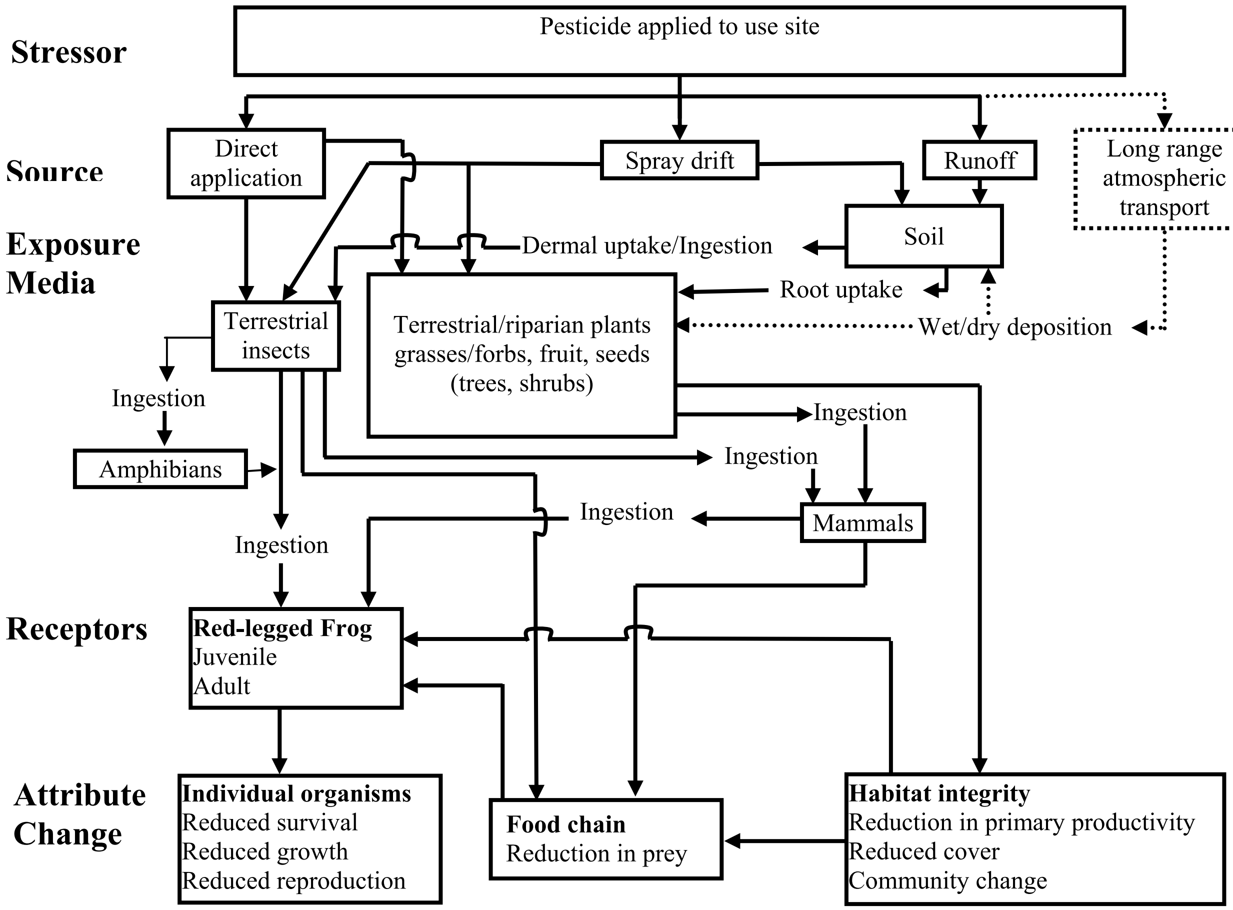


Figure 2.9.2. Conceptual model for chlorothalonil effects on terrestrial phase of the red-legged frog.

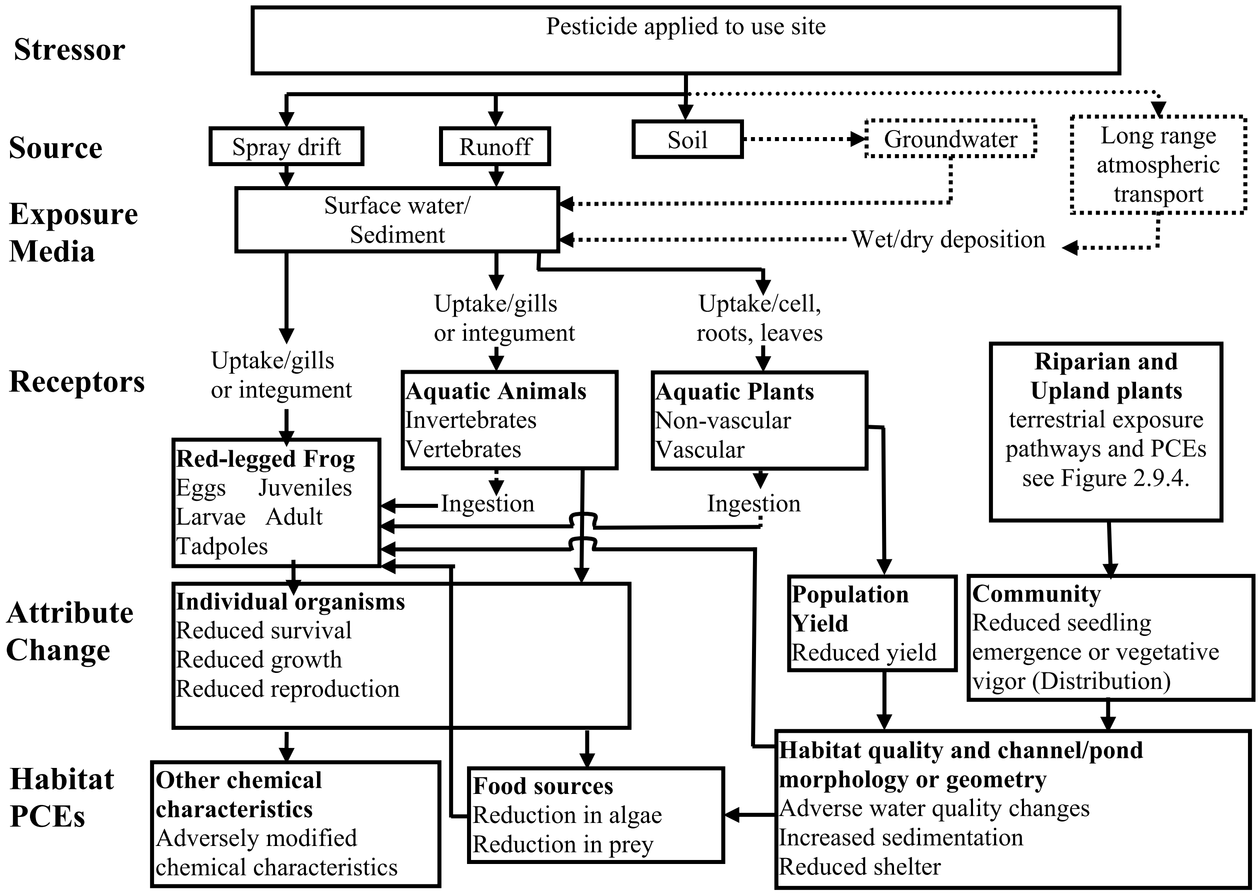


Figure 2.9.3. Conceptual Model for Chlorothalonil Effects on Aquatic Component of Red-Legged Frog Critical Habitat.

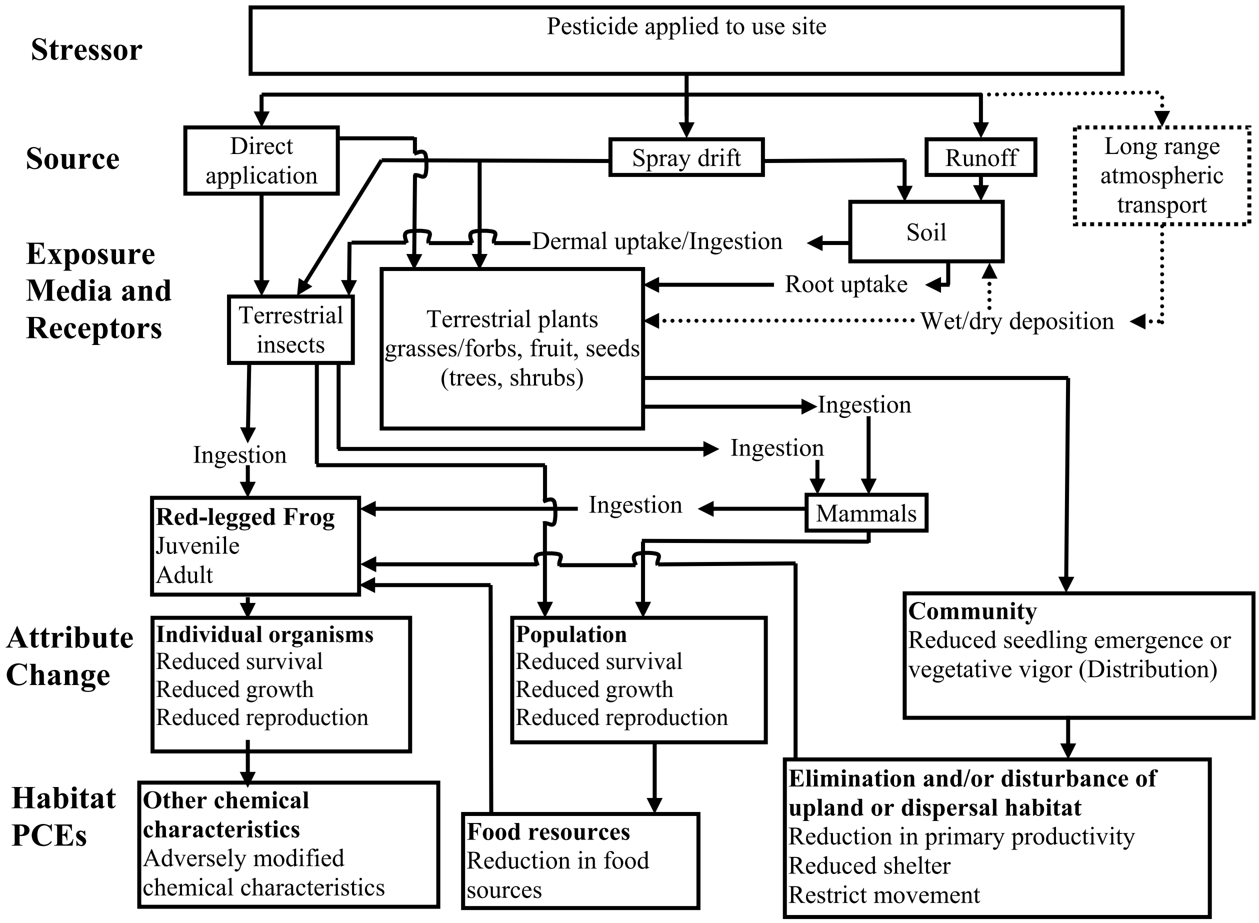


Figure 2.9.4. Conceptual Model for Chlorothalonil Effects on Terrestrial Component of the Red-Legged Frog Critical Habitat.

2.10 Analysis Plan

In order to address the risk hypothesis, the potential for adverse effects on the CRLF, its prey, and its habitat are estimated. 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.

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 are based on an action area. The action area is considered to be the area directly or indirectly affected by the federal action, as indicated by the exceedance of Agency Levels of Concern (LOCs) used to evaluate direct or indirect effects. 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 CRLF and its designated critical habitat within the state of California.

In this endangered species assessment, direct and indirect effects to the CRLF and potential modification to its critical habitat are evaluated in accordance with the methods (both baseline and species-specific refinements, when appropriate) described in the Agency's Overview Document (U.S. EPA 2004).

2.10.1 Analysis of Toxicity

Data identified in Section 2.8 are used as measures of effect for direct and indirect effects to the CRLF. Analysis of potential sensitivity of the CRLF and organisms on which it depends for survival or reproduction is evaluated using the most sensitive available acute and chronic endpoints reported from either registrant submitted studies or the open literature. Open literature was searched using The ECOTOXicology database (ECOTOX). ECOTOX is a source for locating single chemical toxicity data for aquatic life, terrestrial plants, and wildlife. ECOTOX was created and is maintained by the USEPA, Office of Research and Development, and the National Health and Environmental Effects Research Laboratory's Mid-Continent Ecology Division (ECOTOX, 2006).

For acute effects, the most sensitive reliable acute EC_{50}/ LC_{50} from the available submitted and open literature studies are used. For chronic effects, the most sensitive NOAEC from submitted reproduction and life-cycle studies and the open literature are used. The open literature contains numerous studies. Only studies that produced reliable toxicity values that are based on toxicological endpoints that are directly correlated with survival or reproduction of the CRLF were used for RQ calculations.

The assessment of risk for direct effects to the CRLF makes the assumption that toxicity of chlorothalonil to birds is similar to terrestrial-phase CRLF. The same assumption is made for fish and aquatic-phase CRLF.

Potential sensitivity of species on which the CRLF depend for survival and reproduction (invertebrates, aquatic and terrestrial plants, fish, mammals, and other amphibians) is also evaluated using the most sensitive acute and chronic toxicity value from the most sensitive species tested. If LOCs are exceeded based on the most sensitive toxicity value, then other factors, including the potential magnitude of effect and the biology and behavior of the assessed species, are considered in the effects determination.

2.10.2. Analysis of Exposure

The environmental fate properties of chlorothalonil suggest that runoff and spray drift represent the dominant potential transport mechanisms of chlorothalonil to the aquatic and terrestrial habitats of the CRLF. In this assessment, transport of chlorothalonil through runoff and spray drift is considered in deriving quantitative estimates of chlorothalonil exposure to CRLF, its prey, and its habitats.

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. 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 T-REX and AgDRIFT. In addition, differences in dietary behaviors such as food intake levels and food items of terrestrial phase amphibians and birds were evaluated using T-HERPS.

PRZM (v3.12beta, May 24, 2001) and EXAMS (v2.98.04, Aug. 18, 2002) are screening simulation models coupled with the input shell pe4v01.pl (Aug.8, 2003) to generate daily exposures and 1-in-10 year EECs of chlorothalonil that may occur in surface water bodies adjacent to application sites receiving chlorothalonil through runoff and spray drift. PRZM simulates pesticide application, movement and transformation on an agricultural field and the resultant pesticide loadings to a receiving water body via runoff, erosion and spray drift. EXAMS simulates the fate of the pesticide and resulting concentrations in the water body. The standard scenario used for ecological pesticide assessments assumes application to a 10-hectare agricultural field that drains into an adjacent 1-hectare water body that is 2 meters deep (20,000 m^3 volume) with no outlet. PRZM/EXAMS is used to estimate screening-level exposure of aquatic organisms to chlorothalonil. The measure of exposure for aquatic species is the 1-in-10 year return peak or rolling mean concentration. The 1-in-10 year peak is used for estimating acute exposures of direct effects to the CRLF, as well as indirect effects to the CRLF through effects to potential prey items, including: algae, aquatic invertebrates, fish and frogs. The 1-in-10-year 60-day mean is used for assessing chronic exposure to the CRLF and fish and frogs serving as prey items. The 1-in-10-year 21-day mean is used for assessing aquatic invertebrate chronic exposure, which are also potential prey items.

Exposure estimates for terrestrial phase CRLF and terrestrial invertebrates and mammals (serving as potential prey) assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX model (version 1.3.1, 12/07/2006). This model incorporates the Kenega nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph approximate a 95th percentile residue value from field measurements (Hoerger and Kenega, 1972). The Fletcher *et al.* (1994) modifications to the Kenega nomograph are based on measured field residues from 249 published research papers, including information on 118 species of plants, 121 pesticides, and 17 chemical classes.

For modeling purposes, direct exposures of the CRLF to chlorothalonil through contaminated food are estimated using the EECs for the small bird (20 g) which consumes small insects. Dietary-based and dose-based exposures of potential prey (small mammals) are assessed using the small mammal (15 g) which consumes short grass. The small bird (20g) consuming small insects and the small mammal (15g) consuming short grass are used because these categories represent the largest (most conservative) RQs of the size and dietary categories in T-REX that are appropriate surrogates for the CRLF and of its terrestrial prey items. Estimated exposures to terrestrial insects to chlorothalonil are bound by using estimated residue levels on small insects and large insects.

A spray drift model, AgDRIFT was used to assess exposures of terrestrial phase CRLF and its prey to chlorothalonil deposited on terrestrial habitats by spray drift. AgDRIFT (version 2.01; dated 5/24/2001) was used to estimate the distance from the treated areas spray drift levels could result in potential effects.

2.10.3. Analysis of Risk

Risk characterization is the integration of exposure and ecological effects characterization to determine the potential ecological risk from the labeled use of chlorothalonil and the potential of direct and indirect effects to CRLF 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. For the assessment of chlorothalonil risks, 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 Table 2.10.1). These criteria are used to indicate when chlorothalonil uses, as directed on the label, have the potential to cause adverse direct or indirect effects to the CRLF.

Table 2.10.1. Agency risk quotient (RQ) metrics and levels of concern (LOC) per risk class.

Risk Class	Description	RQ	LOC
Aquatic Habitats			
Acute Listed Species	CRLF may be potentially directly affected or indirectly affected via reduction in animal prey (i.e. invertebrates, fish and aquatic-phase amphibians).	Peak EEC/EC_{50}[1]	0.05
Acute Non-Listed Species	CRLF may be potentially directly affected or indirectly affected via reduction in animal prey (i.e. invertebrates, fish and aquatic-phase amphibians).	Peak EEC/EC_{50}[1]	0.5
Chronic Listed and Non-Listed Species	Potential for chronic risk to CRLF through direct or indirect effects. Indirect effects represented by effects to invertebrates, fish or amphibians, which represent potential prey.	60-day EEC/NOEC (CRLF) 21-day EEC/NOEC (invertebrates)	1
Non-Listed	Potential indirect effects to the CRLF may occur via reduction in aquatic plant abundance.	Peak EEC/ EC_{50}	1
Terrestrial Habitats			
Acute Listed Species	CRLF may be potentially directly affected or indirectly affected via reduction in terrestrial animal prey (i.e. mammals and terrestrial phase amphibians).	Dietary EEC [2]/LC_{50} Or Dose EEC [2]/LD_{50}	0.1
Acute Listed Species	CRLF may be potentially directly affected or indirectly affected via reduction in animal prey (i.e. invertebrates).	EEC [2]/LD_{50}	0.05
Acute Non-Listed Species	CRLF may be potentially affected by use by indirect effects through effects to terrestrial animal prey (i.e. mice and terrestrial-phase amphibians).	Dietary EEC [2]/LC_{50} Or Dose EEC [2]/LD_{50}	0.5
Chronic Listed Species	Potential for chronic risk to CRLF through direct or indirect effects. Indirect effects represented by effects to small mammals and terrestrial amphibians, which represent potential prey.	EEC [2]/NOAEC	1
Non-Listed	Potential for indirect effects to CRLFs may occur via changes or reduction in terrestrial plant community.	Peak EEC/ EC_{25}	1

[1] LC_{50} or EC_{50}.
[2] Based on upper-bound Kenaga values.

As part of the effects determination, the Agency will reach one of the following three conclusions regarding the potential for FIFRA regulatory actions regarding chlorothalonil to directly or indirectly affect CRLF individuals or result in modification of designated critical habitat:

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

If the results of the initial baseline assessment show no LOC exceedances to the CRLF or any species on which it may depend for survival or reproduction, a "no effect" determination is made for the FIFRA regulatory action. If, however, LOC exceedances suggest that potential direct or indirect effects to individuals are anticipated and/or effects may impact the PCEs of the designated critical habitat, the Agency concludes a preliminary "may affect" determination for the FIFRA regulatory action regarding chlorothalonil.

If a determination is made that use of chlorothalonil within the action area(s) "may affect" individual CRLFs and/or designated critical habitat, additional information is considered to refine the potential for exposure at the predicted levels and for effects to the assessed species and other taxonomic groups upon which these species depend. Additional information including further evaluation of the potential impact of chlorothalonil on the PCEs is also used to determine whether modification of designated critical habitat may occur. Based on the refined information, the Agency uses the best available information to distinguish those actions that "may affect, but are not likely to adversely affect" ("NLAA") from those actions that are "likely to adversely affect" ("LAA") the CRLF or PCEs of designated critical habitat. This information is presented as part of the Risk Characterization in Section 5.

3. Exposure Assessment

3.1 Label Application Rates and Intervals

Chlorothalonil maximum allowable application rates and intervals between applications have been taken from current, Agency approved product labels (Table 3.1.1). Several agricultural uses were not modeled. For example, registered use on strawberries only covers a post-harvest dip product, which is not expected to contribute to environmental surface or ground water concentrations. Approved labels also allow chlorothalonil to be used on both parsnips and soybeans. However, only limited acreage is planted in these crops within California, and available CAL PUR data does not report chlorothalonil use on either parsnips or soybeans from 2000 through 2005. With labeled application rates not exceeding rates for assessed crops, any limited acreage will be encompassed by modeling carrots and snap beans. California climate allows both an early and a late cropping period for some vegetables. In order to minimize pest pressures, both an early and late crop are not normally grown in a single year at the same location. For this assessment, they were modeled separately.

Table 3.1.1. Chlorothalonil Labeled Application Information

Crop	Application Rate (lb. a.i./acre)	Number of Applications	Application Interval (days)
Asparagus [2]	3.0	3	14
Snap Beans [1] (early)	2.25	4	7
Snap Beans [1] (late)	2.25	4	7
Dry Beans [1] (early)	1.5	4	7
Dry Beans [1] (late)	1.5	4	7
Blueberry [1]	3.0	3	10
Carrot [1] (early)	1.5	10	7
Carrot [1] (late)	1.5	10	7
Celery [1] (early)	2.25	7	7
Celery [1] (late)	2.25	7	7
Cole Crops [1] (early)	1.5	8	7
Cole Crops [1] (late)	1.5	8	7
Conifers [1]	4.1	4	7
Corn [1] (sweet and seed)	1.5	6	7
Cucurbit Foliage [1]	6.25 and 2.25	1 and 12	7
Filbert, Almond, Pistachio[1]	3.0	6	14
Golf Course Greens [2]	11.3 or 7.3	6 or 10	14 or 7
Golf Course Tees [2]	11.3 or 7.3	4 or 7	14 or 7
Golf Course Fairways [2]	11.3 and 7.3	1 and 2	7
Golf Course Roughs [2]	11.3 and 7.3	1 and 2	7
Grass Grown for Seed [2]	1.5	3	14
Ornamentals	1.55	23	7
Roses	1.1	33	7
Pachysandra (low boxwood)	3.1	11	7
Onion (bulb)	2.25	6	7
Garlic	2.25	7	7
Green Onion, Shallot, Onion Grown for Seed	2.25	3	7
Passion Fruit and Mango	1.5	5	14
Peanut	1.1	8	14
Potato	1.1	10	5
Sod Farm	11.3 and 7.3	1 and 2	7
Stone Fruit, Including Cherries	3.1	5	10
Tomato	2.15	7	7
Turf (general)	11.3	2	7

[1] aerial application [2] ground spray application

3.2 Aquatic Exposure Assessment

3.2.1 Modeling Approach

The EECs (Environmental Effects Concentrations) were calculated using the EPA Tier II PRZM (Pesticide Root Zone Model) and EXAMS (Exposure Analysis Modeling System). 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.

The most recent PRZM/EXAMS linkage program (PE4-PL, version 01) was used for all surface water simulations. Linked crop-specific scenarios and meteorological data were used to estimate exposure resulting from use on crops and turf. Simulations were conducted using the Standard Ecological Pond scenario in EXAMS. Additional information is included in Appendix D.

3.2.2 Modeling Inputs

The aqueous model predictions are based on maximum labeled application rates, date of application, and the chemical, physical and environmental fate properties for chlorothalonil. Scenarios developed specifically for this CRLF assessment and a California turf scenarios developed for a previous organophosphate cumulative assessment have been used to estimate surface water concentrations. Where two cropping periods are possible in a single year, the scenarios that were used were modified by advancing the crop emergence, maturation, and harvest dates by six months, while allowing all other scenario parameters to remain the same. This insures that chlorothalonil would not be modeled using a scenario with an application date that would allow application to bare ground, as would be appropriate only for pre-emergence pesticides.

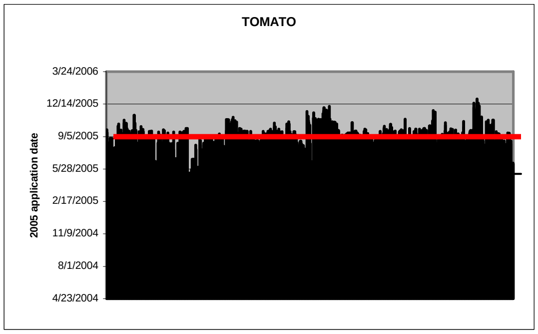
Application dates for aquatic modeling (Table 3.2.2) were chosen using the California meteorological data for chosen scenarios and 2005 CDPR PUR usage data[13] for chlorothalonil applications (Figure 3.2.3.). The data were downloaded from the web site, and sorted by crops modeled for this assessment. The sorted data was then plotted with Excel as a bar graph, with the x-axis of the plot representing the individual applications, and the y-axis being the reported application date. A visual examination of the resulting plots was conducted to assist in choosing an application date for the Tier 2, aquatic modeling.

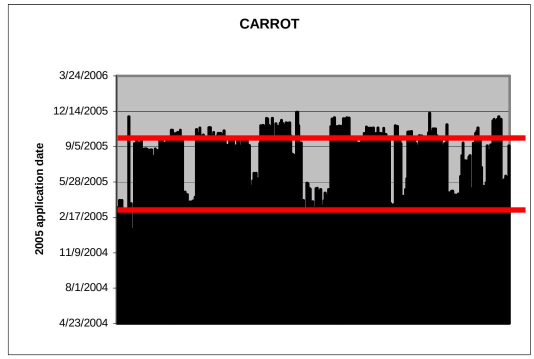
Except for crops grown in desert areas of California where irrigation is essential, agricultural crops that have more than one cropping season per year in California were modeled with both early and late cropping dates. Crops grown in California deserts are not expected to produce surface water contamination due to pesticide transport through

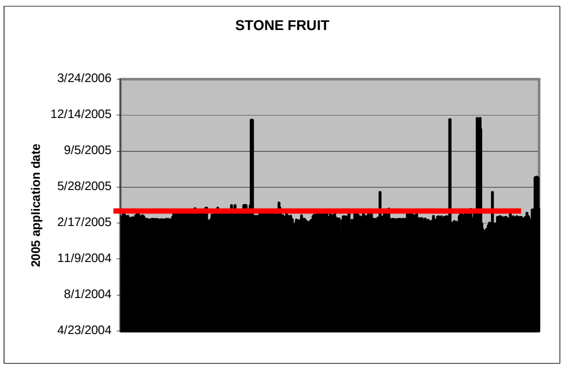
[13] The California Department of Pesticide Regulation's Pesticide Use Reporting database provides a census of pesticide applications in the state. See http://www.cdpr.ca.gov/docs/pur/purmain.htm.

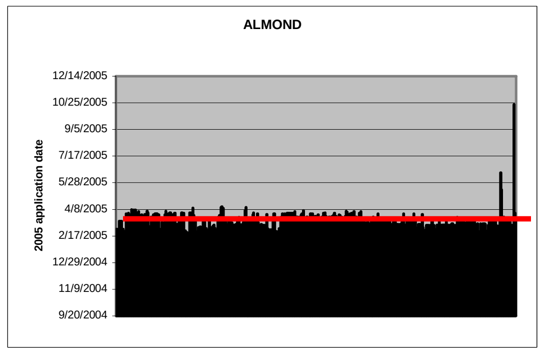
storm water run off, and have not been considered here. It is expensive for farmers to irrigate desert grown crops, and it is unlikely that farmers would bear the unnecessary expense of irrigating fields until they reach the point of run off. Modeled early and late season crops considered in this assessment were: beans, carrots, celery, green and bulb onions, and cole crops. The February 28, 2007 BEAD memo (U.S. EPA, 2007) outlining the maximum number of crop cycles per year in California for various use sites was consulted to determine which crops would have more than one cropping period per year. Additionally, the plotted 2005 Pesticide Use Report Data[14], used to choose an application date was also employed to further validate information in the BEAD memo.

[14] http://calpip.cdpr.ca.gov/cfdocs/calpip/prod/main.cfm


TOMATO
2005 application date
3/24/2006
12/14/2005
9/5/2005
5/28/2005
2/17/2005
11/9/2004
8/1/2004
4/23/2004


CARROT
2005 application date
3/24/2006
12/14/2005
9/5/2005
5/28/2005
2/17/2005
11/9/2004
8/1/2004
4/23/2004


STONE FRUIT
2005 application date
3/24/2006
12/14/2005
9/5/2005
5/28/2005
2/17/2005
11/9/2004
8/1/2004
4/23/2004


ALMOND
2005 application date
12/14/2005
10/25/2005
9/5/2005
7/17/2005
5/28/2005
4/8/2005
2/17/2005
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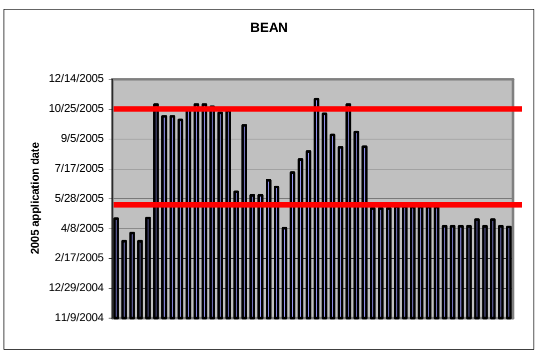
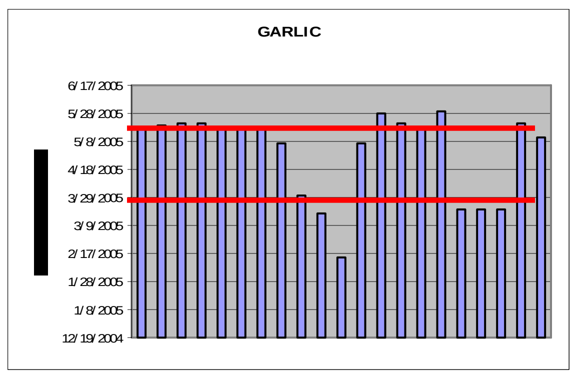
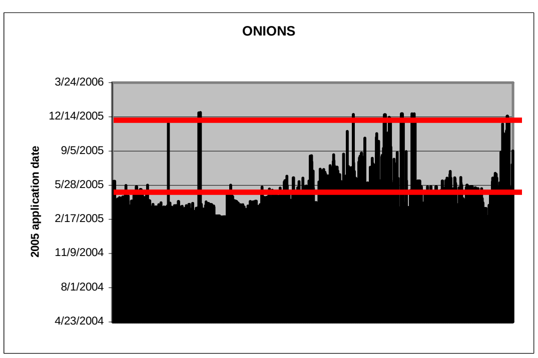
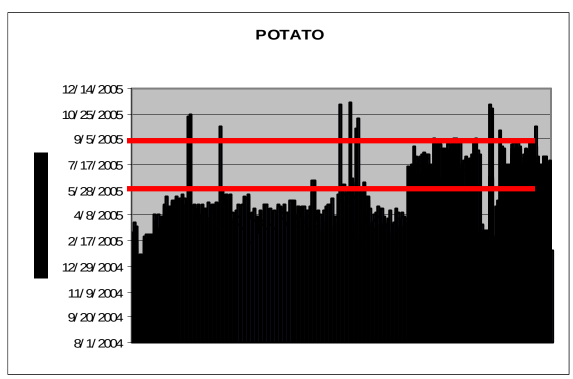
11/9/2004
9/20/2004


BEAN
2005 application date
12/14/2005
10/25/2005
9/5/2005
7/17/2005
5/28/2005
4/8/2005
2/17/2005
12/29/2004
11/9/2004


GARLIC
6/17/2005
5/28/2005
5/8/2005
4/18/2005
3/29/2005
3/9/2005
2/17/2005
1/28/2005
1/8/2005
12/19/2004


ONIONS
2005 application date
3/24/2006
12/14/2005
9/5/2005
5/28/2005
2/17/2005
11/9/2004
8/1/2004
4/23/2004


POTATO
12/14/2005
10/25/2005
9/5/2005
7/17/2005
5/28/2005
4/8/2005
2/17/2005
12/29/2004
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9/20/2004
8/1/2004

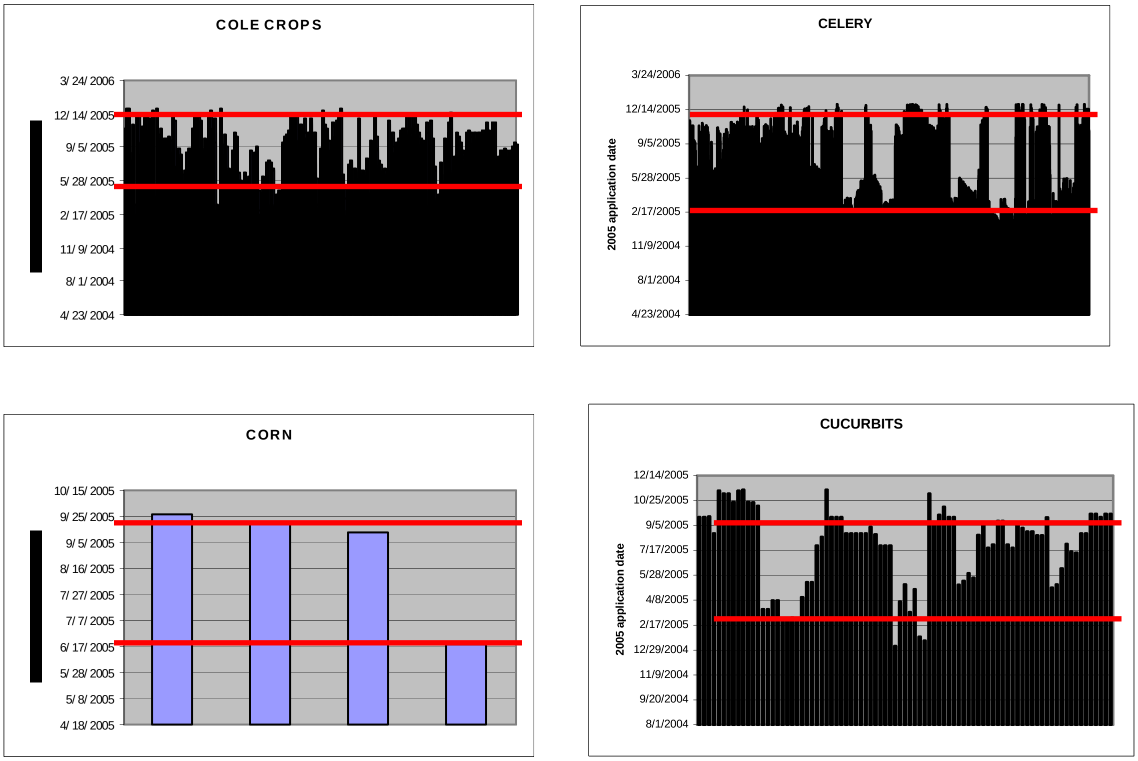

Figure 3.2.2. Plotted 2005 California Use Dates

Table 3.2.2. Chlorothalonil Tier 2 Aquatic Modeling Scenarios and Application Dates

Crop	PRZM/EXAMS Scenario	First Application Date
Asparagus [2]	CARowCrop no_irrig	March 1
Snap Beans [1] (early)	CARowCrop no_irrig	March 7
Snap Beans [1] (late)	CARowCropLate no_irrig	October 1
Dry Beans [1] (early)	CARowCrop no_irrig	March 7
Dry Beans [1] (late)	CARowCropLate no_irrig	October 1
Blueberry [1]	CAWineGrapes no_irrig	April 1
Carrot (early) [1]	CARowCrop no_irrig	March 1
Carrot (late) [1]	CARowCropLate no_irrig	September 15
Celery (early) [1]	CARowCrop no_irrig	January 15
Celery (late) [1]	CARowCropLate no_irrig	September 15
Cole Crops (early) [1]	CAColeCrop_noirrig	February 1
Cole Crops (late) [1]	CAColeCrop_noirrig	July 2
Conifers [1]	ORXmasTreeC	October 1
Corn [1] (sweet and seed)	CAcornOP	May 1
Cucurbit [1]	CAmellons no_irrig	May 15
Filbert, Almond, Pistachio[1]	CAalmond_Nirrig	March 1
Golf Course Turf [2]	CAturf_noirrig	January 3
Grass Grown for Seed [2]	CAturf_noirrig	January 3
Ornamentals [2]	CANursery no_irrig	March 15
Roses [2]	CANursery no_irrig	March 15
Pachysandra [2] (low boxwood)	CANursery no_irrig	March 15
Onion [1] (bulb)	CAonion no_irrig	February 1
Garlic [1]	CAgarlic no_irrig	March 20
Green Onion, Shallot, Onion Grown for Seed [1]	CAonion no_irrig CAonionLate no_irrig	February 1 September 9
Passion Fruit and Mango [1]	CAcitrus_Nirrig	February 15
Peanut [1]	CAPotato_noirrig	May 15
Potato [1]	CAPotato_noirrig	February 17
Sod Farm [2]	CAturf_noirrig	January 3
Stone Fruit, Including Cherries [1]	CAfruit_Nirrig	March 1
Tomato [1]	CAtomato_Nirrig	July 24
Turf [1] (general)	CAturf_Noirrig	November 1

[1] aerial application [2] ground spray application

3.2.3. Selecting Chemical Specific Input Parameters

The appropriate PRZM and EXAMS input parameters for chlorothalonil 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 II, February 28, 2002). The environmental fate data used to estimate the modeling input values appear in Table 3.2.3.

Table 3.2.3. Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs[1] for the California Red Legged Frog Assessment

Fate Property	Value	MRID (or source)
Molecular Weight	**265.91 amu**	Chlorothalonil RED, EPA 738-R-99004, April, 1999
Henry's constant at 20 °C	**2.6 x 10^{-7} atm - m^3/mole**	Chlorothalonil RED, EPA 738-R-99004, April, 1999
Vapor Pressure at 26 °C	**5.7 x 10^{-7} torr**	MRID 00153732
Solubility in Water at 25 °C	**0.8 mg/L**	Chlorothalonil RED, EPA 738-R-99004, April, 1999
Photolysis in Water	10 hours (**0.4 days**)	MRIDs 45710223, (40183418)
Aerobic Soil Metabolism	**71 days** (90% upper bound on mean of 68, 24, 22 and 24 days; 35.4 + ((3.2 x 22.4)/sqrt 4)	MRID 00087351
Hydrolysis	**stable** @ pH =5 and 7	MRID 0040539
Aerobic Aquatic Metabolism (water column)	**35.2 days** (90% upper bound on mean of 13, 21 and 2.5 days; 12.2 + ((4.3 x 9.36)/sqrt 3)	MRID 45908001, (42226101)
Anaerobic Aquatic Metabolism (benthic)	**15 days** (range 5 to 15 days reported)	MRID 00147975
K_d	**19.5**	MRID 00115105
Application Efficiency	0.95 percent (0.99 percent)	EFED Guidance for aerial (ground) application
Spray Drift Fraction	0.05 percent (0.01 percent)	EFED Guidance for aerial (ground) application

[1] – Inputs determined in accordance with EFED "*Guidance for Chemistry and Management Practice Input Parameters for Use in Modeling the Environmental Fate and Transport of Pesticides*" dated February 28, 2002

3.2.4 Results

Aquatic EECs are presented in Table 3.2.4. Turf uses, golf course, sod farms and general turf uses, along with chlorothalonil uses for ornamental crops produced the highest estimated environmental concentrations (EECs). When there is more than one cropping period a year, late season crops generally produced EECs about 20% higher than the early season crops. Cole crops were the exception, with earlier crops producing EECs that were about 20% higher than EECs for the late cropping period.

Table 3.2.4. Tier II Estimated Aquatic Estimated Environmental Concentration (EECs) of Chlorothalonil

Crop	App Rate (lb. a.i./acre)	No of App/ App Interval (days)	1-in-10-Year Annual Exceedance Probability		
			Peak EEC (ppb)	21-day EEC (ppb)	60-day EEC (ppb)
Asparagus	3.0	3 / 14	28.8	23.8	18.0
Early Snap Beans	2.25	4 / 7	31.7	26.2	19.5
Late Snap Beans	2.25	4 / 7	38.5	30.0	23.3
Early Dry Beans	1.5	4 / 7	21.1	17.5	13.0
Late Dry Beans	1.5	4 / 7	25.6	20.0	13.1
Blueberry	3.0	3 / 10	23.9	19.4	14.4
Early Carrots	1.5	10 / 7	31.0	26.2	23.4
Late Carrots	1.5	10 / 7	65.1	53.0	43.0
Early Celery	2.25	7 / 7	63.3	51.6	42.0
Late Celery	2.25	7 / 7	68.7	54.5	41.4
Early Cole Crops	1.5	8 / 7	63.6	53.1	41.7
Late Cole Crops	1.5	8 / 7	52.8	41.7	30.2
Conifers	4.1	4 / 7	18.8	16.0	12.0
Corn	1.5	6 / 7	21.5	17.9	12.6
Cucurbit	6.25 plus 2.25[15]	1 plus 4[16] / 7	27.8	23.2	17.9
Filberts, Almonds, Pistachios	3.0	6 / 12	29.0	23.6	17.5
Total Golf Course Turf (adjusted)[17]	11.3 plus 7.3[18]	1 or 2 plus 2, 4 or 7[19] /7	279	262	148
Grass Grown for Seed or Hay	1.5	3 / 14	29.5	21.5	12.4
Sod Farms	11.3 plus 7.3[20]	1 plus 2[21] / 7	274	260	146
General Turf	11.3	2 / 7	115	90.2	61.6
Ornamentals	1.55	23 / 7	139	114	72.7
Roses	1.1	33 / 7	108	83.3	53.3
Pachysandra	3.1	11 / 7	121	96.7	66.6
Bulb Onions	2.25	6 / 7	32.5	25.2	19.4
Garlic	2.25	7 / 7	35.4	31.7	25.8
Early Green, Shallot, Seed Onions	2.25	3 / 7	19.6	15.2	10.9
Late Green, Shallot, Seed Onions	2.25	3 / 7	15.0	11.7	8.1
Passion Fruit	1.5	5 / 14	2.6	2.2	2.1
Peanut	1.1	8 / 14	7.0	5.5	5.2
Potatoes	1.1	10 / 5	19.5	16.8	13.8
Stone Fruit and Cherries	3.1	5 / 10	31.0	25.5	20.4
Tomatoes	2.15	7 / 7	46.7	33.9	27.9

15 Single initial application at higher rate followed by four applications at lower rate
16 Single initial application at higher rate followed by four applications at lower rate
17 Golf Course Adjustment Factors (GCAF) for Modifying Estimated Drinking Water Concentrations and Estimated Environmental Concentrations Generated by Tier I (FIRST) and Tier II (PRZM/EXAMS) Models http://www.epa.gov/oppefed1/models/water/golf_course_adjustment_factors.htm
18 Initial application(s) at higher rate followed by multiple applications at lower rate
19 Initial application(s) at higher rate followed by multiple applications at lower rate - See Table 3.2.3.b for specific values of individual types of for golf courses
20 Single initial application at higher rate followed by two applications at lower rate
21 Single initial application at higher rate followed by two applications at lower rate

For golf course turf, EECs for individual turf types were modeled separately adjusted by the appropriate EFED golf course adjustment factors[22]. Greens, tees, fairways and roughs were adjusted by factors of 0.026, 0.024, 0.29 and 0.66, respectively. While annual application rates for greens and tees are much higher than labeled rates for fairways and roughs, greens and tees compose a much smaller percentage of golf courses, and result in a much smaller contribution to the estimated environmental concentrations. EECs resulting from treatment of only greens and tees would be much lower (less than 8 %) than when chlorothalonil is applied to the entire golf course. A more complete assessment of individual and total allowable golf course values appears in Table 3.2.5.

Table 3.2.5. Tier II Refined Estimated Aquatic Estimated Environmental Concentration (EECs) of Use of Chlorothalonil (ground spray application) on Golf Course Turf (adjusted by GCAF)

Golf Course Turf Type	Application Specification			Unadjusted 1-in-10-Year Annual Exceedance Probability			Golf Course Adjust. Factor	Adjusted 1-in-10-Year Annual Exceedance Probability		
	App Rate(s) lbs/acre[23]	No Apps[24]	App Interval days	Peak EEC ppb	21-day EEC ppb	60-day EEC ppb		Peak EEC ppb	21-day EEC ppb	60-day EEC ppb
Greens	11.3 plus 7.23	2 plus 7	7	382	303	258	2.6%	9.9	7.9	6.7
Tees	11.3 plus 7.23	2 plus 4	7	369	293	144	2.4%	8.9	7.0	3.5
Fairways	11.3 plus 7.23	1 plus 2	7	274	260	146	29%	79	75	42
Roughs	11.3 plus 7.23	1 plus 2	7	274	260	146	66%	181	172	96
Total Golf Course Turf [25]	11.3 plus 7.23	mixed	7	--	--	--	100%	**279**	**262**	**148**

[22] Golf Course Adjustment Factors (GCAF) for Modifying Estimated Drinking Water Concentrations and Estimated Environmental Concentrations Generated by Tier I (FIRST) and Tier II (PRZM/EXAMS) Models http://www.epa.gov/oppefed1/models/water/golf_course_adjustment_factors.htm

[23] Initial application(s) at higher rate followed by multiple applications at lower rate

[24] Initial application(s) at higher rate followed by multiple applications at lower rate

[25] Sum of adjusted values for greens, tees, fairways and roughs,

3.2.5 Existing Monitoring Data

3.2.5.1. Water Monitoring

Available NAWQA[26] (USGS National Water Quality Assessment Data Warehouse) aquatic monitoring data indicate that chlorothalonil was not detected in either surface water or ground water at any of the site types monitored throughout the United States. Available SWAMP[27] (California State Water Resources Control Board, Surface Water Ambient Monitoring Program) aquatic monitoring data indicate that chlorothalonil was not detected in surface water at any of the site types monitored throughout California. Additionally, local monitoring data from southern Florida also indicate that chlorothalonil was not present in any samples tested. However, data for specific use patterns (application rate, spatial and temporal distributions) that are necessary to evaluate the monitoring data are not currently available. Further, groundwater monitoring data from Suffolk County, New York[28] confirmed that chlorothalonil metabolites were present in ground water, but the identified metabolite(s) were not identified to be of concern for the aquatic portion of this assessment.

3.2.5.2. Surface Water Monitoring in California

Surface water samples (324) were collected from 32 USGS[29] water monitoring stations in 10 CA counties from March 18, 1993 to Nov. 2, 2002. The counties (# of samples) include Alpine (4), El-Dorado (4), Merced (87), Nevada (4), Orange (10), Sacramento (57), San Bernardino (8), San Joaquin (50), Stanislaus (74), Sutter (2), and Yolo (24). Minimum reporting limit ranged from 0.0350 to 0.5780 µg/L. There was one detection of chlorothalonil (0.290 µg/L) in a surface water sample from Merced County (USGS Station # 1123500) on Feb 08, 1994.

3.2.5.3. Ground Water Monitoring in California

Ground water samples (381) were collected from 297 USGS[30] water monitoring wells in 19 CA counties from August 11, 1993 to Sept 21, 2004. The counties (# of samples) include Butte (9), Colusa (4), Fresno (82), Glenn (12), Kern (4), Kings (8), Los Angeles (2), Madera (14), Merced (31), Orange (26), Placer (3), Riverside (16), Sacramento (30), San Bernardino (10), San Joaquin (30), Stanislaus (56), Sutter (17), Tulare (23), Yolo (1), and Yuba (3). Minimum reporting limit ranged from 0.0350 to 0.480 µg/L. There were no chlorothalonil detections in the ground water samples.

[26] USGS National Water Quality Assessment Data Warehouse http://web1.er.usgs.gov/NAWQAMapTheme/index.jsp
[27] California Environmental Protection Agency, State Water Resources Control Board, Surface Water Ambient Monitoring Program (SWAMP) http://www.swrcb.ca.gov/swamp/
[28] MRID 44006001
[29] Data not located through the NAWQA data warehouse
[30] Data not located through the NAWQA data warehouse

3.2.5.4. Atmospheric Monitoring in California

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,[31] 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,[32] California was targeted to coincide with applications to celery. Distance from application site 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,[33] 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[34] 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/m3 for the highest 10 week air concentration.

Secondary drift of volatilized residues from the Central Valley, and the subsequent deposition of several pesticides, including chlorothalonil, onto distant ecosystems of the Sierra Nevada Mountains through wet and dry deposition of gases/ particles were reported by LeNoir *et al.* in 1999.[35] Prevailing summertime winds blowing across the Central Valley eastward to the Sierra Nevada Mountains transported airborne chlorothalonil. Both air and surface water samples were collected in the Sequoia

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[31] 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

[32] 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

[33] 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

[34] 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

[35] LeNoir, et. al., Summertime Transport of Current-use pesticides from California's Central Valley to the Sierra Nevada Mountain Range,USA

National Park. Chlorothalonil was detected in 50% of the air samples at the 1.24 to 1.93 ng/m^3 range, with duplicate air samples not varying by more than 40% Dry deposition of chlorothalonil at elevations of 200, 533, and 1920 meters were not greater than 18 ng/m^3/day. Surface water contaminated by chlorothalonil deposited through winter rainfall ranged from 1.94 to 6.62 ng/L at elevations between 118 and 2042 meters, with concentrations reported below the limit of detection at elevations above 3000 meters. Although the peak application time for chlorothalonil in the Central Valley was during June, deposition in the Sequoia National Park did not appear in significant concentrations until the end of summer, when applications had declined.

Terrestrial field dissipation studies[36] indicate that chlorothalonil dissipates from a terrestrial test plot with a total system half-life of four to eleven weeks.

3.3 Terrestrial Exposure Assessment

The terrestrial exposure model, T-REX (Version 3.1, December, 2006), was used to estimate exposures to terrestrial animals, including birds, mammals, and terrestrial invertebrates. Consistent with the Overview document (U.S. EPA, 2004), birds are used as surrogates for terrestrial phase CRLFs, while mammals, terrestrial-phase amphibians, and terrestrial invertebrates serve as food items of the CRLF.

T-REX (version 1.3.1.) was used to estimate the dietary residues of chlorothalonil for all assessed uses. Input values include application rate, interval, and number of applications, which are presented in Table 3.3.1 for the various uses of chlorothalonil. A foliar dissipation half-life of 12.3 days was used for this assessment. A foliar dissipation half-life of 4.1 days was reported by Willis and McDowell (1987). Because only a single value was reported, the single value of 4.1 days was multiplied by 3, which is consistent with input guidance for other fate parameters used for aquatic modeling. In addition, dislodgable residue studies report half lives that are equivalent to or less than 12 days (MRIDs 44868601, 44868602), which further supports the use of a 12.3 day foliar dissipation half-life.

T-REX generates estimated exposure concentrations (EECs) and calculates risk quotients (RQs). An example output is included in Appendix F. It provides estimates of upper bound and mean concentrations of chemical residues on the surfaces of different food items that may be sources of dietary exposure to terrestrial phase CRLFs (*e.g.,* small and large insects) and to terrestrial animals that the CRLF may consume such as small mammals and terrestrial invertebrates. Estimated concentrations on such food items are presented in Table 3.3.1. The dietary concentrations are used to calculate dietary risk quotients, and are also converted to daily doses using estimated food intake levels to calculate dose-based risk quotients for relevant size classes of animals. Daily doses used to calculate risk quotients are presented in the Risk Estimation section (Section 5.1), and

[36] MRIDs 00071625, 00087369, 00087301, 00087332, 00071627

detailed methodology for calculating daily doses is presented in the T-REX user's guide, which is available on-line at the following url:

http://www.epa.gov/oppefed1/models/terrestrial/trex_usersguide.htm

In addition, chlorothalonil (or its degradates) has shown the potential to bioconcentrate in aquatic organisms. Bioconcentration factors (BCF) in whole fish and in oysters were approximately 2700 in both species. As discussed in Section 6, the analytical methodology used in the BCF studies was inadequate to determine whether chlorothalonil or its degradates bioconcentrated. Therefore, it was assumed that the residues in aquatic organisms are equal in toxicity to chlorothalonil. Residue levels in aquatic organisms were estimated using the following equation:

Concentration (mg/L) = BCF (L/kg) x 21-day EEC (mg/L)

The resulting EECs are included in Table 3.3.1 as "aquatic food" EECs. Note that aquatic EECs for many uses were above the available LC_{50}s in fish; therefore, mortality would be expected to be high at these EECs such that accumulation estimates may not be applicable. However, given that a small number of fish species have been tested, fish consumed by the CRLF could be less sensitive to chlorothalonil than tested species. Therefore, residue levels were estimated for all uses regardless of the proximity of the EEC to the LC50.

Table 3.3.1. T-REX model inputs and results (EECs, ppm) for chlorothalonil

Use	Application Rate (lbs a.i./A)	No. of Apps	App. Interval	EEC (ppm)				
				Short grass	Tall grass	Small Insect	Large Insect	Aquatic Food[a]
Peanut	1.1	8	14	494	226	278	31	15
Grass grown for seed	1.5	3	14	598	274	336	37	58
Passion fruit	1.5	5	14	647	297	364	40	6
Roses	1.1	33	7	810	371	456	51	225
Dry beans	1.5	4	7	876	402	493	55	54
Corn	1.5	6	7	1001	459	563	63	48
Potato	1.1	10	5	1034	474	582	65	45
Cole crops	1.5	8	7	1057	485	596	66	143
Carrots	1.5	10	7	1083	496	609	68	143
Ornamentals	1.55	23	7	1141	523	642	71	308
Green onions, leek, shallot, onion grown for seed	2.25	3	7	1149	527	646	72	41

Use	Application Rate (lbs a.i./A)	No. of Apps	App. Interval	EEC (ppm)				
				Short grass	Tall grass	Small Insect	Large Insect	Aquatic Food[a]
Filberts, almonds, pistachios	3	6	12	1272	583	716	80	64
Snap beans	2.25	4	7	1315	603	740	82	81
Blueberry and asparagus	3	3	10	1363	625	767	85	52
Tomato	2.15	7	7	1490	683	838	93	92
Onion (dry bulb), garlic, and cucurbits[b]	2.25	6	7	1552	711	873	97	86 (garlic) 68 (onion) 63 (cucurbit)
Celery	2.25	7	7	1586	727	892	99	147
Stone fruits including cherries	3.1	5	10	1624	744	913	101	69
Pachysandra	3.1	11	7	2262	1037	1273	141	261
Conifers	4.1	4	7	2396	1098	1348	150	43
Turf and Golf courses[c]	1 application at 11.3 lbs a.i./Acre + 1 applications at 7.2 lbs a.i./Acre	2	7	3540	1600	2000	220	--
	2 apps at 11.3 lbs a.i./Acre + 7 apps at 7.2 lbs a.i./acre	9	7	5200	2400	3000	328	707
	5 apps at 7.2 lbs a.i./acre	5	7	4583	2100	2578	286	--

[a] Aquatic EECs for a number of uses are considerably higher than the least sensitive LC_{50} in fish; therefore, mortality would be expected to be high at these EECs such that accumulation estimates may not be applicable. However, given that a small number of fish species have been tested, fish consumed by the CRLF could be less sensitive than all tested species. Therefore, accumulation was assumed to occur at levels that produced high mortality in tested fish species.

[b] Although application rates and intervals for bulb onions and cucurbits are different, resulting estimated concentrations on mammalian food items are equivalent assuming 1 application at 6.25 + a second application at 2.25 lbs a.i./Acre 7 days later. Therefore, cucurbit and onion EECs are presented together.

[c] Golf courses were also used to represent general turf and sod farms. The maximum application rate for sod farms and golf courses is equivalent; however, the maximum seasonal application rate for turf and sod farms is 26 lbs a.i./Acre. EECs for the golf course application rate included in Table 3.3.1 of 5 applications at 7.2 lbs a.i./Acre (7-day interval) are essentially equivalent to EECs resulting from the sod farm application rate of 11.3 lbs a.i./Acre (2 applications, 7-day interval).

3.3.1. Potential Exposure to SDS-3701

As discussed in Section 4, a major degradate, SDS-3701, has been shown to be more toxic than chlorothalonil to birds and mammals. Therefore, potential exposures to and risk from this degradate are considered in this assessment.

A comparison of studies conducted on chlorothalonil and SAR estimates on SDS-3701 indicate that SDS-3701 is expected to be somewhat more mobile and more persistent than chlorothalonil (see Section 2.4.1. Environmental Fate Assessment). A comparison of estimated environmental fate parameters for chlorothalonil and SDS- 3701 was conducted using EPI Suite (version 3.12), a structural analysis model developed by the Office of Pollution, Prevention and Toxic Substances, and Syracuse Research Corporation[37]. The resulting modeled environmental fate values are in approximate agreement with submitted laboratory data for chlorothalonil. Given the structural similarity of chlorothalonil and SDS-3701 and the relatively good agreement between the experimental and estimated environmental fate values for chlorothalonil, SAR estimated environmental fate parameters for SDS-3701 are considered to be reasonable in lieu of experimental data. A comparison of the results of this modeling indicated that SDS-3701 may be slightly more mobile than chlorothalonil. Other estimated environmental fate values for SDS-3701 (*e.g.,* persistence, solubility, volatility) are roughly comparable to those of the parent compound.

There are insufficient 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. 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. However, these studies do not provide a dependable basis for estimating the amount of SDS-3701 that may form on avian and mammalian food items as described in U.S. EPA (1999). Therefore, 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 40% of applied parent material. Therefore, terrestrial EECs for SDS-3701 were assumed to be 40% of the chlorothalonil EECs. It is acknowledged that the amount of degradate that forms will be dependent on a number of factors and will not likely be uniform or consistent in the environment. Therefore, as an exploratory bounding exercise EECs for SDS-3701 will be calculated by multiplying the chlorothalonil EECs by 0.4 and 0.1. However, it is uncertain if 10% truly represents a low-end potential exposure value. The 1999 RED reported that use of a 10% formation rate would be conservative.

[37] EPI Suite (copyright 2000 U.S. Environmental Protection Agency) was developed by the EPA's Office of Pollution Prevention Toxics and Syracuse Research Corporation (SRC).

3.4 Terrestrial Plant Exposure Assessment

The available toxicity data indicate that chlorothalonil does not adversely affect terrestrial plants at 16 lbs a.i./Acre (MRIDs 42433808 and 42433809), which is greater than the maximum labeled application rate of chlorothalonil. Therefore, potential exposures to terrestrial plants at levels expected to occur in the environment are not anticipated to result in effects to terrestrial plants to such an extent that indirect effects to the CRLF would occur. For this reason, terrestrial plant EECs and RQs are not presented in this assessment, and a determination is made that chlorothalonil has no effect on the CRLF by affecting terrestrial plants.

4. Effects Assessment

This assessment evaluates the potential for chlorothalonil to directly or indirectly affect the California red legged frog (CRLF) or modifying designated critical habitat of the CRLF. As previously discussed in Section 2.8, assessment endpoints for the CRLF include direct toxic effects on survival, reproduction, and growth, as well as indirect effects, such as reduction of the prey base and/or habitat modification. 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 the CRLF. Designated critical habitat and PCEs are described in Section 2.6. Toxicity data used to evaluate direct and indirect effects to the CRLF are summarized in Table 4.1.

Table 4.1 Summary of Toxicity Data on Chlorothalonil Used to Assess Direct and Indirect Effects Modification to Critical Habitat

Toxicity Data	Assessment Endpoint	Comment
Acute and chronic freshwater fish studies.	- Direct effects to the aquatic phase of CRLF - Indirect effects to aquatic phase CRLF (reduction in prey base)[1]	No aquatic amphibian data available. Fish data used as surrogate for amphibians.
Acute and chronic freshwater invertebrate studies	- Indirect effects to aquatic phase of CRLF (reduction in prey base)[1]	Distribution of sensitivity used to evaluate potential magnitude of effect on prey base.
Acute studies on vascular and non-vascular aquatic plants and/or terrestrial plants	- Indirect effects to aquatic and/or terrestrial phase CRLF via reduction in food supply, aquatic and/or terrestrial habitat, cover and/or primary productivity.	--
Acute and chronic avian studies	- Direct effects to the terrestrial phase of CRLF	No terrestrial amphibian data available. Bird data used as surrogate for amphibians.
Acute and chronic mammalian studies Acute terrestrial invertebrate studies Acute and chronic studies on birds (surrogate for terrestrial phase amphibians)	- Indirect effects to terrestrial phase CRLFs (reduction in prey base and indirect effect to habitat (use of mammal burrows))	No terrestrial amphibian data available. Bird data used as surrogate for amphibians.

[1] Adult frogs are no longer in the "aquatic phase" of the amphibian life cycle; however, submerged adult frogs are considered "aquatic" for the purposes of this assessment because exposure pathways (including diet) in the water are considerably different that exposure pathways on land.

Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and a comprehensive review of the open literature. Other sources of information, including use of the acute dose response analysis to establish the probability of an individual effect at RQs presented in this assessment and reviews of the Ecological Incident Information System (EIIS) are conducted to further refine the characterization of potential ecological effects associated with exposure to chlorothalonil and its degradate of concern.

Only data used directly in this assessment are presented. However, a description of all registrant submitted and open literature data considered as part of this assessment are included in Appendix B. Typically, this assessment used the most sensitive toxicity data available. Reasons for not using studies identified in the open literature that were more sensitive than those used in this assessment to calculate RQs are also provided in Appendix H. A summary of the available toxicity data used to evaluate potential direct effects, indirect effects, use of the probit dose response relationship, and the incident information for chlorothalonil are provided in Sections 4.1 through 4.4.

One degradate of chlorothalonil, SDS-3701, has been shown to form by multiple degradation pathways at levels up to approximately 40% of applied parent material. SDS-3701 has been shown to be more toxic than chlorothalonil to birds and mammals than parent material. Therefore, available toxicity data on SDS-3701 are also described.

4.1 Toxicity Data Used to Evaluate Potential Direct Effects to the CRLF

4.1.1 Toxicity to Freshwater Fish

4.1.1.1. Acute Studies

The available acute fish toxicity studies suggest that chlorothalonil is very highly toxic to freshwater fish on an acute basis. Available LC_{50} values from registrant submitted studies or from the open literature are relatively consistent within and across the eight species tested (Table 4.1.1). LC_{50}s range from 10.5 µg/L (rainbow trout) to 120 µg/L (tilapia). Available studies are further described in Appendix B.

Table 4.1.1. Freshwater Fish Acute Toxicity Findings for Chlorothalonil

Test Species	LC_{50} ppb a.i.	Citation (MRID or Ecotox No.)	Toxicity Category	Comment
Registrant Submitted Studies				
Rainbow trout *(Oncorhyncus mykiss)*	18 – 42	45710219 00056486	very highly toxic	--
Fathead minnow *(Pimephales promelas)*	23	00030391	very highly toxic	--
Bluegill sunfish *(Lepomis macrochirus)*	51 - 84	Pitcher (1976) 00041439 00029410	very highly toxic	--
Channel catfish *(Oncorhynchus mykiss)*	48	00030390	very highly toxic	--
Open Literature Studies				
Jollytail	16	Ecotox No. 87454	very highly toxic	
Spotted mountain galaxias	19 – 29	Ecotox No. 87454	very highly toxic	Tested species has not been evaluated in registrant submitted studies.
Threespine stickleback	69	Ecotox No. 7055	very highly toxic	Tested species has not been evaluated in registrant submitted studies.
Rainbow trout	10.5 - 76	Ecotox No. 87454; 7055	very highly toxic	The 10.5 µg/L value is the most sensitive acute LC_{50} available, but is consistent with the range of LC_{50}s in rainbow trout. 10.5 µg/L was chosen for use in risk quotient calculations. Study used an oxygen level of 50%; however, controls were not affected by the low DO, and the oxygen levels are not outside of the range expected to occur in the environment.
Tilapia	100 - 120	Ecotox No. 229772	highly toxic	--

As discussed in Section 2, SDS-3701 is a major degradate that may persist in the environment. The available data indicate that SDS-3701 is 2 to 3 orders of magnitude less toxic than chlorothalonil to freshwater fish. A summary of the available toxicity data is presented in Table 4.1.2. below. Additional details on these studies are in Appendix B.

Table 4.1.2. Freshwater Fish Acute Toxicity Findings—SDS-3701

Test Species	LC_{50} (μg/L)	Citation (MRID)
Bluegill sunfish	15,000 to 45,000	00029415 00030393

4.1.1.2 Chronic Exposure Studies (Growth/Reproduction)

The most sensitive chronic fish bioassay on chlorothalonil was an early life stage study in fathead minnows (MRID 00030391). Exposure to chlorothalonil at 6.5 μg/L and higher caused adverse effects on reproduction; survival was also reduced at 16 μg/L (see Table 4.1.3). No studies were located in the open literature that produced a more sensitive NOAEC based on endpoints that are directly correlated with EPA's assessment endpoints defined in Section 2.

Table 4.1.3. Summary of Early Life Stage Study in Fathead Minnows Using Chlorothalonil

Test Species	NOAEC (ppb)	LOAEC (ppb)	Citation (MRID #)	Endpoints Affected
Fathead minnow *(Pimephales promelas)*	3	6.5	00030391	12% reduction in number of eggs per spawn relative to controls; survival and hatching success was also reduced at 16 μg/L; 91% mortality occurred at 16 μg/L.

4.1.1.3 Sublethal Effects and Additional Open Literature Information in Fish

Sublethal effects anticipated to affect survival, growth, or reproduction were not reported in the available studies at levels lower than those used to estimate risk to the CRLF. A description of available toxicity studies is in Appendix B.

4.1.2. Birds

No suitable studies were located that evaluated potential adverse effects to terrestrial phase amphibians. Therefore, consistent with U.S. EPA (2004), birds were used as surrogate species for terrestrial phase CRLFs. Available bird toxicity data is summarized below, additional discussion of the available data is presented in Appendix B.

4.1.2.1. Acute Studies

Chlorothalonil is practically non-toxic to birds on an acute oral gavage basis and a subacute dietary basis. No mortality occurred in studies that tested up to 2000 mg/kg-bw and 4640 mg/kg-bw in acute oral gavage studies and at dietary concentrations up to 21,500 ppm in subacute studies. Based on the lack of mortality in the available studies, RQs were not calculated for the acute avian risk assessment. Available acute and subacute toxicity data are summarized in Table 4.1.4.

Table 4.1.4 Summary of Avian Acute Oral and Subacute Dietary Toxicity Studies for Chlorothalonil

Species	LD_{50} (mg/kg-bw)	MRID
Mallard Japanese quail	LD_{50}0: >4640 mg/kg-bw LD_{50}0: >2000 mg/kg-bw	00068753 40964105
Mallard	LC_{50}: >10,000 to >21,500 ppm	00030389, 00039146
Northern Bobwhite	LC_{50}: > 10,000 ppm	00030388

SDS-3701 has been shown to be considerably more toxic than chlorothalonil to birds on an acute basis. Available acute and subacute avian studies with SDS-3701 are summarized in Table 4.1.5 below. The most sensitive LD_{50} and LC_{50} of 158 mg/kg-bw and 1746 ppm, respectively, were used to calculate RQs.

Table 4.1.5. Summary of Avian Acute Oral and Subacute Dietary Toxicity Studies for SDS-3701

Test Species	Results	MRID
Mallard	LD_{50} = 158 mg/kg	00030395
Northern Bobwhite	LC_{50} = 1746 ppm	00115109
Mallard	LC_{50} = 2000 ppm	00115108

4.1.2.2. Chronic Studies

The available reproduction studies in birds have produced a wide range of effect levels. In the most sensitive study (MRID 45710218), an 18% reduction in the number of eggs laid occurred at 624 ppm in bobwhite quail. Subsequently, the number of 14-day survivors was also reduced by 18% at 624 ppm relative to controls. The NOAEC was 153 ppm. In other studies, no adverse effects on reproduction were observed at up to 10,000 ppm in mallard ducks and 1000 ppm in bobwhite quail. Reproduction was adversely affected at 5000 ppm in bobwhite quail. The most sensitive NOAEC of 153 ppm was used for RQ calculations. The available avian reproduction studies are summarized in Table 4.1.6 below.

Table 4.1.6. Summary of Avian Reproduction Studies for Chlorothalonil

Species	NOAEC/LOAEC (mg/kg-diet)	LOAEC Endpoints	MRID No.
Mallard	>10,000 (reprod.)	>10,000 (reprod.) Skin yellowing; no reproductive effects cited at any test level (1000, 5000, 10,000 ppm)	40964102
Bobwhite quail	1000 (reprod.)	5000 (reprod.) Skin yellowing; "overt signs of toxicity and reduced reproduction" cited at 5000 ppm; "overt signs of toxicity, mortalities, and profound effects upon several reproductive parameters related to egg production, hatching success, and survival of hatchlings" cited at 10,000 ppm.	40964104
Bobwhite quail	153	624 LOAEC based on an 18% reduction in no. of eggs laid per hen and no. of 14-day survivors	45710218

Available avian reproduction studies using SDS-3701 are summarized in Table 4.1.7. SDS-3701 has been shown to be more toxic to bird reproduction than chlorothalonil. In mallard ducks and bobwhite quail, the NOAECs for SDS-3701 are 200- and 1.5-fold lower, respectively, than NOAECs for chlorothalonil.

Table 4.1.7 Summary of Avian Reproduction Findings for SDS-3701

Test Species	NOAEC PPM	LOEL PPM	Endpoints affected	MRID
Mallard	50[a]	100[a]	Reduction in eggshell thickness seen at 100 ppm; at 250 ppm 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.	40729402
Bobwhite quail	100	250	Reduction in numbers of eggs laid (39% reduction), number of eggs set (34% reduction), and 14-day survivors (37 % reduction) relative to controls	40729404

a Eggshell thickness was not considered to be a relevant endpoint for assessing potential risk to terrestrial phase amphibians. Therefore, a NOAEC of 100 ppm was chosen for risk quotient calculations.

4.2. Toxicity Data Used to Evaluate Potential Indirect Effects to the CRLF

Toxicity to food items of the CRLF and to organisms important to its habitat requirements were evaluated as part of the indirect effects assessment. These data are summarized in Sections 4.2.1 to 4.2.5 below. Additional descriptions of the toxicity data are included in Appendix B. Fish and terrestrial phase amphibians may also be important food components of the CRLF. However, the toxicity of chlorothalonil and SDS-3701 to these taxa was described in Section 4.1. The most sensitive (lowest) toxicity values are initially used to distinguish whether chlorothalonil or SDS-3701 may affect the CRLF by potentially reducing food availability. The magnitude of potential effects to the CRLF's diet is evaluated using all appropriate available data for each food item taxa.

4.2.1 Toxicity to Freshwater Invertebrates

4.2.1.1.Acute Exposure Studies

Chlorothalonil

The freshwater invertebrate toxicity findings for technical chlorothalonil are summarized in the Table 4.2.1 below. Registrant submitted studies in daphnids produced EC_{50}s that ranged from 54 µg/L to 68 µg/L. Open literature studies typically produced LC/EC_{50}s that were less sensitive than registrant-submitted studies. However, one study (Davies *et al*., 1994) reported LC_{50} values for two invertebrate species that were more sensitive to chlorothalonil than daphnids. 96-hour LC_{50} values for the giant Tasmanian freshwater crayfish and the freshwater atyid shrimp were 12 µg/L and 16 µg/L, respectively, and 7-day LC_{50}s were 3.6 and 12, respectively.

These species are not native North American species; however, no studies in other crayfish or freshwater shrimp species were located. Therefore, toxicity studies in these species were considered to be potentially relevant to CRLF dietary components.

Table 4.2.1. Summary of Freshwater Invertebrate Toxicity Findings

Test Species	LC_{50} (ppb)	MRID or ECOTOX No.
Daphnia magna	48-hr EC50: 54 - 68	MRID 00068754 MRID 45710222
Giant Tasmanian Freshwater Crayfish (*Astacopsis gouldi*)	4-Day LC_{50} = 16 (14.4-17.9) 7-Day LC_{50} = 10.9 (9.1-13.1)	ECOTOX No. 64835 Davies et. al 1994
Freshwater atyid shrimp *(Parataya australiensis)*	4-Day LC_{50} = 12.0 ppb (7.9-18.1) 7-Day LC_{50} = 3.6ppb (2.1-6.0)	ECOTOX No. 64835 Davies et. al 1994

SDS-3701

SDS-3701 was considerably less toxic than chlorothalonil to freshwater invertebrates. The EC_{50} in daphnids was 26,000 ppb (MRID 00030394).

4.2.1.2. Chronic Exposure Studies

Available registrant-submitted reproduction studies in aquatic invertebrates are summarized in Table 4.2.2. The most sensitive available NOAEC was 0.6 µg/L (MRID 45710222). The LOAEC in this study was 1.8 µg/L, which was based on increased mortality; 25% mortality was observed at 1.8 µg/L compared to 7% mortality in controls. Additional details on these studies are provided in Appendix B. No studies were located in the open literature that produced a more sensitive NOAEC based on endpoints that are directly correlated with EPA's assessment endpoints defined in Section 2.

Table 4.2.2 Freshwater Aquatic Invertebrate Chronic Toxicity Data for Chlorothalonil

Species	21-day NOAEC (µg/L)	Endpoints Affected	MRID No. Author/Year	Comment
Daphnia magna	NOAEL = 39 LOAEL = 79	survival, cumulative no. of offspring per female	MRID 00115107	Flow through study
	NOAEL = 0.6 LOAEL = 1.8	Parental mortality was 25% at 1.8 µg/L compared with 7% in controls.	MRID 45710222	Supplemental static renewal study; supplemental classification based on instability of the test substance; nominal concentrations at the NOAEC and LOAEC were 1.0 and 3.4 µg/L, respectively.

4.2.2. Toxicity to Aquatic Plants

Aquatic plants are a primary food source of the larval (tadpole) life stage of the CRLF. Primary productivity is essential for supporting the growth and abundance of the CRLF. In addition, freshwater vascular and non-vascular plant data is used to evaluate a number of the PCEs associated with the critical habitat impact analysis.

The available aquatic plant toxicity studies using technical grade chlorothalonil are summarized in Table 4.2.3. The 14-day EC_{50} for the freshwater vascular plant (duckweed) is 630 µg/L (NOAEC = 290 µg/L), based on decreased dry weight of biomass. The lowest 7-day EC_{50} for freshwater non-vascular plants is 6.8 µg/L, based on growth inhibition in green algae (Mezcua *et al*., 2002; ECOTOX No. 80359). Results of the available data are summarized in Table 4.2.3. Additional details are provided in Appendix B.

The most sensitive aquatic plant study was from Mezcua *et al*. (2002), which reported a 72-hour EC_{50} of 6.8 ppb in *Selenastrum capricorotum* in a study that followed OECD Guideline 201.

Table 4.2.3. Non-target Aquatic Plant Toxicity Data for Chlorothalonil

Species	EC_{50}/NOAEC (µg/L)	Endpoints Affected	MRID No.
Duckweed (*Lemna gibba*)	EC_{50} = 630 ppb (95% C.I.: 550-730ppb)	Biomass (dry weight)	44908102
Diatom (*Navicula pelliculosa*)	EC_{50} = 14 ppb (95% C.I.: 12-17 ppb)	Cell density	44908105
Green Algae (*Selenastrum capricornutum*)	EC_{50}= 190 µg/L	Growth inhibition	42432801
Green Algae (*Selenastrum capricornutum*)	EC_{50}: 6.8 µg/L	Growth inhibition	ECOTOX No. 80359

4.2.3. Toxicity to Mammals

4.2.3.1 Acute Exposure (Mortality) Studies

Available toxicity data are summarized in Table 4.2.4. Chlorothalonil is practically non-toxic to small mammals on an acute oral basis (LD_{50} >10,000 mg/kg bw, MRID 00094940). The degradate, SDS-3701, is more toxic than chlorothalonil with an LD_{50} of 242 mg/kg-bw, which classifies SDS-3701 as moderately toxic to mammals.

Table 4.2.4. Summary of Acute Mammalian Toxicity Studies on Chlorothalonil and SDS-3701

Species	LD_{50} (mg/kg-bw)	Citation MRID
Chlorothalonil		
Rat	>10,000	00094941
SDS-3701		
Rat	242	001098

4.2.3.2 Chronic Exposure (Growth/Reproduction) Studies

Results of mammalian reproduction studies using chlorothalonil and SDS-3701 are summarized in Table 4.2.5 below. Reproductive impairment was not observed in two 2-generation reproduction toxicity studies (MRIDs 41706201, 45710209) at the highest levels tested (3000 ppm, approximately 230 to 250 mg/kg-bw). However, neonatal body weight by Day 21 was significantly lower than controls at 3000 ppm (MRID 41706201). The NOAEL for this effect was 1500 ppm (115 mg/kg-bw). Additional details are in Appendix B.

SDS-3701 was studied in a 1-generation and a 3-generation reproduction toxicity studies. No reproductive impairment occurred in these studies up to the maximum dose tested of approximately 6 mg/kg-bw (120 ppm – 125 ppm). These studies are summarized in Table 4.2.5.

Table 4.2.5. Mammalian Reproduction Toxicity Data for Chlorothalonil.

Species	Reproduction or Offspring NOAEL	Reproduction or Offspring LOAEL	Citation MRID
Chlorothalonil			
Rat (2 - generation reproduction)	1500 ppm (115 mg/kg-bw)	3000 ppm LOAEL based on decrease in pup weight at Day 21	41706201
	3000 ppm (234 mg/kg-bw)	None	45710209
SDS-3701			
3-Generation reproduction study	125 ppm (6.25 mg/kg-bw)	No ecologically relevant reproductive impairment occurred at any dose level.	00127844
1-Generation reproduction study	120 ppm (6 mg/kg-bw)	No ecologically relevant reproductive impairment occurred at any dose level.	00127845

4.2.4. Toxicity to Terrestrial Invertebrates

Toxicity studies on terrestrial invertebrates were evaluated to assess the potential for chlorothalonil to induce indirect effects to the terrestrial phase CRLF via a reduction in prey base. Submitted studies using honey bees in addition to open literature data were used to assess potential effects to terrestrial invertebrates. The acute contact LD_{50} for chlorothalonil is > 181 µg/bee and it is, therefore, classified as practically non-toxic to bees on an acute contact exposure basis (MRID 00136935, 00077759). Results of the studies are summarized in Table 4.2.6.

Table 4.2.6 Summary of Honey Bee Toxicity Data

Species	% a.i.	LD_{50} (µg a.i./bee)	Toxicity Category	MRID No.
Honey bee	Tech.	>181 µg/bee, (14% mortality occurred at 181 µg/bee)	Practically non-toxic	00036935
Honey bee	Tech.	>181 µg/bee	Practically non-toxic	00077759

The data available from the open literature indicate variable sensitivity of terrestrial invertebrates to chlorothalonil. Many of these studies evaluated effects to pest species, and utility of the studies to risk assessment is limited due to the exposure routes used in the studies and the various study designs. Therefore, the honey bee studies were used for risk estimation. Other studies located in the open literature are discussed in the risk description (Section 5.2) to further support risk conclusions, and a description of the available terrestrial invertebrate data is included in Appendix B.

4.2.5 Toxicity to Terrestrial Plants

Terrestrial plant toxicity data are used to evaluate the potential for chlorothalonil to affect riparian zone vegetation within the action area for the CRLF. In addition, several PCEs associated with designated critical habitat for the CRLF (i.e., geomorphically stable banks, water quality and substrate composition) rely on the presence of riparian vegetation.

Results of Tier I toxicity studies with monocots and dicots indicate that seedling emergence and vegetative vigor are not significantly impacted by exposure to chlorothalonil at levels that exceed the maximum labeled application rate. Results of the studies are summarized in Table 4.2.7.

Table 4.2.7: Nontarget Terrestrial Plant Toxicity Findings

Study	% a.i.	Results (lb a.i./A)	Citation (MRID #)
Seed germination/seedling emergence--Tier 1 (122-1A); 10 species	97.9	EC_{25}: ≥ 16	42433808
Vegetative vigor--Tier 1 (122-1B); 10 species	97.9	EC_{25}: ≥ 16	42433809

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

The probit dose-response relationship is used as a tool for providing additional information on the potential for acute direct effects to the CRLF and aquatic and terrestrial animals on which the CRLF may depend for sustenance (U.S. EPA, 2004). As part of the risk characterization, an interpretation of the listed species RQ 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 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 study used to establish the acute toxicity measure 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. The upper and lower bounds of the effects probability are based on available information on the 95% confidence interval of the slope.

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

Probit slopes used to characterize the probability of individual effects occurring to various taxa are in Table 4.3.1 The dose-response analysis is presented in Section 5.2 (Risk Description).

Table 4.3.1. Probit slopes for various taxa

Taxa	Probit Slope (95% C.I.)	Study Type and Species	Reference (MRID)
Chlorothalonil			
Fish	5.6 (2.8 – 8.3)[a]	Rainbow trout	45710219
Aquatic Invertebrates	4.6 (3.1 – 6.0)[a]	Daphnia magna	45710221
Birds	4.5 (2 – 9)[b]	Default slope was used because toxicity value was above the highest dose tested; therefore, a dose-response relationship was not established.	
Mammals	4.5 (2 – 9)[b]		
Terrestrial Invertebrates	4.5 (2 – 9)[b]		
SDS-3701			
Birds	6.5 (2.6 – 10.3)	Acute oral gavage/mallard duck	00030395
Mammals	4.5 (2 – 9)[b]	Default slope used	

a probit slope could not be derived from the study used to calculate RQs because dose-response data were not reported in the published study. Therefore, the lowest (most conservative) probit slope across registrant submitted studies was used.
b Default slope was used because the data were inadequate for probit analysis.

4.4 Incident Database Review

Thirty-two incidents potentially resulting from chlorothalonil use have been recorded in the Ecological Incident Information System (EIIS) as of June 17, 2007. Incidents recorded in the EIIS database are ranked according to level of certainty with which the incident can be linked with chemical exposure. These incidents are summarized in Table 4.4.1. Additional details on the incidents are included in Appendix E.

Table 4.4.1. Summary of Incident Information

Taxa	Number of Incidents		
	Chlorothalonil was confirmed or likely to have been the primary cause or contributor to the incident	**Insufficient information is available to conclude whether or not chlorothalonil was likely a primary contributing factor.**	**Incidences in which causes other than chlorothalonil exposures are more likely.**
Birds and reptiles	1 (accidental spill; birds and turtles were affected)	0	1 (birds)
Bees	0	4 (chlorothalonil, in addition to insecticides such as carbofuran and metamidophos were detected in affected bees)	0
Aquatic Animals	2 (both incidents were accidental spills)	7 (see Appendix E)	0
Terrestrial Plants	1 (misuse, intentional poisoning)	17 (all reported damage to directly treated plant) 9 home use 3 conifer or ornamental use 4 agricultural uses	1 (likely caused by glyhposate contamination)

5. Risk Characterization

Risk characterization is the integration of the exposure and effects characterization to determine the potential ecological risk from varying chlorothalonil use scenarios within the action area and likelihood of direct and indirect effects on the CRLF and its designated critical habitat. 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 CRLF and/or their designated critical habitat (i.e., "no effect," "likely to adversely affect," or "may affect, but not likely to adversely affect").

5.1 Risk Estimation

The highest PRZM/EXAMS EEC was initially used to derive risk quotients. In cases where LOCs were not exceeded based on the highest EEC across all uses, additional RQs were not derived because RQs based on lower EECs would also not exceed LOCs. However, if LOCs are exceeded based on the highest EEC across all uses, then use-specific RQs are also derived. RQs for all assessed uses are included in Appendix J.

In cases where the baseline RQ exceeds one or more LOC (i.e., "may affect"), additional factors including the biology and life history characteristics of the assessed species are considered and used to characterize the potential for chlorothalonil to adversely affect the CRLF and its designated critical habitat. RQs used to evaluate potential direct and indirect effects to the CRLF and to designated critical habitat are in Sections 5.1.1 and 5.1.2. RQs are described and interpreted in Section 5.2 (risk description).

5.1.1 Direct Effects (Chlorothalonil)

As discussed in Section 4, direct effects to the CRLF associated with acute and chronic exposure to chlorothalonil are based on the most sensitive toxicity data available for surrogate fish (aquatic phase) and bird (terrestrial phase) species. A range of RQs for direct effects to the aquatic and terrestrial-phase CRLF is presented in Table 5.1.1. Detailed RQs across all uses assessed are included in Appendix J.

5.1.1.1. RQs Used to Estimate Risk to Aquatic Phase CRLFs

Acute RQs used to evaluate potential direct effects to aquatic phase CRLFs exceeded the Agency's LOCs for endangered species (0.05) for all labeled uses. RQs ranged from 0.25 (passion fruit) to 27 (golf courses). Similarly, chronic RQs exceeded the LOC of 1.0 for all uses except passion fruit. Chronic RQs ranged from 0.7 (passion fruit) to 49 (golf courses). These RQs are further discussed as they relate to the effects determination in Section 5.2.

5.1.1.2. RQs Used to Estimate Risk to Terrestrial Phase CRLFs

Terrestrial phase CRLF chronic RQs for direct effects exceeded the chronic LOC of 1.0 for all uses. RQs ranged from approximately 2 to 20. Acute RQs were not calculated for terrestrial phase CRLFs due to the lack of mortality occurring at the highest test levels, which exceeded the limit dose for acute studies in birds. These RQs are further discussed as they relate to the effects determination in Section 5.2.

5.1.1.3. RQs Used to Estimate Risk from Exposure to SDS-3701

RQs were also calculated for the major degradate, SDS-3701, for terrestrial phase CRLFs. Acute and chronic LOCs were exceeded for all uses based on an assumption that 40% of the applied chlorothalonil forms SDS-3701. However, LOCs were also exceeded for a number of uses based on an alternative assumption that the amount of SDS-3701 that forms on CRLF food items is 10%. There is considerable uncertainty in RQs calculated for SDS-3701 based on the uncertainties associated with the amount of SDS-3701 that may form on food items of the CRLF. RQs are further discussed as they relate to the effects determination in Section 5.2.

Table 5.1.1. Summary of Direct Effects RQs (Chlorothalonil) for the Red Legged Frog

Effect to CRLF	Phase	Toxicity Value	EEC	RQ	RQ Comment
Acute Toxicity	Aquatic	Fish LC_{50}: 10.5 µg/L	Turf uses: Up to 279 µg/L Passion fruit: 2.6 µg/L Peanuts: 7 Other uses: 15 – 139 µg/L	Turf uses: **Up to 27** Passion fruit: 0.25 Peanuts: 0.67 Other uses: 1.4 - 13	Based on a probit slope of 5.6 (2.8 – 8.4), probability of an individual mortality at an RQ of 0.25 would be approximately 1 in 2700 (1 in 22 to 1 in 5E6). Peak EECs exceeded the LC_{50} for all uses except passion fruit (RQ = 0.25) and peanuts (RQ = 0.67).
	Terrestrial[a]	Avian LD_{50}: >4640 mg/kg-bw	RQ not calculated		No mortality occurred at any dose or concentration tested that exceeded the limit dose. Therefore, RQ calculations were not considered appropriate. Potential risks are discussed in detail in Section 5.2.
		Avian LC_{50}: >21,500 ppm	RQ not calculated		
Chronic Toxicity	Aquatic	NOAEC: 3 µg/L	Passion fruit: 2.1 µg/L Turf uses: up to 148 µg/L Other Uses: 5.2 - 73 µg/L	Passion fruit: 0.7 Turf: **Up to 49** Other Uses: **1.7 - 24**	LOC not exceeded for passion fruit LOC exceeded for all other uses.
	Terrestrial[a]	NOAEC: 153 ppm	Golf Course: 3000 ppm Other Uses 278 ppm – 1348 ppm	Golf Course: **20** Other Uses **1.8 – 8.8**	RQs were estimated to exceed the LOC for approximately 50 days after the **final** application at an RQ of 20. RQ would exceed the LOC for up to 20 feet from the treated area assuming ground spray. The highest RQ of 8.8 was estimated to be exceeded as far as 89 feet from the treated area assuming aerial spray and 10 feet from the treated area assuming ground spray. The LOAEC was 624 ppm based on an 18% reduction in number of eggs laid per pen.

a Terrestrial RQs are based on residue levels in/on small insects.

An analysis was also conducted to evaluate potential risks to terrestrial phase CRLFs that consume aquatic animals contaminated via bioaccumulation. BCF values for chlorothalonil or its degradates were approximately 2700 for oysters and fish. Assuming the highest estimated aquatic organism tissue concentration across food crops (celery: 147 mg/kg), ornamentals (308 mg/kg), and turf uses (707 mg/kg: golf courses), a BCF of

2700, a large (200-gram) terrestrial phase frog, and a 15-gram prey fish (or 15 grams of aquatic organisms daily), the resulting EEC (dose) would be as indicated in Table 5.1.2. Estimations across all uses are included in Appendix J.

Table 5.1.2. Estimated bioaccumulated residue levels in fish exposed to chlorothalonil and resulting dose to a large CRLF

Use	Estimated fish tissue concentration[a]	Estimated dose to large frog[b]
Food crop (late celery)	147 ppm	11 mg/kg-bw
Ornamentals	308 ppm	23 mg/kg-bw
Golf Course	707 ppm	53 mg/kg-bw

[a] Calculations were as follows: 21-Day EEC (mg/L) x BCF (L/kg) = estimated fish tissue concentration (mg/kg, ppm)
[b] Estimated fish tissue conc. (mg/kg) x fish weight (assumed 0.015 kg) / 0.2 kg frog = dose (mg a.i./kg frog)

A comparison of the estimated fish tissue concentrations to the most sensitive avian chronic NOAEC of 153 ppm suggests that chlorothalonil uses on carrots, cole crops, celery, ornamentals, and turf (including sod farms and golf courses could result in aquatic animal tissue residue levels that exceed the most sensitive avian NOAEC (RQs presented in Appendix J). The highest residue levels were estimated to be 707 ppm (golf courses), which is approximately 5-fold higher than the NOAEC of 153 ppm. There is considerable uncertainty in the estimated tissue levels given uncertainties in the BCF studies as described in Section 6.

5.1.2. Direct Effects RQs (SDS-3701)

In addition to chlorothalonil, a major degradate, SDS-3701, is also included in this assessment due to its elevated toxicity to terrestrial animals relative to chlorothalonil. SDS-3701 has been shown to form up to approximately 40% of applied chlorothalonil by weight in microbial metabolism studies. Therefore, the amount of SDS-3701 that could form on food items of the CRLF and species on which it may depend for sustenance could be up to approximately 40%. The available residue studies are not sufficient to allow for a refined estimation of the amount of SDS-3701 that may form on CRLF food sources. Therefore, RQs were calculated assuming that EECs for SDS-3701 were 10% or 40% of the chlorothalonil EECs (Table 5.1.3).

Table 5.1.3. RQs Used to Evaluate the Potential for SDS-3701 to Directly Affect the CRLF

Effect to CRLF	Surrogate Species	Toxicity Value	EEC	RQ	RQ Comment
Direct Effect to CRLF	Birds	LC_{50}: 1746 ppm	10% assumption: 28 – 300 ppm 40% Assumption 111 – 1200	10% assumption: 0.016 – **0.17** 40% Assumption 0.06 – **0.69**	RQs are uncertain because the amount of SDS-3701 that may form on food items of the CRLF is highly uncertain and is expected to be variable. Based on a probit slope of 6.5 (2.6 – 10; MRID 00030395), estimated probability of an individual mortality at an RQ of 0.39 would be approximately 1 in 250 (95% CI: 1 and 7 to 1 in 4.6E4). Probability of an individual effect under the 40% formation assumption would be >1 in 2 because the EEC exceeds the LD50.
		Adjusted LD_{50}: 82 mg/kg-bw	10% assumption: 32 – 342 mg/kg-bw[a] 40% assumption 127 - 1368	10% assumption **0.39 – 4.2** 40% assumption **1.5 – 17**	
		NOAEC: 100 ppm[b]	10% assumption: 28 – 300 ppm 40% Assumption 111 - 1200	10% assumption 0.28 - **3** 40% Assumption **1.1 - 12**	At 250 ppm, adult body weight, food consumption, and gonad development were affected, as well as observed effects on number of eggs laid, embryonic development, eggshell thickness, hatchability, and hatching survival.

a Acute dose-based EECs were estimated by assuming that a small bird (surrogate for terrestrial phase frogs) consumes 114% of its body weight daily.
b Eggshell thickness was affected at 100 ppm (NOAEC = 50 ppm); however, the relevance of this endpoint to the CRLF is questionable and was not considered appropriate for risk assessment.

5.1.3 Indirect Effects RQs

This section presents RQs used to evaluate the potential for chlorothalonil to induce indirect effects on the CRLF. Pesticides have the potential to exert indirect effects upon listed species by inducing changes in structural or functional characteristics of affected communities. Perturbation of forage or prey availability and alteration of the extent and nature of habitat are examples of indirect effects. A number of these indirect effects are also considered as part of the critical habitat modification evaluation in Section 5.1.4.

In conducting a screen for indirect effects, direct effects LOCs for each taxonomic group (i.e., freshwater fish, invertebrates, aquatic plants, terrestrial plants, and mammals) are employed to make inferences concerning the potential for indirect effects upon listed species that rely upon non-listed organisms in these taxonomic groups as resources critical to their life cycle (U.S. EPA, 2004). This approach used to evaluate indirect effects to listed species is endorsed by the Services (USFWS/NMFS, 2004b). If no direct effect listed species LOCs are exceeded for organisms on which the CRLF depends for survival or reproduction, indirect effects are not expected to occur.

If LOCs are exceeded for organisms on which the CRLF depends for survival or reproduction, dose-response analysis is used to estimate the potential magnitude of effect associated with an exposure equivalent to the EEC. The greater the probability that exposures will produce effects on taxon, the greater the concern for potential indirect effects for listed species dependant upon that taxon (U.S. EPA, 2004). RQs used to evaluate the potential for chlorothalonil and SDS-3701 to indirectly affect the CRLF are in Tables 5.1.4 to 5.1.6. Discussion of the RQs as they relate to the effects determination is presented in Section 5.2.

Table 5.1.4. RQs used to evaluate the potential for chlorothalonil to induce indirect effects to the CRLF

Indirect Effect	Taxa	Toxicity Value (µg/L)	EEC[a]	RQ[b]	Preliminary Conclusion and Comment
Reduction in Food Supply	Aquatic Invertebrates	EC_{50}: 3.6 µg/L	Peak EEC - Approx. 2.6 µg/L – 279 µg/L	0.72 – 78	Based on LOC exceedances for all uses, chlorothalonil "may affect" the CRLF. Additional discussion of the LOC exceedances as they relate to the effects determination is presented in Section 5.2.
		NOAEC: 0.6 µg/L	21-day - Approx. 2 µg/L – 300 µg/L	4 - 440	
	Terrestrial Invertebrates	LD_{50}: >181 µg/bee (1400 ppm)	278 ppm to 3000 ppm	0.2 - 2	See calculations presented in Table 5.1.5.
	Mammals	LD_{50} >10,000 mg/kg-bw	Not presented	Not calculated	No mortality occurred at up to 10,000 mg/kg-bw, which is 2-fold greater than the limit dose for this type of study. Therefore, calculation of RQs was considered to be inappropriate. Additional discussion is presented in Section 5.2.
		Adjusted NOAEL: 253 mg/kg-bw[c]	470 – 4750[a]	1.9 – 20[b]	LOCs are exceeded for all uses, indicating chlorothalonil "may affect" the CRLF. Additional analysis is needed to allow for an effects determination.
	Terrestrial Amphibians	See direct effects RQs			
	Fish	See direct effects RQs			
		See direct effects RQs			
Reduction in food supply; Primary productivity	Vascular Aquatic Plants	Duckweed EC_{50}: 630 µg/L	Peak EEC: 2.6 - 279	<LOC	No LOCs were exceeded for vascular plants
	Non-Vascular Aquatic Plants	Green Algae EC_{50}: 6.8 µg/L		0.38 - 41	LOCs were exceeded for all uses except passion fruit for non-vascular plants. Additional evaluation is presented in Section 5.2.

a. EECs are in mg/kg-bw and were estimated assuming a small (15-gram) mammal consumes 95% of its body weight daily (U.S. EPA, 1993) and estimated residue levels on short grass.
b RQs presented for mammals are based on the short-grass food item. These RQs as they relate to the effects determination are discussed in Section 5.2.
c NOAEL was adjusted for a 15-gram mammal using methodology presented in T-REX User's Guide available on-line at http://www.epa.gov/oppefed1/models/terrestrial/trex_usersguide.htm

In order to assess the risks of foliar applications of chlorothalonil to terrestrial invertebrates, which are considered prey of CRLF in terrestrial habitats, the honey bee was 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/0.128 g, which is based on the assumed weight of an adult honey bee (Mayer and Johansen, 1990). The resulting toxicity value is 181 / 0.128 = 1400 µg/g (ppm). EECs calculated by T-REX for small and large insects are divided by the estimated toxicity value for terrestrial invertebrates estimated using the honey bee LD_{50}. RQ values for large and small insect exposures were used to bound the exposure estimates for terrestrial invertebrates to chlorothalonil. These RQs are presented in Table 5.1.5, and are further characterized as they relate to the effects determination in Section 5.2.

Table 5.1.5. Indirect effects to the terrestrial-phase CRLF through effects to potential prey items (terrestrial invertebrates).

Use	Small Insect EEC	Small Insect RQ	Large Insect EEC	Large Insect RQ
All uses except golf courses	278 - 1350	0.2 – 0.95	31 - 150	0.02 - 0.11
Golf Courses	3000	2.1	328	0.23

RQs used to estimate indirect effects to the CRLF from exposure to SDS-3701 are in Table 5.1.6. RQs were not calculated for aquatic organisms due to the considerably lower toxicity of SDS-3701 to aquatic organisms relative to chlorothalonil.

Table 5.1.6. RQs used to evaluate the potential for SDS-3701 to indirectly affect the CRLF via Reducing Mammal Abundance

Surrogate Species	Toxicity Value	EEC[a]	RQ	RQ Comment
Mammal	Adjusted LD_{50}: 532 mg/kg-bw[a]	10% assumption 47 - 490 40% assumption 190 - 2000	10% assumption 0.09 – 0.93 40% assumption 0.37 – 3.4	LOC exceedances suggest that some or all uses of chlorothalonil could result in SDS-3701 levels that could indirectly affect the CRLF via reducing mammalian prey. Additional discussion is in Section 5.2.
	NOAEL 125 ppm (6.25 mg/kg-bw; adjusted NOAEL = 13.7 mg/kg-bw)[b]	10% assumption 47 - 490 40% assumption 190 - 2000	10% assumption 3.4 – 36 40% assumption 14 - 144	
Birds	See direct effects RQs presented in Table 5.1.1.			

[a] Mammal EEC was based on residue estimations for short grass food items.
[b] NOAEL was adjusted for a 15-gram mammal using methodology presented in T-REX User's Guide available on-line at http://www.epa.gov/oppefed1/models/terrestrial/trex_usersguide.htm

5.1.4 Modification to Designated Critical Habitat

Taxa for which RQs were used to evaluate the potential for chlorothalonil to modify critical habitat are listed in Table 5.1.7. RQs used to evaluate potential direct and indirect effects to the CRLF that were presented in Section 5.1.2 are also used to determine if use of chlorothalonil may modify critical habitat. Based on LOC exceedances for birds, mammals, fish, aquatic invertebrates, and non-vascular plants (Section 5.1.2), use of chlorothalonil has the potential to modify critical habitat of the CRLF. Discussion of the RQs as they relate to the effects determination is presented in Section 5.2.

Table 5.1.7 PCE Groupings for Critical Habitat Impact Analysis

PCE	Measure of Ecological Effect	Comment
- Characteristics necessary for normal behavior, growth, and viability of all CRLF life stages related to: (1) Aquatic habitat for shelter, foraging, predator avoidance and aquatic dispersal for juvenile and adult CRLF's (2) Water chemistry/quality including temperature, oxygen content and turbidity for normal growth of both CRLF and their prey (3) Substrates with low amount of sedimentation necessary for viability of CRLF (4) Alteration in channel/pond morphology	- Acute vascular and non-vascular aquatic plant data and/or - Terrestrial plant seedling emergence and vegetative vigor data	LOCs were exceeded for non-vascular plants for all uses except passion fruit (RQs ranged from 0.38 to 41). LOCs were not exceeded for terrestrial plants.
Reduction/modification of aquatic-based food sources for pre-metamorphs	Acute vascular and non-vascular aquatic plant data	LOCs were exceeded for non-vascular plants for all uses except passion fruit (RQs ranged from 0.38 to 41).
Alteration in both terrestrial (dispersal and upland) and aquatic habitat (riparian vegetation)	Terrestrial plant seedling emergence and vegetative vigor data	LOCs were not exceeded for terrestrial plants.
Alteration of other chemical characteristics necessary for normal behavior, growth, and viability of aquatic CRLF's and their food source (includes juveniles and submerged adult frogs)	Most sensitive acute and chronic data on freshwater fish and/or invertebrates	LOCs were exceeded for freshwater fish and invertebrates for all uses of chlorothalonil. Acute invertebrate RQs ranged from 0.7 to 78. Chronic RQs ranged from 4 to 440.
(1) Alteration of chemical characteristics necessary for normal behavior, growth, and viability of terrestrial CRLF's and their food source (2) Reduction and/or modification of food sources for terrestrial phase juveniles and adults	Most sensitive - Acute data on honey bees and/or - Acute and chronic data on mammals - Acute and chronic data on birds	Direct and indirect effects RQs were exceeded for all uses. Acute and chronic RQs were also exceeded for SDS-3701.

5.2 Risk Description

The risk description synthesizes an overall conclusion regarding the likelihood of adverse impacts and/or modification leading to an effects determination (i.e., "no effect," "may affect, but not likely to adversely affect," or "likely to adversely affect") for the CRLF and designated critical habitat for the CRLF.

If the RQs presented in the Risk Estimation (Section 5.1) show no direct or indirect effects for individual CRLFs, and no modification to PCEs of the CRLF's designated critical habitat (RQs < LOC), a "no effect" determination is made, based on screening-level modeled EECs of chlorothalonil use within the action area. If, however, direct or indirect effects to the individual CRLFs are anticipated or effects may modify the PCEs of the CRLF's designated critical habitat (RQs > LOC), the Agency concludes a preliminary "may affect" determination for the FIFRA regulatory action regarding chlorothalonil.

RQs presented in Section 5.1 indicate that LOCs were exceeded for birds, mammals, fish, aquatic and terrestrial invertebrates, and non-vascular plants.

These LOC exceedances suggest that labeled uses of chlorothalonil "may affect" the CRLF. Therefore, additional evaluation was performed to determine whether chlorothalonil or its degradate (SDS-3701) is likely or not likely to adversely affect CRLFs in areas down wind, down gradient, or down stream of use sites.

The criteria used to make determinations that the effects of an action are "not likely to adversely affect" the CRLF and designated critical habitat for the CRLF 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. For example, use of dose-response information to estimate the likelihood of effects can inform the evaluation of some discountable effects.

- 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 the established direct and indirect assessment endpoints for the CRLF is provided in Section 5.2.1 and 5.2.2. A description of the risk and effects determination for the critical habitat impact analysis is provided in Section 5.2.3

5.2.1 Direct Effects

5.2.1.1. Aquatic Phase CRLFs, Acute Effects

A summary of the acute fish risk quotients is presented in Table 5.2.1 below. RQs exceed the endangered species LOC of 0.05 for all labeled uses (RQs range from 0.25 to 27). These risk quotients suggest that all uses of chlorothalonil "may affect" the CRLF.

Table 5.2.1. Acute RQs used to evaluate the potential for chlorothalonil to adversely affect aquatic phase CRLFs

Toxicity Value	EEC	RQ	RQ Comment
Fish LC_{50}: 10.5 µg/L	Turf and golf course uses: Up to 279 Other Uses: 2.6 - 139	Turf and golf course uses: **Up to 27** Other Uses: **0.25 – 13**	Based on a probit slope of 5.6 (2.8 – 8.4), probability of an individual mortality at an RQ of 0.25 would be approximately 1 in 2700 (1 in 22 to 1 in 5E6). Peak EECs exceeded the LC_{50} for all uses except passion fruit (RQ = 0.25) and peanuts (RQ = 0.67); therefore, the probability of an individual effect would be 1 in 2 or greater for uses except passion fruit and peanuts.

A number of factors are considered when determining whether or not chlorothalonil is likely to adversely affect the CRLF including an estimation of the likelihood of mortality at the RQs presented in this assessment, an examination of assumptions made in the RQ calculations, and the proximity of potential uses to its habitat.

Usage data obtained from California's Department of Pesticide Regulation (CDPR PUR) database indicates that the predominant use in California from 2002 to 2005 was tomatoes (35% by weight of all reported uses). However, chlorothalonil has been applied to numerous crops at various times throughout the year, and that its use may occur at times when aquatic phase CRLFs are present.

As described in Section 4, the probit slope from available acute studies was used to estimate the likelihood of mortality of a single frog at the RQs presented in this assessment. A probit slope of 5.6 (2.8 – 8.4) was used for this analysis (MRID 45710219). At the *lowest* RQ of 0.25, the probability of an individual mortality would be approximately 1 in 2700 (95% CI: 1 in 22 to 1 in 5E6). EECs for all uses except passion fruit and peanuts exceeded the most sensitive LC_{50} in fish of 10.5 µg/L. Therefore, the probability of an individual mortality occurring at RQs for all uses except passion fruit and peanuts is >1 in 2.

RQs presented in Section 5.1 were based on the most sensitive study from the most sensitive species (rainbow trout LC_{50} of 10.5 µg/L). However, even if RQs were based on the least sensitive available fish LC_{50} of 120 µg/L (tilapia, Ecotox No. 229772), RQs across all uses except passion fruit and peanuts would exceed the endangered species LOC of 0.05 and the restricted use LOC of 0.1.

There are no data to allow for comparison of sensitivity of fish relative to aquatic-phase CRLFs. Therefore, it is uncertain if use of a fish LC_{50} is conservative. The CRLF would need to be approximately 260-fold less sensitive than the most sensitive fish species tested to result in no LOC exceedances for all uses except for turf and golf course uses, and 520 times less sensitive to result in no LOC exceedances for turf uses (including golf courses).

The highest RQ was based on the golf course use pattern. The predominant contribution of the aquatic EECs for golf courses was from use on golf course roughs. Acute RQs for each component of the golf course result in exceedance of the acute LOC of 0.5; RQs for greens, tees, fairways, and roughs were 0.9, 0.8, 7.5, and 17, respectively. As the number of treated sites on a golf course increases, the potential exposure levels also increase. Given that treatment on each individual component of the golf course resulted in LOC exceedance, any assumption of combination of treated sites within a golf course would also result in LOC exceedance. Another uncertainty in the golf course EECs is that golf courses are frequently mowed. If clippings are removed from the golf course, then EECs could be reduced.

In addition to the incident data cited previously, a study by W. Ernst, *et al.* (1991), was intended to determine the residues in a pond directly treated with chlorothalonil (drift simulation), and to determine, among other things, any acute impacts to fish. Residue levels in the pond immediately after direct spraying of the water surface ranged from 171 to 883 ppb. Rainbow trout were exposed by placing them in cages suspended in the treated pond (10 fish per cage; five cages). No mortalities of caged rainbow trout were observed; however, high mortality occurred in two other species (stickleback and boatman). It is unclear why no rainbow trout died even though water concentrations were higher than the LC50 in trout. This study represents only one pond, and it is not known if these results would be duplicated in other situations where fish were exposed. The sizes of the trout in the study are not provided, although they are described as 1-year old hatchery grown fish. At this age, they could be as large as five or six inches. This is much larger than the specimens used in laboratory tests, which are usually between one and two inches long. It is possible that younger fish are more sensitive than the fish used in Ernst *et al.*

5.2.1.2. Aquatic Phase CRLFs, Chronic Exposure

A summary of chronic fish risk quotients is presented in Table 5.2.2 below. RQs exceed the chronic LOC of 1.0 for all uses except passion fruit. Therefore, all chlorothalonil uses except passion fruit are presumed to potentially affect aquatic phase CRLFs. An evaluation of whether labeled chlorothalonil uses are likely to adversely affect the CRLF is presented below.

Table 5.2.2. Chronic RQs used to evaluate the potential for chlorothalonil to directly adversely affect aquatic phase CRLFs

Toxicity Value	EEC	RQ	RQ Comment
NOAEC: 3 µg/L	Passion fruit: 2.1 Turf and Golf Courses: up to 148 Other Uses: 8.6 - 73	Passion fruit: **0.7** Turf and Golf Courses: **Up to 49** Other Uses: **2.9 - 24**	LOC was not exceeded for passion fruit LOCs exceeded for all other uses.

The most sensitive NOAEC was 3 µg/L based on a 12% reduction in number of eggs per spawn relative to controls in fathead minnows at 6.5 µg/L (LOAEC). Survival and hatching success were reduced at 16 µg/L; survival at 16 µg/L was 9%. 60-day EECs exceeded the LOAEC of 6.5 µg/L for all uses except passion fruit, and 60-Day EECs exceeded the level observed to produce 91% mortality from MRID 00030391 for 11 of the 32 uses modeled (see Appendix J). Therefore, there is potential for CRLFs that reside in habitats that receive runoff and drift from chlorothalonil use sites to be exposed to chlorothalonil at concentrations associated with high levels of mortality in fish.

In habitats that are clear and shallow, the 60-day EECs are likely to be conservative because chlorothalonil degrades rapidly by photodegradation (half-life = 10 hours). However, chlorothalonil is also likely to partition to sediment and organic matter in the water, which would likely attenuate photodegradation.

The highest EEC was based on the golf course use pattern. The predominant contribution of the aquatic EECs for golf courses was from use on golf course roughs. If chlorothalonil is applied to golf course roughs, tees, greens, and fairways, 60-day EECs would be approximately 150 µg/L. Chronic EECs for each component of the golf course exceeded the most sensitive chronic NOAEC of 3 µg/L. RQs for each individual component of the golf course were 2.2 (greens), 1.2 (tees), 14 (fairways), and 32 (roughs). As the number of treated sites on a golf course increases, the potential exposure levels also increase. Given that treatment on each individual component of the golf course resulted in LOC exceedance, any assumption of combination of treated sites within a golf course would also result in LOC exceedance.

Because the 60-day EECs exceeded the NOAEC and the LOAEC for all uses except passion fruit, labeled use of chlorothalonil is considered likely to adversely affect aquatic phase CRLFs located in aquatic habitats that receive input from chlorothalonil use sites other than passion fruit.

Conclusion: Potential for chlorothalonil to directly affect aquatic-phase CRLFs: Considering the best available data, all registered uses of chlorothalonil are considered likely to adversely affect aquatic phase CRLFs located in waters with drainage from areas sprayed with chlorothalonil.

SDS-3701 is orders of magnitude less toxic to fish than chlorothalonil, and EECs for SDS-3701 were not expected to be greater than those estimated for chlorothalonil. Therefore, SDS-3701 is presumed to have "no effect" on the aquatic phase CRLF.

5.2.1.3. Acute Risks, Terrestrial Phase CRLFs

No studies in terrestrial-phase amphibians were available for chlorothalonil; therefore, birds were used as surrogate species (U.S. EPA, 2004). No mortality occurred at doses up to 4640 mg/kg-bw or at dietary concentrations up to 21,000 ppm in the available acute oral gavage and subacute dietary studies, respectively. For this reason, risk quotients were not calculated, and it was concluded that chlorothalonil will have "no effect" on terrestrial phase CRLFs via acute toxicity. The highest EEC for insectivore birds was 3000 ppm (golf course), which corresponds to a daily dose of 3400 mg/kg-bw. These levels are lower than the highest levels tested in available acute toxicity studies.

5.2.1.4. Chronic Risk, Terrestrial Phase CRLFs

Avian reproduction RQs are summarized in Table 5.2.3 below. The reproduction LOC was exceeded for all labeled uses of chlorothalonil based on a bird reproduction NOAEC of 153 ppm. RQs ranged from 1.8 to 20.

Table 5.2.3. Summary of Chronic Direct Effects RQs for Terrestrial-Phase Red Legged Frogs

Phase	Toxicity Value	EEC	RQ[a]	RQ Comment
Terrestrial	NOAEC:[b] 153 ppm	Golf Course: 3000	Golf Course: **20**	RQ were estimated to exceed the LOC for approximately 50 days after the **final** application at an RQ of 20 (ground spray) assuming a foliar dissipation half life of 12 days. The LOC was estimated to be exceeded for up to 20 feet from the treated area assuming ground spray.
		Other Uses 278 - 1348	Other Uses **1.8 – 8.8**	The highest RQ of 8.8 was estimated to exceed the LOC for up to 89 feet from the treated area assuming aerial spray and 10 feet from the treated area assuming ground spray.

[a] Terrestrial RQs are based on residue levels in/on small insects.
[b] The LOAEC was 624 ppm based on an 18% reduction in number of eggs laid per pen.

RQs were based on the "small insect" food item. The CRLF consumes a variety of food items including Arachnids, amphipods, isopod, insects, and mollusks. The most commonly observed prey species are larval alderflies (*Sialis* cf. *californica*), pillbugs (*Armadilliadrium vulgare*), and water striders (*Gerris* sp) with a preference for the sowbug (see Section 2). Therefore, the CRLF is assumed to consume both large and small insects. RQs based on the large insect EEC exceeded the chronic LOC of 1.0 only for the golf course use. Large insect EECs for uses other than golf courses ranged from 31 – 150, resulting in RQs of 0.2 to 0.98, respectively.

Based on a foliar dissipation half-life of 12.3 days and an RQ of 20 (golf courses), the chronic avian LOC was estimated to be exceeded for up to 50 days after the *final* chlorothalonil application. AgDRIFT (version 2.0, available at http://www.AgDRIFT.com/) was used to estimate distances from the treated site needed to reduce deposition to levels that would not exceed LOCs. Based on ground applications for golf courses EECs would be reduced by approximately 95% at 20 feet from the treated site, resulting in no chronic LOC exceedances. There is additional uncertainty in potential risks from chlorothalonil use on golf courses due to the high frequency of mowing that typically occurs on golf courses. Golf course EECs were calculated assuming that foliar dissipation occurs via "natural" processes. Frequent mowing could result in EECs that are lower than those used in this assessment.

At an RQ of 1.8 to 8.8 (non-golf course EECs), the LOC would be exceeded for approximately 10 to 39 days after the *final* chlorothalonil application based on a foliar dissipation half-life of 12.3 days. AgDRIFT analysis (aerial application) suggests that residue levels would be reduced by approximately 90% at 89 feet from the treated field, resulting in no LOC exceedances.

In addition, food items of the CRLF include aquatic invertebrates and fish. Because chlorothalonil or its degradates have been shown to bioaccumulate in aquatic organisms, consumption of contaminated aquatic food items could represent a potentially important exposure route. As discussed in Section 5.1, BCFs for chlorothalonil (or its metabolites) were approximately 3000 in both oysters and fish. Fish tissue residues were estimated to exceed the reproduction NOAEC of 153 ppm for several uses including carrots, cole crops, celery, ornamentals, and turf (including sod farms and golf courses, see Appendix J).

There is considerable uncertainty in estimating potential risks to the CRLF via consumption of contaminated aquatic organisms because it is uncertain if chlorothalonil or its degradates bioconcentrate in aquatic organisms. Therefore, the toxicity of bioaccumulated material within aquatic animals is uncertain. For this assessment, it was assumed that the accumulated residue was equivalent in toxicity to chlorothalonil. In addition, peak EECs exceeded the most sensitive LC_{50} in fish or invertebrates for most uses. Tissue accumulation within an individual will be limited by its sensitivity to chlorothalonil because accumulation will likely be limited after an organism dies. However, based on the limited number of available surrogate organisms with toxicity data, it was assumed that populations of tolerant aquatic food items of terrestrial phase CRLFs were present, and accumulation was not limited by mortality. Last, the tissue residue estimation only accounted for bioconcentration from the water and did not consider the potential contribution of both submersion and dietary exposures to body burden. Because potential BCFs for aquatic invertebrates and fish were high (approximately 3000), there is potential for dietary exposure to contribute to the body burdens of higher trophic level aquatic organisms to CRLFs that are in the water and consume aquatic organisms. However, even without quantifying both exposure routes in combination estimated residue levels exceeded the most sensitive avian reproduction NOAEC of 153 ppm for a number of uses.

Avian reproduction RQs were based on the most sensitive NOAEC of 153 ppm (MRID 45710218). The LOAEC from this study was 624 ppm, which was based on an 18% reduction in the number of eggs laid per hen and resulting 14-day survivors. There is uncertainty in this LOAEC because the 18% reduction was considered to be biologically significant by the study authors and by U.S. EPA, but was not statistically significant at the 5% level. A second study in bobwhite quail did not observe any effects at up to 1000 ppm or reproductive impairment at up to 5000 ppm.

Another important uncertainty in the terrestrial phase CRLF exposure assessment is that terrestrial phase amphibians are poikilotherms, which means that their body temperature varies with environmental temperature, while birds are homeotherms (temperature is regulated, constant, and largely independent of environmental temperatures). As a consequence, the caloric requirements of terrestrial phase amphibians 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 (U.S. EPA, 1993):

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

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

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 dietary exposure, is reasoned to be protective of terrestrial phase amphibians. 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 toxicity data in amphibians are lacking. Although the current risk assessment process does not estimate daily doses for birds for chronic exposures, the reproduction avian RQs may result in conservative risk conclusions to terrestrial-phase amphibians given their expected lower food intake relative to birds.

Conclusion, Potential for chlorothalonil to directly affect terrestrial-phase CRLFs: Considering the best available data, all registered uses of chlorothalonil are considered likely to adversely affect terrestrial-phase CRLFs that are within up to approximately 90 feet from the treated area (although distance varies with use, application method, and environmental conditions).

5.2.1.5. Acute Effects, SDS-3701

SDS-3701 is considerably more toxic than chlorothalonil to birds on an acute basis with an LD_{50} of 158 mg/kg-bw. However, the amount of SDS-3701 that may form on the CRLF food items is highly uncertain. Soil metabolism studies suggest that SDS-3701 could form at levels approaching 40% of applied parent material. However, the extent and rate of degradation and composition of the degradates that form in soil may be considerably different than those that may form on dietary items of the CRLF such as invertebrates. Abiotic degradation processes result in formation of SDS-3701 at levels considerably lower than 40%, and it is unknown if SDS-3701 is a metabolite in terrestrial invertebrates. The available magnitude of residues and foliar dissipation studies described in the 1999 RED document (U.S. EPA, 1999) do not provide sufficient information to allow for an estimate of peak SDS-3701 residue levels. Therefore, an assumption that SDS-3701 may form up to 40% of applied chlorothalonil was used to calculate risk quotients.

As previously discussed, this assessment used birds as a surrogate for terrestrial-phase amphibians. Terrestrial amphibian and avian dietary behavior and energetic needs are considerably different from each other. The avian risk assessment is considered to represent a conservative assessment of exposure and risk such that if avian RQs do not exceed LOCs, then it is likely that LOCs would also not be exceeded for terrestrial phase amphibians. However, this assessment indicates that avian LOCs are exceeded for the degradate SDS-3701. Therefore, terrestrial amphibian dietary behavior was considered in context of the effects determination.

Terrestrial phase amphibian RQs that incorporate food intake rates and food items specific to the CRLF are provided in Tables 5.2.4 and 5.2.5 below. These RQs were calculated using a spreadsheet model (T-HERPS), which is an alteration of T-REX. The primary change from T-REX is that T-HERPS replaces the avian food intake equation with a herptile allometric equation (U.S. EPA, 1993) to allow for a refined estimation of food intake for terrestrial amphibians. Also, T-HERPS includes a screen for consumption of contaminated mammals and amphibians because over half of the diet of larger CRLF may be vertebrates such as small mammals and terrestrial phase amphibians (see Section 2). Methodology incorporated into T-HERPS is described in detail in Appendix G. RQs were calculated assuming both a 40% and a 10% conversion to SDS-3701, which are presented in Tables 5.2.4 and 5.2.5 using the golf course EECs as an example.

Table 5.2.4. Upper Bound Kenaga, Acute Terrestrial Herpatofauna Dose-Based Risk Quotients for SDS-3701 (40% Formation Assumption)

Size Class (grams)	Adjusted LD_{50}	EECs and RQs									
		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Small Herbivore Mammals		Small Insectivore Mammal		Small Amphibians	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
1.4	158.00	47	**0.30***	5.1	0.03	N/A	N/A	N/A	N/A	N/A	N/A
37	158.00	46	**0.29***	5.0	0.03	N/A	N/A	N/A	N/A	1.6	0.01
238	158.00	30	**0.19***	3.3	0.02	202	**1.3***	3.5	0.02	1.0	0.01

N/A: Not applicable because the prey item would be larger than the size class of the assessed species.
* RQ exceeds LOC

Table 5.2.5. Upper Bound Kenaga, Acute Terrestrial Herpetofauna Dose-Based Risk Quotients for SDS-3701 (10% Formation Assumption)

Size Class (grams)	Adjusted LD_{50}	EECs and RQs									
		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Small Herbivore Mammals		Small Insectivore Mammal		Small Amphibians	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
1.4	158	11.66	0.07	1.27	0.01	N/A	N/A	N/A	N/A	N/A	N/A
37	158	11.45	0.07	1.25	0.01	N/A	N/A	N/A	N/A	0.40	<0.01
238	158	7.51	0.05	0.82	0.01	50	**0.32***	0.87	0.01	0.26	<0.01

N/A: Not applicable because the prey item would be larger than or similar to the size class of the assessed species.

Incorporation of herptile allometric equations for dose estimation reduces EECs and RQs relative to RQs that use avian food intake estimates. There is considerable uncertainty in the amount of SDS-3701 that may form on food items of the CRLF. However, assuming that SDS-3701 forms 40% of the applied parent material would result in the endangered species LOC exceedance for at least one food item of the CRLF for all uses. The highest RQ was calculated for the small herbivore mammal food item (RQs ranged from 0.12 (peanuts) to 1.3(turf and golf course). LOCs would also be exceeded for a number of uses (bulb onions, garlic, cucurbits, celery, stone fruits, pachysandra, conifers, and turf) assuming SDS-3701 is present at levels of 10% of chlorothalonil EECs.

The highest RQ was based on the mammalian food item (consumption of contaminated mammals). The mammal food item RQ assumes that a 35-gram mammal consumes a daily amount of contaminated short grass and is then eaten by a CRLF. The California mouse was the only mammal identified as a dietary source of the CRLF, and this species is omnivorous consuming insects and various types of vegetation. Therefore, the prey mammal RQs may be overestimated by the assumption that the small mammal consumes short grass. Also, these RQs assume that 40% of chlorothalonil is transformed to SDS-

3701, no elimination or metabolism occurred within the mammal food item prior to being consumed, and the small mammal prey is 35 grams. There is uncertainty in each of these assumptions, and there is no available metabolism data for SDS-3701 to allow for quantification of daily elimination of SDS-3701 in small mammals. T-HERPS analysis suggests that the endangered species LOC would be exceeded for the pachysandra, conifers, and turf uses for CRLFs that consume small invertebrates (SDS-3701 acute direct effects analysis). Additional uncertainties in the T-HERPS model are described in Appendix G.

Conclusions: Based on LOC exceedance for at least one food item after considering dietary behavior of the CRLF relative to birds and assuming 40% transformation to SDS-3701, it was concluded that SDS-3701 is likely to adversely affect the CRLF for all uses. However, the analysis utilized a number of conservative assumptions.

5.2.1.6. Chronic Effects, SDS-3701

The chronic avian LOC was exceeded for all uses for SDS-3701 assuming SDS-3701 is found at 40% of the peak chlorothalonil EECs. Chronic avian RQs do not incorporate food ingestion rates, and therefore, potential effects of reduced food intake of terrestrial phase amphibians relative to birds are not quantified. However, given the lower food intake of terrestrial phase amphibians relative to birds, the chronic avian RQs are likely to be conservative. Also, as previously discussed, the CRLF consumes a variety of invertebrates (and vertebrates). An assumption that the CRLF consumes only large insects would result in no LOC exceedances even if SDS-3701 is found on food items at 40% of the chlorothalonil EECs. Although the chronic risk conclusions are likely conservative due to the use of the 40% conversion rate to SDS-3701, the reduced food intake levels of herptiles relative to birds, and the assumption that the assessed frog consumed only small insects, the RQ exceedances suggests that potential effects to the CRLF from chronic exposure to SDS-3701 cannot be precluded.

Conclusion: Based on exceedance of acute or chronic LOCs for all uses for at least one food item under an assumption that SDS-3701 is found at 40% of the peak chlorothalonil EECs, it was concluded that SDS-3701 is likely to adversely affect the CRLF. However, there is considerable uncertainty in this conclusion.

5.2.2 Indirect Effects to the CRLF

The potential for chlorothalonil to indirectly affect the CRLF is evaluated in Sections 5.2.2.1 to 5.2.2.7.

5.2.2.1. Potential for Chlorothalonil to Indirectly Affect the CRLF by Affecting Aquatic Vegetation

Aquatic vegetation serves as an important source of food of aquatic phase CRLFs and also supports habitat requirements for both aquatic phase and terrestrial phase CRLFs. Aquatic plant RQs used to evaluate potential for chlorothalonil to affect aquatic plants to an extent that may result in indirect effects to the CRLF are summarized in Table 5.2.6 below. RQs across all assessed uses are included in Appendix J.

Table 5.2.6. Aquatic Plant RQs Used to Evaluate the Potential for Chlorothalonil to Indirectly Affect the CRLF

Plant Taxa	Species	EEC	RQ	Comment
Vascular Aquatic Plants	Duckweed EC_{50}: 630 μg/L	Peak EEC: 2.6 - 279	<LOC	No LOCs were exceeded for vascular plants
Non-Vascular Aquatic Plants	Green Algae EC_{50}: 6.8 μg/L		0.38 -41	LOCs were exceeded for all uses except passion fruit for non-vascular plants.

The most sensitive vascular plant tested was green algae (EC_{50} = 6.8 μg/L). No LOCs were exceeded for vascular plants. Peak EECs exceeded the green algae EC_{50} for all uses except passion fruit and the diatom EC_{50} of 14 μg/L for all uses except for passion fruit and peanuts. In addition, longer-duration (e.g., 60-day) EECs were estimated to exceed EC50s for a number of uses, which suggests that reduction in abundance of sensitive non-vascular plants could occur for an extended period under some conditions. These data suggest that a food item of juvenile CRLFs could be impacted to an extent that could adversely affect aquatic phase CRLFs.

An important uncertainty in the aquatic plant assessment is that there was considerable variability in the reported EC_{50}s for green algae. EC_{50}s reported in the open literature ranged from 6.8 μg/L (ECOTOX No. 80359) to 8,000 μg/L (ECOTOX No. 65723). Therefore, potential effects to the aquatic plant community will depend on a number of factors including presence of sensitive species and environmental conditions. These LOC exceedances suggest that potential reduction in abundance of non-vascular aquatic plants could adversely affect aquatic phase CRLFs. Also, aquatic concentrations associated with >50% effect on green algae and diatoms may be exceeded for >60 days for a majority of the uses. Therefore, it was concluded that labeled uses (except passion fruit) of chlorothalonil are likely to adversely affect aquatic phase CRLFs that receive inputs from areas sprayed with chlorothalonil.

5.2.2.2. Potential for Chlorothalonil to Indirectly Affect the CRLF by Affecting Terrestrial Vegetation

As noted in Section 4, chlorothalonil use did not result in adverse effects to terrestrial plants at application rates up to 16 lbs a.i./Acre, which is higher than the maximum labeled application rate of 11 lbs a.i./Acre. Therefore, chlorothalonil use is expected to have no effect on CRLFs resulting from potential effects to terrestrial vegetation, including riparian vegetation. However, several terrestrial plant incidents have been reported for chlorothalonil (Section 4.4) that were associated with its labeled use. Most of the incidences were associated with damage to plants on which it is labeled for use (e.g., ornamentals). One incident was reported in which a mixture of Ridomil and Bravo 81W was misused to intentionally damage crops. In all other incidences, chlorothalonil was not confirmed to have been the cause of the plant damage. Given the low number of plant incidences relative to the long history of use of chlorothalonil and the low toxicity of chlorothalonil to terrestrial plants, the presence of these incidents does not alter the effects determination.

5.2.2.3. Potential for Chlorothalonil to Indirectly Affect the CRLF by Affecting Aquatic Invertebrates

RQs for the most sensitive aquatic invertebrate species tested were initially used to evaluate whether labeled uses of chlorothalonil could adversely affect the CRLF. Acute RQs for all uses resulted in LOC exceedances and ranged from 0.72 to 78 for acute effects and 4 to 440 for chronic effects. Aquatic invertebrate RQs were >1 (EEC was higher than the most sensitive LC_{50}) for all uses except passion fruit. Based on the probit slope of 4.6 (95% CI: 3.1 – 6.0; see Section 4), the probability of an individual mortality at the lowest RQ of 0.72 (passion fruit) would be approximately 1 in 4 (1 in 3 to 1 in 5).

The acute toxicity value of 3.6 µg/L was initially used for RQ calculation. The range of acute LC_{50}/EC_{50} values for aquatic invertebrates is from 3.6 µg/L to 200 µg/L, with the 50^{th} percentile of 40 µg/L. Based on the 50^{th} percentile LC_{50}, RQs for all uses except peanuts and passion fruits would result in RQs of 0.5 or greater.

Similarly, chronic RQs for aquatic invertebrates exceeded the chronic LOC of 1.0 for all uses. RQs ranged from 4 to 440. The most sensitive LOAEC of 1.8 µg/L, which was based on 25% immobility compared with 7% in controls, was exceeded for all uses as well. These data suggest that potential impacts to aquatic invertebrate abundance could be substantial if the exposed animals are as sensitive as the most sensitive species tested. There is some uncertainty in this conclusion, however, because the number of aquatic invertebrate species that have been tested in chronic bioassays is limited, and the NOAECs vary considerably and range from 0.6 µg/L to 39 µg/L for daphnids. RQs based on a NOAEC of 39 µg/L would also exceed LOCs for a number of uses.

Conclusion: Labeled uses of chlorothalonil have the potential to adversely affect the CRLF by reducing availability of aquatic invertebrate prey base to an extent that could result in a "take" as defined in Section 5.2. Therefore, a conclusion of likely to adversely affect the CRLF was made for all uses.

5.2.2.4. Potential for Chlorothalonil to Indirectly Affect the CRLF by Affecting Terrestrial Invertebrates

Terrestrial invertebrate RQs, based on the honey bee data, are presented in Table 5.2.7.

Table 5.2.7. Indirect effects to the terrestrial-phase CRLF via effects to potential prey items (terrestrial invertebrates)[a]

Use	Small Insect EEC	Small Insect RQ	Large Insect EEC	Large Insect RQ
All uses except golf courses	278 - 1350	0.2 – 0.96	31 - 150	0.02 - 0.11
Golf Courses	3000	2.1	328	0.23

a Endpoint based on acute contact honey bee LD_{50} of 181 µg/bee.

The honey bee RQs suggest that terrestrial insects could be affected by use of chlorothalonil. Honey bee RQs ranged from 0.2 to 2.1. The magnitude of potential effects to terrestrial invertebrates that are of similar sensitivity to chlorothalonil was estimated using the default probit slope of 4.5 because mortality levels were insufficient to establish a dose-response. Based on a probit slope of 4.5, mortality levels could be sufficient to result in indirect effects to the CRLF for a number of uses including tomatoes, onions, garlic, stone fruits, pachysandra, conifers, and golf courses. For these uses, based on the assumed probit slope of 4.5 (with bounds of 2 – 9), the magnitude of potential effects was estimated to be >15%. The RQs are likely conservative given that the highest dose tested in the available honey bee LD_{50} study produced only 14% mortality, resulting in an LD_{50} of >181 µg/bee.

In addition, a number of studies are available that evaluated the toxicity of chlorothalonil to terrestrial invertebrates. The utility of many of these studies is generally limited as discussed in Appendix B. However, the available data suggest that sensitive terrestrial invertebrates exist, but many of the species tested are not expected to be affected to an extent that would produce indirect effects to the CRLF. Dietary exposure for the corn earworm and the fall armyworm resulted in significantly increased mortality relative to controls (Lynch, 1996), and treatment of *Entomophthora muscae* at 0.0054% solution resulted in 100% mortality (Carruthers et. al., 1985; ECOTOX No. 71029). Other species tested (listed in Table 5.2.8) were not affected at levels that were reportedly equivalent to maximum labeled application rates.

Table 5.2.8. Terrestrial Invertebrate Species Tested that did not Result in Adverse Effects at Levels Tested to an Extent that would Result in Indirect Effects to the CRLF.

Species	Reference
Beetles Mustard beetle Rove beetle Carabid beetles	90531: Cherry et. al. 1992 63488: Samsoe-Petersen, 1995 89639: Smitley and Rothwell, 2003
Earthworms Oligochaeta	71484: Potter *et. al*. 1990
Mites *Amblyseius victoriensis*	67984: James *et.al*. 1995
Aphids *Aphidius rhopalosiphi* *Aphidoletes aphidimyza*	64665: Jansen, 1999 89884: Helyer, 1991
Thrips *Thrips tobaci*	90255: Al-Dosari *et al*., 1996

Conclusion: Sensitivity of terrestrial invertebrates is variable. However, LOC exceedances and potential impact of sensitive terrestrial invertebrates could be sufficient to adversely affect CRLFs. Therefore, a conclusion of LAA was made for tomatoes, onions, garlic, stone fruits, pachysandra, conifers, and golf courses. For other uses of chlorothalonil, potential magnitude of effect to abundance of sensitive terrestrial invertebrates was estimated to be insufficient to result in indirect effects to the CRLF. Therefore, it was concluded that chlorothalonil use for all other labeled uses is not likely to adversely affect (NLAA) the CRLF.

5.2.2.5. Potential for Chlorothalonil and SDS-3701 to Indirectly Affect the CRLF by Affecting Mammals

Mammals may serve as food items of larger terrestrial phase CRLFs. Therefore, potential for chlorothalonil and SDS-3701 to affect abundance of mammalian food items was evaluated. RQs used to evaluate the potential for chlorothalonil and SDS-3701 to affect the CRLF are in Table 5.2.9 below.

Table 5.2.9. RQs used to evaluate the potential for chlorothalonil and SDS-3701 to induce indirect effects to the CRLF by reducing abundance of mammal food items.

Toxicity Value (µg//L)	EEC	RQ[a]	Preliminary Conclusion and Comment
Chlorothalonil			
Adjusted NOAEL: 253 mg/kg-bw	470 – 4750[b]	1.9 – 20	LOCs are exceeded for all uses, indicating chlorothalonil "may affect" the CRLF. Additional analysis is needed to allow for an effects determination.
SDS-3701			
Adjusted LD_{50}: 532 mg/kg-bw	10% assumption 47 - 490 40% assumption 190 - 2000	10% assumption 0.09 – 0.93 40% assumption 0.35 – 3.7	LOCs exceedances suggest that all uses of chlorothalonil could result in SDS-3701 levels that could indirectly affect the CRLF.
NOAEC 125 ppm (6.25 mg/kg-bw; adjusted NOAEL = 13.7 mg/kg-bw)[c]	10% assumption 47 - 490 40% assumption 190 – 2000	10% assumption 3.4 – 36 40% assumption 14 - 144	

a RQs presented for mammals are based on the short-grass food item.
b. EECs are in mg/kg-bw and were estimated assuming a small (15-gram) mammal consumes 95% of its body weight daily (U.S. EPA, 1993) and estimated residue levels on short grass.
c NOAEL and LD50 was adjusted for a 15-gram mammal relative to the size of a lab rat using methodology presented in T-REX User's Guide available on-line at http://www.epa.gov/oppefed1/models/terrestrial/trex_usersguide.htm

As discussed previously, acute exposure to chlorothalonil is not likely to adversely affect CRLFs by reducing abundance of mammalian food items because no mortality occurred at doses that exceeded the limit dose for mammals. However, chronic LOCs were exceeded for mammals for both chlorothalonil and SDS-3701, and acute LOCs were exceeded for SDS-3701. Chronic mammalian RQs exceeded the LOC of 1.0 for all uses modeled and ranged from 1.9 to 20 for chlorothalonil. The LOAEL in the 2-generation reproduction toxicity study used to calculate risk quotients was based on a significant reduction in pup weight (Day 21) at a dose of approximately 2-fold higher than the NOAEL. EECs for all uses exceeded the LOAEL. The chronic RQ was estimated to exceed the LOC for up to approximately 140 feet from the treated field for golf courses (ground application) and for up to 2100 feet from the treated field for other uses (aerial applications) (AgDRIFT, version 2.0).

Mammalian RQs were based on the short grass food item for 15-gram mammals. However, one common prey mammal, the California mouse, consumes a variety of vegetation and insects. RQs exceed the chronic LOC for all uses for short grass, tall grass, and small insect food items. Therefore, alternative assumptions regarding dietary composition would still result in LOC exceedance for all uses for mammals. The LOC for large insects was exceeded only for the golf course use.

Acute and chronic LOCs were also exceeded for SDS-3701. There is considerable uncertainty in estimating the amount of SDS-3701 that may form on food items of the CRLF. A 40% conversion rate was used (i.e., SDS-3701 concentrations were estimated to be 40% of chlorothalonil EECs) for this assessment because the maximum amount of SDS-3701 that was observed to form in the submitted soil metabolism study was approximately 40%. If more or less SDS-3701 forms on mammalian food items then RQs would be higher or lower, respectively. The acute RQ was associated with potential magnitude of effects of >10% for all uses except for passion fruit, peanuts, and grass grown for seed assuming a probit slope of 4.5. Also, the chronic LOC was exceeded for all uses; chronic RQs ranged from 14 to 144.

Conclusion: Because either acute or chronic LOCs were exceeded for all uses and acute RQs were associated with potential magnitude of effect that could indirectly affect the CRLF, there is potential for chlorothalonil and SDS-3701 to reduce abundance of mammals to an extent that could adversely affect the CRLF.

5.2.2.6. Potential for Chlorothalonil to Indirectly Affect the CRLF by Reducing Fish as Food Items

Potential risk to fish were described in Section 5.2.1 (direct effects). Acute LOCs were exceeded for fish for all uses. LOCs would be exceeded if the most sensitive or least sensitive LC_{50} was used for RQ calculations.

The peak EEC was exceeded the most sensitive LC50 for all uses except passion fruit and peanuts (see Appendix J). Therefore, magnitude of effect could exceed 50% for fish that are as sensitive as the most sensitive species tested for most uses. In addition, the chronic LOC was exceeded for all uses except passion fruit. Chronic RQs for all other uses were approximately 2 or greater.

Conclusion: Based on LOC exceedances and resulting potential magnitude of effects to fish abundance, chlorothalonil is likely to adversely affect the CRLF by reducing fish abundance.

5.2.2.7.Potential for Chlorothalonil to Indirectly Affect the CRLF by Reducing Abundance of Other Terrestrial Phase Amphibians

Based on the analysis in Section 5.2.1 (direct effects), acute (SDS-3701) and chronic (SDS-3701 and chlorothalonil) LOCs were exceeded for birds. Incorporating factors such as food intake levels specific for small herptiles, acute RQs for SDS-3701 for insectivore herptiles were as high as 0.3 (golf course EECs, small insect food item). Potential magnitude of effect to prey amphibians at this exposure level would be <1% based on a probit slope of 5.6, which would constitute an insignificant indirect effect to the CRLF.

However, the chronic avian LOC was exceeded for all uses for SDS-3701, assuming that SDS-3701 EECs are 40% of the chlorothalonil EECs. As previously discussed, the CRLF consumes a variety of invertebrates (and vertebrates for larger frogs). An assumption that the CRLF consumes only large insects would result in no LOC exceedances even if SDS-3701 is found on food items at 40% of chlorothalonil levels. The chronic risk conclusions are likely conservative due to the use of the 40% conversion rate to SDS-3701 and the reduced food intake levels of herptiles relative to birds. However, the RQ exceedance suggests that potential effects to terrestrial phase amphibians could be sufficient to adversely affect the CRLF.

In addition, the chronic avian LOC was also exceeded for chlorothalonil. The most sensitive NOAEC was 153 ppm in the diet based on an 18% reduction in the number of eggs laid and resulting reduction in 14-day survivors at 623 ppm. The LOAEC would be exceeded for many of the labeled uses. Although the avian RQs are likely conservative given the lower energetic needs and food intake of terrestrial phase amphibians relative to birds, the current risk assessment process does not consider food intake for estimating chronic/reproductive risk to birds.

Conclusion: Exceedance of the chronic LOC for all uses suggests that some effect on abundance of terrestrial phase amphibians could occur. The chronic avian RQs may overestimate potential risks to terrestrial phase amphibians, and the potential effect may or may not be of sufficient magnitude to be meaningfully measurable in the context of a take. However, the currently available information is not sufficient to preclude potential effects to terrestrial phase amphibians at levels that could adversely affect CRLFs. Therefore, a conclusion of LAA was made for all uses.

5.2.3 Modification to Designated Critical Habitat

5.2.3.1 Direct Effects to Aquatic Plants

The following PCEs are evaluated in order to determine whether modification of designated critical habitat for the CRLF may occur via actions that directly affect aquatic vascular and non-vascular plants: (1) alteration of channel/pond morphology or geometry; (2) maintenance of water quality parameters such as oxygen content and temperature; (3) alteration in sediment deposition within stream channel or pond; (4) alteration in habitat which provides shelter, foraging, predator avoidance and aquatic dispersal territories for juveniles and adults; (5) alteration of other chemical characteristics necessary for maintenance of CRLF food source; and (6) reduction and/or modification of aquatic-based food sources for pre-metamorphs (e.g. algae).

As discussed previously, direct effects to vascular plants from chlorothalonil uses are not expected. However, direct risk to non-vascular plants exceeded the LOC for all uses except passion fruit based on an algae EC_{50} of 6.8 µg/L and all uses except passion fruit and peanuts based on the most sensitive diatom EC_{50} of 14 µg/L. Therefore, indirect effects to CRLF individuals via reduction in aquatic-based food sources for pre-metamorphs could occur. The effects determination for the critical habitat impact analysis PCE associated with reduction and/or modification of aquatic-based food sources for pre-metamorphs (e.g. algae) is "likely to adversely affect". However, whether or not reduction in the most sensitive non-vascular plant tested would result in modification to the CRLF's critical habitat will depend on a number of factors, including the presence of other less sensitive non-vascular plants (the green algae LOC was not exceeded for any use).

Direct effects to aquatic vascular plants from chlorothalonil uses are lower than the LOC. PCEs including alteration of channel/pond morphology or geometry; maintenance of water quality parameters; and alteration in sediment deposition within stream channel or pond; alteration in habitat which provides shelter, foraging, predator avoidance and aquatic dispersal territories for juveniles and adults are associated with a healthy aquatic vascular plant community. The available data suggests that chlorothalonil will have "no effect" on PCEs associated with presence of vascular aquatic plants within designated critical habitat of the CRLF.

5.2.3.2 Modification to Designated Critical Habitat via Effects to Riparian Vegetation

Reduction in riparian vegetation could impact the following PCEs: (1) presence and maintenance of geomorphically stable stream and river channels; (2) maintenance of water quality parameters including temperature and turbidity; (3) presence and maintenance of silt-free substrates necessary for viability of the CRLF; (4) presence and maintenance of riparian habitat for shelter, foraging, predator avoidance, aestivation and terrestrial dispersal; and (5) habitat support for the food source of CRLF's.
Based on the lack of LOC exceedance for terrestrial plants, chlorothalonil is expected to have "no effect" on PCEs associated with riparian habitat within designated critical habitat.

5.2.3.3 Modification to Designated Critical Habitat via Effects to Chemical Characteristics Necessary for Normal Behavior, Growth, and Viability of All CRLF Life Stages

The critical habitat impact analysis associated with chemical characteristics necessary for normal behavior, growth, and viability of all life stages of the CRLF is based on the direct effects and indirect effects analysis. If LOCs are exceeded for direct effects or for indirect effects based on a reduction in food items, then the chemical environment is presumed to be such that normal behavior, growth, and viability of the CRLF's critical habitat may be modified. Potential direct and indirect effects were previously evaluated.

Labeled uses of chlorothalonil were considered likely to adversely affect both aquatic and terrestrial phase CRLFs by direct effects. Also, reduction in abundance of some food items may occur. Therefore, the effects determination for chemical characteristics necessary for normal behavior, growth, and viability of all CRLF life stages is "likely to adversely affect" the CRLF.

5.2.3.4. Spatial Analysis Summary

Spatial analysis was conducted for the purpose of determining the potential extent that the established species range could overlap with potential chlorothalonil use sites. As described in detail in Appendix C, there is overlap between the potential use sites and species range as defined by core areas and critical habitat. For non-forestry uses, the greatest overlap occurred within the recovery units 4, 5, 7, and 8 with 26% to 27% of these core areas overlapping with the action area (potential use site + spray drift extension needed to reduce RQs to levels that are lower than LOCs). There was considerably more overlap between potential forestry use sites and habitat range with 45% to 91% of the recovery units overlapping with the action area. Chlorothalonil is labeled for use on trees such as conifers; however, the California Department of Pesticide Regulation's Pesticide Use Reporting (PUR) database (2002 – 2005) does not report any uses on "forestry". The primary uses on trees other than orchard trees listed in the PUR database is nurseries (Appendix L). Additional discussion on the spatial analysis used to define the action area is in Section 2.7 and in Appendix C.

6. Assumptions, Limitations and Uncertainties

6.1 Uncertainties Related to Aquatic Exposures

Overall, the uncertainties inherent in the exposure assessment tend to result in both an over-estimation and under-estimation of exposures. Among the most significant overestimation of the total mass of chlorothalonil to a single watershed could result from the assumed application to golf course fairways and roughs. Treatment of only the greens and tees of a golf course produce EECs 93% less than the values estimated for treatment of the entire course.

Factors that may account for under-estimation of exposure in the refined modeling relative to the most vulnerable watersheds may include differences between pond volume, field size, and flow dynamics relative to habitat characteristics of the CRLF. Furthermore, the impact of setbacks on runoff estimates has not been quantified, although well-vegetated setbacks may result in significant reduction in runoff loading of chlorothalonil.

6.1.1 Modeling Assumptions and Uncertainties

Overall, the uncertainties addressed in this assessment cannot be quantitatively characterized. However, given the available data and the tendency to rely on conservative modeling assumptions, it is expected that the modeling results in high-end exposure estimates, particularly at the screening level.

In general, the simplifying assumptions used in this assessment appear from the characterization in Section 3.2.6 to be reasonable. There are also a number of assumptions that tend to result in over-estimation of exposure. Although these assumptions cannot be quantified, they are qualitatively described. For instance, modeling in this assessment for each chlorothalonil use assumes that all applications have occurred concurrently on the same day at the exact same application rate. This is unlikely to occur in reality, but is a reasonable conservative assumption in lieu of actual data.

6.1.2 Impact of Vegetative Setbacks on Runoff

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

6.1.3 PRZM Modeling Inputs and Predicted Aquatic Concentrations

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

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

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

The Agency acknowledges that there are some unique aquatic habitats that are not accurately captured by this modeling scenario and modeling results may, therefore, under- or over-estimate exposure, depending on a number of variables. For example, aquatic-phase CRLFs may inhabit water bodies of different size and depth and/or are located adjacent to larger or smaller drainage areas than the EXAMS pond. The Agency does not currently have sufficient information regarding the hydrology of these aquatic habitats to develop a specific alternate scenario for the CRLF. As previously discussed in

Section 2.5.4 and Attachment 1, CRLFs prefer habitat with perennial (present year-round) or near-perennial water and do not frequently inhabit vernal (temporary) pools because conditions in these habitats are generally not suitable (Hayes and Jennings 1988). Therefore, the EXAMS pond is assumed to be representative of exposure to aquatic-phase CRLFs. In addition, the Services agree that the existing EXAMS pond represents the best currently available approach for estimating aquatic exposure to pesticides (USFWS/NMFS 2004).

6.1.4. Bioconcentration in Fish and Mollusks

The bioconcentration of chlorothalonil was studied in oysters and bluegill sunfish, and analyzed by normal and reverse phase one-dimensional TLC. While this analytical method may be adequate for monitoring the progress of experiment, more rigorous analytical techniques could have been employed at study termination to confirm the identity of the analytes being monitored through TLC, especially when different solvents were used for serial extractions. As a result the conservative assumption was made that all unidentified residues were chlorothalonil.

6.1.5. Atmospheric Transport/Deposition

Certain factors, including variations in topography, cover, and meteorological conditions over the transport distance are not accounted for by the AgDRIFT model (*i.e.*, it models spray drift from aerial and ground applications in a flat area with little to no ground cover and a steady, constant wind speed and direction). Therefore, in most cases, the drift estimates from AGDRIFT will overestimate exposure, especially as the distance increases from the site of application, since the model does not account for potential obstructions (*e.g.*, large hills, berms, buildings, trees, *etc*.). Furthermore, conservative assumptions are made regarding the droplet size distributions being modeled ('ASAE Very Fine to Fine' for orchard uses and 'ASAE Very Fine' for agricultural uses), the application method (*i.e.*, aerial), release heights, and wind speeds. Alterations in any of these inputs would decrease the area of potential effect.

Additionally, factors affecting the uncertainties inherently associated with monitoring of atmospheric transport and deposition of chlorothalonil can include, but are not limited to:

- uncertainties in sampling time,
- location of sampling sites,
- sampling methods,
- detection methods and limit,
- use of control samples and instrumental calibration,
- recovery efficiency,
- analysis of duplicate samples,
- storage stability,
- method detection limit,
- atmospheric conditions, and
- correlation of chlorothalonil application and sample collection.

6.1.6. Potential Exposures from Residential Uses

Several ornamental and fruits/vegetable uses assessed as agricultural commodities are also grown in residential areas in gardens. Several products that contain chlorothalonil are labeled for home/garden use at rates equivalent to those modeled in this assessment for agricultural commodities (Appendix K). Assuming a 2000 square foot garden (20 x 100 ft) for 4, ¼-acre lots would result in a treated area of approximately 8000 square feet or approximately 18% of an acre. Therefore, labeled uses for gardens in residential areas would result in EECs that are approximately 20% of the agricultural settings assuming that all houses in the watershed apply chlorothalonil to their lot at approximately the same time.

6.2. Uncertainties Related to Terrestrial Exposures

The Agency relies on the work of Fletcher *et al*. (1994) for setting the assumed pesticide residues in wildlife dietary items. These residue assumptions are believed to reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify. The field measurement efforts used to develop the Fletcher estimates of exposure involve highly varied sampling techniques. It is possible that much of these data reflect residues averaged over entire above ground plants in the case of grass and forage sampling.

It was assumed that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy differences. Direct comparison of a laboratory dietary concentration- based effects threshold to a fresh-weight pesticide residue estimate would result in an underestimation of field exposure by food consumption by a factor of 1.25 – 2.5 for most food items.

Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods do not account for a potentially important aspect of food requirements. Depending upon species and dietary matrix, bird assimilation of wild diet energy ranges from 23 – 80%, and mammal's assimilation ranges from 41 – 85% (U.S. Environmental Protection Agency, 1993). If it is assumed that laboratory chow is formulated to maximize assimilative efficiency (e.g., a value of 85%), a potential for underestimation of exposure may exist by assuming that consumption of food in the wild is comparable with consumption during laboratory testing. In the screening process, exposure may be underestimated because metabolic rates are not related to food consumption.

For this baseline terrestrial risk assessment, a generic bird or mammal was assumed to occupy either the treated field or adjacent areas receiving a treatment rate on the field.

Actual habitat requirements of any particular terrestrial species were not considered, and it was assumed that species occupy the modeled treatment area.

6.2.1. SDS-3701 Formation

There is considerable uncertainty in the amount of SDS-3701 that may form in the environment, particularly on/in animal prey items of the CRLF. Based on maximum formation observed in a soil metabolism study, it was assumed that SDS-3701 levels were 40% of chlorothalonil levels. However, other degradation processes in/on food items of the CRLF could lead to SDS-3701 levels lower or higher than 40%.

6.2.2. Presence of Hexachlorobenzene as a Manufacturing Byproduct

Hexachlorobenzene is a manufacturing by-product of chlorothalonil. The maximum allowable concentration of HCB in technical grade chlorothalonil is 0.004%. Therefore, HCB would need to be 25,000 times more toxic than chlorothalonil or be found in the environment at 25,000 times higher concentrations to result in risks equivalent to chlorothalonil.

The available data suggest that hexachlorobenzene (HCB) is no more acutely toxic than chlorothalonil and/or SDS-3701 to aquatic or terrestrial animals. U.S. EPA (1988) and WHO (1995) reported that either acute or chronic toxicity to aquatic animals is not expected at levels up to its solubility (approximately 4 – 5 µg/L). The most sensitive acute and chronic aquatic toxicity values used in this assessment for chlorothalonil were approximately 4 µg/L and 0.6 µg/L, respectively.

WHO (1995) reports LD_{50}s in mammals of >2000 mg/kg-bw for HCB. LC_{50}s in birds were 617 ppm in ring-necked pheasants (U.S. FWS, 1975) and 568 ppm in Japanese quail (U.S. FWS, 1986). LD_{50}s were >5000 mg/kg-bw in mallard ducks (U.S. FWS, 1975). These acute avian toxicity reference values are similar to those presented in Section 4 for chlorothalonil and SDS-3701. Effects on reproduction from HCB exposure were observed at levels as low as 20 ppm diet in Japanese quail with no reproductive impairment occurring at 5 ppm. A NOAEC of 20 ppm (1 mg/kg-bw) was reported in a 4-generation reproduction toxicity study in rats (Grant *et al.*, 1977; cited in WHO, 1997). The most sensitive avian and mammalian reproduction endpoints for chlorothalonil or SDS-3701 was 100 ppm (birds) and 120 ppm (6 mg/kg-bw) (mammals). Therefore, HCB was approximately 20-fold and 6-fold more toxic than chlorothalonil or its degradate in birds and mammals, respectively.

Given that the maximum allowable concentration of HCB in technical grade chlorothalonil is 0.004%, the elevated toxicity of HCB to reproduction of birds and mammals relative to chlorothalonil and SDS-3701 is unlikely to result in a detectable contribution to potential ecological risks relative to chlorothalonil and SDS-3701.

However, a primary concern for HCB is bioaccumulation. The fish BCF is approximately 13,000 (CA OEHHA, 2000). The current assessment assumed that the chlorothalonil fish bioconcentration factor (BCF) was approximately 3000 (approximately 4-fold lower than the HCB BCF). The difference in bioaccumulation potential is modest relative to the difference in expected environmental release of chlorothalonil relative to HCB. Therefore, even considering the greater bioaccumulation potential and elevated toxicity of HCB relative to chlorothalonil and SDS-3701, potential ecological risks from HCB are expected to be negligible (unmeasureable in the environment) relative to chlorothalonil and SDS-3701.

6.2.3. Aquatic/Atmospheric Transport/Deposition of SDS-3701

Available data indicate that SDS-3701 is expected to be somewhat more mobile and more persistent that the parent compound, chlorothalonil. Factors affecting the uncertainties associated with both the aquatic and the atmospheric transport and deposition of SDS-3701 are the same as those affecting the parent compound, chlorothalonil.

6.3 Effects Assessment Uncertainties

6.3.1. Use of Surrogate Species to Represent Sensitivity to Chlorothalonil

Toxicity data for aquatic- or terrestrial-phase amphibians are not available for use in this assessment. Therefore, fish and avian toxicity data, respectively, are used as a surrogate for aquatic- and terrestrial-phase CRLFs. If the surrogate species are substantially more or less sensitive than the CRLF, then risk would be over- or under- estimated, respectively.

6.3.2. Age Class and Sensitivity of Effects Thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. The acute toxicity data for fish are collected on juvenile fish between 0.1 and 5 grams. Aquatic invertebrate acute testing is performed on recommended immature age classes (e.g., first instar for daphnids, second instar for amphipods, stoneflies, mayflies, and third instar for midges).

Testing of juveniles may overestimate toxicity at older age classes for pesticide active ingredients that act directly without metabolic transformation because younger age classes may not have the enzymatic systems associated with detoxifying xenobiotics. In so far as the available toxicity data may provide ranges of sensitivity information with respect to age class, this assessment uses the most sensitive life-stage information as measures of effect for surrogate aquatic animals, and is therefore, considered as protective of the California Red Legged Frog.

6.3.2. Sublethal Effects

For the acute risk assessment, the screening risk assessment relies on the acute mortality endpoint. 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 is used to assess chronic risk. Consideration of additional sublethal data in the assessment 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.

Some sublethal effects have been reported in toxicity studies. However, these effects typically occurred at levels above the lowest NOAEC in fish that was used to derive risk quotients. Also, no data are available to link the sublethal measurement endpoints to direct mortality or diminished reproduction, growth or survival that are used by OPP as assessment endpoints.

6.3.3 Impact of Multiple Stressors on the Effects Determination

The influence of length of exposure and concurrent environmental stressors to the CRLF (i.e., construction of dams and locks, fragmentation of habitat, change in flow regimes, increased sedimentation, degradation of quantity and quality of water in the watersheds of the action area, predators, etc.) will likely affect the species response to chlorothalonil. Additional environmental stressors may affect sensitivity to the fungicide, although there is the possibility of additive/synergistic reactions. Timing, peak concentration, and duration of exposure are critical in terms of evaluating effects, and these factors will vary both temporally and spatially within the action area. Overall, the effect of this variability may result in either an overestimation or underestimation of risk. However, as previously discussed, the Agency's LOCs are intentionally set low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

6.3.4. Potential Exposure to Pesticide Mixtures

As discussed in Section 2.2, this assessment evaluates potential effects resulting from exposure to chlorothalonil and its degradate, SDS-3701. In the environment, multiple chemical stressors may co-occur. Quantifying the uncertainty of the presence of multiple stressors is beyond the scope of this assessment; however, some studies have evaluated potential interactive effects of several limited pesticide mixtures. Studies have reported that pesticide mixtures containing chlorothalonil show increased toxicity, decreased toxicity, and no effect on toxicity relative to toxicity of the individual pesticides within the mixture. Davies and White (1985) did not observe a significant ($p<0.05$) change in toxicity of a chlorothalonil:acephate mixture relative to chlorothalonil toxicity in rainbow trout. DeLorenzo and Serrano (2003) reported that atrazine and chlorothalonil interaction was synergistic in the marine algae, *D. tertiolecta*. EC50s for atrazine and chlorothalonil were 69 ug/L and 64 ug/L, respectively, compared with an EC50 of 18 ug/L for a 1:1 mixture of the two substances. Fernandez-Alba et al (2002) reported synergistic interactions with chlorothalonil and Irgarol 1051 (1:1 ratio) in *Vibrio fischeri* and *Selenastrum capricornotum*, but antagonistic effects in *Daphnia magna*. Teather et al. (2005) reported observing no interactive effects of a mixture of sublethal levels of chlorothalonil, azinphos-methyl, and endosulfan.

As discussed further in **Appendix I,** acute oral toxicity data (i.e., LD50 values) from mammalian studies for formulated products that contain chlorothalonil and one or more additional active ingredients were also evaluated for potential interactive effects. The LD50 values are potentially useful only to the extent that a wild mammal would consume plants or animals immediately after these dietary items were directly sprayed by the product. Given uncertainties associated with the differential rates of degradation, transport, etc. for the active ingredients in the formulation with increasing time post application, a qualitative discussion of potential acute mammalian risk of the multiple-ai product relative to the single chlorothalonil active ingredient is completed (U.S. EPA 2004). While a quantitative evaluation of the data is not possible with currently accepted scientific methods, as a screening tool, a qualitative analysis can be used to indicate if formulated products exhibit interactive effects (e.g., synergism or antagonism).

A review of LD50 values for four multi-ai products (Table 6.1.2) show greater toxicity (lower LD50 values) than the individual active ingredient toxicity based on the LD50 values and percentage of each component. Although the active ingredients are not expected to have similar mechanisms of action, metabolites, or toxicokinetic behavior, based on these evaluations of the best available data and the Agency's existing guidance, it is not possible to conclude that these formulations reflect an independent additive toxicity response and not an interactive effect. It is also possible that materials other than the active ingredients, such as surfactants and/or adjuvants, are contributing to the elevated toxicity of the formulated product.

The LD50s for products that demonstrated elevated toxicity relative to the toxicity of the individual chlorothalinil active ingredient and the associated use sites are in Table 6.1.2.

One of the four products, Fungitrol 2002, is used only in industrial applications such as making of caulk and adhesives, and is not further considered in this assessment. Two products (Tilt Bravo SE and Moncut CL Flowable) are labeled only for use on peanuts, and the remaining product (Quadris Opti) that showed elevated toxicity relative to the active ingredients is labeled for use on beans, peas, ornamental plants, carrots, celery, cucurbits, green onions, bulb onions, and tomatoes. Therefore, potential acute risks to mammals may have been underestimated for these uses. When adjusted for amount of chlorothalonil in the product, the LD50s for these three products were 8- to 16-fold more toxic than technical grade chlorothalonil. The lowest adjusted LD50 was 1331 mg/kg-bw (LD50 of 606 mg/kg-bw adjusted for a 15-gram mammal). The highest EEC for the labeled use of these products is celery with a mammalian short grass EEC of 1507 mg/kg-bw (See Section 3). Therefore, the highest RQs for this product could be as high as 1.1, which is equivalent to the RQ for this use for the degradate SDS-3701.

Data were not located that evaluated the toxicity of these products or these co-ingredients in taxonomic groups other than mammals. Therefore, it is uncertain if potential interactive effects extend beyond mammals.

Table 6.1.2. Toxicity of formulated Products that Showed Elevated Toxicity Relative to Each a.i. component

Product	Co-Formulation	Uses	LD50 of co-ingredient (mg/kg-bw)	Product LD50 (mg/kg-bw)	LD50 adjusted for % chlorothalonil (mg/kg-bw)
Quadris Opti	Chlorothalonil (46%) Azoxystrbin (4.6%)	Beans, peas, lupin, carrots, celery, cucurbits, green onions, bulb onions, tomatoes	Azoxystrobin LD50: >5000	1750 (95% CI: 732 – 4440)	805 (337 – 2042)
Tilt Bravo SE	Chlorothalonil (38.5%) Propiconazole (2.9%)	Peanuts	Propiconazole LD50: 1517 mg/kg-bw	3129 (95% CI: 1750 – 5000)	1205 (674 – 1925)
Moncut CL Flowable	Chlorothalonil (38.6%) Flutolanil (10.3%)	Peanuts	Flutolanil LD50: >5000 mg/kg-bw	1570 (95% CI: 1140 – 2410)	606 (440 – 930)

Together, the data suggest that environmental mixtures that contain chlorothalonil could result in increased toxicity, decreased toxicity, or no change in toxicity of mixtures relative to chlorothalonil. Also, use of three formulated products on commodities listed in Table 6.1.2 could result in risks to mammals that are higher than those discussed in Section 5 of this assessment for chlorothalonil, but are similar to mammalian risks described for the degradate, SDS-3701.

6.4. Use Data

County-level usage data were obtained from California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database. Four years of data (2002 – 2005) were included in this analysis because statistical methodology for identifying outliers, in terms of area treated and pounds applied, was provided by CDPR for these years only. No methodology for removing outliers was provided by CDPR for 2001 and earlier pesticide data; therefore, this information was not included in the analysis because it may misrepresent actual usage patterns. CDPR PUR documentation indicates that errors in the data may include the following: a misplaced decimal; incorrect measures, area treated, or units; and reports of diluted pesticide concentrations. In addition, it is possible that the data may contain reports for pesticide uses that have been cancelled. The CPDR PUR data does not include home owner applied pesticides; therefore, residential uses are not likely to be reported. As with all pesticide use data, there may be instances of misuse and misreporting. The Agency made use of the most current, verifiable information; in cases where there were discrepancies, the most conservative information was used.

6.5. Action Area

An example of an important simplifying assumption that may require future refinement is the assumption of uniform runoff characteristics throughout a landscape. It is well documented that runoff characteristics are highly non-uniform and anisotropic, and become increasingly so as the area under consideration becomes larger. The assumption made for estimating the aquatic Action Area (based on predicted in-stream dilution) was that the entire landscape exhibited runoff properties identical to those commonly found in agricultural lands in this region. However, considering the vastly different runoff characteristics of: a) undeveloped (especially forested) areas, which exhibit the least amount of surface runoff but the greatest amount of groundwater recharge; b) suburban/residential areas, which are dominated by the relationship between impermeable surfaces (roads, lots) and grassed/other areas (lawns) plus local drainage management; c) urban areas, that are dominated by managed storm drainage and impermeable surfaces; and d) agricultural areas dominated by Hortonian and focused runoff (especially with row crops), a refined assessment should incorporate these differences for modeled stream flow generation. As the zone around the immediate (application) target area expands, there will be greater variability in the landscape; in the context of a risk assessment, the runoff potential that is assumed for the expanding area will be a crucial variable (since dilution at the outflow point is determined by the size of the expanding area). Thus, it important to know at least some approximate estimate of types of land use within that region. Runoff from forested areas ranges from 45 – 2,700% less than from agricultural areas; in most studies, runoff was 2.5 to 7 times higher in agricultural areas (e.g., Okisaka *et al*., 1997; Karvonen *et al*., 1999; McDonald *et al*., 2002; Phuong and van Dam 2002). Differences in runoff potential between urban/suburban areas and agricultural areas are generally less than between agricultural

and forested areas. In terms of likely runoff potential (other variables – such as topography and rainfall – being equal), the relationship is generally as follows (going from lowest to highest runoff potential):
Three-tiered forest < agroforestry < suburban < row-crop agriculture < urban.

There are, however, other uncertainties that could serve to counteract the effects of the aforementioned issue. For example, the dilution model considers that 100% of the agricultural area has the chemical applied, which is almost certainly a gross over-estimation. Thus, there will be assumed chemical contributions from agricultural areas that will actually be contributing only runoff water (dilutant); so some contributions to total contaminant load will really serve to lessen rather than increase aquatic concentrations. In light of these (and other) confounding factors, the Agency believes that this model gives us the best available estimates under current circumstances.

6.6 General Uncertainties

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

When evaluating the significance of this risk assessment's direct/indirect and habitat modification effects determinations, it is important to note that pesticide exposures and predicted risks to the 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 CRLF life stages within specific recovery units and/or designated critical habitat within the action area. 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 species.

- Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase frogs. While existing information provides a preliminary picture of the types of food sources utilized by the frog, 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 frogs and potential modification to critical habitat.

7. Addressing the Risk Hypotheses

In order to conclude this risk assessment, it is necessary to address the risk hypotheses defined in Problem Formulation (Section 2.9). Based on the results of this assessment, several hypotheses can be rejected, meaning that they are not of concern for the CRLF. However, several of the original hypotheses cannot be rejected, meaning that the statements represent concerns in terms of effects of chlorothalonil on the CRLF.

Based on the results of this assessment, the following hypotheses <u>can</u> be rejected:

- Labeled uses of chlorothalonil within the action area may indirectly affect the CRLF or modify designated critical habitat by reducing or changing the composition of the terrestrial plant community (i.e., riparian habitat) required to maintain acceptable water quality and habitat in the ponds and streams comprising the species' current range and designated critical habitat;

- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by reducing or changing upland habitat within 200 ft of the edge of the riparian vegetation necessary for shelter, foraging, and predator avoidance.

- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by reducing or changing dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.

- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by reducing or changing breeding and non-breeding aquatic habitat (via modification of water quality parameters, habitat morphology, and/or sedimentation).

Based on the results of this assessment, the following hypotheses <u>can not</u> be rejected.

- Labeled uses of chlorothalonil within the action area may directly affect the CRLF by causing mortality or by adversely affecting growth or fecundity;

- Labeled uses of chlorothalonil within the action area may indirectly affect the CRLF by reducing or changing the composition of food supply;

- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by reducing the food supply required for normal growth and viability of juvenile and adult CRLFs;

- Labeled uses of chlorothalonil within the action area may modify the designated critical habitat of the CRLF by altering chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs.

- Labeled uses of chlorothalonil within the action area may indirectly affect the CRLF or modify designated critical habitat by reducing or changing the composition of the aquatic plant community in the ponds and streams comprising the species' current range and designated critical habitat, thus affecting primary productivity and/or cover;

8. Summary of Direct and Indirect Effects to the California Red Legged Frog and Modification to Designated Critical Habitat for the California Red Legged Frog

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 the CRLF and its designated critical habitat. A summary of the risk conclusions and effects determination for the CRLF and its designated critical habitat, given the uncertainties discussed in Section 6, is presented in Tables 7.1 and 7.2.

Based on estimated environmental concentrations for the currently registered uses of chlorothalonil, RQ values are above the Agency's LOC for direct acute and chronic effects on the CRLF. There is also potential for chlorothalonil to adversely affect the CRLF by affecting its prey base. RQs exceed the LOC for acute and chronic risks to aquatic invertebrates and for acute risk to terrestrial invertebrates. When considering the prey of larger CRLF in aquatic and terrestrial habitats (e.g. frogs, fish and small mammals), RQs for these taxa also exceed the LOC for acute and chronic risk. Based on these LOC exceedances, the initial effect determination is “may affect.” Consideration of factors such as dietary behavior of the CRLF relative to surrogate species used in risk estimation, variability in tested species sensitivity to chlorothalonil, and potential magnitude of effect was used to further define the effect determination as “likely to adversely affect,” based on direct effects to the CRLF in its aquatic and terrestrial habitats as well as indirect effects to the CRLF through effects to its prey in aquatic and terrestrial habitats (See Section 5.2). In addition, labeled uses of chlorothalonil within the action area may result in modification of designated critical habitat of the CRLF by altering chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.

RQ values for terrestrial plants and aquatic vascular plants do not exceed LOCs; therefore, indirect effects to the CRLF through effects on aquatic vascular plants and terrestrial habitats is a “no effect” (NE) determination.

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.

Table 8.1. Chlorothalonil and SDS-3701 use-specific direct effects determinations[1,2] for the CRLF

Use	Aquatic-phase		Terrestrial-phase	
	Acute	Chronic	Acute[3]	Chronic[4]
Peanuts	LAA	LAA	LAA	LAA
Passion fruit	LAA	NE	LAA	LAA
Onions (green, seed)	LAA	LAA	LAA	LAA
Shallots	LAA	LAA	LAA	LAA
Conifers	LAA	LAA	LAA	LAA
Potatoes	LAA	LAA	LAA	LAA
Dry beans	LAA	LAA	LAA	LAA
Corn	LAA	LAA	LAA	LAA
Blueberries	LAA	LAA	LAA	LAA
Grass grown for seed or hay	LAA	LAA	LAA	LAA
Cucurbits	LAA	LAA	LAA	LAA
Filberts, almonds, pistachios	LAA	LAA	LAA	LAA
Asparagus	LAA	LAA	LAA	LAA
Bulb onions	LAA	LAA	LAA	LAA
Stone fruits and cherries	LAA	LAA	LAA	LAA
Snap beans	LAA	LAA	LAA	LAA
Carrots	LAA	LAA	LAA	LAA
Garlic	LAA	LAA	LAA	LAA
Tomatoes	LAA	LAA	LAA	LAA
Cole crops	LAA	LAA	LAA	LAA
Celery	LAA	LAA	LAA	LAA
Roses	LAA	LAA	LAA	LAA
Turf	LAA	LAA	LAA	LAA
Pachysandra	LAA	LAA	LAA	LAA
Ornamentals	LAA	LAA	LAA	LAA
Sod farms	LAA	LAA	LAA	LAA
Golf courses	LAA	LAA	LAA	LAA

1 LAA = likely to adversely affect; NE = no effect; NLAA = not likely to adversely affect
2 Effects determinations include chlorothalonil and SDS-3701
3 Acute risks to CRLF from exposure to chlorothalonil were below the endangered species concern level; LAA determination was based on potential risk to SDS-3701, assuming 40% formation rate.
4 Chronic LOC was exceeded for both chlorothalonil and SDS-3701

Table 8.2. Chlorothalonil use-specific indirect effects determinations[1] based on effects to prey.

Use	Non-vascular plant	Aquatic Invertebrates		Terrest. Invert. (Acute)	Aquatic phase amphibians and fish		Terrestrial-phase frogs		Small Mammals	
		Acute	Chronic		Acute	Chronic	Acute[2]	Chronic[3]	Acute[2]	Chronic[3]
Peanuts	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	NLAA	LAA
Passion fruit	NE	LAA	LAA	NLAA	NLAA	NE	NLAA	LAA	NLAA	LAA
Onions (green, seed)	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Shallots	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Conifers	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Potatoes	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Dry beans	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Corn	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Blueberries	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Grass grown for seed or hay	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	NLAA	LAA
Cucurbits	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Filberts, almonds, pistachios	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Asparagus	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Bulb onions	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Stone fruits and cherries	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Snap beans	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Carrots	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Garlic	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Tomatoes	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Cole crops	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Celery	LAA	LAA	LAA	NLAA	LAA	LAA	NLAA	LAA	LAA	LAA
Roses	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Turf	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Pachysandra	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Ornamentals	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Sod farms	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA
Golf courses	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA

[1] LAA = likely to adversely affect; NLAA = not likely to adversely affect; NE = no effect
[2] Effects determination for chlorothalonil was "no effect"; LAA and NLAA determination is for SDS-3701.
[3] Chronic LOC was exceeded for both chlorothalonil and SDS-3701

Table 8.3. Chlorothalonil Effects Determination Summary for the CRLF (Direct and Indirect Effects)

Assessment Endpoint	Effects	NLAA/LAA Discrimination[1]	Basis
Aquatic Phase			
1. Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases (eggs, larvae, tadpoles, juveniles and adults)	Acute direct effects	LAA	RQs exceeded the endangered species LOC for all uses. EECs exceeded the most sensitive LC_{50} for all uses except passion fruit and peanuts.
	Chronic direct effects	LAA	The chronic LOC was exceeded for all uses except passion fruit. The 60-day EEC exceeded the LOAEC (level at which 12% reduction in number of eggs per spawn relative to controls occurred) for all uses except passion fruit and peanuts.
2. Survival, growth, and reproduction of CRLF individuals via indirect effects to prey (freshwater invertebrates)	Acute direct effects to freshwater invertebrates	LAA	RQs ranged from 0.72 to 78. The peak EEC exceeded the most sensitive LC_{50} for all uses except passion fruit. RQs based on 50th percentile LC_{50} of approximately 40 µg/L would be 0.5 or higher for all uses except passion fruit and peanuts.
	Chronic direct effects to freshwater invertebrates	LAA	The lowest RQ was 3.7 (passion fruit); the highest RQ was >400 (golf course).
3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat and/or primary productivity (i.e. aquatic plant community)	Direct effects to aquatic non-vascular plants	LAA	RQs for green algae exceeded the LOC for all uses except passion fruit; RQs for diatoms exceed the LOC for all uses except passion fruit and peanuts.
	Direct effects to aquatic vascular plants	NE	No LOCs were exceeded for vascular plants.
	Direct effects to aquatic emergent vascular plants	NE	No LOCs were exceeded for aquatic vascular plants or for terrestrial plants.
Terrestrial Phase			
4. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	Acute direct effects	LAA (SDS-3701 only)	The endangered species LOC was exceeded for conifers, bulb onions, stone fruits, garlic, tomatoes, celery, pachysandra, and golf courses.
	Chronic direct effects	LAA	LOCs were exceeded for all uses for chlorothalonil and SDS-3701
5. Survival, growth, and reproduction of CRLF individuals via indirect effects on prey (i.e., terrestrial invertebrates, small terrestrial vertebrates)	Acute direct effects to most sensitive prey	LAA	Potential effect to mammals and terrestrial invertebrates could be of sufficient magnitude to adversely affect CRLFs for a number of uses.
	Chronic direct effects to most sensitive prey	LAA	Both chlorothalonil and SDS-3701 could affect small vertebrates to an extent that could adversely affect the CRLF for all uses.
6. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (i.e. riparian vegetation)	Direct effects to monocots	NE	No LOCs were exceeded.
	Direct effects to dicots	NE	No LOCs were exceeded.

[1] Potential effects to CRLFs will be influenced by many factors, and potential exposures and risks are not expected to be uniformly distributed in the environment

Table 8.4. Effects Determination Summary for the Critical Habitat Impact Analysis

Assessment Endpoint	Effects Determination	Basis
Aquatic Phase PCEs (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)		
Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.	No effect	Chlorothalonil did not affect terrestrial plants at levels that exceed the maximum labeled application rate.
Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.[1]	Habitat modification	Aquatic non-vascular plant LOCs were exceeded for green algae and diatoms.
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	Habitat modification	RQs exceeded for acute and chronic effects to prey items (invertebrates, fish, aquatic phase amphibians)
Reduction and/or modification of aquatic-based food sources for pre-metamorphose (*e.g.,* algae)	Habitat modification	Non-vascular plant LOCs were exceeded
Terrestrial Phase PCEs (Upland Habitat and Dispersal Habitat)		
Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or drip line surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance	No effect	Chlorothalonil did not affect terrestrial plants at levels that exceed the maximum labeled application rate.
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal	No effect	
Reduction and/or modification of food sources for terrestrial phase juveniles and adults	Habitat modification	Chlorothalonil and/or its degradate could affect prey items of the CRLF (terrestrial invertebrates, terrestrial vertebrates, terrestrial-phase amphibians).
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	Habitat modification	Chlorothalonil poses acute and chronic risk to prey items of the CRLF (terrestrial invertebrates, mice, terrestrial-phase frogs).

[1] Physico-chemical water quality parameters such as salinity, pH, and hardness are not evaluated because these processes are not biologically mediated and, therefore, are not relevant to the endpoints included in this assessment.

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