Risks of Dimethoate Use to the Federally-Listed California Red Legged Frog
(*Rana aurora draytonii*)

Pesticide Effects Determination

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Table of Contents

ACKNOWLEDGEMENT 3

TABLE OF CONTENTS 4

APPENDICES 5

ATTACHMENTS 5

LIST OF FIGURES 5

LIST OF TABLES 6

1. EXECUTIVE SUMMARY 9

1. EXECUTIVE SUMMARY 9

2. PROBLEM FORMULATION 15

2.1 PURPOSE 15
2.2 SCOPE 17
2.3 PREVIOUS ASSESSMENTS 18
2.4 STRESSOR SOURCE AND DISTRIBUTION 19
2.4.1 Environmental Fate and Transport Assessment 19
2.4.2 Mechanism of Action 22
2.4.3 Use Characterization 22
2.5 ASSESSED SPECIES 25
2.5.1 Distribution 26
2.5.2 Reproduction 31
2.5.3 Diet 32
2.5.4 Habitat 32
2.6 DESIGNATED CRITICAL HABITAT 33
2.7 ACTION AREA 35
2.8 ASSESSMENT ENDPOINTS AND MEASURES OF ECOLOGICAL EFFECT 39
2.8.1 Assessment Endpoints for the CRLF 39
2.8.2. Assessment Endpoints for Designated Critical Habitat 40
2.9 CONCEPTUAL MODEL 42
2.9.1 Risk Hypotheses 42
2.9.2 Diagram 43
2.10 ANALYSIS PLAN 46
2.10.1. Measures to Evaluate the Risk Hypothesis and Conceptual Model 47

3. EXPOSURE ASSESSMENT 51

3.1 AQUATIC EXPOSURE ASSESSMENT 51
3.1.1 Existing Water Monitoring Data for California 51
3.1.2. Modeling Approach 53
3.1.3. Aquatic Modeling Results 61
3.2. TERRESTRIAL EXPOSURE ASSESSMENT 63
3.2.1. Modeling Approach 63
3.2.2. Terrestrial Animal Exposure Modeling Results 65
3.2.3. Spray Drift Modeling 67

4. EFFECTS ASSESSMENT 70

4.1. EVALUATION OF AQUATIC FRESHWATER ECOTOXICITY STUDIES FOR DIMETHOATE 71
4.1.1. Toxicity to Freshwater Fish 73
4.1.2. Toxicity to Aquatic-phase Amphibians 73
4.1.3. Toxicity to Freshwater Invertebrates 73

4.1.4. Toxicity to Aquatic Plants *73*
4.2. Evaluation of Terrestrial Ecotoxicity Studies for Dimethoate 74
4.2.1. Toxicity to Birds *77*
4.2.2. Toxicity to Terrestrial-phase Amphibians *77*
4.2.3. Toxicity to Mammals *77*
4.2.4. Toxicity to Terrestrial Invertebrates *77*
4.2.5. Toxicity to Terrestrial Plants *77*
4.3. Comparison of toxicities of dimethoate and omethoate 78
4.3.1. Aquatic organisms *78*
4.3.2. Terrestrial organisms *78*
5.1. Risk Estimation 80
5.1.1. Exposures in the Aquatic Habitat *80*
5.1.2. Exposures in the Terrestrial Habitat *84*
5.2. Risk Description 88
5.2.1. Direct Effects *89*
5.2.2. Indirect Effects (through effects to prey) *101*
5.2.3. Indirect Effects (through effects to habitat) *112*
5.2.4. Primary Constituent Elements of Designated Critical Habitat *113*
5.2.5. Action Area *114*
5.2.6. Description of Assumptions, Limitations, Uncertainties, Strengths and Data Gaps *122*
5.2.7. Addressing the Risk Hypotheses *127*

6. CONCLUSIONS 128

7. REFERENCES 130

Appendices

Appendix A. Use Closure Memo for Dimethoate
Appendix B. Analysis of dimethoate use in California over 2001-2005
Appendix C. Detailed analysis of final dimethoate action area and overlap of action area with CRLF core areas and critical habitat
Appendix D. Output files from PRZM/EXAMS modeling
Appendix E. Example output from T-REX v.1.3.1 model
Appendix F. List of citations accepted and rejected by ECOTOX criteria
Appendix G. The Risk Quotient Method and Levels of Concern
Appendix H. Ecological incidents associated with dimethoate
Appendix I. Output from T-HERPS v.1.0 model
Appendix J. Individual Effect Analysis
Appendix K. Review of ECOTOX database for dimethoate and omethoate

Attachments

Attachment 1: Status and Life History of California Red-legged Frog
Attachment 2: Baseline Status and Cumulative Effects for the California Red-legged Frog

List of Figures

Figure 1. Historical Extent (2002) of dimethoate usage. 25
Figure 2. Recovery Unit, Core Area, Critical Habitat, and Occurrence Designations for CRLF. 30
Figure 3. CRLF Reproductive Events by Month. 31

Figure 4. Initial area of concern for crops described by agricultural landcover which corresponds to potential dimethoate use sites. This map represents the area potentially directly affected by the federal action. 37
Figure 5. Initial area of concern for crops described by orchard, vineyard and forestry landcover which corresponds to potential dimethoate use sites. This map represents the area potentially directly affected by the federal action. 38
Figure 6. Conceptual model for potential effects of dimethoate on the aquatic phase of the California red-legged frog. 43
Figure 7. Conceptual model for the potential effects of dimethoate on the terrestrial phase of the California red-legged frog. 44
Figure 8. Conceptual model for the potential effects of dimethoate on aquatic components of the California red-legged frog critical habitat. 45
Figure 9. Conceptual model for the potential effects of dimethoate on terrestrial components of the California red-legged frog critical habitat. 46
Figure 10. CDPR reported concentrations of dimethoate in surface waters in CA (includes detections and non-detections, which are represented as 0). 53
Figure 11. Chance of individual mortality to terrestrial-phase CRLF when considering acute dose-based RQs. 97
Figure 12. Chance of individual mortality to terrestrial-phase CRLF when considering acute dietary-based RQs. 98
Figure 13. Final action area for crops described by agricultural landcover which corresponds to potential dimethoate use sites. This map represents the area potentially directly and indirectly affected by the federal action. 117
Figure 14. Final action area for crops described by orchard, vineyard and forest landcover which corresponds to potential dimethoate use sites. This map represents the area potentially directly and indirectly affected by the federal action. *Within recovery units. 118

List of Tables

Table 1. Dimethoate Effects Determination Summary for the California Red-legged Frog. 12
Table 2. Potential risks directly to prey of CRLF due to dimethoate exposures from specific uses (yes or no).* 13
Table 3. Environmental fate and transport data for dimethoate. 19
Table 4. Foliar dissipation data for dimethoate. 21
Table 5. Methods and rates of application of currently registered used of dimethoate in California. 24
Table 6. California Red-legged Frog Recovery Units with Overlapping Core Areas and Designated Critical Habitat. 28
Table 7. Dimethoate uses and their respective GIS landcovers used to depict the initial dimethoate area of concern for this assessment. 36
Table 8. Summary of Assessment Endpoints and Measures of Ecological Effects for Direct and Indirect Effects of Dimethoate on the California Red-legged Frog. 40
Table 9. Summary of Assessment Endpoints and Measures of Ecological Effect for Primary Constituent Elements of Designated Critical Habitat. 41
Table 10. Agency risk quotient (RQ) metrics and levels of concern (LOC) per risk class. 50
Table 11. PRZM scenario assignments according to uses of dimethoate. 54
Table 12. PRZM/EXAMS input parameters. 57
Table 13. Use specific parameters used to model aquatic EECs using PRZM/EXAMS. 58
Table 14. Application dates for PRZM/EXAMS simulations for modeling associated with dimethoate uses. 59

Table 15. One-in-ten-year dimethoate EECs for aquatic environments from the application of dimethoate to uses in California. 62
Table 16. Input parameters for foliar applications used to derive terrestrial EECs for dimethoate with T-REX. 64
Table 17. Upper-bound Kenaga nomogram EECs for dietary- and dose-based exposures of the CRLF and its prey to dimethoate. 66
Table 18. Scenario and standard management input parameters for simulation of dimethoate in spray drift using AgDisp with Gaussian far-field extension. 68
Table 19. AgDrift Input parameters that vary with crop and formulation are used for estimating drift from one application of dimethoate. 68
Table 20. Distance from the edge of the treated field to get below LOC for crops with aerial spray application of dimethoate. 69
Table 21. Summary of most sensitive toxicity endpoint for assessing direct and indirect effects of dimethoate to CRLF in aquatic habitats. Study classifications based on EFED's ecotoxicity database. 72
Table 22. Categories of Acute Toxicity for Aquatic Organisms. 72
Table 23. Summary of most sensitive toxicity for assessing direct and indirect effects of dimethoate to CRLF in terrestrial habitats. Study classifications based on EFED's ecotoxicity database. 75
Table 24. Categories for mammalian acute toxicity based on median lethal dose in mg per kilogram body weight (parts per million). 76
Table 25. Categories of avian acute oral toxicity based on median lethal dose in milligrams per kilogram body weight (parts per million). 76
Table 26. Categories of avian subacute dietary toxicity based on median lethal concentration in milligrams per kilogram diet per day (parts per million). 76
Table 27. Comparison of toxicities of technical dimethoate and omethoate to aquatic organisms (units in mg/L). 78
Table 28. Comparison of acute oral toxicities (LD_{50}, units in mg/kg) of technical dimethoate and omethoate to birds. 79
Table 29. Risk Quotient values for acute and chronic exposures directly to the CRLF in aquatic habitats. 81
Table 30. Risk Quotient values for indirect effects to aquatic-phase CRLF due to effects to its prey. 83
Table 31. Acute and chronic, dietary-based RQs and dose-based RQs for direct effects to the terrestrial-phase CRLF. RQs calculated using T-REX. 85
Table 32. RQs for determining indirect effects to the terrestrial-phase CRLF through effects to potential prey items, specifically terrestrial invertebrates. 86
Table 33. RQs for determining indirect effects to the terrestrial-phase CRLF through effects to potential prey items, specifically terrestrial mammals. 87
Table 34. Revised dose-based RQs[1] for 1.4 g CRLF consuming different food items. EECs calculated using T-HERPS. 91
Table 35. Revised dose-based RQs[1] for 37 g CRLF consuming different food items. EECs calculated using T-HERPS. 92
Table 36. Revised dose-based RQs[1] for 238 g CRLF consuming different food items. EECs calculated using T-HERPS. 93
Table 37. Revised acute dietary-based RQs[1] for CRLF consuming different food items. EECs calculated using T-HERPS. 94
Table 38. Single aerial application rate not exceeding acute LOC for dietary- and dose-based exposures of the CRLF to dimethoate. 95
Table 39. Single ground application rate not exceeding acute LOC for dietary- and dose-based exposures of the CRLF to dimethoate. 96
Table 40. Revised chronic dietary-based RQs[1] for CRLF consuming different food items. EECs calculated using T-HERPS. 100

Table 41. RQs and associated likelihood of individual effects to aquatic invertebrates due to dimethoate exposures. 102
Table 42. Acute dose-based RQs and associated likelihood of individual effects to terrestrial mammals due to dimethoate exposures. 105
Table 43. Acute dose-based RQs and associated likelihood of individual effects to terrestrial-phase frogs (prey) due to dimethoate exposures. 107
Table 44. Acute dietary-based RQs and associated likelihood of individual effects to terrestrial-phase frogs (prey) due to dimethoate exposures. 109
Table 45. Potential for risk to prey of CRLF due to dimethoate exposures from specific uses (yes or no). This information is used to determine whether effects of dimethoate on these prey will indirectly affect the CRLF 111
Table 46. Down stream dilution factors used to determine extent of lotic action area for uses of dimethoate. 114
Table 47. Quantitative results of spatial analysis of lotic aquatic action area relevant to dimethoate uses (in km). 115
Table 48. Spray drift distances used to determine extent of action area for uses of dimethoate. 115
Table 49. Overlap between CRLF habitat (core areas and critical habitat) and agricultural action area by recovery unit (RU#). 119
Table 50. Overlap between CRLF habitat (core areas and critical habitat) and orchard, vineyard and forestry action area by recovery unit (RU#). 119
Table 51. Reported county level uses of dimethoate in California during 2002-2005 and their relation to presence or absence of CRLF critical habitat or core areas within the county. 120
Table 52. 1-in-10 year peak estimates of dimethoate concentrations in aquatic and terrestrial habitats resulting from deposition of dimethoate at 0.102 µg/L dimethoate in rain. 125

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 use of dimethoate on agricultural and non-agricultural sites. In addition, this assessment evaluates whether these actions can be expected to result in the destruction or 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 (i.e. the EPA) 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.

Dimethoate is nationally registered for over 40 uses in agriculture and ornamental production. Aerial applications are allowed for all uses, with the exception of citrus, Brussels sprouts, and outdoor nursery. From 2001-2005, the percentage of total dimethoate use in California was highest on alfalfa (19.7% of total use), tomato (13.5%), beans (11.3%), broccoli (10.6%), corn (9.3%), citrus (8.4%), lettuce (7.5%) and cotton (7.1%). Use data from 2001-2005 for California indicate that dimethoate is applied throughout the year, with the majority of applications occurring during the summer months (June-August). The overall annual average for reported uses in California over this three year period was 249,405 lbs.

The environmental fate properties of dimethoate along with monitoring data identifying its presence in surface waters in California indicate that dimethoate has the potential to be transported to non-target areas. In this assessment, transport of dimethoate from initial application sites via runoff and spray drift are considered in deriving quantitative estimates of dimethoate exposure to CRLF, its prey and its habitats.

Since CRLFs exist within aquatic and terrestrial habitats, exposure of the CRLF, its prey and its habitats to dimethoate are assessed separately for the two habitats. Tier-II exposure models (PRZM and EXAMS) are used to estimate high-end exposures to aquatic habitats resulting from runoff and spray drift from different uses. Peak model-estimated aquatic environmental concentrations, resulting from different dimethoate uses, range from 0.1 to 20.3 µg/L. These estimates are supplemented with analysis of available California surface water monitoring data from U. S. Geological Survey's National Water Quality Assessment (NAWQA) program and the California Department of Pesticide Regulation. The maximum concentration of dimethoate reported by NAWQA from 2001-2006 for California surface waters is 0.158 µg/L. This value is two orders of magnitude less than the maximum model-estimated environmental concentration (which corresponds to use on cottonwoods), but is within the range of environmental concentrations estimated for different uses. The maximum concentration of dimethoate reported by the California Department of Pesticide Regulation surface water database from 1991-2005

(11.31 µg/L) is on the same order of magnitude when compared to the highest peak model-estimated environmental concentration.

The T-REX model is used to estimate dimethoate exposures to terrestrial-phase CRLF, its potential prey and its habitat resulting from uses involving foliar applications. T-HERPS is used to further characterize exposures of terrestrial-phase CRLF to dietary and dose-based exposures of dimethoate resulting from foliar applications. AgDRIFT and AGDISP are also used to estimate deposition of dimethoate on terrestrial and aquatic 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 and/or modification of its habitat. Direct effects to the CRLF in the aquatic habitat are based on toxicity information for freshwater fish, which are generally 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 CRLF's prey items and designated critical habitat requirements in the aquatic habitat are dependant on the availability of freshwater aquatic invertebrates 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 insects, small terrestrial mammals and frogs. Indirect effects due to modification of the riparian and terrestrial habitats could not be quantitatively characterized since measurement endpoints were unavailable for terrestrial monocotyledenous and dicotyledonous plants; however, indirect effects to the terrestrial habitat are qualitatively characterized.

Dimethoate's primary mode of action as an insecticide is through inhibition of acetylcholine esterase. Dimethoate is moderately toxic to freshwater fish and very highly toxic to freshwater invertebrates on an acute exposure basis. Toxicity categories for aquatic plants have not been defined; however, if classification for animals were applied to aquatic plants, dimethoate would be classified as very highly toxic to unicellular aquatic plants. The no observed adverse effect concentration (NOAEC) for chronic effects to the rainbow trout is 0.43 mg/L, with a lowest observed adverse affect concentration (LOAEC) of 0.84 mg/L for a reduction in growth. Available chronic toxicity data for aquatic invertebrates (waterfleas) indicate effects to reproduction, survival and growth at 0.1 mg/L. In order to adjust this chronic endpoint for the most sensitive aquatic invertebrate species under acute exposure conditions, the acute-to-chronic ratio (ACR) is used to determine an adjusted NOAEC for stonefly of 0.0005 mg/L. Dimethoate is very highly toxic to birds on an acute oral exposure basis, moderately toxic on a subacute dietary exposure basis and highly toxic to mammals on an acute oral exposure basis. Dimethoate is also very highly toxic to honey bees on an acute contact exposure basis. Chronic exposures of Northern bobwhite quail to dimethoate indicate reproductive effects with a NOAEC of 4 ppm and a LOAEC of 10.1 ppm. Chronic exposures of rats to dimethoate in a developmental neurotoxicity study indicate a NOAEL of 0.1 mg/kg-bw/day corresponding to a LOAEL of 0.5 mg/kg-bw/day for pup death and brain cholinesterase inhibition.

Dimethoate degrades into one notable degradate, omethoate (also known as dimethoxon). Omethoate was not detected in any of the laboratory studies examining the environmental fate of dimethoate but was detected in terrestrial field and foliar dissipation studies. Since laboratory studies did not provide data with which to estimate the formation and decline of the omethoate, no half-lives are available with which to populate PRZM/EXAMS to estimate aquatic exposure. Exposure to omethoate residues on terrestrial forage items are discussed qualitatively in this assessment. Toxicity data for omethoate indicate that this oxon is more toxic than the parent dimethoate on an acute exposure basis to aquatic invertebrates and mammals, but of similar toxicity to fish and birds, which represent the surrogates of the CRLF. Given that acute and chronic risk quotients are exceeded for the parent compound alone, any contribution in toxicity from omethoate would increase the risk estimates.

Risk quotients (RQs) are derived as quantitative estimates of potential high-end risk. Acute and chronic RQs are compared to the Agency's Levels of Concern (LOCs) for Federally-listed threatened (listed) species to identify if dimethoate use within the action area has any direct or indirect effect on the CRLF and its designated critical habitat. Based on terrestrial estimated environmental concentrations for the currently registered uses of dimethoate, RQ values exceed the Agency's LOC for direct acute and chronic risk to the CRLF; this represents a "may affect" determination. RQs exceed the LOC for acute and chronic risks to aquatic invertebrates and for acute risks to terrestrial invertebrates. Therefore, there is a potential to indirectly affect juvenile and adult CRLFs due to effects on the invertebrate prey base in aquatic and terrestrial habitats. The effects determination for indirect effects to the CRLF due to effects on its prey base is "may affect." When considering the prey of larger CRLFs in aquatic and terrestrial habitats (*e.g.* frogs, fish and small mammals), RQs for terrestrial-phase frogs and small mammals also exceed the LOC for acute and chronic risks, resulting in a "may affect" determination. RQ values for unicellular plants in aquatic habitats do not exceed the LOC. Risk of dimethoate use on riparian and terrestrial vegetation cannot be discounted given the lack of terrestrial plant toxicity data. Therefore, the determination for indirect effects to the CRLF through effects to its habitat is "may affect."

All "may affect" determinations are further refined using available evidence to determine whether dimethoate is "not likely to adversely affect" (NLAA) or "likely to adversely affect" (LAA) the CRLF. Additional evidence employed to distinguish between NLAA and LAA determinations includes available monitoring data, reports of ecological incidents and likelihood of individual mortality analysis.

Refinement of all "may affect" determinations results in: a "LAA" determination based on direct effects to the terrestrial-phase CRLF, a "LAA" determination for indirect effects to the CRLF based on effects to its prey and a "LAA" determination for indirect effects to the CRLF based on effects to its habitat (**Table 1**). **Table 2** includes information on whether specific uses of dimethoate pose risks to specific taxa of CRLF prey. Consideration of CRLF critical habitat indicates a determination of "habitat modification" for aquatic and terrestrial designated critical habitats. **The overall CRLF effects determination for dimethoate use is "LAA."**

Table 1. Dimethoate Effects Determination Summary for the California Red-legged Frog.

Assessment Endpoint	Effects Determination[1]	Basis for Determination
Direct effects to CRLF	LAA	-Based on a lack of LOC exceedances by acute and chronic RQs, direct effects to the CRLF in aquatic habitats are not expected for any use of dimethoate. -Refined acute and chronic RQs for the terrestrial-phase CRLF exceed the LOC for all uses of dimethoate. -Analysis of individual effects (considering acute dose-based exposures) indicates that the chance of individual mortality to terrestrial-phase CRLF ranges from 1 in 180 individuals to 1 in 1 individuals. -EECs resulting from spray drift exposures are sufficient to exceed the acute LOC for terrestrial-phase CRLF at distances >990 feet. -Refined chronic EECs (estimated using T-HERPS) are sufficient to exceed the LOAEC for reproductive effects. -For all uses of dimethoate, the effects determination is LAA based on acute and chronic exposures of dimethoate to the terrestrial-phase CRLF.
Indirect effects to tadpole CRLF via reduction of prey (*i.e.*, algae)	NE	-RQs do not exceed the LOC for algae. Therefore, applications of dimethoate are not expected to affect this food source.
Indirect effects to juvenile CRLF via reduction of prey (*i.e.*, invertebrates)	LAA	-Table 2 includes information on whether specific uses of dimethoate pose risks to specific taxa of CRLF prey. -Acute and chronic RQs for aquatic invertebrates and acute RQs for terrestrial invertebrates exceed the LOCs. -Estimates of individual chance of effects to aquatic invertebrates indicate that acute exposures of dimethoate result in ≤1.1% chance of mortality to aquatic invertebrate individuals. Based on this analysis, acute effects to aquatic invertebrates are insignificant to CRLF. - Comparison of chronic aquatic EECs to the LOAEC for aquatic invertebrates indicates that the majority of EECs are sufficient to exceed the LOAEC. -Estimates of individual chance of effects to terrestrial invertebrates indicate that acute exposures of dimethoate result in approximately 100% chance of mortality to terrestrial invertebrate individuals. -Chronic effects to aquatic invertebrates and acute effects to terrestrial invertebrates have the potential to result in indirect effects to the CRLF.
Indirect effects to adult CRLF via reduction of prey (*i.e.*, invertebrates, fish, frogs, mice)	LAA	- Table 2 includes information on whether specific uses of dimethoate pose risks to specific taxa of CRLF prey. - Chronic effects to aquatic invertebrates and acute effects to terrestrial invertebrates have the potential to result in indirect effects to the CRLF (see specific explanation in row above). - Based on a lack of LOC exceedances by acute and chronic RQs, direct effects to fish and aquatic-phase frogs are not expected. - There is potential for acute and chronic effects to terrestrial-phase frogs representing prey based on: - LOC exceedances by refined acute RQs for terrestrial-phase frogs; - individual effects analysis the majority of uses of dimethoate have the potential to result in mortality to individual frogs; - LOC exceedances by chronic RQs; - Refined chronic EECs are sufficient to exceed the LOAEC for reproductive effects. - Although acute RQs for mice exceed the LOC, individual effects analysis indicates that acute exposures of mice would only result in mortality that would be significant to the CRLF only for applications of dimethoate to citrus and non-cropland areas adjacent to vineyards. The effects of all other uses are insignificant to the CLRF. RQs exceed the LOC by factors ranging 30X to 2082X. Comparisons of chronic EECs to the LOAEC indicate that EECs are sufficient to exceed the LOAEC for all uses of dimethoate. - Overall, exposures of dimethoate have the potential to decrease populations of several types of prey of the CRLF, indicating that it is likely that uses of dimethoate can adversely affect the CRLF through indirect effects to its prey.
Indirect effects to CRLF via reduction of habitat and/or primary productivity (*i.e.*, plants)	LAA	-Based on RQs for unicellular plants inhabiting aquatic habitats, applications of dimethoate are not expected to affect these plants. -Available data from the literature combined with spray drift deposition modeling suggest that dimethoate could affect plant biomass as far as 390 feet from the edge of the treatment site. -There are two reported incidents involving effects of dimethoate to plants. - Several dimethoate product labels indicate that use of dimethoate at label rates could result in phytotoxicity to several types of plants. -Risks of dimethoate to riparian and terrestrial plants cannot be quantified or discounted.

[1]LAA = likely to adversely affect; NLAA = not likely to adversely affect; NE = no effect

Table 2. Potential risks directly to prey of CRLF due to dimethoate exposures from specific uses (yes or no).*

Use	Algae	Aquatic Invertebrates		Terrestrial Invertebrates (Acute)	Aquatic-phase frogs and fish		Terrestrial-phase frogs		Small Mammals	
		Acute	Chronic		Acute	Chronic	Acute	Chronic	Acute	Chronic
Alfalfa	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
beans	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
broccoli	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Brussels sprouts	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
cauliflower	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
celery	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Chinese cabbage	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
citrus	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes
conifer [1]	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
cotton	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Cottonwood [2]	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Endive (escarole)	No	No	Yes	Yes	No	No	No	Yes	No	Yes
field corn	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
garbanzo beans	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
grass for seed	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
ornamentals	No	No	No	Yes	No	No	No	Yes	No	Yes
honeydew	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
kale	No	No	Yes	Yes	No	No	No	Yes	No	Yes
Kohlrabi	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
lentils	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
lettuce (leaf)	No	No	Yes	Yes	No	No	No	Yes	No	Yes
Lupine	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
melon	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
mustard greens	No	No	Yes	Yes	No	No	No	Yes	No	Yes
Non-cropland[3]	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes
pears	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
peas (succulent)	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
pecans	No	No	Yes	Yes	No	No	No	Yes	No	Yes
peppers	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
popcorn	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
potatoes	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Safflower	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
sainfoin	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
sorghum	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Swiss chard	No	No	Yes	Yes	No	No	No	Yes	No	Yes
tomatoes	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
triticale	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
turnips	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Wheat	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes

*This information is used to determine whether or not effects of dimethoate on prey will indirectly affect the CRLF.

[1]seed orchards [2]For pulp [3]Areas adjacent to vineyards

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. Characterizing 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 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 influence the recovery of prey resources 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.

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 procedures outlined in the Overview Document (U.S. EPA 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 insecticide dimethoate on vegetable crops, fruit, tree nuts, citrus, forage crops, forests and outdoor nurseries. In addition, this assessment evaluates whether these actions can be expected to result in the 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 agreement entered in the Federal District Court for the Northern District of California on October 20, 2006.

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 screening level and species-specific refinements, when appropriate) described in the Agency's Overview Document (U.S. EPA 2004) and evaluated by the U. S. Fish and Wildlife Service (USFWS/NMFS 2004).

In accordance with the Overview Document, provisions of the Endangered Species Act (ESA), and the Services' *Endangered Species Consultation Handbook*, the assessment of effects associated with registrations of dimethoate 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 dimethoate 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.

As part of the "effects determination," one of the following three conclusions will be reached regarding the potential for registration of dimethoate at the use sites described in this document to affect CRLF individuals and/or result in the modification of designated CRLF critical habitat:

- “No effect”;
- “May affect, but not likely to adversely affect”; or
- “May affect and likely to adversely affect”.

Designated critical habitat identifies specific areas that have the physical and biological features, (known as primary constituent elements or PCEs) essential to the conservation of listed species. The PCEs for CRLFs are aquatic and upland areas where suitable breeding and non-breeding aquatic habitat is located, interspersed with upland foraging and dispersal habitat (Section 2.6).

If the results of initial screening-level assessment methods show no direct or indirect effects (no LOC exceedances) upon individual CRLFs or upon the PCEs of the species’ designated critical habitat, a “no effect” determination is made for the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulatory action regarding dimethoate as it relates to this species and its designated critical habitat. If, however, direct or indirect effects to individual CRLFs are anticipated and/or effects may impact the PCEs of the CRLF’s designated critical habitat, a preliminary “may affect” determination is made for the FIFRA regulatory action regarding dimethoate.

If a determination is made that use of dimethoate within the action area(s) associated with the CRLF “may affect” this species and/or its designated critical habitat, additional information is considered to refine the potential for exposure and for effects to the CRLF and other taxonomic groups upon which this species depend (*e.g.,* aquatic and terrestrial vertebrates and invertebrates, aquatic plants, riparian vegetation, etc.). Additional information, including spatial analysis (to determine the overlay of CRLF habitat with dimethoate use) and further evaluation of the potential impact of dimethoate on the PCEs is also used to determine whether modification to 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” from those actions that “may affect and are likely to adversely affect” the CRLF and/or the PCEs of its designated critical habitat. This information is presented as part of the Risk Characterization in Section 5 of this document.

The Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Because dimethoate is expected to directly impact living organisms within the action area (defined in Section 2.7), critical habitat analysis for dimethoate 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 (*i.e.*, the biological resource requirements for the listed species associated with the critical habitat or important physical aspects of the habitat that may be reasonably influenced through biological processes). Activities that may modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the species. Evaluation of actions related to use of dimethoate that may alter the PCEs of the CRLF’s critical habitat form the basis of the critical habitat impact analysis. Actions that may affect the CRLF’s designated critical habitat have been identified by the Services and are discussed further in Section 2.6.

2.2 Scope

Dimethoate is an organophosphate insecticide used to kill mites and insects systemically and on contact. Its mode of action is through inhibition of acetylcholinesterase. It is used against mites and a wide range of insects, including, but not limited to scale insects, thrips, aphids, leaf miners, leaf hoppers, flea hoppers, plant bugs, corn rootworms, lygus bugs, loopers, grasshoppers, alfalfa weevils, planthoppers, fir cone midges, loblolly pine sawflies and whiteflies. Dimethoate is registered for use on 39 crops relevant to California.

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 dimethoate in accordance with the approved product labels for California is "the action" being assessed.

This endangered species assessment is for currently registered uses of dimethoate 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.

This assessment quantitatively considers effects of exposures to dimethoate only. Dimethoate degrades into one notable degradate, omethoate (also known as dimethoxon). Omethoate was not detected in any of the laboratory studies examining the environmental fate of dimethoate but was detected in terrestrial field and foliar dissipation studies. Since laboratory studies did not provide data with which to estimate the formation and decline of the omethoate, no half-lives are available with which to populate PRZM/EXAMS to estimate aquatic exposure. Exposure to omethoate residues on terrestrial forage items are discussed qualitatively in this assessment. Toxicity data for omethoate indicate that the oxon is more toxic than the parent on an acute exposure basis to aquatic invertebrates and mammals, but of similar toxicity to fish and birds, which represent the surrogates for the CRLF. Given that acute and chronic risk quotients are exceeded for the parent compound alone, any contribution in toxicity from omethoate would increase the risk estimates.

This assessment considers only the single active ingredient of dimethoate. However, the assessed species and their environments may be exposed to multiple pesticides simultaneously. Interactions of other toxic agents with dimethoate could result in additive effects, synergistic effects or antagonistic effects. Evaluation of pesticide mixtures is beyond the scope of this assessment because of the myriad factors that cannot be quantified based on the available data. Those factors include identification of other possible co-contaminants and their concentrations, differences in the pattern and duration of exposure among contaminants, and the differential effects of other physical/chemical characteristics of the receiving waters (*e.g.* organic matter present in sediment and suspended water). Evaluation of factors that could influence additivity/synergism is beyond the scope of this assessment and is beyond the capabilities of the available data to allow for an evaluation. However, it is acknowledged that not considering mixtures could over- or under-estimate risks depending on the type of interaction and factors discussed above.

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). Dimethoate does not have any registered products that contain multiple active ingredients.

2.3 Previous Assessments

In January 2004, a revised environmental fate and ecological risk assessment was published in support of the interim reregistration eligibility decision on dimethoate (USEPA 2006). This was a national-level assessment of the risks of dimethoate to aquatic and terrestrial organisms and was intended to update an earlier science chapter (USEPA 1998). The updated assessment concluded that risk to non-listed terrestrial animals from exposure to dimethoate could not be discounted. RQs for non-listed aquatic animals were below the LOC, indicating that risk from dimethoate to these organisms was low. Due to a lack of terrestrial plant and aquatic vascular plant effects data and due to reports of terrestrial plant incidents, risk to plants was presumed.

Because the Agency had determined that dimethoate shares a common mechanism of toxicity with the structurally-related organophosphates insecticides, a cumulative human health risk assessment for the organophosphate pesticides was necessary before the Agency could make a final determination of reregistration eligibility of dimethoate. At this time, a cumulative ecological risk assessment for the organophosphate pesticides has not been completed.

EPA consulted with the U. S. Fish and Wildlife Service in 1989 regarding dimethoate impacts on some endangered species (USFWS 1989). As a result, the U.S. Fish and Wildlife Service issued a formal Biological Opinion which identified reasonable and prudent measures and alternatives to mitigate effects of dimethoate use on endangered species.

EPA also consulted with the National Marine Fisheries Service concerning dimethoate effects on endangered salmon and steelhead. In its assessment, the Agency determined that the use of dimethoate may affect 19 salmon and steelhead evolutionarily significant units (ESUs), may affect but is not likely to adversely affect two ESUs and will have no effect on four ESUs (Williams 2004).

2.4 Stressor Source and Distribution

2.4.1 Environmental Fate and Transport Assessment

As described in the supplement to the environmental fate and ecological risk assessment chapter (U. S. EPA 2004) dimethoate is a highly mobile, generally non-persistent organophosphate insecticide. The primary route of dissipation is microbially-mediated degradation in aerobic soil. Dissipation studies indicate that dimethoate rapidly dissipates from soil and foliar surfaces (**Table 3**). Omethoate was not reported in laboratory fate studies involving degradation of dimethoate. It was, however, observed in terrestrial field dissipation and foliar dissipation studies. Results of fate and transport studies associated with dimethoate are briefly described below.

Table 3. Environmental fate and transport data for dimethoate.

Study	Value	Source
Aerobic Soil Metabolism Half-life	2.4 d	MRID 42843201
Anaerobic Soil Metabolism Half-life	22 d	MRID 42884402
Hydrolysis Half-life	pH 5: 156 d pH 7: 68 d pH 9: 4.4 d	MRID 00159761
Aqueous Photolysis Half-life	353 d	MRID 00159762
Soil Photolysis Half -life	no significant degradation	MRID 43276401
Soil Water Partition Coefficient (K_d)	sand 0.06 L (kg-soil)$^{-1}$ sandy loam: 0.30 L (kg-soil)$^{-1}$ silt loam: 0.57 L (kg-soil)$^{-1}$ clay loam: 0.66 L (kg-soil)$^{-1}$	MRID 00164959
Field Dissipation DT_{50}	CA loamy sand: 11 d CA sandy loam ~ 9 d CA sandy loam: ~16 d TX silt loam ~ 9 d Chenango gravelly silt loam: < 5 d	MRID 42884403 MRID 42884403 MRID 42884403 MRID 43388001 MRID 43388002
Foliar Dissipation Half-life	mean value: 2.8 d	See **Table 5**

Microbial degradation

In an aerobic soil metabolism study, dimethoate degraded rapidly, with a half-life of 2.4 days. The majority of dimethoate residues were composed of carbon dioxide, accounting for >50% of total residues by day 7 of the test and approximately 75% by day 181. Two non-volatile degradates, desmethyl dimethoate and dimethylthiophosphoric acid, were identified but were present at levels less than 2% during the aerobic soil metabolism study.

Under anaerobic soil conditions, dimethoate degrades, with a half-life of approximately 22 days. The major non-volatile degradate was desmethyl dimethoate.

Hydrolysis

Dimethoate hydrolyzes slowly in sterile buffered solutions under acidic (pH 5) conditions, with an observed half life of 156 days. Desmethyl dimethoate was the only degradate observed at this pH (12.2% of total dimethoate residues).

Dimethoate also hydrolyzes slowly in sterile buffered solutions under neutral (pH 7) conditions, with an observed half life of 68 days. Desmethyl dimethoate was the only major degradate observed, comprising 22.1% of the residues at the end of the 30-day observation period. Throughout this study, dimethoate and desmethyl dimethoate comprised <96% of the original dimethoate residues. Dimethoylphosphorothioc acid was also identified as a degradate, comprising 1.9% of dimethoate residues at 30 days.

Under alkaline conditions (pH 9), dimethoate degrades to desmethyl dimethoate and dimethylthiophosphoric acid with a half-life of 4.4 days. One day after test initiation, both degradates were observed. At day 30, desmethyl dimethoate and dimethoylphosphorothioc acid composed 62.1 and 36.0%, respectively, of the total dimethoate residues.

Photolysis

Dimethoate photodegrades slowly in water ($T_{1/2}$ = 353 days). No significant photodegradation occurred in the soil photolysis study.

Mobility

Dimethoate is highly mobile in soil. In a soil column leaching study, 72-100% of applied radioactivity was eluted from the columns (loam, silt loam, sandy loam, and sand). Calculated K_d values based on these column studies ranged from 0.06 L kg^{-1} for sand to 0.66 L kg^{-1} for clay loam. Degradate mobility has not been well defined; however, based on the aged leaching data as well as the metabolism data, degradates are not expected to persist and move through the soil profile.

Volatility

A study measuring the volatility of dimethoate from the soil surface showed this not to be a significant route of dissipation. After 30 days, only 2.7% of the applied radioactivity had volatilized, 0.7% of which was CO_2. The majority of the radioactivity (83%) was extracted from the soil and most of this (93.2%) was dimethoate.

Field Dissipation

The results of five terrestrial field studies indicate that dimethoate dissipates with half-lives ranging 5 and 15 days when applied post-emergence to green beans, grapes, and bare ground in California, grain sorghum in Texas, and bare ground in New York (MRIDs 433880-02, 433880-01 and 428844-03). These results are reasonably consistent with those that might be expected from the laboratory studies although the persistence is somewhat longer in the field studies.

When detected, dimethoate was mostly in the top layer of soil (0-6"), with some detections below 6". Omethoate was detected in the top layer of soil in all five studies. In the California bare ground study, omethoate was found through day 159 of the study.

Foliar Dissipation

Foliar dissipation was assessed using data compiled by Willis and McDowell, 1987. This paper is a summary of data on the persistence of pesticides on foliage. In this document, 28 measurements of dimethoate dissipation on foliage were identified on whole plant or on foliage. Of these, four were completed in Egypt, and it could not be determined whether they were appropriate for assessing foliar dissipation in the United States, so they were not used. For the remaining 24 (**Table 4**), the mean foliar dissipation half-life was 2.8 days, and the upper 90% confidence bound on the mean was 2.9 days. Note that these were all field studies, and that these are dissipation rather than degradation half-lives. In some cases, the author of the study noted when rain occurred during the trial. However, absence of that information in **Table 4** is an indication that the author did not note whether precipitation occurred rather than the absence of precipitation.

Table 4. Foliar dissipation data for dimethoate.

Crop	Author[1]	Comment	$T_{½}$ (days)
apple	Pree et al. 1976		5.4
alfalfa	Shaw and Ziener, 1964		1.4
apple	Pree et al. 1976		7.2
apple	Pree et al. 1976	rained 80 mm	2.6
apple	Pree et al. 1976	rained 11 mm	4.1
birdsfoot trefoil	Shaw and Ziener, 1966		2.1
sorghum	Dorough et al. 1966		4
ladino clover	Shaw and Ziener, 1966		1.8
lemon	Bellows et al., 1985		2.2
coastal bermuda grass	Beck et al., 1966	22.6 mm rain	3.1
corn	Beck et al., 1966	90.2 mm rain	2.7
soybeans	Beck et al., 1966	0 mm rain	0.9
beet	Vail et al., 1967	0 mm rain	2.5
broccoli	Nelson et al., 1966		3
cabbage	Nelson et al., 1966		1.7
chard	Vail et al., 1967	5.1 mm rain	2.6
collards	Nelson et al., 1966		2.5
leaf lettuce	Vail et al., 1967	5.1 mm rain	2.8
lima beans	Nelson et al., 1966		2.2
snap beans	Nelson et al., 1966		2.6
soybeans	Nelson et al., 1966		1.2
turnip	Vail et al., 1967	83.8 mm rain	3.1
turnip	Nelson et al., 1966		3.2
wheat	Lee and Westcott, 1981		2.5

[1]As cited in Willis and McDowell 1987.

In addition to the literature studies, a registrant-submitted study (MRID 464864-01) provided information on the degradation of dimethoate, and the formation and decline of omethoate on ground-level vegetation and canopy arthropods in a mandarin orchard in Spain. The dissipation half-life values for plants and insects were 2.56 and 4.84 days, respectively, for dimethoate. For omethoate the dissipation half-life values for plants and insects were 3.94 and 5.13 days, respectively. This study indicates that omethoate forms in nontarget animal forage items and that at peak levels, these residues were as high as 41% of the parent.

Estimates of foliar dissipation half-lives for total dimethoate residues (which include omethoate) are available from several registrant-submitted studies involving several crops, including wheat (MRIDs 466780-01, 466780-05 and 466780-10) and lettuce (MRID 466780-07). For wheat, foliar dissipation half-lives ranged 3.1 to 7.4 days. For lettuce, the estimated foliar dissipation half-life was 0.98 days. The upper 95% confidence limit for these values is 5.48 days (mean = 3.56, stdev = 2.23). For more information, see Jones and Steeger 2006.

In a dimethoate magnitude of residue study conducted with olives, omethoate residues ranged from 1.1 to 17% of total residues (dimethoate and omethoate) measured on the day of application. After 7 days, omethoate comprised up to 96% of total residues measured on olives (MRID 466780-09).

2.4.2 Mechanism of Action

Dimethoate is an organophosphate insecticide used to kill mites and insects systemically and on contact. Its mode of action is through inhibition of acetylcholinesterase. Organophosphate toxicity is based on the inhibition of the enzyme acetylcholinesterase which cleaves the neurotransmitter acetylcholine. Inhibition of acetylcholinesterase by organophosphate insecticides, such as dimethoate, interferes with proper neurotransmission in cholinergic synapses and neuromuscular junctions.

As a phosphorodithioate organophosphate, the chemical is subject to bioactivation into its oxon form (omethoate) similar to other members of this class. Certain taxonomic groups, such as birds, have been demonstrated to be more sensitive to the oxon compared to the parent compound (Walker 1982). The enhanced sensitivity of birds to this group of bioactivated organophosphate insecticides is potentially due to physiological and biochemical differences among or between birds and other animals (Walker 1982; Chambers and Carr 1995; Brealey et al. 1980). Thus, the rate at which a phosphorodithioate pesticide is transformed to its oxon and the rate at which the oxon is subsequently detoxified can influence toxicity. However, the oxon is potentially orders of magnitude more toxic than the parent compound. It is not possible, however, to gauge the toxicity of the oxon from looking at the parent alone since available studies do not indicate how much of the parent is converted to the oxon.

2.4.3 Use Characterization

Dimethoate is nationally registered for over 40 uses in agriculture and ornamental production. The specific uses and their maximum application rates are identified in **Table 5.** Specific registration numbers associated with dimethoate are available in **Appendix A**. Aerial applications are allowed for all uses, with the exception of citrus, Brussels sprouts, non-cropland areas adjacent to vineyards and outdoor nursery. Dimethoate use on non-cropland areas adjacent to vineyards is permitted according to a special local needs label (SLN # CA-970003) and is relevant only to Napa, Sonoma, Mendocino and Lake counties in northern California.

Pesticide use information from the California Department of Pesticide Regulation (CDPR 2007a), include county-level data for various dimethoate uses from 2002-2005. Past uses of dimethoate include the majority of the uses identified in **Table 5**, as well as uses that are no longer permitted. Analysis of the mass of dimethoate applied with consideration of the application area indicates that applications have been made at or above the maximum application rates identified in **Table 5**. In situations were the use data indicate higher than maximum label application rates, the discrepancy is considered to be most likely due to misreporting.

As of 2002, over 1.4 million pounds of dimethoate were applied annually in the United States; the highest poundage (487,270 lbs) was applied to corn. Alfalfa hay (181,652 lbs) and wheat (122,051 lbs) represented the second and third highest total pounds of dimethoate applied. **Figure 1** depicts the extent of estimated annual dimethoate use nationally as of 2002.

From 2001-2005, the percentage of total dimethoate use in California was highest on alfalfa (19.7% of total use), tomato (13.5%), beans (11.3%), broccoli (10.6%), corn (9.3%), citrus (8.4%), lettuce (7.5%) and cotton (7.1%) (CDPR 2007a). The total annual average for reported uses over this three year period was 249,405 lbs. Use data from 2001-2005 for California indicate that dimethoate is applied throughout the year, with the majority of applications occurring during the summer months (June-August). A more thorough analysis of the 2001-2005 data for applications of dimethoate in California is provided in **Appendix B**.

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for dimethoate represent the FIFRA regulatory action; therefore, labeled use and application rates specified on the label form the basis of this assessment. The assessment of use information is critical to the development of the action area and selection of appropriate modeling scenarios and inputs. Specific uses and their application practices are in **Table 5**.

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

Table 5. Methods and rates of application of currently registered used of dimethoate in California.

Use	Max. App. Rate (lb a.i./acre)	Max. No. of Apps.	Application Intervals (days)
Alfalfa[1]	0.5	1	NA
beans[2]	0.5	2	14
broccoli	0.5	3	7
Brussels sprouts	1	6	7
cauliflower	0.5	3	7
celery	0.5	3	7
Chinese cabbage	0.5	3	7
Citrus	2	unknown	NA
conifer seed orchards	1	1	NA
cotton[2]	0.5	2	14
cottonwood (for pulp)	1	3	unknown
Endive (escarole)	0.25	3	7
field corn	0.5	1	NA
garbanzo beans	0.5	1	NA
grass for seed	0.5	2	90
herbaceous ornamentals	0.25	1	NA
honeydew	0.5	2	7
kale	0.25	2	15
kohlrabi	0.5	3	7
lentils	0.5	2	7
lettuce (leaf)	0.25	3	7
Lupine	0.5	2	unknown
melon	0.5	2	7
mustard greens	0.25	2	9
Non-cropland areas adjacent to vineyards	2	2	unknown
pears	0.5	1	NA
peas (succulent)	0.5	1	NA
pecans	0.33	1	NA
peppers	0.33	5	7
popcorn	0.5	1	NA
potatoes	0.5	2	7
Safflower[1]	0.5	1	NA
sainfoin	0.5	1	NA
sorghum	0.5	2	7
Swiss chard	0.25	3	7
tomatoes	0.5	2	6
triticale	0.5	2	unknown
turnips	0.25	7	3
Wheat[1]	0.5	1	NA

[1]per crop/cutting

[2]per season

NA = not applicable

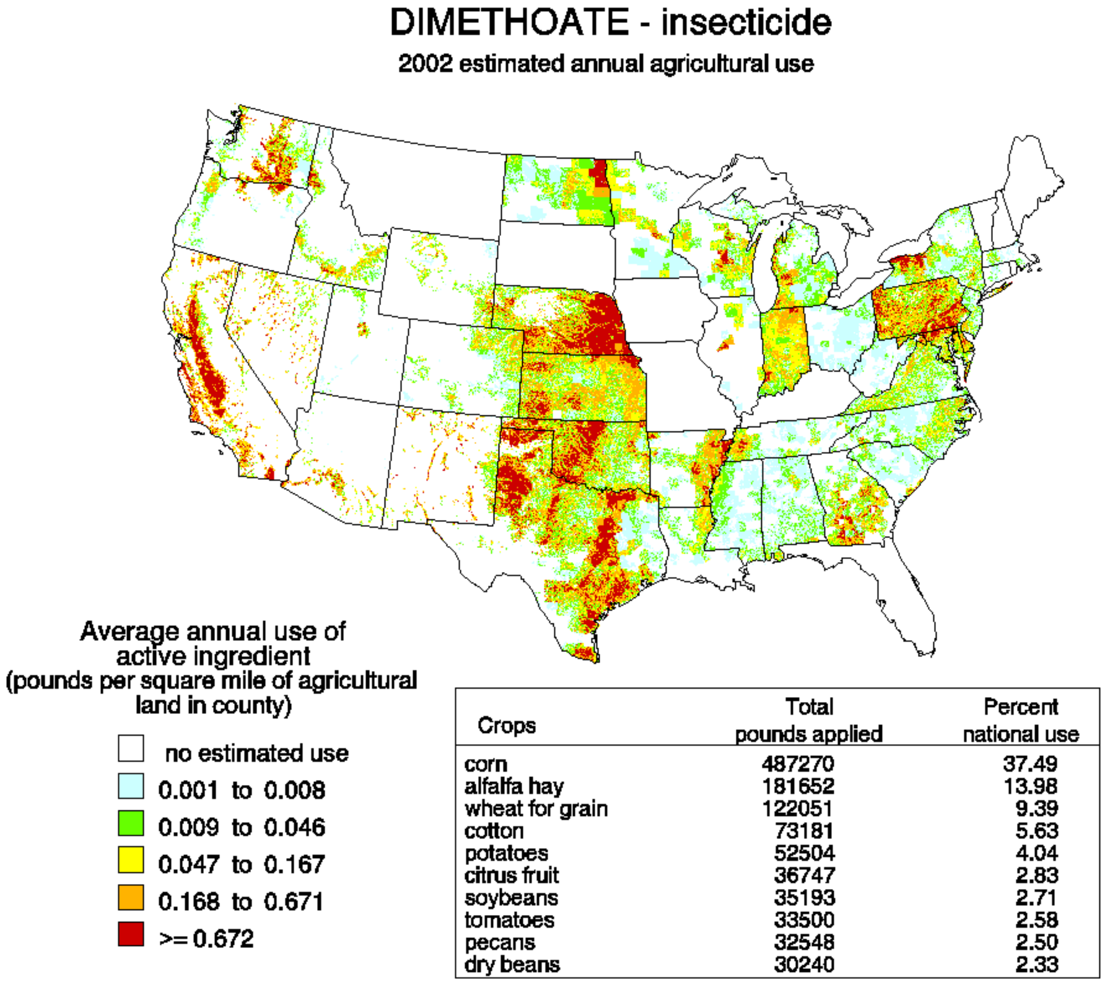


Figure 1. Historical Extent (2002) of dimethoate usage.
(Source http://ca.water.usgs.gov/pnsp/pesticide_use_maps/show_map.php?year=02&map=m6006).

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 elevation 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**). 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 elevation maximum for the species of 1,500 m above sea level. The eight recovery units for the CRLF are listed in **Table 6** and shown in **Figure 2**.

Core Areas

USFWS has designated 35 core areas across the eight recovery units to focus their recovery efforts for the CRLF (see **Figure 2**). **Table 6** 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 location information is evaluated within the broader context of recovery units. For example, if no labeled uses of dimethoate occur (or if labeled uses occur at predicted exposures less than the Agency's LOCs) within an entire recovery unit, that particular recovery unit would not be included in the action area and 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 6** (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.

Other Known Occurrences from the CNDBB

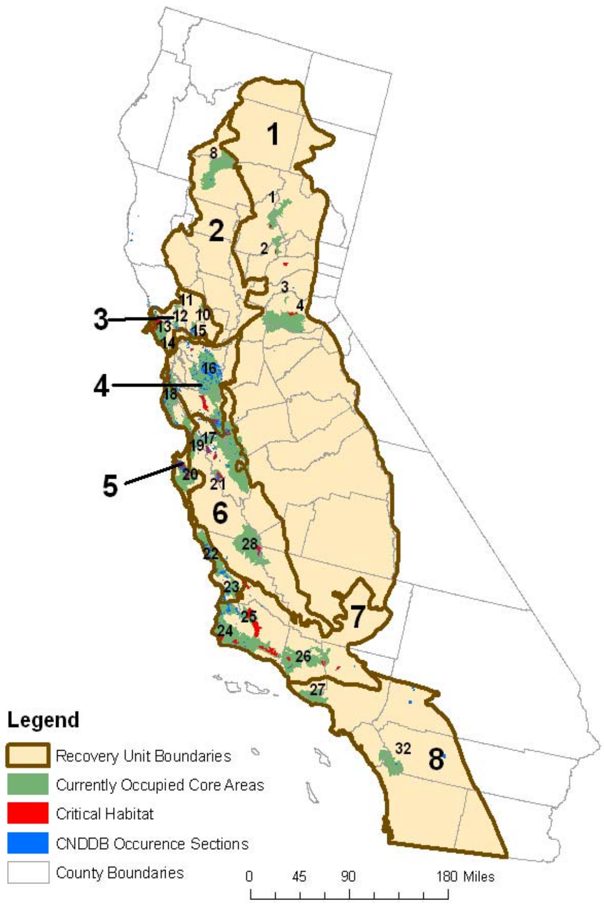
The CNDDB provides location and natural history information on species found in California. The CNDDB serves as a repository for historical and current species location sightings. Information regarding known occurrences of CRLFs outside of the currently occupied core areas and designated critical habitat 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.

Table 6. California Red-legged Frog Recovery Units with Overlapping Core Areas and Designated Critical Habitat.

Recovery Unit [1] (Figure 2)	Core Areas [2,7] (Figure 2)	Critical Habitat Units [3]	Currently Occupied (post-1985) [4]	Historically Occupied [4]
Sierra Nevada Foothills and Central Valley (RU#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 (RU#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 (RU#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 (RU#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 (RU#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)	--	✓	
	--	SLO-8[6]		
	Arroyo Grande Creek (23)	--	✓	
	Santa Maria River-Santa Ynez River (24)	--	✓	
Diablo Range and Salinas Valley (RU#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 (RU#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 (RU#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

Core Areas

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

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

Figure 2. Recovery Unit, Core Area, Critical Habitat, and Occurrence Designations for CRLF.

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 3** depicts CRLF annual reproductive timing.

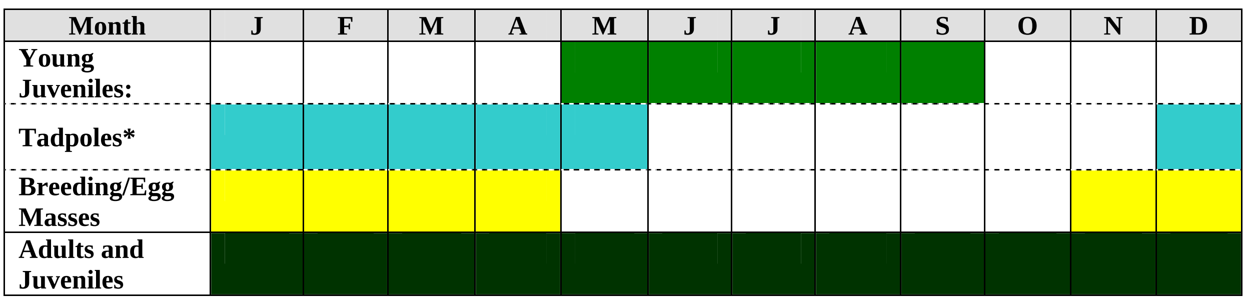


Figure 3. CRLF Reproductive Events by Month.

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), and dense vegetation close to water and shading 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 6**.

'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 the 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 modification standards for designated critical habitat (USFWS 2006). Activities that may modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the species. Evaluation of actions related to use of dimethoate 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 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 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 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 Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Because dimethoate is expected to directly impact living organisms within the action area, critical habitat analysis for dimethoate 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 dimethoate is likely to encompass considerable portions of the United States based on its 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 CRLF 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 dimethoate may be expected to have on the environment, the exposure levels to dimethoate that are associated with those effects, and the best available information concerning the use of dimethoate 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 dimethoate. An analysis of labeled uses and review of available product labels was completed. This analysis indicates that the following uses are considered as part of the federal action evaluated in this assessment: alfalfa, beans, broccoli, Brussels sprouts, cauliflower, celery, Chinese cabbage, cotton, endive (escarole), field corn, garbanzo beans, grass for seed, herbaceous ornamentals, honeydew, kale, kohlrabi, lentils, lettuce, lupine, melon, mustard greens, peas, peppers, popcorn, potatoes, safflower, sainfoin, sorghum, soybeans, Swiss chard, tomatoes, triticale, turnips, wheat, conifer seed orchards, cottonwood, pears, pecans and citrus.

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 typically based on available land cover data. Local land cover data available for the state of California were analyzed to refine the understanding of potential dimethoate uses. 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; 2) orchard, vineyard and forestry landcovers. The specific uses which correspond to each of these landcovers are depicted in **Table 7**. Maps representing the land cover types that make up the initial areas of concern for these separate uses are depicted in **Figures 4 and 5**. These maps represent the areas that may be directly affected by the federal action.

Table 7. Dimethoate uses and their respective GIS landcovers used to depict the initial dimethoate area of concern for this assessment.

GIS layer	Uses
agriculture	alfalfa, beans, broccoli, Brussels sprouts, cauliflower, celery, Chinese cabbage, cotton, endive (escarole), field corn, garbanzo beans, grass for seed, herbaceous ornamentals, honeydew, kale, kohlrabi, lentils, lettuce, lupine, melon, mustard greens, peas, peppers, popcorn, potatoes, safflower, sainfoin, sorghum, soybeans, Swiss chard, tomatoes, triticale, turnips, wheat
Orchard, vineyard and forestry	pears, pecans, citrus, conifer seed orchards, cottonwood, non-cropland areas adjacent to vineyards

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. In this assessment, transport of dimethoate through runoff and spray drift is considered in deriving quantitative estimates of dimethoate exposure to CRLF, its prey and its habitats.

Since this screening level risk assessment defines taxa that are predicted to be exposed through runoff and drift to dimethoate at concentrations above the Agency's Levels of Concern (LOC), the action area is expanded to include areas that are affected indirectly by this federal action. Two methods are employed to define the areas indirectly affected by the federal action, and thus the total action area. These are the down stream dilution assessment for determining the extent of the affected lotic aquatic habitats (flowing water) and the spray drift assessment for determining the extent of the affected terrestrial and lentic aquatic (standing water) habitats. In order to define the final action areas relevant to uses of dimethoate, 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 aquatic habitats (*e.g.* ponds, pools, marshes) overlapping with the terrestrial areas are also indirectly affected by the federal action. **The analysis of areas indirectly affected by the federal action, as well as the determination of the final action area for dimethoate is described in the risk discussion (Section 5.2.5).** Additional analysis related to the intersection of the dimethoate action area and CRLF habitat used in determining the final action area is described in **Appendix C.**

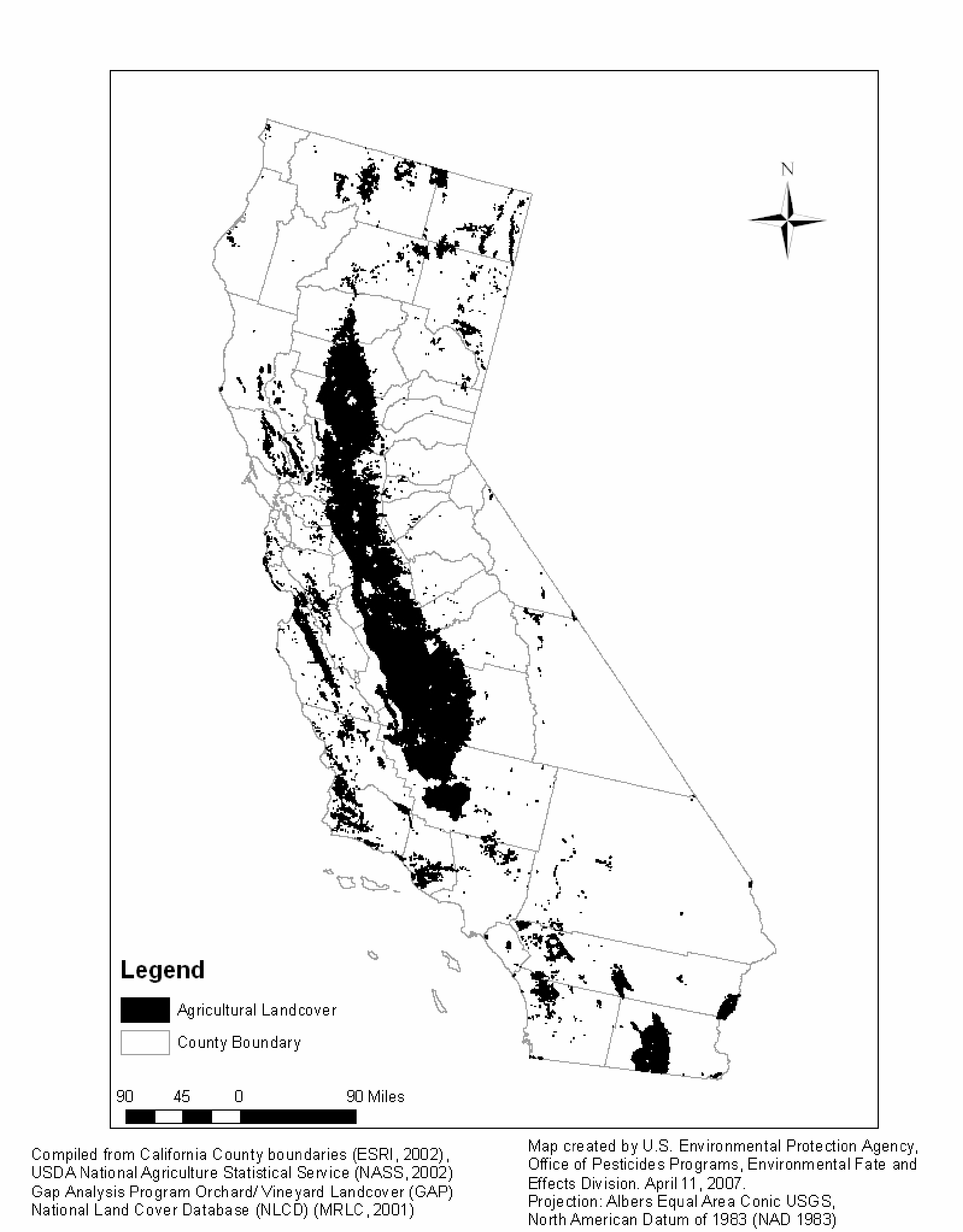
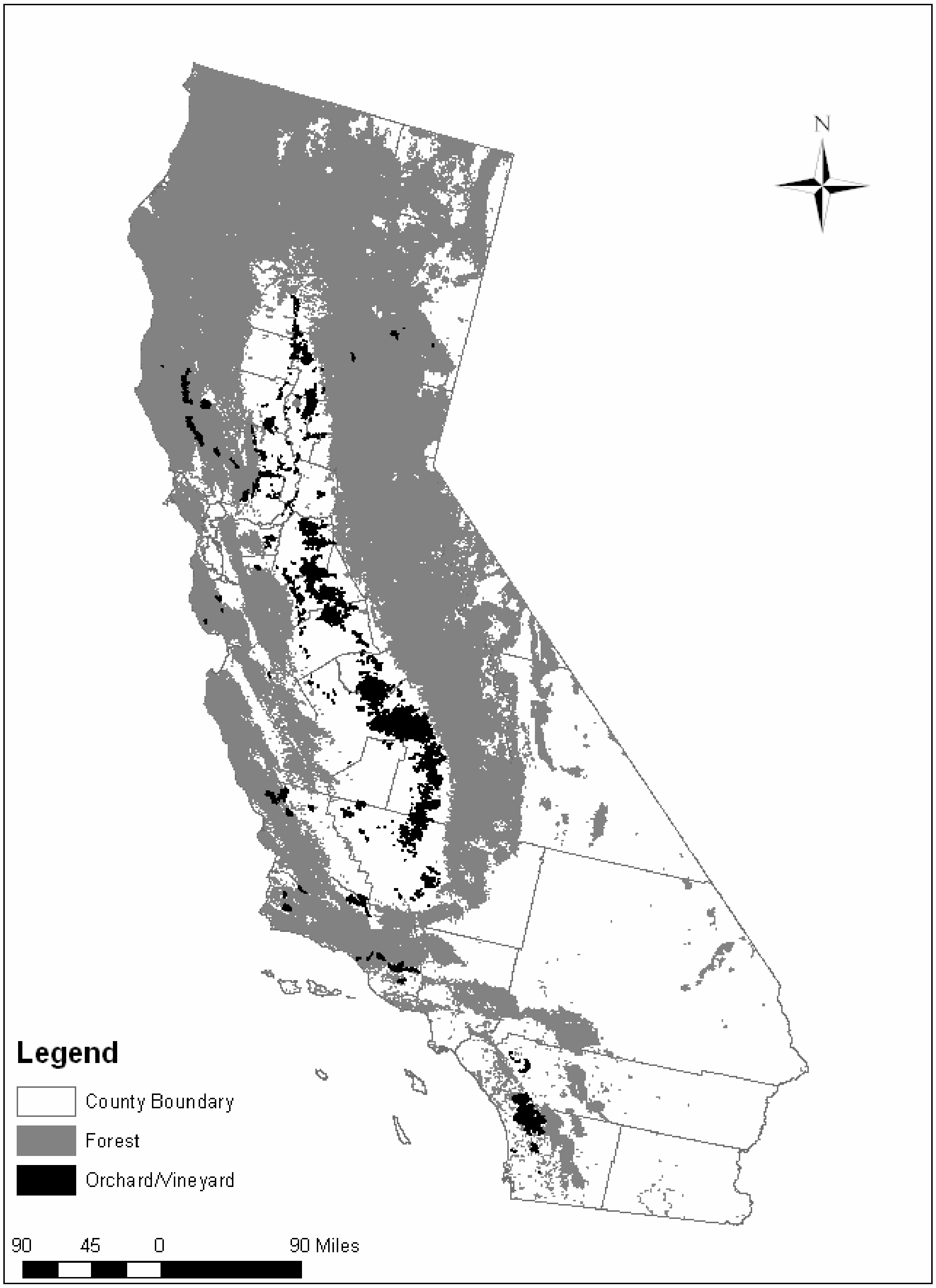


Figure 4. Initial area of concern for crops described by agricultural landcover which corresponds to potential dimethoate use sites. This map represents the area potentially directly affected by the federal action.



Compiled from California County boundaries (ESRI, 2002),
USDA National Agriculture Statistical Service (NASS, 2002)
Gap Analysis Program Orchard/ Vineyard Landcover (GAP)
National Land Cover Database (NLCD) (MRLC, 2001)

Map created by U.S. Environmental Protection Agency,
Office of Pesticides Programs, Environmental Fate and
Effects Division. April 11, 2007.
Projection: Albers Equal Area Conic USGS,
North American Datum of 1983 (NAD 1983)

Figure 5. Initial area of concern for crops described by orchard, vineyard and forestry landcover which corresponds to potential dimethoate use sites. This map represents the area potentially directly affected by the federal action.

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" (USEPA 1992). Selection of the assessment endpoints is based on valued entities (*e.g*., CRLF, organisms important in the life cycle of the CRLF, and the PCEs of its designated critical habitat), the ecosystems potentially at risk (e.g,. water bodies, riparian vegetation, and upland and dispersal habitats), the migration pathways of dimethoate (*e.g.*, runoff, spray drift, *etc*.), and the routes by which ecological receptors are exposed to the pesticide (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 dimethoate is provided in **Table 8**.

Table 8. Summary of Assessment Endpoints and Measures of Ecological Effects for Direct and Indirect Effects of Dimethoate on the California Red-legged Frog.

Assessment Endpoint	Measures of Ecological Effects
Aquatic Phase (eggs, larvae, tadpoles, juveniles, and adults)[a]	
1. Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases	1a. Rainbow Trout LC_{50} 1b. Rainbow Trout NOAEC
2. Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants)	2a. Stonefly acute EC_{50} 2b. Stonefly chronic NOAEC[c] 2c. Algae EC_{50}
3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community)	3a. Algae 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. no data are available for deriving RQs
Terrestrial Phase (Juveniles and adults)	
5. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	5a. Red winged blackbird acute LD_{50} [b] 5b. Ring-necked pheasant subacute LC_{50} [b] 5b. Northern bobwhite quail chronic NOAEC [b]
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)	6a. Honeybee acute contact LD_{50} 6b. Laboratory rat LD_{50} 6c. Laboratory rat chronic NOAEC 6d. Red winged blackbird acute LD_{50} [b] 6e. Ring-necked pheasant subacute LC_{50} [b] 6f. Northern bobwhite quail chronic NOAEC [b]
7. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian vegetation)	7a. no data are available for deriving RQs

[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] Estimated using acute-to-chronic ratio.

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 dimethoate 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 modify critical habitat are those that alter the PCEs and may jeopardize the continued existence of the CRLF. 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 dimethoate effects data are available.

Assessment endpoints and measures of ecological effect selected to characterize potential modification to designated critical habitat associated with exposure to dimethoate are provided in **Table 9**. 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 dimethoate on critical habitat of the CRLF are described in **Table 9**. 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 modification standard established by USFWS (2006).

Table 9. Summary of Assessment Endpoints and Measures of Ecological Effect for Primary Constituent Elements of Designated Critical Habitat.

Assessment Endpoint	Measures of Ecological Effect
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.	Algae EC_{50}
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.*	Algae EC_{50}
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	Rainbow Trout LC_{50} Rainbow Trout NOAEC Stonefly acute EC_{50} Stonefly chronic NOAEC Algae EC_{50}
Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)	Algae EC_{50}
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 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	no data are available for deriving RQs
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	
Reduction and/or modification of food sources for terrestrial phase juveniles and adults	
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	

*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.

2.9 Conceptual Model

2.9.1 Risk Hypotheses

Risk hypotheses are specific assumptions about potential 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 dimethoate to the environment. The following risk hypotheses are presumed for this endangered species assessment:

- Labeled uses of dimethoate within the action area may directly affect the CRLF by causing mortality or by affecting growth or fecundity;
- Labeled uses of dimethoate within the action area may indirectly affect the CRLF by reducing or changing the composition of food supply;
- Labeled uses of dimethoate within the action area may indirectly affect the CRLF and/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 dimethoate within the action area may indirectly affect the CRLF and/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 dimethoate 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 dimethoate 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 dimethoate 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 dimethoate 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 dimethoate 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 (dimethoate), 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 6 and 7**, and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in **Figures 8 and 9**. Exposure routes shown in dashed lines are not quantitatively considered because the resulting exposures are expected to be so low as not to cause effects to the CRLF.

The environmental fate properties of dimethoate along with monitoring data identifying its presence in surface waters and precipitation in California indicate that runoff, spray drift, volatilization and limited atmospheric transport and deposition represent potential transport mechanisms of dimethoate to the aquatic and terrestrial habitats of the CRLF. These transport properties (*e.g*. sources) are depicted in the conceptual models below (**Figures 6-9**) along with the receptors of concern and the potential attribute changes in the receptors due to exposures to dimethoate. Based on available fate and transport data for dimethoate, field dissipation studies and lack of detections of dimethoate in ground water samples, dimethoate is not expected to reach ground water at levels sufficient to be of concern to the CRLF.

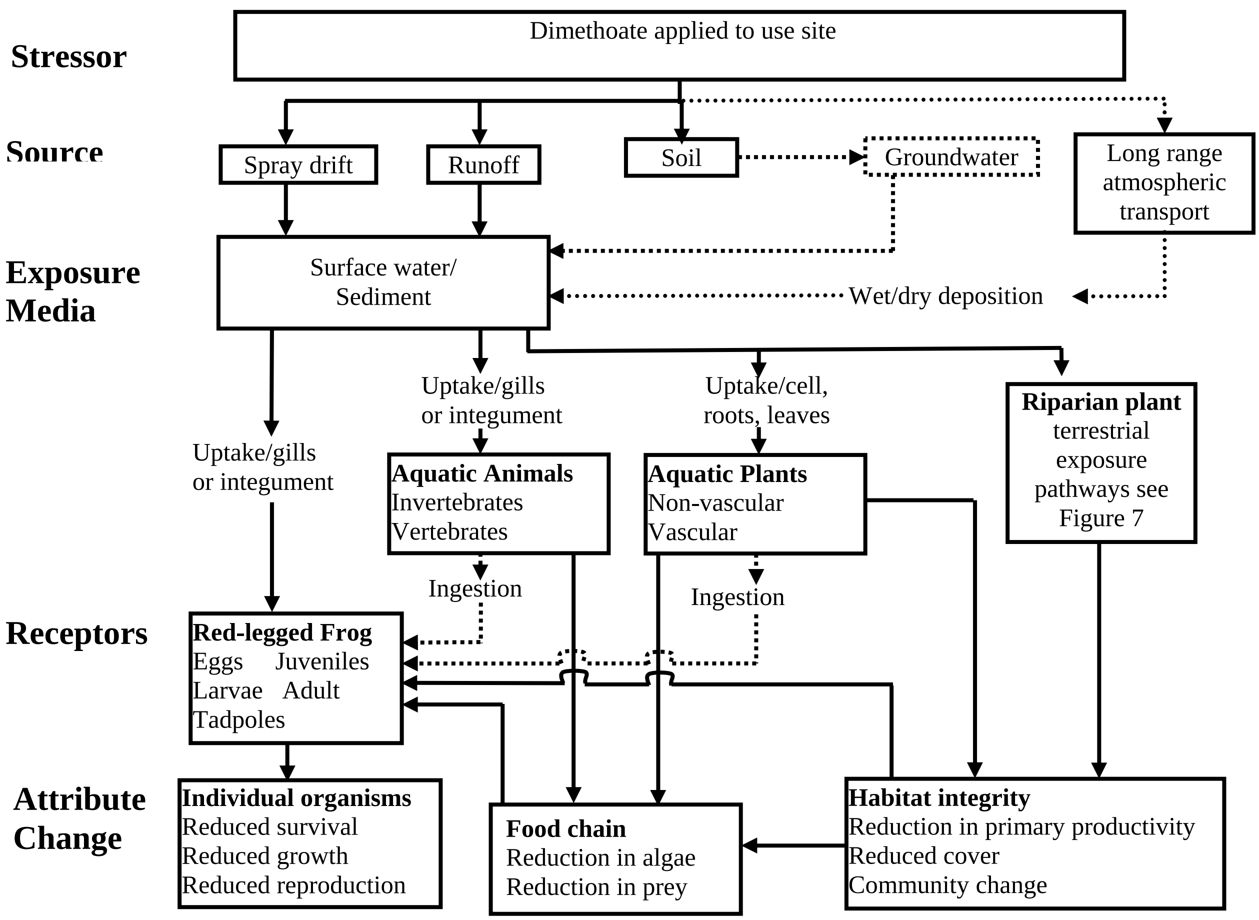


Figure 6. Conceptual model for potential effects of dimethoate on the aquatic phase of the California red-legged frog.

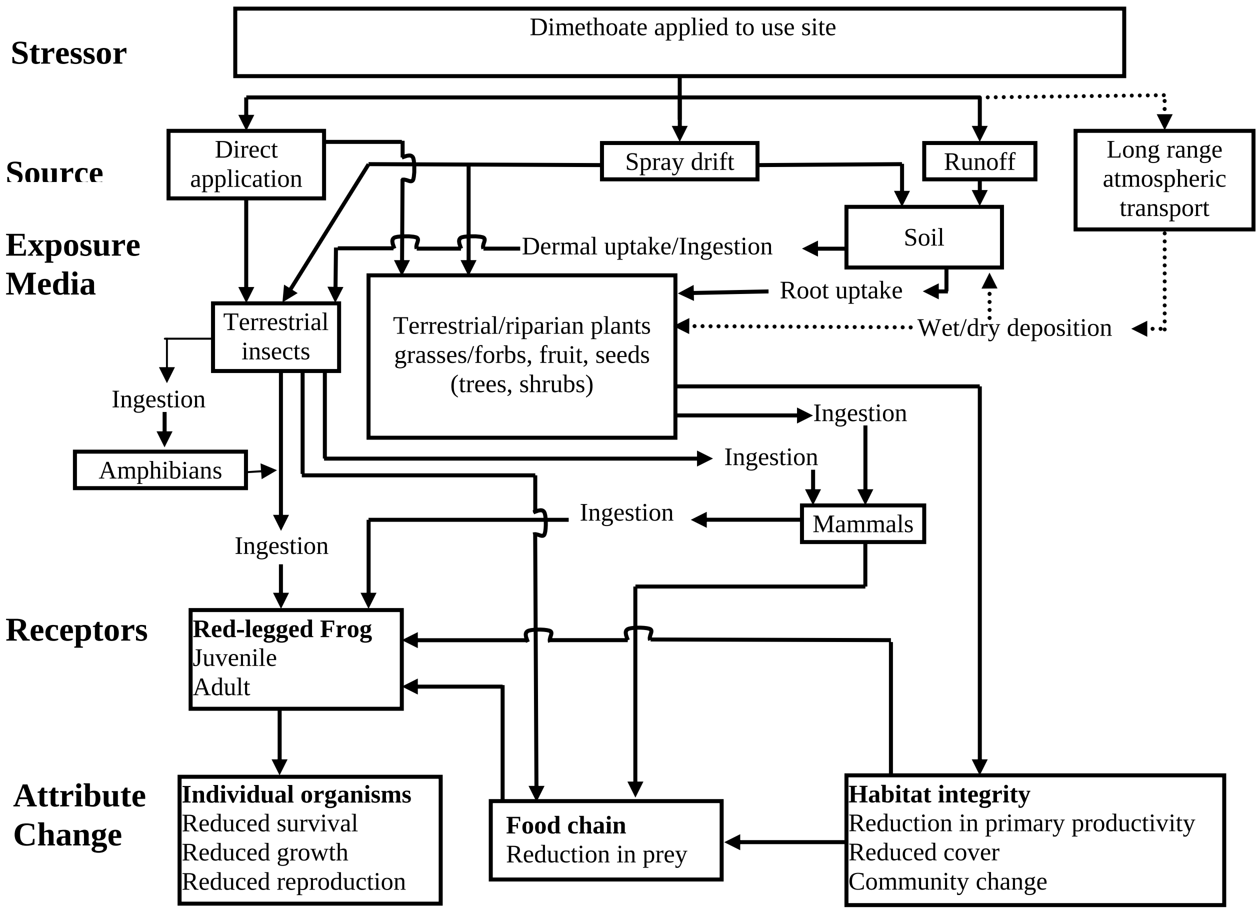


Figure 7. Conceptual model for the potential effects of dimethoate on the terrestrial phase of the California red-legged frog.

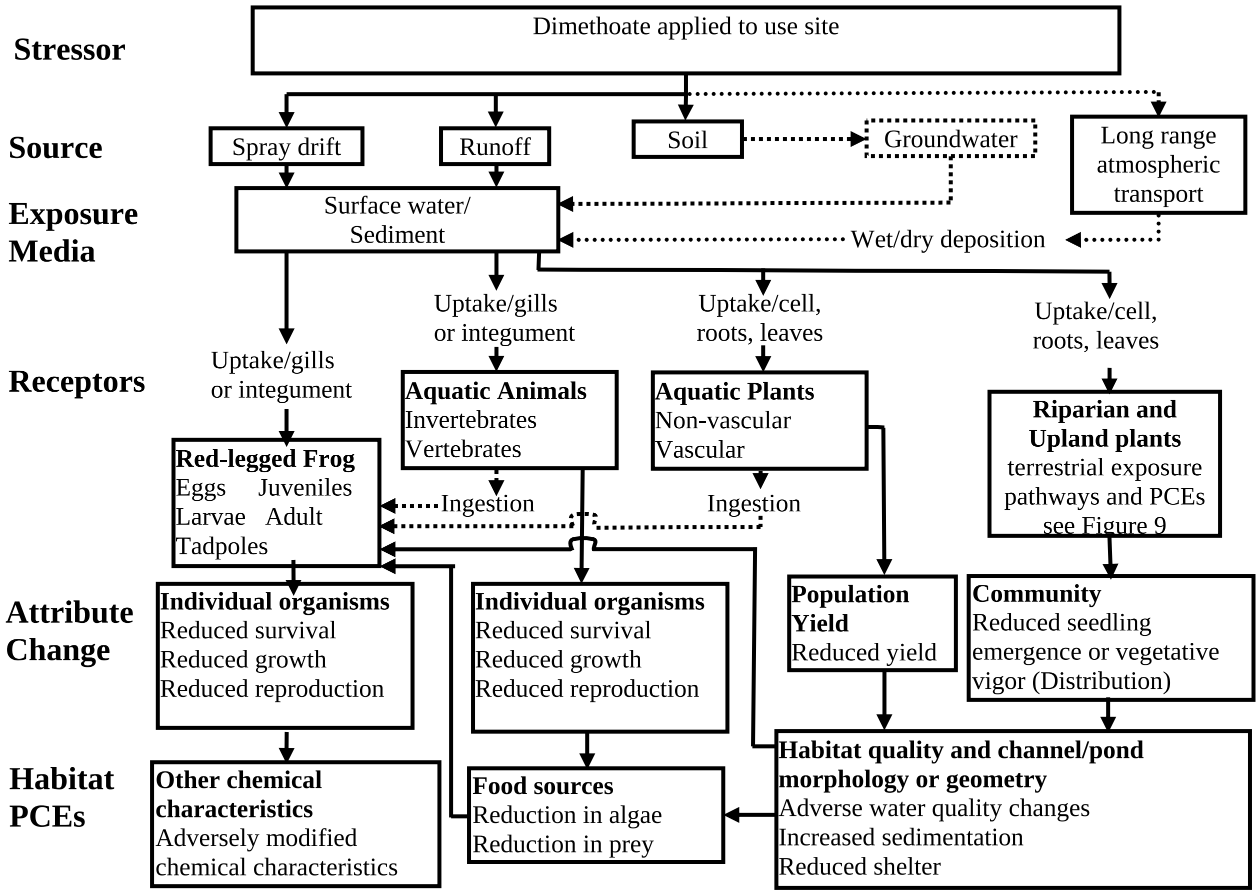


Figure 8. Conceptual model for the potential effects of dimethoate on aquatic components of the California red-legged frog critical habitat.

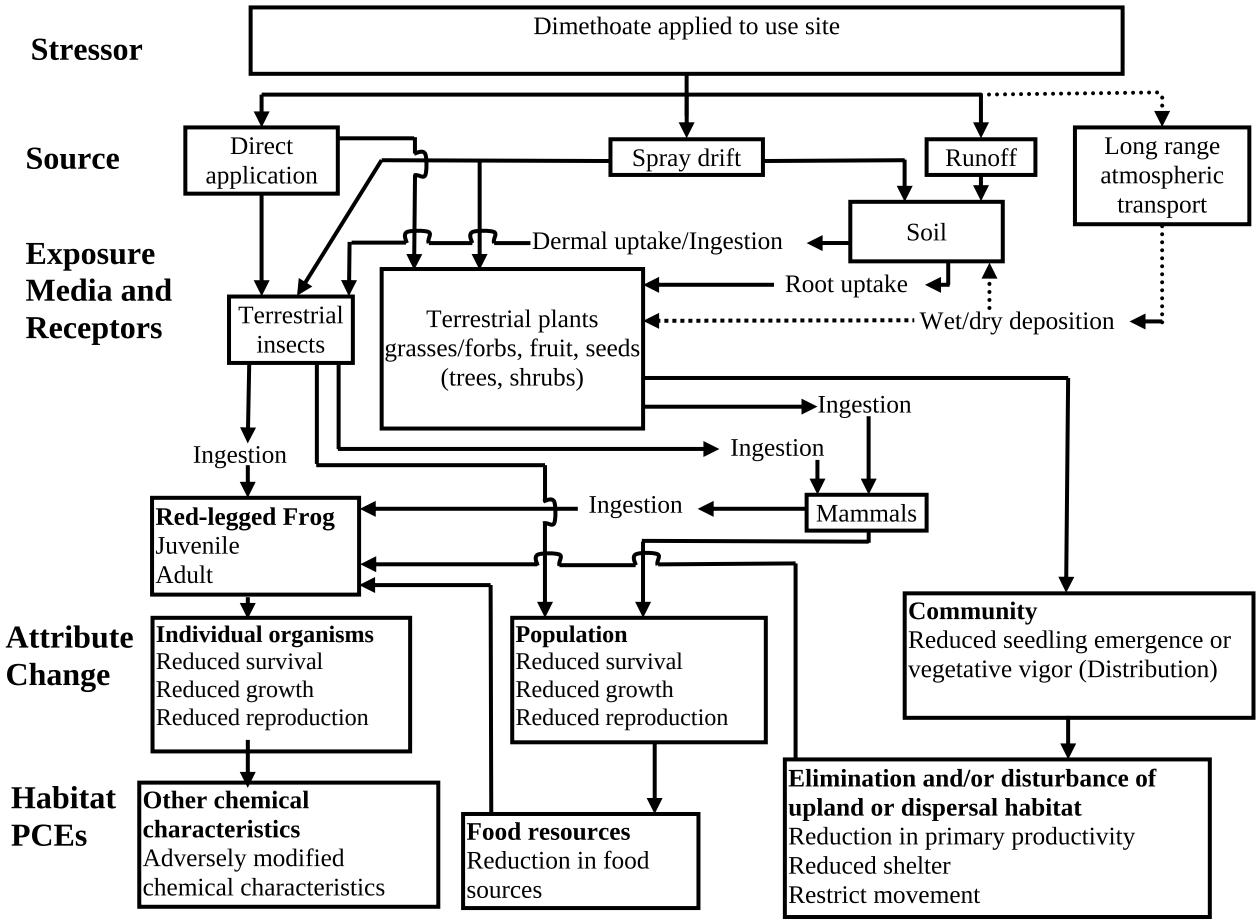


Figure 9. Conceptual model for the potential effects of dimethoate on terrestrial components of the California red-legged frog critical habitat.

2.10 Analysis Plan

In order to address the risk hypothesis, the potential for effects on the CRLF, its prey and its habitat is estimated. In the following sections, the use, environmental fate, and ecological effects of dimethoate are characterized and integrated to assess the risks. This was accomplished using a risk quotient (ratio of exposure concentration to effects concentration) approach. Although risk is often defined as the likelihood and magnitude of ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/or magnitude of an effect. However, as outlined in the Overview Document (USEPA 2004), the likelihood of effects to individual organisms from particular uses of dimethoate is estimated using the probit dose-response slope and either the level of concern (discussed below) or actual calculated risk quotient value.

2.10.1. Measures to Evaluate the Risk Hypothesis and Conceptual Model

2.10.1.1. Measures of Exposure

The environmental fate properties of dimethoate along with monitoring data identifying its presence in surface water, in air and in precipitation in California indicate that spray drift, volatilization, atmospheric transport and subsequent deposition represent potential transport mechanisms of dimethoate to the aquatic and terrestrial habitats of the CRLF. In this assessment, transport of dimethoate through runoff and spray drift is considered in deriving quantitative estimates of dimethoate exposure to CRLF, its prey and its habitats. Although volatilization of dimethoate from treated areas resulting in atmospheric transport and deposition represent relevant transport pathways leading to exposure of the CRLF and its habitats, adequate tools are unavailable at this time to quantify exposures through these pathways. Therefore, volatilization, atmospheric transport and wet and dry deposition from the atmosphere are discussed only qualitatively in this assessment.

Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EECs) of dimethoate 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 was T-REX. These models were parameterized using relevant reviewed registrant-submitted environmental fate data.

PRZM (v3.12.2, May 2005) and EXAMS (v2.98.4.6, April 2005) are screening simulation models coupled with the input shell pe5.pl (Aug 2007) to generate daily exposures and 1-in-10 year EECs of dimethoate that may occur in surface water bodies adjacent to application sites receiving dimethoate 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, 2-meters deep (20,000 m^3 volume) with no outlet. PRZM/EXAMS was used to estimate screening-level exposure of aquatic organisms to dimethoate. 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 chronic exposure for aquatic invertebrates, 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 represented the 95^{th} percentile of residue values from actual 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. These modifications represent the upper bound of the expanded data set. For modeling purposes, direct exposures of the CRLF to dimethoate 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 were used because these categories represent the largest RQs of the size and dietary categories in T-REX that are appropriate surrogates for the CRLF and one of its prey items. Estimated exposures of terrestrial insects to dimethoate are bound by using the dietary-based EECs for small insects and large insects.

Birds are currently used as surrogates for terrestrial-phase CRLF. However, amphibians are poikilotherms (body temperature varies with environmental temperature) while birds are homeotherms (temperature is regulated, constant, and largely independent of environmental temperatures). Therefore, amphibians tend to have much lower metabolic rates and lower caloric intake requirements than birds or mammals. As a consequence, birds are likely to consume more food than amphibians on a daily dietary intake basis, assuming similar caloric content of the food items. Therefore, the use of avian food intake allometric equation as a surrogate for amphibians is likely to result in an over-estimation of exposure and risk for reptiles and terrestrial-phase amphibians. Therefore, T-REX (version 1.3.1) has been refined to the T-HERPS model (v. 1.0), which allows for an estimation of food intake for poikilotherms using the same basic procedure as T-REX to estimate avian food intake.

Two spray drift models, AGDISP and AgDRIFT were used to assess exposures of terrestrial-phase CRLF and its prey to dimethoate deposited in spray drift. AGDisp (version 8.13; dated 12/14/2004) (Teske and Curbishley, 2003) is used to simulate aerial and ground applications using the Gaussian far-field extension. AgDrift (version 2.01; dated 5/24/2001) is used to simulate spray blast applications to orchard crops.

2.10.1.2. Measures of Effect

Data identified in Section 2.8 are used as measures of effect for direct and indirect effects to the CRLF. Data were obtained from registrant submitted studies or from literature studies identified by ECOTOX. The ECOTOXicology database (ECOTOX) was searched in order to provide more ecological effects data and in an attempt to bridge existing data gaps. 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, 2007).

The assessment of risk for direct effects to the CRLF makes the assumption that avian toxicity is similar to terrestrial-phase CRLF. The same assumption is made for fish and aquatic-phase CRLF. Aquatic invertebrates and algae represent potential prey of the CRLF in the aquatic habitat. Aquatic plants and semi-aquatic plants represent habitat of CRLF. Terrestrial invertebrates and small mammals represent potential prey of the CRLF in the terrestrial habitat.

The acute measures of effect used for animals in this assessment are the LD_{50}, LC_{50} and EC_{50}. The acronym "LD" stands for "Lethal Dose" and LD_{50} is the amount of a material, given all at once, that is estimated to cause the death of 50% of the test organisms. The acronym "LC" stands for "Lethal Concentration" and LC_{50} is the concentration of a chemical that is estimated to kill 50% of the test organisms. The acronym "EC" stands for "Effective Concentration" and the EC_{50} is the concentration of a chemical that is estimated to produce a specific effect in 50% of the test organisms. Endpoints for chronic measures of exposure for listed and non-listed animals are the NOAEL/NOAEC and NOEC. The acronym "NOAEL" stands for "No Observed-Adverse-Effect-Level" and refers to the highest tested dose of a substance that has been reported to have no harmful (adverse) effects on test organisms. The NOAEC (*i.e.*, "No-Observed-Adverse-Effect-Concentration") is the highest test concentration at which none of the observed effects were statistically different from the control. The NOEC is the No-Observed-Effects-Concentration. For non-listed plants, only acute exposures are assessed (*i.e.*, EC_{25} for terrestrial plants and EC_{50} for aquatic plants).

2.10.1.3. Integration of Exposure and Effects

Risk characterization is the integration of exposure and ecological effects characterization to determine the potential ecological risk from the use of dimethoate on fruits, nuts, vegetables and ornamentals, and the likelihood 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 ecological effects on non-target species. For the assessment of dimethoate 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 10**). These criteria are used to indicate when dimethoate's uses, as directed on the label, have the potential to cause direct or indirect effects to the CRLF.

Table 10. 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 affected by use via direct or indirect effects.	Peak EEC/EC_{50}[1]	0.05
Chronic Listed Species	Potential for chronic risk to CRLF through direct or indirect effects. Indirect effects represented by effects to invertebrates, which represent potential prey.	60-day EEC/NOEC (CRLF) 21-day EEC/NOEC (invertebrates)	1
Non-Listed	Potential for effects in non-listed plants.	Peak EEC/ EC_{50}	1
Terrestrial Habitats			
Acute Listed Species	CRLF may be potentially affected by use via direct or indirect effects.	Dietary EEC [2]/LC_{50} Or Dose EEC [2]/LD_{50}	0.1
Acute Listed Species	Potential effects to terrestrial invertebrates. CRLF may be potentially affected by use via direct or indirect effects.	EEC [2]/LD_{50}	0.05
Chronic Listed Species	Potential for chronic risk to CRLF through direct or indirect effects. Indirect effects represented by effects to small mammals, which represent potential prey.	EEC [2]/NOAEC	1
Non-Listed	Potential for effects in non-listed plants.	Peak EEC/ EC_{25}	1

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

2.10.1.4. Data Gaps

No data are available for assessing the effects of exposures of dimethoate to freshwater, vascular plants. Generally, data for duckweed (*Lemna gibba*) are used to assess these effects. In addition, no data are available for deriving RQs to assess the effects of exposures of dimethoate to riparian and terrestrial vegetation, which are generally represented by effects data for terrestrial agricultural crop species.

3. Exposure Assessment

3.1 Aquatic Exposure Assessment

3.1.1 Existing Water Monitoring Data for California

EFED finalized the Environmental Fate and Ecological Risk assessment for dimethoate in 2006 (USEPA 2006). That assessment contained a surface water exposure assessment as well as an ecological risk assessment. The data included in that risk assessment and the conclusions associated with monitoring data are briefly described below. For more detailed information, see USEPA 2006. California specific monitoring data for dimethoate are summarized below. These data include United States Geological Survey's (USGS) National Water Quality Assessment (NAWQA) and the CDPR Surface Water Database. Available monitoring data are not necessarily targeted to detect maximum environmental concentrations of dimethoate, and therefore are not necessarily representative of peak concentrations of dimethoate that may be observed in the field.

3.1.1.1. Previous Assessment

A number of National and California-specific surface water monitoring studies are discussed in the Environmental Fate and Ecological Risk Assessment supporting the Interim Reregistration Eligibility Decision (IRED) for dimethoate (USEPA 2006). Sources of monitoring data used in that assessment included: STORET (Storage and Retrieval) database (USEPA 2007), several USGS surveys (Coupe *et al*. 1995; Kimbrough and Litke 1996), the Pilot Reservoir Monitoring Study (Blomquist *et al*. 2001) the Washington State Pesticide Monitoring Program (Davis 1996 and 2000), and the California Department of Pesticide Regulation (CDPR) investigations in the San Joaquin Watershed (Ross et al 1996, 1999 and 2000).

Dimethoate was detected in surface waters included in 3 of the 6 studies cited above (the Pilot Reservoir Monitoring Study, the Washington State Monitoring Program and the CDPR San Joaquin Basin Study). The highest detection of dimethoate in California was 2.4 µg/L, which was from a sample collected in the main stem of the San Joaquin River. The results of the San Joaquin Basin Study indicate that dimethoate was present all summer long in the main stem of the San Joaquin River during 1991-1992. For more detailed information, see USEPA 2006.

3.1.1.2. NAWQA Data for California

NAWQA monitoring data are available for dimethoate from California surface waters and ground waters (USGS 2007). No monitoring data are available for the degradate omethoate.

Dimethoate was detected in 8.7% of 265 surface water samples from 2001-2006, with a maximum concentration of 0.158 µg/L. The level of quantification for these analyses was 0.0061 µg/L. During this time period, 270 ground water samples contained no detectable levels of dimethoate.

NAQWA data are defined by the landcover composition of the watershed of the surface waters from which samples were taken. Of the available surface water samples, dimethoate was detected in waters from agricultural (9 of 33 samples), mixed (12 of 120 samples) and other (2 of 82 samples) land cover types. As would be expected from its use patterns, dimethoate was not detected in surface waters from urban watersheds (30 total samples).

3.1.1.3. California Department of Pesticide Regulation Surface Water Database

CDPR maintains a database of monitoring data of pesticides in CA surface waters. Data are available from 1990-2005 for 27 counties for several pesticides and their degradates. The sampled water bodies include rivers, creeks, urban streams, agricultural drains, the San Francisco Bay delta region and storm water runoff from urban areas. The database contains data from 51 different studies by federal, state and local agencies as well as groups from private industry and environmental interests. Some data reported in this database are also reported by USGS in NAWQA; therefore, there is some overlap between these two data sets. Unlike NAWQA data, the land use (*e.g*. agriculture, urban) associated with the watershed of the sampled surface waters is not defined in the CDPR database; therefore, the available data do not allow for a link of the general use pattern and the individual data. Data for dimethoate are included in this database. Data are not included for omethoate (CDPR 2007b).

Dimethoate was detected in 11.3% of 2061 surface water samples from 1991-2005, with a maximum concentration of 11.31 µg/L (**Figure 10**). The level of quantification for these analyses ranged 0.04-0.1 µg/L.

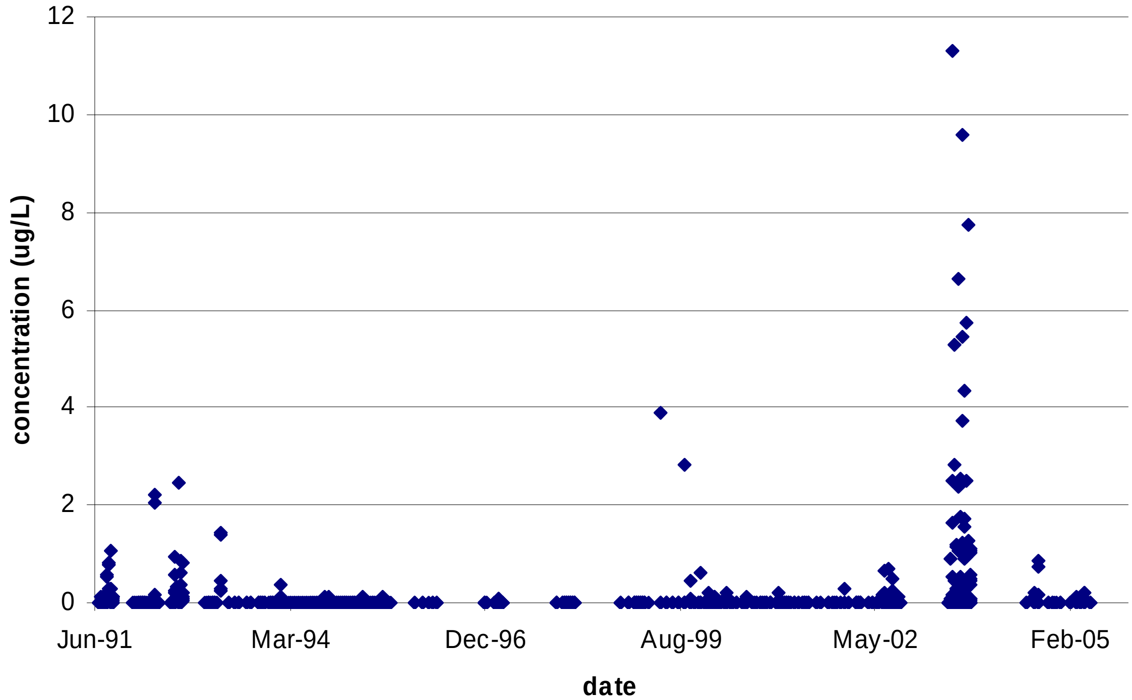


Figure 10. CDPR reported concentrations of dimethoate in surface waters in CA (includes detections and non-detections, which are represented as 0).

3.1.2. Modeling Approach

As stated above, the Tier II models used to calculate aquatic EECs are PRZM and EXAMS. For this modeling effort, PRZM scenarios designed to represent different crops and geographic areas of CA are used in conjunction with the standard pond environment in EXAMS. Use-specific and chemical-specific parameters for the Pe5 shell as well as PRZM scenarios are described below. An example of an output file from PRZM/EXAMS is in **Appendix D**.

3.1.2.1. PRZM scenarios

Several standard PRZM scenarios already exist for California, including: CA almond, CA citrus, CA cotton, CA fruit, CA nursery, CA tomato. In addition, several scenarios that were developed for the cumulative organophosphate assessment are available, two of which are useful for this assessment: CA alfalfa and CA corn. Scenarios were developed for CRLF assessments, including several that are relevant to this assessment: CA cole crop, CA forestry, CA melon, CA potato, CA row crop, CA turf, CA wheat and CA wine grapes. PRZM scenarios used to model aquatic exposures resulting from applications of specific uses are identified in **Table 11.** In cases where a scenario does not exist for a specific use, it is necessary to assign a surrogate scenario. Those surrogates are assigned to be most representative of the use being considered. Justifications for assignments of surrogates are defined below.

Table 11. PRZM scenario assignments according to uses of dimethoate.

PRZM scenario	Uses
CA alfalfa	Alfalfa, lupine, sainfoin
CA almond	Pecans
CA citrus	Citrus
CA cole crop	Broccoli, cauliflower, Chinese cabbage, kohlrabi, kale, mustard greens
CA corn	Field corn, popcorn
CA cotton	Cotton
CA forestry	Conifer seed orchards, cottonwood (for pulp)
CA fruit	Pears
CA lettuce	Endive (escarole), lettuce, Swiss chard
CA melon	Honeydew, melon
CA nursery	Herbaceous ornamentals
CA potato	Potatoes, turnips
CA row crop	Beans, celery, garbanzo beans, lentils, peas, peppers
CA tomato	Tomatoes
CA turf	Grass for seed
CA wheat	Safflower, sorghum, wheat, triticale
CA wine grapes	Non-cropland areas adjacent to vineyards

Alfalfa scenario

This scenario is intended to represent alfalfa production in CA and is therefore, directly relevant to this use. It is used as a surrogate for lupine and sainfoin, which are legumes grown as forage. Since alfalfa is also a perennial legume, it is assumed that it would have similar cultivation requirements as lupine and sainfoin. No data have been identified to indicate where in CA lupine and sainfoin are grown.

Almond scenario

This scenario is intended to represent almond production in CA. Pecan is a nut tree with similar cultural practices as almonds. Primary California producing areas are located in the same areas as other nut crops, from Chico-Orland area in the north to Bakersfield in the south.

Citrus scenario

This scenario is intended to represent citrus production in CA, including cultivation of oranges, grapefruit, lemon, tangelo and tangerines. Therefore, this scenario is directly relevant to modeling dimethoate applications to citrus.

Cole crop scenario

This scenario is intended to represent cole crop production, specifically broccoli, in the Central California coast and Coastal Valley Mountain range. Therefore, exposures resulting from applications of dimethoate to broccoli, Brussels sprouts, Chinese cabbage, cauliflower, kohlrabi, kale and mustard greens, all of which are classified as "cole crops," are modeled using this scenario.

Corn scenario

This scenario is intended to represent corn production in CA therefore, this scenario is directly relevant to this use.

Cotton scenario

This scenario is intended to represent cotton production in CA therefore, this scenario is directly relevant to this use.

Forestry scenario

This scenario is intended to represent cultivation of trees used for forestry purposes. It is assumed that this scenario would be representative of trees grown for pulp (specifically cottonwood trees) and seeds.

Fruit scenario

The CA fruit scenario represents an orchard in Fresno County, which is located in the Central Valley of California. This scenario is intended to represent non-citrus fruit, including peaches, plums, prunes, pears and apples. Therefore, this scenario is used to represent applications of dimethoate to pears.

Lettuce scenario

This scenario is intended to represent lettuce, which is a leafy vegetable. It is assumed that this scenario is representative of other leafy vegetables, including Swiss chard and endive.

Melon scenario

This scenario is intended to represent applications of pesticides to melons in CA and is therefore, directly relevant to this use.

Nursery scenario

This scenario is intended to represent applications of pesticides on ornamentals in outdoor nurseries in CA and is therefore, directly relevant to this use.

Potato scenario

The CA potato scenario is representative of a field in Kern County. According to the 2002 census of agriculture (USDA 2007), the majority of turnips grown in California were from Kern County. Therefore, it is assumed that this crop would grow under similar conditions as the potato.

Row crop scenario

This scenario is intended to represent production of carrots, beans, peppers and other crops in CA, and is therefore, directly relevant to these uses. Peas and celery are considered row crops and are classified in this category. Therefore, this scenario is used to represent fields growing beans, garbanzo beans, lentils, celery, peppers and peas.

Tomato scenario

This scenario is intended to represent applications of pesticides to tomatoes in CA and is therefore, directly relevant to this use.

Turf scenario

This scenario is intended to represent applications of pesticides to turf in CA. Classifications of turf include sod farms, parks, recreational fields, golf courses and grass grown for seed. Therefore, this scenario is relevant to modeling applications of dimethoate to grass grown for seed.

Wheat scenario

This scenario is intended to represent wheat, barley and oats production in CA. Triticale is a hybrid of rye and wheat. It is assumed that this scenario is representative of cultivation of other grain crops in CA, including sorghum, safflower and triticale.

Wine grape scenario

This scenario is intended to represent cultivation of grapes in northern coastal CA, specifically in Sonoma, Napa, Lake and Mendocino Counties. This scenario is used as a surrogate for the non-cropland areas adjacent to vineyards in Napa, Sonoma, Mendocino and Lake Counties. It is assumed that the land adjacent to grape vineyards has similar soil and meteorological properties as the vineyards themselves.

3.1.2.2. Input Parameters

Chemical-specific parameters

The appropriate chemical-specific PRZM input parameters are selected from reviewed environmental fate data submitted by the registrant (**Table 3**) and in accordance with EFED water model input parameter selection guidance (U.S. EPA 2002). The input parameters selected are similar to those used in the 2006 dimethoate IRED (U.S. EPA, 2006). No new environmental fate data were incorporated into this assessment. A summary of the chemical specific model inputs used in this assessment are provided in **Table 12**.

Use-specific parameters

Use-specific parameters include application methods and rates (**Table 5**). Maximum rates per application and maximum number of applications per year are based on current label directions (**Table 13**).

Table 12. PRZM/EXAMS input parameters.

Input Parameter	Value	Justification
Molecular Wt. (g/mol)	229.25	Measured value
Solubility in water (mg/L)	32,000	Measured value
Henry's Law Constant (atm-m^3/mol)	8.0e^{-11}	Estimated from solubility and vapor pressure
Kd (L/kg)	0.3	Lowest non-sand value (MRID 00164959)
Aerobic Soil Metabolism Half-life (days)	6.202	3 times a single study value (MRID 42843201)
Aerobic Aquatic Metabolism Half-life (days)	16.4	2 times the aerobic soil metabolism value and adjusted for hydrolysis
Anaerobic Aquatic Metabolism Half-life (days)	40.9	2 times anaerobic soil metabolism half-life (22d) and adjusted for hydrolysis
Foliar Degradation Rate (d^{-1}) (PLDKRT)	0.24	Upper 90% confidence bound on 24 measured values (**Table 4**)
Foliar Washoff Coefficient	0.5	Default value
Hydrolysis Half-life (days)	pH 5: 156 pH 7: 68 pH 9: 4.4	Measured values (MRID 00159761)
Aqueous Photolysis Half-life (days)	353	Measured value (MRID 00159762)

Table 13. Use specific parameters used to model aquatic EECs using PRZM/EXAMS.

Use	Maximum single application rate (kg/ha)	Maximum number of applications per year	Minimum application interval (days)
Alfalfa	0.56	9*	40*
beans***	0.56	2	14
broccoli	0.56	3	7
Brussels sprouts	1.12	6	7
cauliflower	0.56	3	7
celery	0.56	3	7
Chinese cabbage	0.56	3	7
citrus	2.24	Not specified** (model 1 application)	Not specified
conifer seed orchards	1.12	1	NA
cotton++	0.56	2	14
cottonwood (for pulp)	1.12	3	Not specified (assume 7 d)
Endive (escarole)	0.28	3	7
field corn	0.56	1	NA
garbanzo beans	1.12	1	NA
grass for seed	0.56	2	90
herbaceous ornamentals	0.28	1	NA
honeydew	0.56	2	7
kale	0.28	2	15
kohlrabi	0.56	3	7
lentils	0.56	2	7
lettuce (leaf)	0.28	3	7
Lupine	0.56	2	Not specified (assume 7 d)
melon	0.56	2	7
mustard greens	0.28	2	9
Non-cropland areas adjacent to vineyards	2.24	2	Not specified (assume 7 d)
pears	0.56	1	NA
peas (succulent)	0.56	1	NA
pecans	0.37	1	NA
peppers	0.37	5	7
popcorn	0.56	1	NA
potatoes	0.56	2	7
Safflower+++	0.56	1	NA
sainfoin	0.56	1	NA
sorghum	0.56	2	7
Swiss chard	0.28	3	7
tomatoes	0.56	2	6
triticale	0.56	2	Not specified (assume 7 d)
turnips	0.28	7	3
Wheat+++	0.56	1	NA

NA = not applicable
*There is one application allowed per cutting. Since alfalfa can have 2-9 cuttings per year (Kaul 2007), there is a maximum of 9 applications per year. Based on this, it is assumed that there are cuttings throughout the year and there are equal intervals between cuttings. Therefore, there would be 40 d intervals between cuttings and between pesticide applications.
**Label directions indicate that applications to citrus should be repeated as necessary.
***Labels indicate that rates for beans are relevant to season. It is assumed that beans have one crop per year (Kaul 2007).
++Labels indicate that rates for cotton are relevant to each season of growth. Due to limitations of current PRZM scenarios, it is assumed that in CA, only one season of cotton is grown per year.
+++Labels indicate that rates for wheat and safflower are relevant to crop. According to Kaul 2007, only one crop of wheat is grown per year. Since safflower is grouped with wheat, it is assumed that one crop of safflower is also grown per year.

Application dates are not specified on product labels. For this assessment, application dates are generally estimated using available use data for dimethoate applications in California during 2001-2005. The month where the most dimethoate was applied during this time period is used as the application month for modeling purposes (see **Appendix B** for more information on the crop specific analyses). The specific application date is defined as the 15th, to represent the middle of the month. Crop emergence, maturity and harvest dates of each PRZM scenario are considered to verify that the chosen application date and subsequent applications (if there is more than one application per year) fall at a time when the crop is present during the simulation of the PRZM scenario. In some cases, insufficient data were available for defining the historical timing of dimethoate applications to a use. In those instances, surrogate crops, which are defined according to the PRZM scenario groups, are used to define the timing of the dimethoate application. In other cases, the PRZM scenario itself is used to define the appropriate date of the first dimethoate application. For each dimethoate use, the selected application date and its justification are defined in **Table 14**.

Table 14. Application dates for PRZM/EXAMS simulations for modeling associated with dimethoate uses.

Use	PRZM scenario	Application date	Application date comments
Alfalfa	CA alfalfa	2-Jan	There is one application allowed per cutting. Since alfalfa can have 2-9 cuttings per year (Kaul 2007), there is a maximum of 9 applications per year. Based on this, it is assumed that there are cuttings throughout the year and there are equal intervals between cuttings. Therefore, there would be 40 d intervals between cuttings and between pesticide applications. In order to accommodate that many applications, the initial application date was selected as January 2.
beans	CA rowcrop	1-Mar	The emergence date of the PRZM scenario is Jan 1, the maturity date is April 1 and the harvest date is April 8. It is assumed that there is insect pressure on this crop when it is close to maturity. Therefore, the first application date is chosen as one month before the maturity date.
broccoli	CA cole crop	1-Feb	The date of crop emergence in PRZM scenario is Jan 1 and the harvest date is Mar 1. An application date of Feb 1 is selected to allow for all applications to be made to the crop before harvest.
Brussels sprouts	CA lettuce	12-Aug	See CAPUR data
cauliflower	CA cole crop	1-Feb	See broccoli explanation
celery	CA rowcrop	1-Mar	Consistent with beans
Chinese cabbage	CA cole crop	1-Feb	See broccoli explanation
citrus	CA citrus	15-May	See CAPUR data
conifer seed orchards	CA forestry	15-Jan	There are no CAPUR data for past applications of dimethoate to this use. The PRZM scenario indicates that the crop is mature throughout the year. An application date during the rainy period of the year was chosen to derive conservative EECs.
cotton	CA cotton	15-Aug	See CAPUR data
cottonwood (for pulp)	CA forestry	15-Jan	There are no CAPUR data for past applications of dimethoate to this use. The PRZM scenario indicates that the crop is mature throughout the year. An application date during the rainy period of the year is chosen to derive conservative EECs.
Endive (escarole)	CA lettuce	15-Oct	consistent with lettuce
field corn	CA corn	15-Jul	See CAPUR data
garbanzo beans	CA rowcrop	1-Mar	Consistent with beans
grass for seed	CA turf	15-Jan	There are no CAPUR data for past applications of dimethoate to this use. The PRZM scenario indicates that the crop is mature throughout the year. An application date during the rainy period of the year was chosen to derive conservative EECs.
herbaceous ornamentals	CA nursery	15-Aug	See CAPUR data
honeydew	CA melons	1-Jul	According to the CAPUR data, the majority of dimethoate use is in August, with use during June to September. The harvest date of the PRZM scenario is August 2. In order to be consistent with the CAPUR data and the PRZM scenario, an application date of July 1 is selected.
kale	CA cole	1-Feb	See broccoli explanation

	crop		
kohlrabi	CA cole crop	1-Feb	See broccoli explanation
lentils	CA rowcrop	1-Mar	Consistent with beans
lettuce (leaf)	CA lettuce	15-Oct	See CAPUR data
Lupine	CA alfalfa	15-Mar	Data are unavailable to define the specific application month for this use. Therefore, alfalfa is used as a surrogate. According to CAPUR use data for alfalfa, the majority of use is in March.
melon	CA melons	1-Jul	According to the CAPUR data, the majority of dimethoate use on melons is in august, with use June-September. The harvest date of the PRZM scenario is August 2. In order to be consistent with the CAPUR data and the PRZM scenario, an application date of July 1 is selected.
mustard greens	CA cole crop	1-Feb	See broccoli explanation
Non-cropland areas adjacent to vineyards	CA wine grape	15-Jul	Date set to middle of July, which corresponds to peak use month of dimethoate in California, according to CA PUR data for 2001-2005.
pears	CA fruit	15-Jun	CAPUR data (note: this is a limited data set, only 3 applications were reported in CAPUR over 2001-2005, 2/3 were in June)
peas	CA rowcrop	1-Mar	See CAPUR data
pecans	CA almond	15-Jun	See CAPUR data
peppers	CA rowcrop	1-Mar	See CAPUR data
popcorn	CA corn	15-Jul	See CAPUR data
potatoes	CA potato	25-May	According to the CAPUR data, the majority of dimethoate use is in August, with use during June to August. The harvest date of the PRZM scenario is June 15. In order to be consistent with the CAPUR data and the PRZM scenario, an application date of May 25 is selected.
Safflower	CA wheat	15-Mar	consistent with wheat
sainfoin	CA alfalfa	15-Mar	Data are unavailable to define the specific application date for this use. Therefore, the value for lupine is used as a surrogate.
sorghum	CA wheat	15-Mar	Consistent with wheat
Swiss chard	CA lettuce	15-Oct	Consistent with lettuce
tomatoes	CA tomato	15-Jul	See CAPUR data
triticale	CA wheat	15-Mar	Consistent with wheat
turnips	CA potato	15-May	There are insufficient data from CAPUR to define the period of application of dimethoate to turnips. In the PRZM scenario, the emergence date is Feb 16 and the harvest date is June 15. All 7 applications must be between this date range. The maturity date is May 15. It is assumed that there will be insect pest pressure when the crop is mature, but before it is harvested. Therefore, the maturity date was selected as the first application date.
Wheat	CA wheat	15-Mar	See CAPUR data

According to labels, aerial applications are permitted for all dimethoate uses, with the exception of applications to citrus, Brussels sprouts, non-cropland areas adjacent to vineyards and herbaceous ornamentals. For aerial applications, efficiency and spray drift were chosen as 0.95 and 0.05, respectively, according to input parameter guidance (USEPA 2002). For ground applications, input parameter guidance is also used to define efficiency and spray drift as 0.99 and 0.01, respectively (USEPA 2002).

In PRZM, application methods are defined by the Chemical Application Method (CAM) values. A CAM of 1 represents applications to soil with no incorporation. A CAM of 2 is used to represent foliar applications. For the registered uses of dimethoate, with the exception of citrus, it is assumed that applications are made directly to the crop. For these uses, a CAM of 2 is selected. For use of dimethoate on citrus, labels indicate that applications should be made to the soil. For this, a CAM of 1 is selected.

When CAM 2 is selected, it is necessary to identify an IPSCND value, which represents the deposition of dimethoate in the post-season. For this modeling effort, an IPSCND of 1 is chosen to accompany CAM 2 selections. This value represents conversion of dimethoate remaining on foliage to surface application to the top soil layer.

3.1.3. Aquatic Modeling Results

PRZM/EXAMS EECs representing 1-in-10 year peak, 21-day, and 60-day concentrations of dimethoate in the aquatic environment are located in **Table 15**.

Table 15. One-in-ten-year dimethoate EECs for aquatic environments from the application of dimethoate to uses in California.

Use*	peak (µg/L)	21-d (µg/L)	60-d (µg/L)
Alfalfa	6.7	5.5	4.0
beans	5.8	4.5	3.1
broccoli	16.5	13.7	9.4
Brussels sprouts	9.2	6.7	4.2
cauliflower	16.5	13.7	9.4
celery	8.4	6.6	4.5
Chinese cabbage	16.5	13.7	9.4
citrus	1.3	0.9	0.4
conifer seed orchards	7.3	5.8	4.0
cotton	2.5	1.7	1.1
cottonwood (for pulp)	20.3	18.7	13.9
endive (escarole)	5.6	4.4	3.0
field corn	1.4	0.9	0.5
garbanzo beans	2.2	1.7	1.1
grass for seed	4.8	3.7	2.5
herbaceous ornamentals	0.1	0.1	0.1
honeydew	2.3	1.5	0.8
kale	4.2	3.3	2.2
kohlrabi	16.5	13.7	9.4
lentils	4.1	3.2	2.2
lettuce (leaf)	5.6	4.4	3.0
Lupine	4.2	3.1	2.0
melon	2.3	1.5	0.8
mustard greens	6.1	4.8	3.1
Non-cropland areas adjacent to vineyards	3.2	2.5	1.6
pears	1.4	0.9	0.4
peas (succulent)	2.2	1.7	1.1
pecans	1.1	0.8	0.4
peppers	8.2	6.7	5.0
popcorn	1.4	0.9	0.5
potatoes	3.0	2.0	1.1
Safflower	3.9	3.2	2.0
sainfoin	2.7	2.1	1.3
sorghum	8.0	6.8	4.5
Swiss chard	5.6	4.4	3.0
tomatoes	2.4	1.5	0.8
triticale	8.0	6.8	4.5
turnips	4.3	3.3	2.0
Wheat	3.9	3.2	2.0

*All EECs correspond to aerial applications except for ground applications to citrus, Brussels sprouts, non-cropland areas adjacent to vineyards and herbaceous ornamentals.

3.2. Terrestrial Exposure Assessment

3.2.1. Modeling Approach

T-REX (version 1.3.1) is used to calculate dietary and dose-based EECs of dimethoate for the terrestrial-phase CRLF and its potential prey (*e.g.* terrestrial invertebrates, small mammals) inhabiting terrestrial areas. T-REX simulates a 1-year time period. A foliar dissipation half-life of 2.88 days is used based on data cited in USEPA 2006. The default Mineau scaling factor of 1.15 is used (Mineau *et al*. 1996). T-REX incorporates set weights for dose-based or dietary-based exposure data involving either mallard ducks or Northern bobwhite quail. Since the most sensitive toxicity data for acute dose-based and dietary-based exposures of dimethoate to birds involved two species (red-winged blackbird and ring-necked pheasant) that were not mallard duck or bobwhite quail, body weight data for these two species were entered into T-REX. For the red-winged blackbird, the body weight is assumed to be 53 g based on the mean of male and female mean weights for this species as cited in Dunning 1984. For the ring-necked pheasant, the body weight is assumed to be 1135 g based on the mean of male and female mean weights for this species as cited in Dunning 1984. Specific input values, including number of applications, application rate and application interval used in the analyses are located in **Table 16**. An example output from T-REX v.1.3.1 is available in **Appendix E**.

Table 16. Input parameters for foliar applications used to derive terrestrial EECs for dimethoate with T-REX.

Use	Max single ap. Rate (lbs a.i./A)	Max # of apps per year	Application interval (days)
Alfalfa	0.5	9*	40*
beans***	0.5	2	14
broccoli	0.5	3	7
Brussels sprouts	1	6	7
cauliflower	0.5	3	7
celery	0.5	3	7
Chinese cabbage	0.5	3	7
citrus	2	Not specified (assume 1)	Not specified
conifer seed orchards	1	1	NA
cotton++	0.5	2	14
cottonwood (for pulp)	1	3	Not specified (assume 7)
Endive (escarole)	0.25	3	7
field corn	0.5	1	NA
garbanzo beans	0.5	1	NA
grass for seed	0.5	2	90
herbaceous ornamentals	0.25	1	NA
honeydew	0.5	2	7
kale	0.25	2	15
kohlrabi	0.5	3	7
lentils	0.5	2	7
lettuce (leaf)	0.25	3	7
Lupine	0.5	2	Not specified (assume 7)
melon	0.5	2	7
mustard greens	0.25	2	9
Non-cropland areas adjacent to vineyards	2	2	Not specified (assume 7)
pears	0.5	1	NA
peas (succulent)	0.5	1	NA
pecans	0.33	1	NA
peppers	0.33	5	7
popcorn	0.5	1	NA
potatoes	0.5	2	7
Safflower+++	0.5	1	NA
sainfoin	0.5	1	NA
sorghum	0.5	2	7
Swiss chard	0.25	3	7
tomatoes	0.5	2	6
triticale	0.5	2	Not specified (assume 7)
turnips	0.25	7	3
Wheat+++	0.5	1	NA

NA=not applicable
*There is one application allowed per cutting. Since alfalfa can have 2-9 cuttings per year (Kaul 2007), there is a maximum of 9 applications per year. Based on this, it is assumed that there are cuttings throughout the year and there are equal intervals between cuttings. Therefore, there would be 40 d intervals between cuttings and between pesticide applications.
***Labels indicate that rates for beans are per season. It is assumed that beans have one crop per year (Kaul 2007).
+++Labels indicate that rates for wheat and safflower are relevant to crop. According to Kaul 2007, only one crop of wheat is grown per year. Since safflower is grouped with wheat, it is assumed that one crop of safflower is also grown per year.

3.2.2. Terrestrial Animal Exposure Modeling Results

For modeling purposes, exposures of the CRLF to dimethoate through contaminated food are estimated using the EECs for the small bird (20 g) which consumes small insects. EECs used to represent exposure to CRLF are also used to represent exposure values for frogs serving as potential prey of terrestrial-phase CRLF adults. Dietary-based and dose-based exposures of potential prey are assessed using the small mammal (15 g) which consumes short grass. Upper-bound Kenaga nomogram values reported by T-REX for these two organism types are used for derivation of EECs for the terrestrial-phase CRLF and its potential prey (**Table 17**). T-REX reported dietary-based EECs used for small and large insects are available in **Table 17**.

Table 17. Upper-bound Kenaga nomogram EECs for dietary- and dose-based exposures of the CRLF and its prey to dimethoate.

Use	Dietary-based EECs for specific food items (ppm)			Dose-based EECs (mg/kg-bw)	
	Short Grass[1]	Small insect[2, 3]	Large Insect[4]	CRLF[5] (20 g consuming sm. Insects)	Small mammal[6] (15 g consuming short grass)
Alfalfa	120	68	8	77	114
beans	124	70	8	80	118
broccoli	146	82	9	94	140
Brussels sprouts	295	166	18	189	281
cauliflower	146	82	9	94	140
celery	146	82	9	94	140
Chinese cabbage	146	82	9	94	140
citrus	480	270	30	308	458
conifer seed orchards	240	135	15	154	229
cotton	124	70	8	80	118
cottonwood (for pulp)	293	165	18	188	279
Endive (escarole)	73	41	5	47	70
field corn	120	68	8	77	114
garbanzo beans	120	68	8	77	114
grass for seed	120	68	8	77	114
herbaceous ornamentals	60	34	4	38	57
honeydew	142	80	9	91	136
kale	62	35	4	39	59
kohlrabi	146	82	9	94	140
lentils	142	80	9	91	136
lettuce (leaf)	73	41	5	47	70
Lupine	142	80	9	91	136
melon	142	80	9	91	136
mustard greens	67	38	4	43	64
Non-cropland areas adjacent to vineyards	569	320	36	366	543
pears	120	68	8	77	114
peas (succulent)	120	68	8	77	114
pecans	79	45	5	51	76
peppers	97	55	6	62	93
popcorn	120	68	8	77	114
potatoes	142	80	9	91	136
Safflower	120	68	8	77	114
sainfoin	120	68	8	77	114
sorghum	142	80	9	91	136
Swiss chard	73	41	5	47	70
tomatoes	148	83	9	95	141
triticale	142	80	9	91	136
turnips	116	65	7	74	111
Wheat	120	68	8	77	114

[1]Used for dietary-based EECs for deriving RQs for small mammals representing CRLF prey.
[2]Used for dietary-based EECs for deriving RQs for direct exposures to the CRLF.
[3]Used for EECs for deriving RQs for small terrestrial invertebrates representing CRLF prey.
[4]Used for EECs for deriving RQs for large terrestrial invertebrates representing CRLF prey.
[5]Used for dose-based EECs for deriving RQs for direct exposures to the CRLF.
[6]Used for dose-based EECs for deriving RQs for small mammals representing CRLF prey.

3.2.3. Spray Drift Modeling

In order to determine terrestrial habitats of concern due to dimethoate exposures through spray drift, it is necessary to estimate the distance spray applications can drift from the treated field and still be greater than the level of concern. For this assessment, the level of concern for the most sensitive endpoint (acute exposures to terrestrial invertebrates) and exposure duration is used. When this is expressed as an equivalent rate per unit area, it is 2 x 10^{-4} lb a.i./A. This assessment used the AgDisp model. AgDisp (version 8.13; dated 12/14/2004) (Teske and Curbishley, 2003) was used to simulate both aerial and ground applications. For simulation requiring estimates of drift beyond 2400 ft, the Gaussian far field extension mode in AgDisp was used.

Scenario and management practice input parameters for AgDisp fall into three categories. First are parameters for which there is current guidance (from labels). In all cases, there was no information from dimethoate labels relevant to these parameters so they have been set to the default values recommended by the current draft EFED Guidance for AgDisp (EFED 2005). Second are the default input values for AgDisp that do not affect the results of these calculations, or are reference variables whose value would only be changed under special circumstances. "Wind speed" is an example of the former and "height for wind speed measurement" is an example of the latter. These parameters have 'NA' for not applicable in the quality column. Third are the parameters for which no current guidance is available and the default value for AgDisp was used for the input parameter for this set of simulations. The justification for these parameters is "program default" in **Table 18**.

The quality column in **Table 18** provides some qualitative characterization regarding the confidence in the accuracy of that input parameter. When little or no information is available to support the value of a particular input parameter, the characterization in the quality column is poor. In many cases, when this occurs, the variable is set to a value that will produce drift values greater than those that would actually occur, so the results will likely be conservative and protective. When the amount of information supporting a parameter value is typical, the characterization is 'good' and the characterization is 'very good' or 'excellent' when several measurements of high quality support the value for the parameter.

Table 18. Scenario and standard management input parameters for simulation of dimethoate in spray drift using AgDisp with Gaussian far-field extension.

Parameter	Value	Justification	Quality
Nozzle type[1]	Flat fan	Program default	Poor
Boom Pressure[1]	60 lb	Program default	Poor
Spray lines	20	Program default	Poor
Nozzles	42	None available	Poor
Droplet Size Distribution (DSD)	Fine to very fine	Default; draft guidance	NA
Swath Width	60 ft	Program default	Good
Wind Speed	15 mph	Default; draft guidance	Good
Wind direction	- 90°	Default	NA
Air temperature	65° F	Program default	Poor
Relative Humidity	50%	Program default	Poor
Spray Material	Water	Program default	Good
Fraction of active solution that is non-volatile	0.1	Program default	Poor
Fraction of additive solution that is non-volatile	0.1	Program default	Poor
Stability	Overcast	Program default	Poor
Upslope angle	0°	Assume flat surface	Good
Side slope angle	0°	Assume flat surface	Good
Canopy type	none	Default from guidance	Poor
Surface roughness	0.0246 ft	Program default, none provided	Poor
Transport	0 ft	Program default	Poor
Height for wind peed measurement	6.56 ft	Program default	Good
Maximum comp. Time	600 sec	Program default	NA
Maximum downwind distance	2608.24 ft	Program default	NA
Vortex decay rate OGE	0.03355	Program default	NA
Vortex decay rate IGE	1.25	Program default	NA
Aircraft drag coefficient	0.1	Program default	NA
Propeller efficiency	0.8	Program default	NA
Ambient pressure	29.91	Program default	NA
Ground reference	0 ft	Program default	NA
Evaporation rate	84.76 $\mu g \cdot (K \cdot s)^{-1}$	Program default	NA
Specific Gravity (non-volatile)	1.0	Program default	Poor

[1] parameter for ground spray only

AgDrift input parameters that vary with the crop and application type are in **Table 19**. The default release height of 15 ft is used for aerial applications in the absence of other label directions. Spray volumes are the minimum spray volumes from dimethoate labels for each crop. The non-volatile fraction, active fraction and specific gravity were calculated from label information according to current guidance (EFED 2005). The default ½ swath displacement was used as it is standard practice for aerial sprays.

Table 19. AgDrift Input parameters that vary with crop and formulation are used for estimating drift from one application of dimethoate.

Crop Grouping	App method	Release Height	Swath Displacement	Spray Volume (gal)	Non-volatile Fraction	Active Fraction	Specific Gravity of Non-volatile
Garbanzos (0.5 lb $acre^{-1}$)	aerial	15 ft	½	5	0.025	0.086	1.10
Cottonwood (1 lb $acre^{-1}$)	aerial	15 ft	½	10	0.025	0.0112	1.07

Table 20 presents the results of the AGDISP modeling and shows the minimum distances for a single maximum application of dimethoate to cottonwood (1 lb a.i./A) and a single maximum application of dimethoate to garbanzo beans (0.5 lbs a.i./A), where the resulting area-based concentration of dimethoate is below the LOC of 2 $x10^{-4}$ lb/A. This value was estimated using T-REX as the lowest deposition rate that would not exceed any LOC values for terrestrial-phase organisms of interest to this assessment.

Cottonwood and garbanzo beans were the only uses modeled because they represent the highest application rates for uses classified in the action areas of “orchard, vineyard and forestry” and “agriculture,” respectively. The distances cited in **Table 20** for these uses are used to define their respective action areas.

The distances estimated for aerial applications are considerably larger than for ground sprays. Although ground spray may be the typical practice for most uses of dimethoate, aerial application is allowed on the label and that practice is assessed when it is allowed because it has greater drift potential. Most drift events would be expected to have shorter distances due to lower wind speed. In addition, a fine to very-fine spray has been assumed for the ground sprays and ground equipment generally produces a coarser spray. However, there is no language restricting the spray droplet size on the dimethoate labels; therefore, the very fine spray was used as it is the default in the absence of label instructions.

Table 20. Distance from the edge of the treated field to get below LOC for crops with aerial spray application of dimethoate.

Use Pattern	Representative Action Area	App Rate (lb/A)	Distance, 15 mph wind speed
cottonwood	Orchard, vineyard and forestry	1	10,797 ft
garbanzos	agriculture	0.5	10,524 ft

The AGDISP calculations used in this assessment are modeled under spray drift conditions in a flat area without barriers (*e.g.*, trees, structures, hills) with a constant wind speed and using standard application equipment. Several factors could potentially reduce spray drift deposition (*e.g.*, wind barriers, spray drift buffers, and the use of drift-reducing technology); however, potential reductions cannot currently be quantified using available Agency methodologies.

4. Effects Assessment

This assessment evaluates the potential for dimethoate to affect the CRLF. As previously discussed in Section 2.7, 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 and/or modification of its habitat leading to effects on survival, growth or reproduction. Direct effects to the CRLF in aquatic habitats are based on toxicity information for freshwater vertebrates, including fish, which are generally used as a surrogate for amphibians, as well as available amphibian toxicity data from the open literature. Direct effects to the CRLF in terrestrial habitats are based on toxicity information for birds, which are generally used as a surrogate for terrestrial-phase amphibians. Given that the CRLF's prey items and habitat requirements are dependent on the availability of freshwater aquatic invertebrates and aquatic plants, fish, frogs, terrestrial invertebrates and terrestrial mammals, toxicity information for these organisms is also discussed. Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and a comprehensive review of the open literature on dimethoate. A summary of the available freshwater ecotoxicity information for dimethoate are provided in Section 4.1.

Toxicity endpoints are established based on data generated from guideline studies submitted by the registrant, and from open literature studies that meet the criteria for inclusion into the ECOTOX database maintained by EPA/Office of Research and Development (ORD) (U.S. EPA, 2004). Open literature data presented in this assessment were obtained from the 2006 dimethoate supplemental chapter in support of the IRED (U.S. EPA, 2004) as well as information obtained from ECOTOX on September, 2007. The September 2007 ECOTOX search included all open literature data for dimethoate and omethoate (*i.e.*, pre- and post-IRED). In order to be included in the ECOTOX database, papers must meet the following minimum criteria:

- the toxic effects are related to single chemical exposure;
- the toxic effects are on an aquatic or terrestrial plant or animal species;
- there is a biological effect on live, whole organisms;
- a concurrent environmental chemical concentration/dose or application rate is reported; and
- there is an explicit duration of exposure.

Data that pass the ECOTOX screen are evaluated along with the registrant-submitted data, and may be incorporated qualitatively or quantitatively into this endangered species assessment. In general, open literature effects data that are more conservative than the registrant-submitted data are considered. Studies relevant to dimethoate that were accepted by ECOTOX and/or OPPTS are identified in **Appendix F**, as well as dimethoate studies that were rejected by ECOTOX and/or OPPTS. Reviews of studies cited in ECOTOX as containing data that were more sensitive than registrant submitted endpoints relevant to this assessment are included in **Appendix K**.

Toxicity testing reported in this section does not represent all species of bird, mammal, or aquatic organism. Only a few surrogate species for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. For mammals, acute studies are usually limited to Norway rat or the house mouse. The assessment of risk or hazard makes the assumption that avian and reptilian toxicities are similar. The same assumption is used for fish and amphibians.

4.1. Evaluation of Aquatic Freshwater Ecotoxicity Studies for Dimethoate

As described in the Agency's Overview Document (U.S. EPA, 2004), the most sensitive endpoint for each taxon is evaluated. For this assessment, evaluated taxa relevant to the aquatic habitat of the CRLF include freshwater fish, freshwater aquatic invertebrates, and freshwater aquatic plants. Currently, no guideline tests exist for frogs. Therefore, surrogate species are used as described in the Overview Document (U.S. EPA, 2004). In addition, aquatic-phase amphibian ecotoxicity data from the open literature are qualitatively discussed. **Table 21** summarizes the most sensitive ecological toxicity endpoints for the CRLF, its prey and its habitat, based on an evaluation of both the submitted studies and the open literature, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the CRLF is presented below.

Table 21. Summary of most sensitive toxicity endpoint for assessing direct and indirect effects of dimethoate to CRLF in aquatic habitats. Study classifications based on EFED's ecotoxicity database.

Assessment Endpoint	Species (common name)	End-point	Mean concentration (mg/L)	Ref. (MRID)
Measures of Direct Effects				
Acute toxicity to CRLF	*Oncorhyncus mykiss* (Rainbow Trout)	LC_{50}	6.2	40094602
Chronic toxicity to CRLF	*Oncorhyncus mykiss* (Rainbow Trout)	NOAEC[1]	0.43	43106303
Measures of Indirect Effects				
Toxicity to novascular plants composing aquatic habitat and representing prey for tadpole CRLF	*Anabaena variabilis* (blue-green algae)	EC_{50}	0.084	Das and Adhikary 1996
Toxicity to vascular plants composing aquatic habitat	No data are available at this time			
Acute toxicity to invertebrates (prey)	*Pteronarcys californica* (Stonefly)	EC_{50}	0.043	00003503
Chronic toxicity to invertebrates (prey)		NOAEC[2]	0.0005	NA
Acute toxicity to fish and frogs representing prey	*Oncorhyncus mykiss* (Rainbow Trout)	LC_{50}	6.2	40094602
Chronic toxicity to fish and other species of frogs (prey)	*Oncorhyncus mykiss* (Rainbow Trout)	NOAEC[1]	0.43	43106303

[1]LOAEC = 0.84 mg/L. Affected endpoint: reduced growth.

[2] Estimated using acute to chronic ratio with *Daphnia magna* data.

Acute toxicity to aquatic fish and invertebrates is categorized using the system shown in **Table 22** (U.S. EPA, 2004). Toxicity categories for aquatic plants have not been defined. Based on these categories, at most, dimethoate is classified moderately toxic to freshwater fish and very highly toxic to invertebrates on an acute exposure basis.

Table 22. Categories of Acute Toxicity for Aquatic Organisms.

LC_{50} (mg/L)	Toxicity Category
< 0.1	Very highly toxic
> 0.1 – 1.0	Highly toxic
> 1.0 – 10	Moderately toxic
> 10 – 100	Slightly toxic
> 100	Practically nontoxic

4.1.1. Toxicity to Freshwater Fish

As described in the original ecological risk assessment in support of the reregistration eligibility decision on dimethoate, the compound is considered moderately toxic to freshwater fish and aquatic-phase amphibians on an acute exposure basis with 96-hr LC_{50} values ranging between 6.2 to 7.5 mg a.i./L. Rainbow trout (*Oncorhynchus mykiss*) were the most sensitive species (LC_{50}=6.2 mg a.i./L) and this endpoint is used to evaluate acute risks to both fish and aquatic-phase amphibians. On a chronic exposure basis, growth was impaired in rainbow trout in a 96-day study (NOAEC=0.43 mg a.i./L).

4.1.2. Toxicity to Aquatic-phase Amphibians

No registrant-submitted data were available on the toxicity of dimethoate to aquatic-phase amphibians; however, two studies were reported in ECOTOX. Both of these studies reported on the toxicity of Rogor® (30% dimethoate) to the Indian bull frog (*Rana tigerina*) (Mohanty-Hejmadi and Dutta 1981) and to *R. hexadactyla* (Khangarot *et al*. 1985). Only one of the studies (Khangarot *et al*. 1985) provided a 96-hr LC_{50} (7.82 μg/L) suggesting that the formulated endproduct is 3 orders of magnitude more toxic than the technical grade active ingredient [to fish]. Both of these studies have limitations which are discussed further in **Appendix K**. The major limitation associated with each of these studies is that they measure the effects of a dimethoate formulation that is not registered for use in the United States. Therefore it is uncertain whether the enhanced toxicity of Rogor® is due to dimethoate or some constituent (inert) of the formulated product.

4.1.3. Toxicity to Freshwater Invertebrates

Based on 48-hr EC_{50} values ranging from 0.043 to 5.04 mg a.i./L, dimethoate ranged from being classified as very highly to moderately toxic to freshwater invertebrates on an acute exposure basis. The most acute sensitive endpoint, *i.e.*, stonefly (*Pteronarcys californica*) 48-hr EC_{50}=0.043 mg a.i./L, is used in this assessment to evaluate risk to nontarget aquatic invertebrates.

On a chronic exposure basis, waterfleas (*Daphnia magna*) were the most sensitive species tested (21-day NOAEC=0.04 mg a.i./L). In order to determine the equivalent chronic toxicity endpoint for stoneflies, the acute-to-chronic ratio for *D. magna* is determined. The acute EC_{50} and chronic NOAEC for *D. magna* are 3.32 mg/L and 0.04 mg/L, respectively and the acute-to-chronic ratio is 83. Based on the acute-to-chronic ratio, the chronic toxicity value is estimated by dividing the 48-hr EC_{50} (0.043 mg/L) by 83. The resulting estimated NOAEC is 0.0005 mg/L.

4.1.4. Toxicity to Aquatic Plants

No registrant-submitted data are available to assess the toxicity of dimethoate to aquatic plants; however, a total 11 entries on aquatic nonvascular plants were reported in ECOTOX. The most sensitive blue-green algae is *Anabaena variabilis* (15-day EC_{50}=0.084 mg/L; Das and Adhikary

1996) while the most sensitive green algae (*Pseudokirchneriella subcapitata*) had a 96-hr EC_{50} of 36 mg/L (Abdel-Hamid 1996).

4.2. Evaluation of Terrestrial Ecotoxicity Studies for Dimethoate

As described in the Agency's Overview Document (U.S. EPA 2004), the most sensitive endpoint for each taxon is evaluated. For this assessment, evaluated taxa include birds, mammals, terrestrial invertebrates and terrestrial plants. Currently, no guideline tests exist for frogs and thus, no toxicity data are currently required on amphibians. Therefore, surrogate taxa (birds) were used as described in the Overview Document (U.S. EPA 2004). **Table 23** summarizes the most sensitive ecological toxicity endpoints for terrestrial-phase CRLF, based on an evaluation of both the submitted studies and the open literature, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the CRLF are presented below.

Similar to toxicity categories for aquatic organisms, categories of acute toxicity ranging from "practically nontoxic" to "very highly toxic" have been established for terrestrial organisms based on LD_{50} values (**Table 24**), and avian species based on LD_{50} values (**Table 25**). Subacute dietary toxicity for avian species is based on the LC_{50} values (**Table 26**). Based on these categories, dimethoate is very highly toxic to birds on an acute oral exposure basis, highly toxic to birds on a subacute dietary exposure basis and moderately toxic to mammals on an acute oral exposure basis.

Table 23. Summary of most sensitive toxicity for assessing direct and indirect effects of dimethoate to CRLF in terrestrial habitats. Study classifications based on EFED's ecotoxicity database.

Assessment Endpoint	Species (common name)	End-point	Mean concentration	Ref. (MRID)
Measures of Direct Effects				
Acute toxicity to CRLF	*Agelaius phoeniceus* (red-winged blackbird)	LD_{50}	5.4 mg/kg	00020560
Sub-acute toxicity to CRLF	*Phasianus colchicus* (ring-necked pheasant)	LC_{50}	332 mg/kg-diet	00022923
Chronic toxicity to CRLF	*Colinus virginianus* (Northern bobwhite quail)	NOAEC[1]	4.0 ppm	44049001
Measures of Indirect Effects				
Acute toxicity to invertebrates (prey)	*Apis mellifera* (Honey bee)	LD_{50}	0.05 µg a.i./ bee	00026489
Acute toxicity to mammals (prey)	*Rattus norvegicus* (laboratory rat)	LD_{50}	358 mg/kg	00164220
Chronic toxicity to mammals (prey)	*Rattus norvegicus* (laboratory rat)	NOAEL[2]	0.1 mg/kg-bw	45529702 45529703
Acute toxicity to frogs representing prey	*Agelaius phoeniceus* (red-winged blackbird)	LD_{50}	5.4 mg/kg	00020560
Sub-acute toxicity to frogs representing prey	*Phasianus colchicus* (ring-necked pheasant)	LC_{50}	332 mg/kg-diet	00022923
Chronic toxicity to other species of frogs (prey)	*Colinus virginianus* (Northern bobwhite quail)	NOAEC[1]	4.0 ppm	44049001
Toxicity to monocot plants composing wetland and terrestrial habitat	No data are available at this time			
Toxicity to dicot plants composing wetland and terrestrial habitat				

[1] LOAEC = 10.1 ppm. Affected endpoints included: reduced egg production, viable embryos, 3-week old embryos, normal hatchlings, 14-day old survivor weight, adult male and female body weight, egg shell thickness.

[2]LOAEL = 0.5 mg/kg-bw/day. Affected endpoints included: brain/blood acetylcholinesterase inhibition, decreased weight, and increased pup death.

Table 24. Categories for mammalian acute toxicity based on median lethal dose in mg per kilogram body weight (parts per million).

LD_{50} (mg a.i./kg)	Toxicity Category
<10	Very highly toxic
10–50	Highly toxic
51–500	Moderately toxic
501–2000	Slightly toxic
>2000	Practically non-toxic

Table 25. Categories of avian acute oral toxicity based on median lethal dose in milligrams per kilogram body weight (parts per million).

LD_{50} (ppm)	Toxicity Category
<10	Very highly toxic
10-50	Highly toxic
51-500	Moderately toxic
501-2000	Slightly toxic
>2000	Practically non-toxic

Table 26. Categories of avian subacute dietary toxicity based on median lethal concentration in milligrams per kilogram diet per day (parts per million).

LC_{50} (ppm)	Toxicity Category
<50	Very highly toxic
50–500	Highly toxic
501–1000	Moderately toxic
1001–5000	Slightly toxic
>5000	Practically non-toxic

4.2.1. Toxicity to Birds

As described in the previous ecological risk assessment (USEPA 2004), dimethoate ranges from moderately to very highly toxic to birds on an acute oral exposure basis (LD_{50} range 5.4 – 63.5 mg/kg). The compound ranged from highly to slightly toxic on a subacute dietary exposure basis (LC_{50} range 332 – 1011 mg/kg diet). The most sensitive endpoints are the acute oral toxicity value for the red-winged blackbird (*Aeglaius phoeniceous*) (LD_{50}=5.4 mg/kg)) and the sub-acute dietary toxicity value for the ring-necked pheasant (*Phasianus colchicus*) (LC_{50} = 332 mg/kg diet).

Chronic avian toxicity estimates (NOAEC values) for dimethoate range from 4 to 152 mg/kg diet and consistently resulted in reduced egg production and decreased survival of young. The most sensitive endpoint is for the northern Bobwhite quail (*Colinus virginianus*) (NOAEC=4 mg/kg diet).

4.2.2. Toxicity to Terrestrial-phase Amphibians

No terrestrial-phase amphibian toxicity data are available for dimethoate.

4.2.3. Toxicity to Mammals

The most sensitive acute oral toxicity value available for mammals is a LD_{50} = 358 (95% CI: 311-411) mg/kg for exposure of male laboratory rats to dimethoate. Acute oral exposures of female rats to dimethoate resulted in a LD_{50} = 414 (95% C.I.: 363-463) mg/kg (MRID 164220).

As noted in the supplemental risk assessment in support of the interim reregistration eligibility decision, the chronic toxicity estimate for dimethoate is based on a developmental neurotoxicity study (MRID 45529703) reviewed by the Agency's Health Effects Division. The chronic NOAEL of 0.1 mg/kg was established based on observed decrease in pup deaths and brain cholinesterase in rats treated with 0.5 mg/kg-bw/day dimethoate.

4.2.4. Toxicity to Terrestrial Invertebrates

Dimethoate is characterized as highly toxic to terrestrial insects (honeybee acute contact LD_{50}=0.05 µg/bee). For the purpose of this assessment, the honey bee endpoint is used to derive RQs. This toxicity value is converted to units of µg a.i./g (of bee) by multiplying by 1 bee/0.128 g thereby resulting in an LD_{50} = 0.39 µg a.i./g.

4.2.5. Toxicity to Terrestrial Plants

No registrant-submitted data were submitted on the toxicity of dimethoate to terrestrial plants; however, two studies were reported in ECOTOX that are useful for qualitatively describing the phytotoxicity of dimethoate. In a study conducted in Europe, six species of "weeds" were exposed to dimethoate at a rate of 0.02 lb a.i./A. After 28 days, mean dry weight was significantly affected in two species (*Agrostemma githago* and *Urtica urens*), both of which were dicots (Hanley and Whiting 2004). In another study involving exposures of wheat to 0.5 lb a.i./A, chlorosis and necrosis were observed, with mass and overall yield (bushels/acre) unaffected (Chapin an Thomas 1999).

4.3. Comparison of toxicities of dimethoate and omethoate

No data were submitted for exposures of animals to omethoate. Also, ECOTOX did not contain useful data. Data are available from an evaluation conducted by the United Kingdom (UK) for the purpose of evaluating omethoate's use as a pesticide (DEFRA 1993). Information from omethoate studies discussed in section 4.3 was obtained from the UK's report. Because the EPA has not conducted an independent review of these studies, the data relevant to omethoate are used qualitatively for comparison purposes. These data are not used in this risk assessment for derivation of risk quotients.

4.3.1. Aquatic organisms

Acute toxicity data are available for rainbow trout and *D. magna* to compare the toxicities of dimethoate and omethoate. Chronic toxicity data are also available for exposures of *D. magna* to dimethoate and omethoate. Comparison of LC_{50} values for rainbow trout indicate that the toxicity of omethoate is similar to that of dimethoate. Although chronic toxicity data for D. magna indicate a similar response to the two chemicals, acute toxicity data indicate that omethoate is significantly more toxic to *D. magna* than dimethoate (**Table 27**).

Table 27. Comparison of toxicities of technical dimethoate and omethoate to aquatic organisms (units in mg/L).

Species	Endpoint	Dimethoate	Omethoate*	Dimethoate source (MRID)
Rainbow trout	96-h LC_{50}	6.2	9.1	40094602
		7.5	-	40919000
Waterflea (*D. magna*)	48-h EC_{50}	3.32	0.022	Song et al. 1997
	21-d NOAEC	0.04	0.042	42864701
	21-d LOAEC	0.1	0.14	42864701

*Source: DEFRA 1993

4.3.2. Terrestrial organisms

Acute oral toxicity data are available to compare the toxicities of dimethoate and omethoate to birds. Toxicity data are not available for any species exposed (separately) to dimethoate and omethoate. Available data indicate that dimethoate can be classified as very highly toxic to highly toxic to birds, while omethoate can be classified as highly toxic to birds (Table 26). Comparison of LD_{50} values indicate that the toxicity of omethoate to birds is similar to that of dimethoate (**Table 28**). These data indicate that the LD_{50} for dimethoate used in this assessment is the most conservative value available for acute oral exposures of birds to either dimethoate or omethoate.

Table 28. Comparison of acute oral toxicities (LD_{50}, units in mg/kg) of technical dimethoate and omethoate to birds.

Species	Dimethoate	Omethoate	Source (MRID)
Red-winged blackbird	**5.4**	NA	00020560
Canary	NA	**10 to 20**	DEFRA 1993
Ring-necked pheasant	**20**	NA	00160000
Starling	**32**	NA	00020560
Mallard duck	**41.6**	NA	115198
Japanese quail	NA	**49**	DEFRA 1993
Japanese quail	NA	**79.7**	DEFRA 1993
Mallard duck	**63.5**	NA	00160000

NA = not available

Acute toxicity data for honeybees also indicates a similar toxicity of the two chemicals. In an acute contact study, the reported LD_{50} was 0.048 µg/bee for honey bees exposed to technical omethoate (DEFRA 1993). As discussed above, the most conservative acute contact honey bee LD_{50} for dimethoate is 0.05 µg/bee.

Acute toxicity data for rats indicates that omethoate is more toxic to mammals on an acute and chronic basis. Available acute oral toxicity studies for rats exposed to omethoate include LD50 values ranging 22-64 mg/kg (DEFRA 1993). This range indicates that omethoate is an order of magnitude more toxic to rats than dimethoate, for which the documented LD50 is 358 mg/kg. In a chronic toxicity study with rats exposed to technical omethoate, the NOAEL was 0.3 ppm (0.015 mg/kg-bw), with a LOAEL of 1 ppm (0.05 mg/kg-bw) resulting from 20% inhibition of cholinesterase relative to controls. In a reproductive study involving exposures of rats to omethoate, decreases in pup viability were observed as low as 3 ppm (0.15 mg/kg-bw), with a study NOAEL of 1 ppm (0.05 mg/kg-bw) (DEFRA 1993). In a chronic toxicity study with dimethoate, the LOAEL was 0.5 mg/kg-bw for 10% decrease in brain cholinesterase relative to controls as well as a decrease in pup viability (NOAEL of 0.1 mg/kg-bw). These data suggest that 1) on an acute exposure basis, omethoate is significantly more toxic to rats than dimethoate, 2) dimethoate and omethoate affect pup viability at similar levels and 3) omethoate affected rat cholinesterase at lower doses than where effects were observed after dimethoate exposures.

5. Risk Characterization

Risk characterization is the integration of the exposure and effects characterizations to determine the potential ecological risk from varying dimethoate use scenarios within the action area and likelihood of direct and indirect effects on the CRLF, as well as consideration of modification to designated critical habitat. The risk characterization provides an estimation and description of the likelihood of effects; it articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the effects determination (*i.e.*, "no effect," "likely to adversely affect," or "may affect, but not likely to adversely affect") for the CRLF.

5.1. Risk Estimation

Risk is estimated by calculating the ratio of exposure to toxicity. This ratio is the risk quotient (RQ), which is then compared to established acute and chronic levels of concern (LOCs) for each category evaluated (**Appendix G**). For acute exposures to the CRLF and its animal prey in aquatic habitats, as well as terrestrial invertebrates, the LOC is 0.05. For acute exposures to the CRLF and mammals, the LOC is 0.1. The LOC for chronic exposures to CRLF and its prey, as well as acute exposures to aquatic plants is 1.0.

Screening-level RQs are based on the most sensitive toxicity endpoints and modeled EECs in aquatic and terrestrial systems from dimethoate uses defined in **Table 5**.

5.1.1. Exposures in the Aquatic Habitat

5.1.1.1. Direct Effects to CRLF

For assessing acute risks of direct effects to the CRLF, 1-in-10 year peak EECs in the standard pond are used with the lowest acute toxicity value for fish. For chronic risks, 1-in-10 year peak 60-day EECs and the lowest chronic toxicity value for fish are used. Resulting acute and chronic RQs do not exceed the acute listed species LOC (0.05) or chronic listed species LOC (1.0) for any use of dimethoate (**Table 29**).

Table 29. Risk Quotient values for acute and chronic exposures directly to the CRLF in aquatic habitats.

Use	peak (µg/L)	60-d (µg/L)	Acute RQ[1]	Chronic RQ[2]
Alfalfa	6.7	4.0	0.001	0.009
beans	5.8	3.1	0.001	0.007
broccoli	16.5	9.4	0.003	0.022
Brussels sprouts	9.2	4.2	0.001	0.010
cauliflower	16.5	9.4	0.003	0.022
celery	8.4	4.5	0.001	0.010
Chinese cabbage	16.5	9.4	0.003	0.022
citrus	1.3	0.4	0.000	0.001
conifer seed orchards	7.3	4.0	0.001	0.009
cotton	2.5	1.1	<0.001	0.003
cottonwood (for pulp)	20.3	13.9	0.003	0.032
endive (escarole)	5.6	3.0	0.001	0.007
field corn	1.4	0.5	<0.001	0.001
garbanzo beans	2.2	1.1	<0.001	0.003
grass for seed	4.8	2.5	0.001	0.006
herbaceous ornamentals	0.1	0.1	<0.001	0.000
honeydew	2.3	0.8	<0.001	0.002
kale	4.2	2.2	0.001	0.005
kohlrabi	16.5	9.4	0.003	0.022
lentils	4.1	2.2	0.001	0.005
lettuce (leaf)	5.6	3.0	0.001	0.007
Lupine	4.2	2.0	0.001	0.005
melon	2.3	0.8	<0.001	0.002
mustard greens	6.1	3.1	0.001	0.007
Non-cropland areas adjacent to vineyards	6.1	1.6	0.001	0.004
pears	1.4	0.4	<0.001	0.001
peas (succulent)	2.2	1.1	<0.001	0.003
pecans	1.1	0.4	<0.001	0.001
peppers	8.2	5.0	0.001	0.012
popcorn	1.4	0.5	<0.001	0.001
potatoes	3.0	1.1	<0.001	0.003
Safflower	3.9	2.0	0.001	0.005
sainfoin	2.7	1.3	<0.001	0.003
sorghum	8.0	4.5	0.001	0.011
Swiss chard	5.6	3.0	0.001	0.007
tomatoes	2.4	0.8	<0.001	0.002
triticale	8.0	4.5	0.001	0.011
turnips	4.3	2.0	0.001	0.005
Wheat	3.9	2.0	0.001	0.005

[1]Based on LC_{50} value for fish = 6.2 mg/L.
[2]Based on chronic NOAEC for fish = 0.43 mg/L.

5.1.1.2 Indirect Effects to CRLF through effects to prey

For assessing risks of indirect effects of dimethoate to the aquatic-phase CRLF (tadpoles) through effects to its diet, 1-in-10 year peak EECs from the standard pond are used with the lowest acute toxicity value for aquatic unicellular plants to derive RQs. Resulting RQs do not exceed the acute risk LOC (RQ≥1.0) for any uses of dimethoate (**Table 30**).

For assessing risks of indirect acute effects to the aquatic-phase CRLF through effects to prey (invertebrates) in aquatic habitats, 1-in-10 year peak EECs in the standard pond are used with the lowest acute toxicity value for invertebrates. For chronic risks, 1-in-10 year peak 21-day EECs and the lowest chronic toxicity value for invertebrates are used to derive RQs. Resulting acute RQs exceed the acute risk to listed species LOC (RQ≥0.05) for the majority of dimethoate uses. Chronic RQs exceed the chronic risk LOC (RQ>1.0) for all uses of dimethoate, with the exception of use on herbaceous ornamentals (**Table 30**).

5.1.2.3. Indirect Effects to CRLF through effects to habitat (plants)

As noted above, RQs representing unicellular aquatic plants do not exceed the LOC (1.0) (**Table 30**). No data are available to assess the risks of dimethoate to vascular aquatic plants. Given the lack of data, RQ values could not be derived to represent the risks of dimethoate exposure to vascular aquatic plants.

Table 30. Risk Quotient values for indirect effects to aquatic-phase CRLF due to effects to its prey.

Use	peak (µg/L)	21-d (µg/L)	Algae RQ[1]	Acute Invertebrate RQ[2]	Chronic Invertebrate RQ[3]
Alfalfa	6.7	5.5	0.08	**0.16**	**10.9**
beans	5.8	4.5	0.07	**0.14**	**8.9**
broccoli	16.5	13.7	0.20	**0.38**	**27.3**
Brussels sprouts	9.2	6.7	0.11	**0.21**	**13.5**
cauliflower	16.5	13.7	0.20	**0.38**	**27.3**
celery	8.4	6.6	0.10	**0.19**	**13.2**
Chinese cabbage	16.5	13.7	0.20	**0.38**	**27.3**
citrus	1.3	0.9	0.02	0.03	**1.8**
conifer seed orchards	7.3	5.8	0.09	**0.17**	**11.7**
cotton	2.5	1.7	0.03	**0.06**	**3.3**
cottonwood (for pulp)	20.3	18.7	0.24	**0.47**	**37.3**
endive (escarole)	5.6	4.4	0.07	**0.13**	**8.9**
field corn	1.4	0.9	0.02	0.03	**1.8**
garbanzo beans	2.2	1.7	0.03	**0.05**	**3.4**
grass for seed	4.8	3.7	0.06	**0.11**	**7.5**
herbaceous ornamentals	0.1	0.1	<0.01	<0.01	0.2
honeydew	2.3	1.5	0.03	**0.05**	**3.0**
kale	4.2	3.3	0.05	**0.10**	**6.6**
kohlrabi	16.5	13.7	0.20	**0.38**	**27.3**
lentils	4.1	3.2	0.05	**0.10**	**6.3**
lettuce (leaf)	5.6	4.4	0.07	**0.13**	**8.9**
Lupine	4.2	3.1	0.05	**0.10**	**6.1**
melon	2.3	1.5	0.03	**0.05**	**3.0**
mustard greens	6.1	4.8	0.07	**0.14**	**9.6**
Non-cropland areas adjacent to vineyards	6.1	4.8	0.07	**0.14**	**9.6**
pears	1.4	0.9	0.02	0.03	**1.8**
peas (succulent)	2.2	1.7	0.03	**0.05**	**3.4**
pecans	1.1	0.8	0.01	0.03	**1.5**
peppers	8.2	6.7	0.10	**0.19**	**13.5**
popcorn	1.4	0.9	0.02	0.03	**1.8**
potatoes	3.0	2.0	0.04	**0.07**	**3.9**
Safflower	3.9	3.2	0.05	**0.09**	**6.4**
sainfoin	2.7	2.1	0.03	**0.06**	**4.2**
sorghum	8.0	6.8	0.09	**0.19**	**13.7**
Swiss chard	5.6	4.4	0.07	**0.13**	**8.9**
tomatoes	2.4	1.5	0.03	**0.06**	**3.0**
triticale	8.0	6.8	0.09	**0.19**	**13.7**
turnips	4.3	3.3	0.05	**0.10**	**6.7**
Wheat	3.9	3.2	0.05	**0.09**	**6.4**

[1]Based on algae EC_{50} = 84 µg/L.
[2]Based on invertebrate EC_{50} = 43 µg/L.
[3]Based on chronic invertebrate NOAEC = 0.5 µg/L.

5.1.2. Exposures in the Terrestrial Habitat

5.1.2.1. Direct Effects to CRLF

As described above, dietary-based and dose-based exposures modeled in T-REX for a small bird (20g) consuming small invertebrates are used to assess risks of dimethoate to the terrestrial-phase CRLF. Acute, subacute and chronic effects are estimated using the lowest available toxicity data for birds. EECs are divided by toxicity values to estimate acute and chronic dietary-based RQs as well as dose-based RQs. Acute dose-based RQs exceed the LOC (0.1) for all uses of dimethoate, with RQs exceeding the LOC by factors ranging between 80 to 781X. Acute dietary-based RQs are equivalent to or exceed the LOC (0.1) for all uses. Acute dietary based RQs range 1X to 9.6X of the LOC. Chronic dietary-based RQs exceed the LOC (1.0) for all uses of dimethoate, by factors ranging 8.4X to 80X (**Table 31**).

5.1.2.2. Indirect Effects to CRLF through effects to prey

In order to assess the risks of applications of dimethoate to terrestrial invertebrates, which are considered prey of CRLF in terrestrial habitats, the honey bee is used as a surrogate for terrestrial invertebrates. EECs (µg a.i./g of bee) calculated by T-REX for small and large insects are divided by the calculated toxicity value for terrestrial invertebrates, which is 0.39 µg a.i./g of bee. The resulting RQ values for large insect and small insect exposures bound the potential range of exposures for terrestrial insects to dimethoate. For all uses, RQ values exceed the acute risk LOC ($RQ \geq 0.05$) for both large and small terrestrial insects (**Table 32**).

As described above, to assess risks of dimethoate to prey (small mammals) of larger terrestrial-phase CRLF, dietary-based and dose-based exposures modeled in T-REX for a small mammal (15g) consuming short grass are used. Subacute and chronic effects are estimated using the most sensitive mammalian toxicity data. EECs are divided by the toxicity value to estimate acute and chronic dietary-based RQs as well as acute dose-based RQs. Acute dose-based RQ values exceed the listed species acute risk LOC for the majority of dimethoate uses. Across all uses, chronic dose-based and dietary-based RQs exceed the LOC (**Table 33**).

An additional prey item of the adult CRLF is other species of frogs. In order to assess risks to these organisms, dietary-based and dose-based exposures modeled in T-REX for a small bird (20g) consuming small invertebrates are used. These are the same EECs, toxicity values and RQs used to assess direct effects to the CRLF. Acute, dietary-based RQ values are equivalent to or exceed the LOC for all uses of dimethoate; dietary-based chronic RQ values and dose-based RQ values exceed the LOC for listed species for all uses (**Table 29**).

5.1.2.3. Indirect Effects to CRLF through effects to habitat (plants)

No data are available to assess the risks of dimethoate to riparian and terrestrial plants. Given the lack of data, RQ values could not be derived to represent the risks of dimethoate exposure to the riparian and terrestrial habitat of the CRLF.

Table 31. Acute and chronic, dietary-based RQs and dose-based RQs for direct effects to the terrestrial-phase CRLF. RQs calculated using T-REX.

Use	Acute, dietary- based[1,2]	Chronic, dietary-based[3,4]	Acute, dose-based[5,6]
Alfalfa	0.2	16.88	16.48
beans	0.21	17.46	17.04
broccoli	0.25	20.59	20.1
Brussels sprouts	0.5	41.43	40.46
cauliflower	0.25	20.59	20.1
celery	0.25	20.59	20.1
Chinese cabbage	0.25	20.59	20.1
citrus	0.81	67.5	65.91
conifer seed orchards	0.41	33.75	32.95
cotton	0.21	17.46	17.04
cottonwood (for pulp)	0.5	41.17	40.2
Endive (escarole)	0.12	10.29	10.05
field corn	0.2	16.88	16.48
garbanzo beans	0.2	16.88	16.48
grass for seed	0.2	16.88	16.48
herbaceous ornamentals	0.1	8.44	8.24
honeydew	0.24	20.01	19.53
kale	0.1	8.67	8.46
kohlrabi	0.25	20.59	20.1
lentils	0.24	20.01	19.53
lettuce (leaf)	0.12	10.29	10.05
Lupine	0.24	20.01	19.53
melon	0.24	20.01	19.53
mustard greens	0.11	9.4	9.18
Non-cropland areas adjacent to vineyards	0.96	80.02	78.13
pears	0.2	16.88	16.48
peas (succulent)	0.2	16.88	16.48
pecans	0.13	11.14	10.87
peppers	0.16	13.67	13.35
popcorn	0.2	16.88	16.48
potatoes	0.24	20.01	19.53
Safflower	0.2	16.88	16.48
sainfoin	0.2	16.88	16.48
sorghum	0.24	20.01	19.53
Swiss chard	0.12	10.29	10.05
tomatoes	0.25	20.86	20.37
triticale	0.24	20.01	19.53
turnips	0.2	16.3	15.92
Wheat	0.2	16.88	16.48

[1] Based on LC_{50} for ring-necked pheasant = 332 mg/kg-diet
[2] All RQs are equivalent to or exceed the acute listed species LOC of 0.1.
[3] Based on chronic NOAEC of 4.0 ppm for northern bobwhite quail.
[4] All RQs exceed the chronic listed species LOC of 1.0.
[5] Based on LD_{50} for red-winged blackbird = 5.4 mg/kg.
[6] All RQs exceed the acute listed species LOC of 0.1.

Table 32. RQs for determining indirect effects to the terrestrial-phase CRLF through effects to potential prey items, specifically terrestrial invertebrates.

Use	Small invertebrate[1,2]	Large Invertebrate[1,2]
Alfalfa	**173.1**	**19.2**
beans	**179.0**	**19.9**
broccoli	**211.1**	**23.5**
Brussels sprouts	**425.0**	**47.2**
cauliflower	**211.1**	**23.5**
celery	**211.1**	**23.5**
Chinese cabbage	**211.1**	**23.5**
citrus	**692.3**	**76.9**
conifer seed orchards	**346.2**	**38.5**
cotton	**179.0**	**19.9**
cottonwood (for pulp)	**422.3**	**46.9**
Endive (escarole)	**105.6**	**11.7**
field corn	**173.1**	**19.2**
garbanzo beans	**173.1**	**19.2**
grass for seed	**173.1**	**19.2**
herbaceous ornamentals	**86.5**	**9.6**
honeydew	**205.2**	**22.8**
kale	**88.9**	**9.9**
kohlrabi	**211.1**	**23.5**
lentils	**205.2**	**22.8**
lettuce (leaf)	**105.6**	**11.7**
Lupine	**205.2**	**22.8**
melon	**205.2**	**22.8**
mustard greens	**96.5**	**10.7**
Non-cropland areas adjacent to vineyards	**820.7**	**91.2**
pears	**173.1**	**19.2**
peas (succulent)	**173.1**	**19.2**
pecans	**114.2**	**12.7**
peppers	**140.2**	**15.6**
popcorn	**173.1**	**19.2**
potatoes	**205.2**	**22.8**
Safflower	**173.1**	**19.2**
sainfoin	**173.1**	**19.2**
sorghum	**205.2**	**22.8**
Swiss chard	**105.6**	**11.7**
tomatoes	**213.9**	**23.8**
triticale	**205.2**	**22.8**
turnips	**167.2**	**18.6**
Wheat	**173.1**	**19.2**

[1]Based on LD_{50} = 0.05 µg a.i./bee (equivalent to 0.39 µg a.i./g).
[2]All RQ values exceed the LOC of 0.05.

Table 33. RQs for determining indirect effects to the terrestrial-phase CRLF through effects to potential prey items, specifically terrestrial mammals.

Use	Acute, dose-based[1,2]	Chronic, dose-based[3,4]	Chronic, dietary-based[3,4]
Alfalfa	**0.15**	**520.6**	**60**
beans	**0.15**	**538.47**	**62.06**
broccoli	**0.18**	**635.04**	**73.19**
Brussels sprouts	**0.36**	**1278.18**	**147.32**
cauliflower	**0.18**	**635.04**	**73.19**
celery	**0.18**	**635.04**	**73.19**
Chinese cabbage	**0.18**	**635.04**	**73.19**
citrus	**0.58**	**2082.25**	**240**
conifer seed orchards	**0.29**	**1041.12**	**120**
cotton	**0.15**	**538.47**	**62.06**
cottonwood (for pulp)	**0.35**	**1270.07**	**146.39**
Endive (escarole)	0.09	**317.52**	**36.6**
field corn	**0.15**	**520.56**	**60**
garbanzo beans	**0.15**	**520.56**	**60**
grass for seed	**0.15**	**520.56**	**60**
herbaceous ornamentals	0.07	**260.28**	**30**
honeydew	**0.17**	**617.12**	**71.13**
kale	0.07	**267.32**	**30.81**
kohlrabi	**0.18**	**635.04**	**73.19**
lentils	**0.17**	**617.12**	**71.13**
lettuce (leaf)	0.09	**317.52**	**36.6**
Lupine	**0.17**	**617.12**	**71.13**
melon	**0.17**	**617.12**	**71.13**
mustard greens	0.08	**290.12**	**33.44**
Non-cropland areas adjacent to vineyards	**0.69**	**2468.49**	**284.52**
pears	**0.15**	**520.56**	**60**
peas (succulent)	**0.15**	**520.56**	**60**
pecans	**0.1**	**343.57**	**39.6**
peppers	**0.12**	**421.72**	**48.61**
popcorn	**0.15**	**520.56**	**60**
potatoes	**0.17**	**617.12**	**71.13**
Safflower	**0.15**	**520.56**	**60**
sainfoin	**0.15**	**520.56**	**60**
sorghum	**0.17**	**617.12**	**71.13**
Swiss chard	0.09	**317.52**	**36.6**
tomatoes	**0.18**	**643.4**	**74.16**
triticale	**0.17**	**617.12**	**71.13**
turnips	**0.14**	**502.92**	**57.97**
Wheat	**0.15**	**520.56**	**60**

[1]Based on LD_{50} for laboratory rat = 358 mg/kg.
[2]Several RQ values exceed the acute listed species LOC of 0.1.
[3]Based on chronic NOAEC for laboratory rat = 0.1 mg/kg-bw.
[4]All RQ values exceed the chronic listed species LOC of 1.0.

5.2. Risk Description

The risk description synthesizes an overall conclusion regarding the likelihood of impacts 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 its designated critical habitat (*i.e*., modification or no modification).

If the RQs presented in the Risk Estimation (**Section 5.1**) show no indirect effects and LOCs for the CRLF are not exceeded for direct effects, a "no effect" determination is made, based on use of dimethoate within the action area. If, however, indirect effects are anticipated and/or exposure exceeds the LOCs for direct effects, the Agency concludes a preliminary "may affect" determination for the CRLF. Following a "may affect" determination, additional information is considered to refine the potential for exposure at the predicted levels based on the life history characteristics (*i.e.*, habitat range, feeding preferences, etc.) of the CRLF and potential community-level effects to aquatic plants. Based on the best available information, the Agency uses the refined evaluation to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that are "likely to adversely affect" the CRLF.

The criteria used to make determinations that the effects of an action are "not likely to adversely affect" 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 each of the established assessment endpoints for the CRLF is provided below.

5.2.1. Direct Effects

5.2.1.1. Aquatic-phase

Acute and chronic RQ values representing all uses of dimethoate do not exceed the LOCs for direct effects to the CRLF in aquatic habitats. EECs would have to be 1-2 orders of magnitude larger to be of concern for direct effects to the aquatic-phase CRLF. Therefore, the determination for direct effects to the CRLF in aquatic habitats is “No Effect” for uses of dimethoate.

Of the 25 ecological incidents associated with dimethoate exposures, 4 involved fish kills. Since fish are used as surrogates for the aquatic-phase CRLF, incidents involving fish are considered relevant to this assessment. Mortalities of fish were reported for several different species, including bass, sunfish, and many unnamed fish. Two of the incidents were associated with applications that were classified as “misuse,” one incident was associated with a registered use of dimethoate and the remaining incident was unclassified. All incidents were associated with dimethoate and other pesticide exposures to the fish, including 2,4-D, aldicarb, diazinon, disulfoton, chlorpyrifos, malathion, methyl parathion, parathion and thiodan. The certainty of the incidents was defined as possible to probable. Since other pesticides were associated with these incidents, dimethoate’s specific contribution to the observed fish mortalities is uncertain. For more details associated with these incidents, see **Appendix H**.

5.2.1.2. Terrestrial-phase

T-REX calculated acute dose-based RQs, acute dietary-based RQs and chronic dietary-based RQs exceed their respective LOCs, resulting in a “may affect” determination for all uses. In order to explore influences of amphibian-specific food intake equations on potential dose-based and dietary-based exposures of the terrestrial phase CRLF to dimethoate, T-HERPS is used. Modeling with T-HERPS incorporates the same application rates, intervals and number of applications for each use as defined for modeling using T-REX (**Table 16**). Since applications of dimethoate for all uses result in exposures sufficient to exceed the LOC for direct effects to the CRLF, the T-HERPS model was used to estimate EECs and subsequent risks to the CRLF based on amphibian-specific equations. These refined EECs and RQs were used to distinguish “NLAA” and “LAA” determinations. An example output from T-HERPS is available in **Appendix I**.

RQs are calculated for the terrestrial-phase CRLF on the basis of dose and diet. It should be noted that although dietary-based RQ values are considerably lower than dose-based RQ values, the former do not take into account that different-sized animals consume differing amounts of food and that depending on the forage item, an animal has to consume varying amounts due to differing nutrition levels in the food item. If dietary-based RQ values are adjusted to account for differential food consumption, the adjusted RQ value would likely approximate the dose-based RQ value.

Acute exposures

Refined dose-based RQs for small sized (1.4 g) CRLF consuming small insects exceed the acute listed species LOC (0.1) for all uses of dimethoate. RQs representing dimethoate exposures to small CRLF consuming large invertebrates are lower than RQs representing exposures of small CRLF to dimethoate through consumption of small invertebrates. The acute listed species LOC is exceeded for small CRLF consuming large insects for some uses of dimethoate (**Table 34**). This indicates that small CRLF could potentially be affected by acute exposures to dimethoate.

Refined dose-based RQs for medium sized (37 g) and large sized (238 g) CRLF consuming small insects and mammals exceed the acute listed species LOC (0.1) for all uses of dimethoate. The acute listed species LOC is exceeded for medium and large CRLF consuming large insects for some uses of dimethoate. The LOC is not exceeded for medium or large CRLF consuming small-terrestrial phase amphibians (**Tables 35 and 36**). This indicates that medium and large sized CRLF could potentially be affected by acute exposures to dimethoate.

Although dietary-based RQs are generally lower than dose-based RQs, they follow a similar trend when compared to dose-based RQs. Refined acute dietary-based RQs for CRLFs consuming small insects and herbivorous mammals meet or exceed the acute listed species LOC (0.1) for all uses of dimethoate. The acute listed species LOC is exceeded for medium and large CRLF consuming large insects for only the highest use of dimethoate. For CRLFs consuming terrestrial-phase amphibians and small insectivorous mammals, the acute LOC is not exceeded for any use (**Table 37**). This indicates that CRLF could potentially be affected by acute exposures to dimethoate.

Table 34. Revised dose-based RQs[1] for 1.4 g CRLF consuming different food items. EECs calculated using T-HERPS.

Use	Small Insects	Large Insects
Alfalfa	**0.49**	0.05
beans	**0.50**	0.06
broccoli	**0.59**	0.07
Brussels sprouts	**1.19**	**0.13**
cauliflower	**0.59**	0.07
celery	**0.59**	0.07
Chinese cabbage	**0.59**	0.07
citrus	**1.94**	**0.22**
conifer seed orchards	**0.97**	**0.11**
cotton	**0.50**	0.06
cottonwood (for pulp)	**1.18**	**0.13**
endive (escarole)	**0.30**	0.03
field corn	**0.49**	0.05
garbanzo beans	**0.49**	0.05
grass for seed	**0.49**	0.05
herbaceous ornamentals	**0.24**	0.03
honeydew	**0.58**	0.06
kale	**0.25**	0.03
kohlrabi	**0.59**	0.07
lentils	**0.58**	0.06
lettuce (leaf)	**0.30**	0.03
Lupine	**0.58**	0.06
melon	**0.58**	0.06
mustard greens	**0.27**	0.03
Non-cropland areas adjacent to vineyards	**2.30**	**0.23**
pears	**0.49**	0.05
peas (succulent)	**0.49**	0.05
pecans	**0.32**	0.04
peppers	**0.39**	0.04
popcorn	**0.49**	0.05
potatoes	**0.58**	0.06
Safflower	**0.49**	0.05
sainfoin	**0.49**	0.05
sorghum	**0.58**	0.06
Swiss chard	**0.30**	0.03
tomatoes	**0.60**	0.07
triticale	**0.58**	0.06
turnips	**0.47**	0.05
Wheat	**0.49**	0.05

[1]RQ values ≥0.1 exceed the acute listed species LOC.

Table 35. Revised dose-based RQs[1] for 37 g CRLF consuming different food items. EECs calculated using T-HERPS.

Use	Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial-phase Amphibians
Alfalfa	**0.48**	0.05	**13.85**	**0.87**	0.02
beans	**0.49**	0.05	**14.33**	**0.90**	0.02
broccoli	**0.58**	0.06	**16.90**	**1.06**	0.02
Brussels sprouts	**1.17**	**0.13**	**34.01**	**2.13**	0.04
cauliflower	**0.58**	0.06	**16.90**	**1.06**	0.02
celery	**0.58**	0.06	**16.90**	**1.06**	0.02
Chinese cabbage	**0.58**	0.06	**16.90**	**1.06**	0.02
citrus	**1.91**	**0.21**	**55.41**	**3.46**	0.07
conifer seed orchards	**0.95**	**0.11**	**27.70**	**1.73**	0.03
cotton	**0.49**	0.05	**14.33**	**0.90**	0.02
cottonwood (for pulp)	**1.16**	**0.13**	**33.80**	**2.11**	0.04
endive (escarole)	**0.29**	0.03	**8.45**	**0.53**	0.01
field corn	**0.48**	0.05	**13.85**	**0.87**	0.02
garbanzo beans	**0.48**	0.05	**13.85**	**0.87**	0.02
grass for seed	**0.48**	0.05	**13.85**	**0.87**	0.02
herbaceous ornamentals	**0.24**	0.03	**6.93**	**0.43**	0.01
honeydew	**0.57**	0.06	**16.42**	**1.03**	0.02
kale	**0.25**	0.03	**7.11**	**0.44**	0.01
kohlrabi	**0.58**	0.06	**16.90**	**1.06**	0.02
lentils	**0.57**	0.06	**16.42**	**1.03**	0.02
lettuce (leaf)	**0.29**	0.03	**8.45**	**0.53**	0.01
Lupine	**0.57**	0.06	**16.42**	**1.03**	0.02
melon	**0.57**	0.06	**16.42**	**1.03**	0.02
mustard greens	**0.27**	0.03	**7.72**	**0.48**	0.01
Non-cropland areas adjacent to vineyards	**2.26**	**0.25**	**65.68**	**4.11**	0.08
pears	**0.48**	0.05	**13.85**	**0.87**	0.02
peas (succulent)	**0.48**	0.05	**13.85**	**0.87**	0.02
pecans	**0.32**	0.04	**9.14**	**0.57**	0.01
peppers	**0.39**	0.04	**11.22**	**0.70**	0.01
popcorn	**0.48**	0.05	**13.85**	**0.87**	0.02
potatoes	**0.57**	0.06	**16.42**	**1.03**	0.02
Safflower	**0.48**	0.05	**13.85**	**0.87**	0.02
sainfoin	**0.48**	0.05	**13.85**	**0.87**	0.02
sorghum	**0.57**	0.06	**16.42**	**1.03**	0.02
Swiss chard	**0.29**	0.03	**8.45**	**0.53**	0.01
tomatoes	**0.59**	0.07	**17.12**	**1.07**	0.02
triticale	**0.57**	0.06	**16.42**	**1.03**	0.02
turnips	**0.46**	0.05	**13.38**	**0.84**	0.02
Wheat	**0.48**	0.05	**13.85**	**0.87**	0.02

[1]RQ values ≥0.1 exceed the acute listed species LOC.

Table 36. Revised dose-based RQs[1] for 238 g CRLF consuming different food items. EECs calculated using T-HERPS.

Use	Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial-phase Amphibians
Alfalfa	**0.31**	0.03	**2.15**	**0.13**	0.01
beans	**0.32**	0.04	**2.23**	**0.14**	0.01
broccoli	**0.38**	0.04	**2.63**	**0.16**	0.01
Brussels sprouts	**0.77**	0.09	**5.29**	**0.33**	0.03
cauliflower	**0.38**	0.04	**2.63**	**0.16**	0.01
celery	**0.38**	0.04	**2.63**	**0.16**	0.01
Chinese cabbage	**0.38**	0.04	**2.63**	**0.16**	0.01
citrus	**1.25**	**0.14**	**8.61**	**0.54**	0.04
conifer seed orchards	**0.63**	0.07	**4.31**	**0.27**	0.02
cotton	**0.32**	0.04	**2.23**	**0.14**	0.01
cottonwood (for pulp)	**0.76**	0.08	**5.25**	**0.33**	0.03
endive (escarole)	**0.19**	0.02	**1.31**	0.08	0.01
field corn	**0.31**	0.03	**2.15**	**0.13**	0.01
garbanzo beans	**0.31**	0.03	**2.15**	**0.13**	0.01
grass for seed	**0.31**	0.03	**2.15**	**0.13**	0.01
herbaceous ornamentals	**0.16**	0.02	**1.08**	0.07	0.01
honeydew	**0.37**	0.04	**2.55**	**0.16**	0.01
kale	**0.16**	0.02	**1.11**	0.07	0.01
kohlrabi	**0.38**	0.04	**2.63**	**0.16**	0.01
lentils	**0.37**	0.04	**2.55**	**0.16**	0.01
lettuce (leaf)	**0.19**	0.02	**1.31**	0.08	0.01
Lupine	**0.37**	0.04	**2.55**	**0.16**	0.01
melon	**0.37**	0.04	**2.55**	**0.16**	0.01
mustard greens	**0.17**	0.02	**1.20**	0.08	0.01
Non-cropland areas adjacent to vineyards	**1.48**	**0.16**	**10.21**	**0.64**	0.05
pears	**0.31**	0.03	**2.15**	**0.13**	0.01
peas (succulent)	**0.31**	0.03	**2.15**	**0.13**	0.01
pecans	**0.21**	0.02	**1.42**	0.09	0.01
peppers	**0.25**	0.03	**1.74**	**0.11**	0.01
popcorn	**0.31**	0.03	**2.15**	**0.13**	0.01
potatoes	**0.37**	0.04	**2.55**	**0.16**	0.01
Safflower	**0.31**	0.03	**2.15**	**0.13**	0.01
sainfoin	**0.31**	0.03	**2.15**	**0.13**	0.01
sorghum	**0.37**	0.04	**2.55**	**0.16**	0.01
Swiss chard	**0.19**	0.02	**1.31**	0.08	0.01
tomatoes	**0.39**	0.04	**2.66**	**0.17**	0.01
triticale	**0.37**	0.04	**2.55**	**0.16**	0.01
turnips	**0.30**	0.03	**2.08**	**0.13**	0.01
Wheat	**0.31**	0.03	**2.15**	**0.13**	0.01

[1]RQ values ≥0.1 exceed the acute listed species LOC.

Table 37. Revised acute dietary-based RQs[1] for CRLF consuming different food items. EECs calculated using T-HERPS.

Use	Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial-phase Amphibians
Alfalfa	**0.20**	0.02	**0.24**	0.01	0.01
beans	**0.21**	0.02	**0.25**	0.02	0.01
broccoli	**0.25**	0.03	**0.29**	0.02	0.01
Brussels sprouts	**0.50**	0.06	**0.58**	0.04	0.02
cauliflower	**0.25**	0.03	**0.29**	0.02	0.01
celery	**0.25**	0.03	**0.29**	0.02	0.01
Chinese cabbage	**0.25**	0.03	**0.29**	0.02	0.01
citrus	**0.81**	0.09	**0.95**	0.06	0.03
conifer seed orchards	**0.41**	0.05	**0.48**	0.03	0.01
cotton	**0.21**	0.02	**0.25**	0.02	0.01
cottonwood (for pulp)	**0.50**	0.06	**0.58**	0.04	0.02
endive (escarole)	**0.12**	0.01	**0.15**	0.01	<0.01
field corn	**0.20**	0.02	**0.24**	0.01	0.01
garbanzo beans	**0.20**	0.02	**0.24**	0.01	0.01
grass for seed	**0.20**	0.02	**0.24**	0.01	0.01
herbaceous ornamentals	**0.10**	0.01	**0.12**	0.01	<0.01
honeydew	**0.24**	0.03	**0.28**	0.02	0.01
kale	**0.10**	0.01	**0.12**	0.01	<0.01
kohlrabi	**0.25**	0.03	**0.29**	0.02	0.01
lentils	**0.24**	0.03	**0.28**	0.02	0.01
lettuce (leaf)	**0.12**	0.01	**0.15**	0.01	<0.01
Lupine	**0.24**	0.03	**0.28**	0.02	0.01
melon	**0.24**	0.03	**0.28**	0.02	0.01
mustard greens	**0.11**	0.01	**0.13**	0.01	<0.01
Non-cropland areas adjacent to vineyards	**0.96**	**0.11**	**1.13**	0.07	0.03
pears	**0.20**	0.02	**0.24**	0.01	0.01
peas (succulent)	**0.20**	0.02	**0.24**	0.01	0.01
pecans	**0.13**	0.01	**0.16**	0.01	<0.01
peppers	**0.16**	0.02	**0.19**	0.01	0.01
popcorn	**0.20**	0.02	**0.24**	0.01	0.01
potatoes	**0.24**	0.03	**0.28**	0.02	0.01
Safflower	**0.20**	0.02	**0.24**	0.01	0.01
sainfoin	**0.20**	0.02	**0.24**	0.01	0.01
sorghum	**0.24**	0.03	**0.28**	0.02	0.01
Swiss chard	**0.12**	0.01	**0.15**	0.01	<0.01
tomatoes	**0.25**	0.03	**0.29**	0.02	0.01
triticale	**0.24**	0.03	**0.28**	0.02	0.01
turnips	**0.20**	0.02	**0.23**	0.01	0.01
Wheat	**0.20**	0.02	**0.24**	0.01	0.01

[1]RQ values ≥0.1 exceed the acute listed species LOC.

EECs and relevant RQs (**Tables 34-37**) calculated by T-HERPS apply to sites where dimethoate is directly applied. Since dimethoate can be transported through spray drift to non-target areas beyond the treatment site, CLRF outside of direct treatment areas can still be exposed to dimethoate in non-target areas. Exposure and associated risks to the CRLF are expected to decrease with increasing distance away from the treated field or site of application. Based on acute effects data, spray drift deposition of dimethoate as low as 0.0036 lbs a.i./A would be sufficient to exceed the acute listed species LOC for the CRLF. For the majority of dimethoate uses (all uses with a single maximum application rate ≥0.33 lbs a.i./A; see **Table 5** for specific uses), this distance is estimated to extend more than 990 feet beyond the edge of the application site (**Table 38**). Four dimethoate uses (citrus, Brussels sprouts, herbaceous ornamentals and non-cropland areas adjacent to vineyards) allow applications only by ground methods. For maximum single applications to citrus and non-cropland areas (2 lbs a.i./A), deposition is sufficient to exceed the LOC for direct acute effects to the CRLF extending as far as 869 feet from the edge of the application site. For Brussels sprouts and herbaceous ornamentals, deposition from a maximum single application (1 and 0.25 lbs a.i./A, respectively) is sufficient to exceed the LOC extending as far as 545 and 174 feet, respectively from the edge of the application sites (**Table 39**).

Table 38. Single aerial application rate not exceeding acute LOC for dietary- and dose-based exposures of the CRLF to dimethoate.

CRLF size*	Based on dose or diet?	Feeding Category	Highest application rate not exceeding LOC (lbs a.i./A)	Distance from edge of field where LOC is not exceeded (in feet) for single application rate**			
				1 lb a.i./A	0.5 lb a.i./A	0.33 lb a.i./A	0.25 lb a.i./A
medium	Dose	small herbivore mammals	0.0035	>990	>990	>990	741
large	Dose	small herbivore mammals	0.024	390	194	131	102
medium	Dose	small insectivore mammals	0.055	174	89	56	26
Small	Dose	small insects	0.1	98	33	13	7
medium	Dose	small insects	0.1	98	33	13	7
large	Dose	small insects	0.16	59	13	3	0
all	Diet	Small herbivore mammals	0.2	33	7	0	0
all	Diet	Small insects	0.25	23	0	0	0
large	Dose	small insectivore mammals	0.36	10	0	0	0
Small	Dose	large insects	0.9	0	0	0	0
medium	Dose	large insects	0.9	0	0	0	0
large	Dose	large insects	>1***	0	0	0	0
all	Diet	large insects	>1***	0	0	0	0
medium	Dose	terrestrial-phase amphibians	>1***	0	0	0	0
all	Diet	Small insectivore mammals	>1***	0	0	0	0
all	Diet	Terrestrial-phase amphibians	>1***	0	0	0	0
large	Dose	terrestrial-phase amphibians	>1***	0	0	0	0

*Small is defined as 1.4 g. Medium is defined as 37 g. Large is defined as 238 g.
**Estimated using the terrestrial assessment of the Tier 1 version of AgDRIFT. Modeling assumed that applications were done using aerial methods, and assuming that the droplet size distribution was "ASAE fine to medium."
***1 lb a.i./A represents the highest single application rate made by aerial methods for dimethoate.

Table 39. Single ground application rate not exceeding acute LOC for dietary- and dose-based exposures of the CRLF to dimethoate.

CRLF size*	Based on dose or diet?	Feeding Category	Highest application rate not exceeding LOC (lbs a.i./A)	distance from edge of field where LOC is not exceeded (in feet) for single application rate**			
				2 lb a.i./A	1 lb a.i./A	0.5 lb a.i./A	0.25 lb a.i./A
medium	Dose	small herbivore mammals	0.0035	869	545	322	174
large	Dose	small herbivore mammals	0.024	200	105	52	30
medium	Dose	small insectivore mammals	0.055	92	46	26	13
Small	Dose	small insects	0.1	52	26	16	7
medium	Dose	small insects	0.1	52	26	16	7
large	Dose	small insects	0.16	33	20	10	3
all	Diet	Small herbivore mammals	0.2	26	16	7	3
all	Diet	Small insects	0.25	23	13	7	3
large	Dose	small insectivore mammals	0.36	16	10	3	0
Small	Dose	large insects	0.9	7	3	0	0
medium	Dose	large insects	0.9	7	3	0	0
large	Dose	large insects	1.5	3	0	0	0
all	Diet	large insects	>2***	0	0	0	0
medium	Dose	terrestrial-phase amphibians	>2***	0	0	0	0
all	Diet	Small insectivore mammals	>2***	0	0	0	0
all	Diet	Terrestrial-phase amphibians	>2***	0	0	0	0
large	Dose	terrestrial-phase amphibians	>2***	0	0	0	0

*Small is defined as 1.4 g. Medium is defined as 37 g. Large is defined as 238 g.
**Estimated using the terrestrial assessment of the Tier 1 version of AgDRIFT. Modeling assumed that applications were done using ground methods, using a high boom and assuming that the droplet size distribution was "ASAE very fine to fine."
***2 lb a.i./A represents the highest single application rate made by ground methods for dimethoate.

Based on an analysis of the likelihood of individual mortality considering the range of acute dose-based RQs for terrestrial-phase CRLFs (**Tables 34-36**) and a probit dose-response of 2.54 (MRID 00020560), the chance of mortality for RQs which exceed the LOC (0.1) range from 1 in 180 individuals to 1 in 1 individuals **(Figure 11**). This range is relevant to all sizes of CRLF consuming small invertebrates. For medium sized frogs consuming small herbivorous mammals, the chance of individual mortality is approximately 1 in 1 individual for all uses of dimethoate. Essentially, this indicates that if a medium sized CRLF consumes a mouse that was present on a dimethoate treatment site, it would be expected to die due to dimethoate exposure. For large sized CRLF consuming small herbivorous mammals, the chance of individual mortality ranges 1 in 2 individuals to 1 in 1 individual. For CRLF (medium and large sized) consuming small insectivore mammals, the chance of individual mortality ranges from 1 in 180 individuals to 1 in 1 individual.

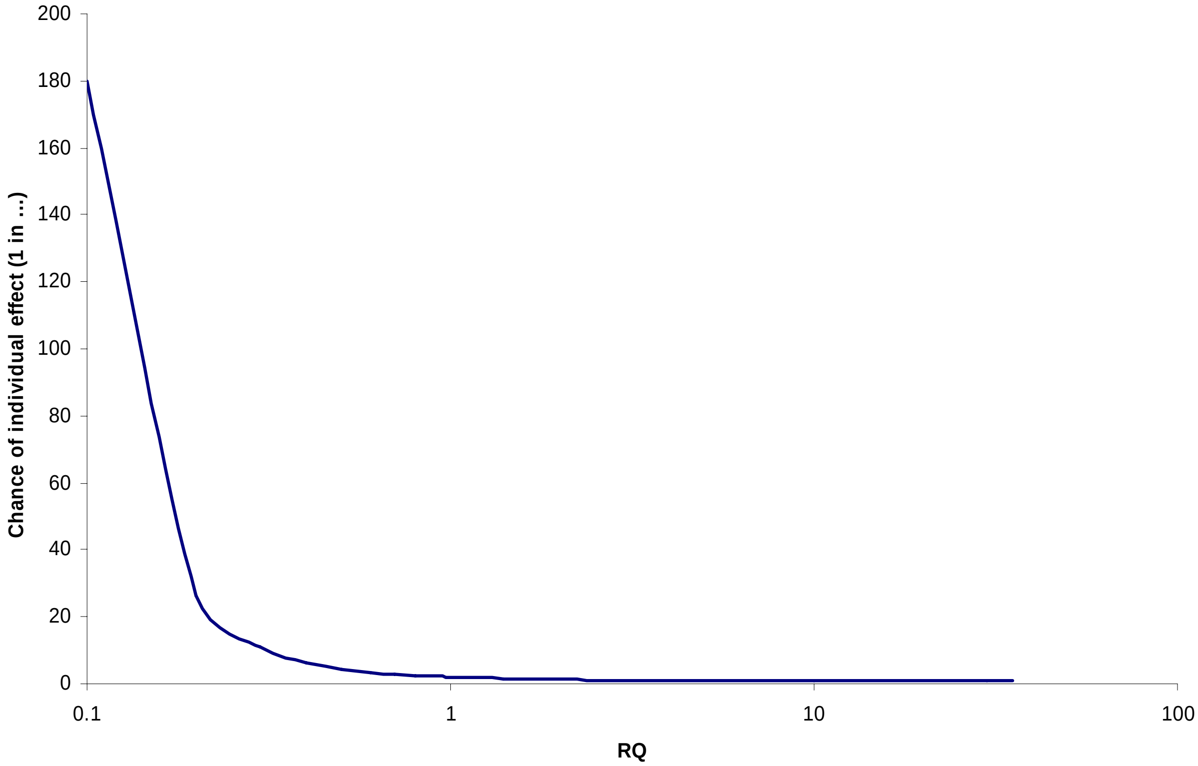


Figure 11. Chance of individual mortality to terrestrial-phase CRLF when considering acute dose-based RQs.

Considering acute dietary-based RQs for the terrestrial phase CRLF **(Table 37)** and a probit dose-response of 10.1 (MRID 00022923), the chance for mortality of RQs exceeding the LOC (0.1) range from 1 in $3.62e^{23}$ to 1 in 1.4 individuals **(Figure 12)**.

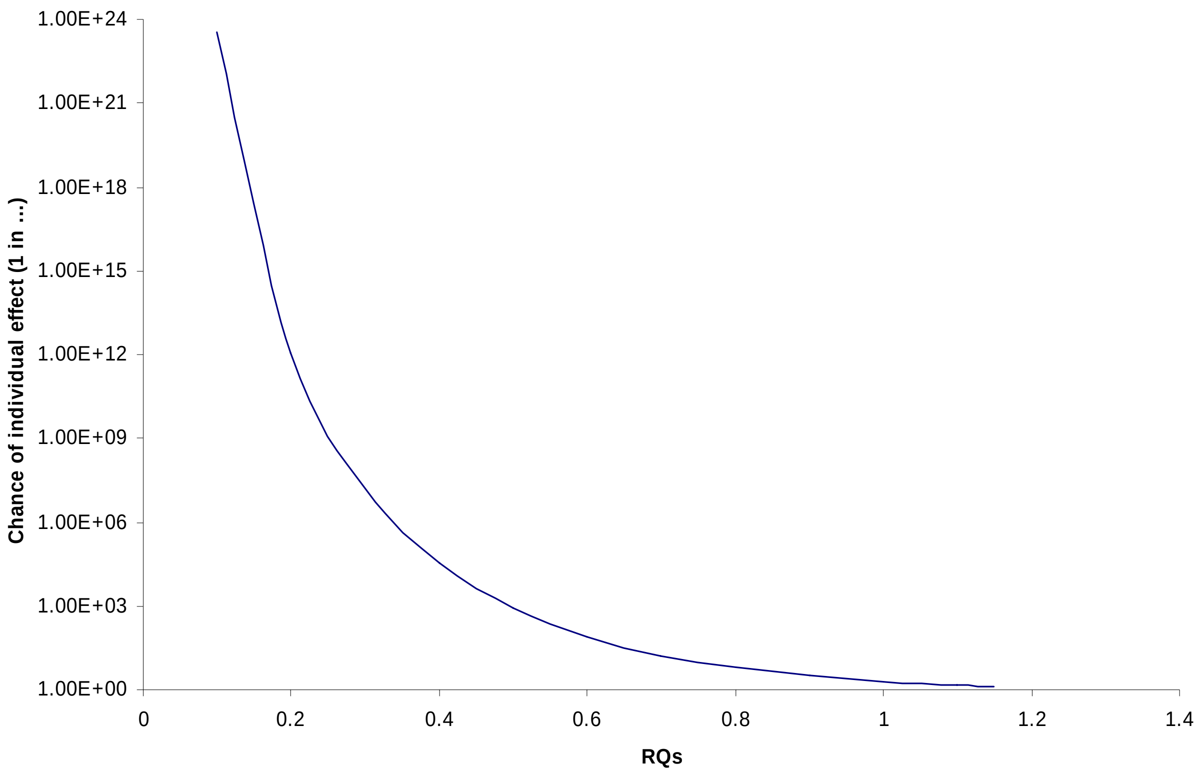


Figure 12. Chance of individual mortality to terrestrial-phase CRLF when considering acute dietary-based RQs.

An analysis of ecological incidents results in no reported effects to terrestrial-phase amphibians involving dimethoate exposures. Since birds are used as surrogates for the terrestrial-phase CRLF, incidents involving birds are considered relevant to this assessment. Of the 25 reported incidents associated with dimethoate, 9 were associated with bird mortalities. These mortalities were associated with Canadian geese, cedar waxwings, a rock dove and turkeys. The incidents were associated with pesticide applications that were classified as "misuse" (3 of 9) and "registered use" (6 of 9). The certainty index indicated that it was possible to highly probable that dimethoate contributed to these mortalities. In 6 of the 9 incidents, other pesticides were associated with the incidents, including pesticides with high avian toxicity. For more details associated with these incidents, see **Appendix H**.

Based on the information in this section, for all uses of dimethoate, the effects determination for acute effects to the terrestrial phase CRLF is "LAA" based on potential mortality through consumption of dimethoate-contaminated food items.

Chronic exposures

Refined chronic dietary-based RQs for CRLFs consuming insects and mammals exceed the chronic listed species LOC (1.0) for all uses of dimethoate. The chronic listed species LOC is exceeded for CRLF consuming terrestrial-phase amphibians for some uses of dimethoate (**Table 40**).

In the available chronic study where Northern bobwhite quail were exposed to dimethoate, the NOAEC was 4 ppm, and the LOAEC was 10.1 ppm, based on reproductive effects. Comparison of the LOAEC directly to chronic dietary-based EECs for CRLF consuming small insects and small mammals indicate that EECs for all uses are sufficient to exceed the concentration where reproductive effects were observed in the laboratory. For CRLFs consuming large invertebrates and terrestrial-phase amphibians, the majority of dimethoate uses have EECs which are insufficient to exceed the LOAEC. Therefore, for some CRLF feeding categories, dimethoate EECs are at levels where reproductive effects were observed in birds, which serve as surrogates for the CRLF.

Based on the information in this section, for all uses of dimethoate, the effects determination for chronic effects to the terrestrial-phase CRLF is "LAA" based on potential reproductive effects.

Table 40. Revised chronic dietary-based RQs[1] for CRLF consuming different food items. EECs calculated using T-HERPS.

Use	Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial-phase Amphibians
Alfalfa	**16.88**	**1.88**	**19.77**	**1.24**	0.59
beans	**17.46**	**1.94**	**20.45**	**1.28**	0.61
broccoli	**20.59**	**2.29**	**24.12**	**1.51**	0.71
Brussels sprouts	**41.43**	**4.60**	**48.54**	**3.03**	**1.44**
cauliflower	**20.59**	**2.29**	**24.12**	**1.51**	0.71
celery	**20.59**	**2.29**	**24.12**	**1.51**	0.71
Chinese cabbage	**20.59**	**2.29**	**24.12**	**1.51**	0.71
citrus	**67.50**	**7.50**	**79.07**	**4.94**	**2.34**
conifer seed orchards	**33.75**	**3.75**	**39.54**	**2.47**	**1.17**
cotton	**17.46**	**1.94**	**20.45**	**1.28**	0.61
cottonwood (for pulp)	**41.17**	**4.57**	**48.23**	**3.01**	**1.43**
endive (escarole)	**10.29**	**1.14**	**12.06**	0.75	0.36
field corn	**16.88**	**1.88**	**19.77**	**1.24**	0.59
garbanzo beans	**16.88**	**1.88**	**19.77**	**1.24**	0.59
grass for seed	**16.88**	**1.88**	**19.77**	**1.24**	0.59
herbaceous ornamentals	**8.44**	**0.94**	**9.88**	0.62	0.29
honeydew	**20.01**	**2.22**	**23.44**	**1.46**	0.69
kale	**8.67**	**0.96**	**10.15**	0.63	0.30
kohlrabi	**20.59**	**2.29**	**24.12**	**1.51**	0.71
lentils	**20.01**	**2.22**	**23.44**	**1.46**	0.69
lettuce (leaf)	**10.29**	**1.14**	**12.06**	0.75	0.36
Lupine	**20.01**	**2.22**	**23.44**	**1.46**	0.69
melon	**20.01**	**2.22**	**23.44**	**1.46**	0.69
mustard greens	**9.40**	**1.04**	**11.02**	0.69	0.33
Non-cropland areas adjacent to vineyards	**80.02**	**8.89**	**93.74**	**5.86**	**2.78**
pears	**16.88**	**1.88**	**19.77**	**1.24**	0.59
peas (succulent)	**16.88**	**1.88**	**19.77**	**1.24**	0.59
pecans	**11.14**	**1.24**	**13.05**	0.82	0.39
peppers	**13.67**	**1.52**	**16.01**	**1.00**	0.47
popcorn	**16.88**	**1.88**	**19.77**	**1.24**	0.59
potatoes	**20.01**	**2.22**	**23.44**	**1.46**	0.69
Safflower	**16.88**	**1.88**	**19.77**	**1.24**	0.59
sainfoin	**16.88**	**1.88**	**19.77**	**1.24**	0.59
sorghum	**20.01**	**2.22**	**23.44**	**1.46**	0.69
Swiss chard	**10.29**	**1.14**	**12.06**	0.75	0.36
tomatoes	**20.86**	**2.32**	**24.43**	**1.53**	0.72
triticale	**20.01**	**2.22**	**23.44**	**1.46**	0.69
turnips	**16.30**	**1.81**	**19.10**	**1.19**	0.57
Wheat	**16.88**	**1.88**	**19.77**	**1.24**	0.59

[1]RQ values ≥1.0 exceed the chronic listed species LOC.

5.2.2. Indirect Effects (through effects to prey)

As discussed in Section 2.5.3, the diet of tadpole CRLF is composed primarily of unicellular nonvascular aquatic plants and detritus. Juvenile CRLF consume primarily aquatic and terrestrial invertebrates. The diet of adult CRLF is composed of aquatic and terrestrial invertebrates, fish, frogs and mice. These prey groups are considered in determining indirect effects to the CRLF caused by direct effects to its prey.

Nonvascular plants

Based on RQs for algae (**Table 30**), applications of dimethoate are not expected to affect this food source. Therefore, indirect effects of dimethoate to CRLF tadpoles by reductions in phytoplankton are not expected based on the animal's diet during this life stage for all uses of dimethoate. Therefore, it is unlikely that there will be affects to algae from aquatic exposures arising from any use of dimethoate. Therefore, all uses of dimethoate, are expected to have no indirect effect on the CRLF via adverse effects to algae.

Aquatic invertebrates

RQ values representing acute exposures to aquatic invertebrates indicate that the majority of uses of dimethoate can potentially result in effects to invertebrates (**Table 30**). Therefore, indirect effects are possible to CRLF juveniles and adults, through decreases in prey.

Based on an analysis of the likelihood of individual mortality using acute RQs for aquatic invertebrates and a probit dose-response of 6.96 (MRID 00003503), the likelihood of individual mortality for each use is available in **Table 41 (**see also **Appendix J).** Based on this analysis the majority of uses of dimethoate result in <0.01% chance of effects to an individual aquatic invertebrate, with the highest EECs (from cottonwood) resulting in 1.12% chance of individual effects. Therefore, although it is possible for acute dimethoate exposures to result in individual effects to aquatic invertebrates, the impact of these effects on the CRLF is insignificant for all uses.

Table 41. RQs and associated likelihood of individual effects to aquatic invertebrates due to dimethoate exposures.

Use	Acute Invertebrate RQ	Likelihood of individual acute effect (%)
Alfalfa	**0.16**	<0.01
beans	**0.14**	<0.01
broccoli	**0.38**	0.17
Brussels sprouts	**0.21**	<0.01
cauliflower	**0.38**	0.17
celery	**0.19**	<0.01
Chinese cabbage	**0.38**	0.17
citrus	0.03	<0.01
conifer seed orchards	**0.17**	<0.01
cotton	**0.06**	<0.01
cottonwood (for pulp)	**0.47**	1.12
endive (escarole)	**0.13**	<0.01
field corn	0.03	<0.01
garbanzo beans	**0.05**	<0.01
grass for seed	**0.11**	<0.01
herbaceous ornamentals	<0.01	<0.01
honeydew	**0.05**	<0.01
kale	**0.10**	<0.01
kohlrabi	**0.38**	0.17
lentils	**0.10**	<0.01
lettuce (leaf)	**0.13**	<0.01
Lupine	**0.10**	<0.01
melon	**0.05**	<0.01
mustard greens	**0.14**	<0.01
Non-cropland areas adjacent to vineyards	**0.07**	<0.01
pears	0.03	<0.01
peas (succulent)	**0.05**	<0.01
pecans	0.03	<0.01
peppers	**0.19**	<0.01
popcorn	0.03	<0.01
potatoes	**0.07**	<0.01
Safflower	**0.09**	<0.01
sainfoin	**0.06**	<0.01
sorghum	**0.19**	<0.01
Swiss chard	**0.13**	<0.01
tomatoes	**0.06**	<0.01
triticale	**0.19**	<0.01
turnips	**0.10**	<0.01
Wheat	**0.09**	<0.01

Chronic RQ values representing exposures to aquatic invertebrates indicate that all but one of the uses of dimethoate (herbaceous ornamentals) can potentially result in effects to invertebrates (**Table 30**). Therefore, indirect effects are possible to CRLF juveniles and adults, through decreases in prey. Chronic EECs exceed the LOC by factors of 1.5X to 37.3X.

RQs for chronic exposures are based on the level where no effects were observed (the NOAEC) in laboratory exposure tests. As discussed in Section 4.1.3, chronic toxicity data are unavailable for the most sensitive species (stonefly) used to assess acute risk. Therefore, an acute-to-chronic ratio was used to estimate the NOAEC for dimethoate exposure to the stonefly. This same approach can be applied to approximate the lowest concentration where effects (LOAEC) would be expected to be observed. Based on the information contained in the dimethoate IRED (USEPA 2006), the 96-hr acute LC_{50}value for waterflea is 3.32 mg/L. With an acute LC_{50} of 3.32 mg/L and a chronic LOAEC of 0.1, the acute to chronic ratio (ACR) for waterflea is 33.2 (3.32÷0.1). When the ACR is applied to the stonefly data, the resulting estimated LOAEC is 0.0013 mg/L.

Direct comparison of 21-d EECs to this estimated LOAEC for the stonefly indicates that EECs are sufficient to exceed this LOAEC for all dimethoate uses except citrus, field corn, herbaceous ornamentals, pears, pecans and popcorn. EECs for all other uses exceed the estimated LOAEC by factors of 1.2X to 14.4X.

It is assumed that the actual exposure concentration where effects are exhibited lies somewhere between the NOAEC and the LOAEC. Given the uncertainty associated with the actual level where effects occur, risks of chronic dimethoate exposures to aquatic invertebrates are based on RQs derived using the NOAEC. Based on chronic LOC exceedances for aquatic invertebrates, all uses of dimethoate, except herbaceous ornamentals, are likely to indirectly affect the CRLF via adverse effects to aquatic invertebrates.

Terrestrial invertebrates

RQ values representing acute exposures to terrestrial invertebrates indicate that all uses of dimethoate can potentially result in effects to invertebrates. Therefore, indirect effects are possible to CRLF juveniles and adults, through decreases in prey. When considering the level where dimethoate causes 50% mortality in honey bees, EECs are sufficient to exceed this level by factors of 9.6X-692X (**Table 32**).

Based on an analysis of the likelihood of individual mortality using the lowest RQ value for terrestrial invertebrates (RQ=9.6 for dimethoate applications to herbaceous ornamentals) and a probit dose-response of 4.5 (default value), the likelihood of individual mortality is 100%. Using a range of 2-9 for probit dose response results in an estimate of 97-100% likelihood of individual mortality. All other RQ values result in an estimation of 100% likelihood of individual mortality in terrestrial invertebrates **(**see **Appendix J)**.

Several terrestrial invertebrate data values are available in the EFED ecotoxicity database relevant to exposures of honeybees to dimethoate (TGAI). Available LD_{50} values are 0.056, 0.083, 0.16, 0.17 and 0.19 µg a.i./bee (MRIDs 00026489, 00059971, 00026489, 00059971 and 00036935, respectively). The highest LD_{50} (0.19 µg a.i./bee) is equivalent to 1.48 µg a.i./g (of bee). Comparison of this value to EECs for small and large terrestrial invertebrates indicates that EECs are 2.5X to 216X times greater than the highest available LD_{50} for honeybees.

A review of the ecological incident database for dimethoate indicates that there are 10 reported incidents of effects to bees. Affected species include honey bees and leaf cutter bees. The legality of the uses was reported as "undetermined" and as "registered uses". In 8 of the 10 incidents, other pesticides, including insecticides, were also associated with the effects to bees. The certainty of the incidents ranged from possible to highly probable. For more details associated with these incidents, see **Appendix H**.

Based on this information, there is potential for indirect effects to the CRLF via direct effects to terrestrial invertebrates due to dimethoate exposures from all uses.

Fish and aquatic-phase amphibians

Based on RQs for used for direct effects to the aquatic-phase CRLF (**Table 29**), applications of dimethoate are not expected to affect fish and aquatic-phase amphibians. Therefore, indirect effects of dimethoate to CRLF tadpoles by reductions in this food source of the adult CRLF are not expected based on the animal's diet during this life stage for all uses of dimethoate. Therefore, it is unlikely that there will be indirect effects to aquatic-phase CRLFs via effects on fish and aquatic-phase amphibians from aquatic exposures arising from any use of dimethoate.

Small terrestrial mammals

RQ values representing acute exposures to terrestrial mammals exceed the LOC (0.1) for all uses of dimethoate except: endive (escarole), herbaceous ornamentals, kale, lettuce, mustard greens, pecans and Swiss chard (**Table 33**). Therefore, there is potential for acute effects of dimethoate to terrestrial mammals.

Based on an analysis of the likelihood of individual mortality using acute dose-based RQs for terrestrial mammals and a probit dose-response of 4.5 (default value), the likelihood of individual mortality for each use is available in **Table 42 (**see also **Appendix J).** Based on this analysis, the majority of dimethoate uses result in <0.1% chance of effects to an individual terrestrial mammal representing prey of the CRLF. Only the highest two RQs (from citrus and non-cropland areas adjacent to vineyards) result in estimations of likelihood of individual effects which represents a significant effect to the CRLF (14.4% and 23.4%, respectively). Therefore, the impact of the indirect dietary effects to terrestrial-phase CRLFs via acute effects on small mammals is insignificant for all uses of dimethoate, except citrus and non-cropland areas adjacent to vineyards.

Table 42. Acute dose-based RQs and associated likelihood of individual effects to terrestrial mammals due to dimethoate exposures.

Use	Acute dose-based RQ	Likelihood of individual acute effect (%)
Alfalfa	0.15	0.01
beans	0.15	0.01
broccoli	0.18	0.04
Brussels sprouts	0.36	2.3
cauliflower	0.18	0.04
celery	0.18	0.04
Chinese cabbage	0.18	0.04
citrus	0.58	14.4
conifer seed orchards	0.29	0.78
cotton	0.15	0.01
cottonwood (for pulp)	0.35	2.0
Endive (escarole)	0.09	<0.01
field corn	0.15	0.01
garbanzo beans	0.15	0.01
grass for seed	0.15	0.01
herbaceous ornamentals	0.07	<0.01
honeydew	0.17	0.03
kale	0.07	<0.01
kohlrabi	0.18	0.04
lentils	0.17	0.03
lettuce (leaf)	0.09	<0.01
Lupine	0.17	0.03
melon	0.17	0.03
mustard greens	0.08	<0.01
Non-cropland areas adjacent to vineyards	0.69	23.4
pears	0.15	0.01
peas (succulent)	0.15	0.01
pecans	0.1	<0.01
peppers	0.12	<0.01
popcorn	0.15	0.01
potatoes	0.17	0.03
Safflower	0.15	0.01
sainfoin	0.15	0.01
sorghum	0.17	0.03
Swiss chard	0.09	<0.01
tomatoes	0.18	0.04
triticale	0.17	0.03
turnips	0.14	0.01
Wheat	0.15	0.01

Dose-based and dietary-based chronic RQs for terrestrial mammals exceed the LOC (1.0) by factors of 30X to 2468X, depending upon the use (**Table 33**). EECs are sufficient to exceed the LOAEC (0.5 mg/kg-bw/day, based on increased pup death and brain ChE inhibition) for all uses by factors of 6X or greater. Based on this information, chronic exposures of dimethoate from all uses have the potential to indirectly affect the CRLF via impacts to terrestrial mammals serving as potential prey items.

Small terrestrial-phase amphibians

In order to explore influences of amphibian-specific food intake equations on potential dose-based and dietary-based exposures of amphibians (prey of CRLF) to dimethoate, the T-HERPS model is used. The Pacific tree frog is used to represent the amphibian prey species. The weight of the animal is assumed to be 2.3 g, and its diet is assumed to be composed of small and large insects. For frogs consuming small insects, the acute LOC (0.1) is exceeded for all uses of dimethoate. For frogs consuming large insects, the acute LOC is exceeded for dimethoate use on Brussels sprouts, citrus and cottonwood (**Table 43**).

Based on an analysis of the likelihood of individual mortality using acute dose-based RQs for terrestrial phase frogs and a probit dose-response of 2.54 (MRID 00020560), the likelihood of individual mortality for each use is available in **Table 43 (**see also **Appendix J).** Based on this analysis the majority of uses of dimethoate result in >10% chance of effects to an individual terrestrial phase frog consuming small insects. The exceptions include: endive (escarole), herbaceous ornamentals, kale, lettuce, mustard greens, pecans and Swiss chard. All of the uses of dimethoate have RQs for frogs consuming large insects which result in <5% chance of acute effects to individual frogs. Based on acute dose-based RQs and individual effects chance for terrestrial-phase frogs (prey of CRLF) which consume small insects, there is potential for effects to this taxa due to dimethoate exposures from all uses, except: endive (escarole), herbaceous ornamentals, kale, lettuce, mustard greens, pecans and Swiss chard.

Table 43. Acute dose-based RQs and associated likelihood of individual effects to terrestrial-phase frogs (prey) due to dimethoate exposures.

Use	Frogs consuming Small Insects		Frogs consuming Large Insects	
	RQ	Likelihood of individual acute effect (%)	RQ	Likelihood of individual acute effect (%)
Alfalfa	0.43	17.6	0.05	0.05
beans	0.45	18.9	0.05	0.05
broccoli	0.53	24.2	0.06	0.10
Brussels sprouts	1.07	53.0	0.12	1.0
cauliflower	0.53	24.2	0.06	0.10
celery	0.53	24.2	0.06	0.10
Chinese cabbage	0.53	24.2	0.06	0.10
citrus	1.94	76.8	0.22	4.7
conifer seed orchards	0.87	43.9	0.1	0.55
cotton	0.45	18.9	0.05	0.05
cottonwood (for pulp)	1.06	52.6	0.12	1.0
endive (escarole)	0.26	6.9	0.03	0.01
field corn	0.43	17.6	0.05	0.05
garbanzo beans	0.43	17.6	0.05	0.05
grass for seed	0.43	17.6	0.05	0.05
herbaceous ornamentals	0.22	4.7	0.02	<0.01
honeydew	0.51	22.9	0.06	0.10
kale	0.22	4.7	0.02	<0.01
kohlrabi	0.53	24.2	0.06	0.10
lentils	0.51	22.9	0.06	0.10
lettuce (leaf)	0.26	6.9	0.03	0.01
Lupine	0.51	22.9	0.06	0.10
melon	0.51	22.9	0.06	0.10
mustard greens	0.24	5.8	0.03	0.01
Non-cropland areas adjacent to vineyards	2.06	78.7	0.23	5.3
pears	0.43	17.6	0.05	0.05
peas (succulent)	0.43	17.6	0.05	0.05
pecans	0.29	8.6	0.03	0.01
peppers	0.35	12.3	0.04	0.02
popcorn	0.43	17.6	0.05	0.05
potatoes	0.51	22.9	0.06	0.10
Safflower	0.43	17.6	0.05	0.05
sainfoin	0.43	17.6	0.05	0.05
sorghum	0.51	22.9	0.06	0.10
Swiss chard	0.26	6.9	0.03	0.01
tomatoes	0.54	24.8	0.06	0.10
triticale	0.51	22.9	0.06	0.10
turnips	0.42	16.9	0.05	0.05
Wheat	0.43	17.6	0.05	0.05

Acute dietary-based RQs for the CRLF, which do not account for the weight of the animal being assessed, can also be used to assess risks to the terrestrial frog prey (**Table 37**). For frogs which consume small insects, RQs meet or exceed the acute LOC (0.1) for all dimethoate uses. For frogs which consume large insects, the acute LOC is not exceeded for any use of dimethoate, with the exception of non-cropland areas adjacent to vineyards

Based on an analysis of the likelihood of individual mortality using acute dietary-based RQs for terrestrial phase frogs and a probit dose-response of 10.1 (MRID 00022923), the likelihood of individual mortality for each use is available in **Table 44.** Based on this analysis the majority of uses of dimethoate result in <0.01% chance of effects to an individual terrestrial phase frog representing prey of the CRLF. Only the two highest RQs (from citrus and non-cropland areas adjacent to vineyards) result in estimates that represent the likelihood of individual effects being a potential significant effect to the CRLF itself (17.8% and 42.9%, respectively). Therefore, the impact of indirect dietary effects to the CRLF via acute effects on small insects is insignificant for all uses of dimethoate except citrus and non-cropland areas adjacent to vineyards.

Table 44. Acute dietary-based RQs and associated likelihood of individual effects to terrestrial-phase frogs (prey) due to dimethoate exposures.

Use	Small Insects	Likelihood of individual acute effect (%)
Alfalfa	**0.20**	<0.01
beans	**0.21**	<0.01
broccoli	**0.25**	<0.01
Brussels sprouts	**0.50**	0.12
cauliflower	**0.25**	<0.01
celery	**0.25**	<0.01
Chinese cabbage	**0.25**	<0.01
citrus	**0.81**	17.8
conifer seed orchards	**0.41**	<0.01
cotton	**0.21**	<0.01
cottonwood (for pulp)	**0.50**	0.12
endive (escarole)	**0.12**	<0.01
field corn	**0.20**	<0.01
garbanzo beans	**0.20**	<0.01
grass for seed	**0.20**	<0.01
herbaceous ornamentals	0.10	<0.01
honeydew	**0.24**	<0.01
kale	0.10	<0.01
kohlrabi	**0.25**	<0.01
lentils	**0.24**	<0.01
lettuce (leaf)	**0.12**	<0.01
Lupine	**0.24**	<0.01
melon	**0.24**	<0.01
mustard greens	**0.11**	<0.01
Non-cropland areas adjacent to vineyards	**0.96**	42.9
pears	**0.20**	<0.01
peas (succulent)	**0.20**	<0.01
pecans	**0.13**	<0.01
peppers	**0.16**	<0.01
popcorn	**0.20**	<0.01
potatoes	**0.24**	<0.01
Safflower	**0.20**	<0.01
sainfoin	**0.20**	<0.01
sorghum	**0.24**	<0.01
Swiss chard	**0.12**	<0.01
tomatoes	**0.25**	<0.01
triticale	**0.24**	<0.01
turnips	**0.20**	<0.01
Wheat	**0.20**	<0.01

Chronic dietary-based RQs for the CRLF, which do not account for the weight of the animal being assessed, can also be used to assess risks to the terrestrial frog prey (**Table 40**). Refined dietary-based RQs indicate that, for all dimethoate uses, there is potential for chronic effects to terrestrial frogs feeding on small and large insects. Chronic RQs are exceeded by factors ranging 1.14X to 80X.

In the available chronic study where Northern bobwhite quail were exposed to dimethoate, the NOAEC was 4 ppm, and the LOAEC was 10.1 ppm, based on reproductive effects. Comparison of the LOAEC directly to chronic dietary-based EECs for terrestrial frogs consuming small insects and small mammals indicate that EECs for all uses are sufficient to exceed the concentration were reproductive effects were observed in the laboratory. For CRLFs consuming large invertebrates and terrestrial-phase amphibians, the majority of dimethoate uses have EECs which are insufficient to exceed the LOAEC. Therefore, for terrestrial phase frogs, dimethoate EECs are at levels where reproductive effects were observed in birds, which serve as surrogates for frogs.

Summary of indirect effects to the CRLF based on effects to prey

When considering indirect effects to the CRLF through effects to its prey, estimates of exposure are sufficient to be of concern for effects based on decreased prey for several taxa of the CRLFs prey for all dimethoate uses. Although effects to the prey of the tadpole life stage (i.e. algae) are not expected for dimethoate uses, effects to the prey of the juvenile and adult life stages of the CRLF are of concern (aquatic and terrestrial invertebrates). **Table 45** includes a summary of dimethoate uses that are expected to have significant (when considering the CRLF), direct effects on the prey of the CRLF. The overall effects determination for the CRLF based on indirect effects due to effects due to prey is “LAA” for all uses of dimethoate.

Table 45. Potential for risk to prey of CRLF due to dimethoate exposures from specific uses (yes or no). This information is used to determine whether effects of dimethoate on these prey will indirectly affect the CRLF.

Use	Algae	Aquatic Invertebrates		Terrestrial Invertebrates (Acute)	Aquatic-phase frogs and fish		Terrestrial-phase frogs		Small Mammals	
		Acute	Chronic		Acute	Chronic	Acute	Chronic	Acute	Chronic
Alfalfa	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
beans	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
broccoli	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Brussels sprouts	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
cauliflower	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
celery	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Chinese cabbage	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
citrus	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes
conifer [1]	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
cotton	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Cottonwood [2]	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Endive (escarole)	No	No	Yes	Yes	No	No	No	Yes	No	Yes
field corn	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
garbanzo beans	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
grass for seed	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
ornamentals	No	No	No	Yes	No	No	No	Yes	No	Yes
honeydew	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
kale	No	No	Yes	Yes	No	No	No	Yes	No	Yes
Kohlrabi	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
lentils	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
lettuce (leaf)	No	No	Yes	Yes	No	No	No	Yes	No	Yes
Lupine	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
melon	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
mustard greens	No	No	Yes	Yes	No	No	No	Yes	No	Yes
Non-cropland[3]	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes
pears	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
peas (succulent)	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
pecans	No	No	Yes	Yes	No	No	No	Yes	No	Yes
peppers	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
popcorn	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
potatoes	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Safflower	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
sainfoin	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
sorghum	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Swiss chard	No	No	Yes	Yes	No	No	No	Yes	No	Yes
tomatoes	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
triticale	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
turnips	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Wheat	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes

[1]seed orchards [2]For pulp [3]Areas adjacent to vineyards

5.2.3. Indirect Effects (through effects to habitat)

As discussed in Section 2.5.4, the habitat of the CRLF varies during its life cycle, with the CRLF surviving in aquatic, riparian and upland areas. Adults rely on riparian vegetation for resting, feeding, and dispersal. 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).

Based on RQs for novascular plants inhabiting aquatic habitats (**Table 30**), applications of dimethoate are not expected to affect these plants. However, data are unavailable for assessing potential risks of dimethoate exposures to vascular aquatic plants and terrestrial plants in the aquatic, riparian and terrestrial habitats of the CRLF. Although dimethoate is an insecticide, there is reason for concern for effects to plants.

Although there are no data available for quantifying RQs for plants inhabiting terrestrial and riparian areas, effects data are available for discussion of potential risks of dimethoate exposures to plants. In a study reported in the literature, two species of dicots were affected (decreased biomass) by single applications of 0.02 lb a.i./A (Hanley and Whiting 2004). This rate is 1-2 orders of magnitude lower than the maximum single application rates of dimethoate (0.25-2.0 lbs a.i./A). Spray drift modeling suggests that for ground applications ranging 0.25-2 lbs a.i./A, deposition of dimethoate is at least 0.02 lb a.i./A for 30-200 feet beyond the edge of the application site (**Table 39**). For aerial applications ranging 0.25-1 lb a.i./A, deposition of dimethoate is at least 0.02 lb a.i./A for 102-390 feet beyond the edge of the application site (**Table 38**). This suggests that maximum single applications of dimethoate have the potential to decrease plant biomass in areas adjacent to treatment sites, as far as 390 feet away from the edge of the treatment site.

In addition, there are two reported ecological incidents involving effects to plants following dimethoate exposures. Both incidents were associated with misuse of the pesticide. One involved effects (burn symptoms) of dimethoate to corn following a discharge of the pesticide onto a 30 acre field. Cyfluthrin was also applied to this field. The certainty index associated with this incident was “highly probable” for both pesticides. The other incident involved drift of dimethoate from an application site to lentil plants (a type of legume) and pastureland. No other pesticides were associated with this incident. The certainty index associated with this incident was “probable.” In both incidents involving dimethoate exposures to plants, residues of dimethoate were measured on the foliage of the affected plants. See **Appendix H** for more information associated with these incidents.

Also, some product labels for dimethoate indicate that use of the product could result in phytotoxicity to select species of ornamental plants (including: river birch, ornamental cherry, *Prunus sp.,* hawthorn, Japanese lace maple and aspens) (registrations 19713-231, 66330-223, 66330-245, 34704-207, 5905-497, 5905-493).

Due to a lack of effects data the extent of risk from dimethoate to plants cannot be quantified. However, available data suggest the potential for effects to plants extending beyond the site of application. Therefore, the determination for indirect effects to the CRLF caused by effects to riparian and terrestrial plants resulting from use of dimethoate is "likely to adversely affect."

5.2.4. Primary Constituent Elements of Designated Critical Habitat

5.2.4.1. Aquatic-Phase (Aquatic breeding habitat and aquatic non-breeding habitat)

Two of the four assessment endpoints for the aquatic-phase primary constituent elements (PCEs) of designated critical habitat for the CRLF are related to potential effects to aquatic and/or riparian plants:

- 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.
- 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.

Since potential effects to riparian vegetation caused by use of dimethoate cannot be discounted, the determination is "habitat modification."

The third aquatic-phase PCE is "alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source." Dimethoate is not expected to alter the chemical characteristics of the water such that growth and viability of the CRLF; however, there is potential for effects to aquatic invertebrates which represent prey of CRLF. Therefore, effects to CRLF habitat defined by this PCE are of concern.

Another of the aquatic-phase PCE is: reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae). RQs do not exceed the LOC for algae for uses of dimethoate. Therefore, for all dimethoate uses, this PCE is not of concern.

5.2.4.2. Terrestrial-Phase (upland habitat and dispersal habitat)

Three of the four assessment endpoints for the terrestrial-phase PCEs of designated critical habitat for the CRLF are related to potential effects to terrestrial plants:

- 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
- 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

- Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.

Since potential effects to terrestrial vegetation caused by use of dimethoate cannot be discounted, the determination is "habitat modification."

The remaining terrestrial-phase PCE is "reduction and/or modification of food sources for terrestrial phase juveniles and adults." RQs exceed LOCs for terrestrial invertebrates, terrestrial mammals and terrestrial frogs which represent a food source for terrestrial phase CRLF. Therefore, the determination for this endpoint is "habitat modification."

5.2.5. Action Area

5.2.5.1. Areas indirectly affected by the federal action

The initial area of concern for dimethoate was previously discussed in Section 2.7 and depicted in **Figures 4 and 5** of the problem formulation. In order to determine the extent of the action area in lotic (flowing) aquatic habitats, the greatest ratio of the RQ to the LOC for any endpoint for aquatic organisms for each use category is used to determine the distance downstream for concentrations to be diluted below levels that would be of concern (*i.e*. result in RQs less than the LOC). For this assessment, this applies to RQs for acute exposures of dimethoate to aquatic invertebrates. For all uses in a landcover category, the highest RQ/LOC ratio is used to define the action area for that group of uses (**Table 46**). The total stream kilometers within the action area that are estimated to be at levels of concern are defined in **Table 47**.

Table 46. Down stream dilution factors used to determine extent of lotic action area for uses of dimethoate.

Action area title	Uses	Down stream dilution factor (RQ/LOC ratio)	Specific use group defining down stream dilution factor
agricultural lands	alfalfa, beans, broccoli, Brussels sprouts, cauliflower, celery, Chinese cabbage, cotton, endive (escarole), field corn, garbanzo beans, grass for seed, herbaceous ornamentals, honeydew, kale, kohlrabi, lentils, lettuce, lupine, melon, mustard greens, peas, peppers, popcorn, potatoes, safflower, sainfoin, sorghum, soybeans, Swiss chard, tomatoes, triticale, turnips, wheat	27.3	Broccoli, kohlrabi, cauliflower, Chinese cabbage
Orchard, vineyard and forests	pears, pecans, citrus, conifer seed orchards, cottonwood, non-cropland areas adjacent to vineyards	37.3	cottonwood

Table 47. Quantitative results of spatial analysis of lotic aquatic action area relevant to dimethoate uses (in km).

Measure	Agriculture	Orchard, Vineyard and Forest
Total Streams in CA	332,962	
Streams within initial area of concern	56,589	153,902
Downstream distance added	4,508	24,530
Streams in aquatic action area	61,097	178,432

When considering the terrestrial and lentic (non-flowing) aquatic habitats of the CRLF, spray drift from dimethoate use sites onto non-target areas could potentially result in exposures of the CRLF, its prey, and its habitat. 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 and aquatic lentic habitats. To account for this, first, the dimethoate application rate which does not result in an LOC exceedance is calculated for each terrestrial taxa of concern. AgDISP was then used to determine the distance required to reach EECs not exceeding any LOCs. These values are defined for each use in **Table 48**.

Table 48. Spray drift distances used to determine extent of action area for uses of dimethoate.

Action area title	Uses	Spray drift distance not exceeding LOC (in feet)	Specific use group defining spray drift distance
agricultural lands	alfalfa, beans, broccoli, Brussels sprouts, cauliflower, celery, Chinese cabbage, cotton, endive (escarole), field corn, garbanzo beans, grass for seed, herbaceous ornamentals, honeydew, kale, kohlrabi, lentils, lettuce, lupine, melon, mustard greens, peas, peppers, popcorn, potatoes, safflower, sainfoin, sorghum, soybeans, Swiss chard, tomatoes, triticale, turnips, wheat	10,524	Alfalfa, beans, broccoli, cauliflower, celery, Chinese cabbage, cotton, corn, garbanzo beans, grass for seed, melons, kohlrabi, lentils, lupine, pears, peas, potatoes, safflower, sainfoin, sorghum, soybeans, tomatoes, triticale, wheat
Orchard, vineyard and forests	pears, pecans, citrus, conifer seed orchards, cottonwood, non-cropland areas adjacent to vineyards	10,797	cottonwood

To understand the area indirectly affected by the federal action due to spray drift from application areas of dimethoate, landcovers are considered as potential application areas. These areas are "buffered" using ArcGIS 9.2. 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 dimethoate in spray drift does not exceed any LOCs. This effectively expands the action area relevant to terrestrial and aquatic lentic habitats so that it includes the area directly affected by the federal action, and the area indirectly affected by the federal action.

5.2.5.2. Final action area

In order to define the final action areas relevant to uses of dimethoate, it is necessary to combine areas directly affected, as well as aquatic and terrestrial habitats indirectly affected by the federal action. This is done separately for the 2 categories of action areas (i.e. agricultural and orchard, vineyard, and forests) using ArcGIS 9.2. Landcovers representing areas directly affected by dimethoate applications are overlapped with indirectly affected aquatic lotic habitats (determined by down stream dilution modeling) and with indirectly affected terrestrial and aquatic lentic habitats (determined by spray drift modeling). 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. The result is the final action area for dimethoate uses (**Figures 13-14**).

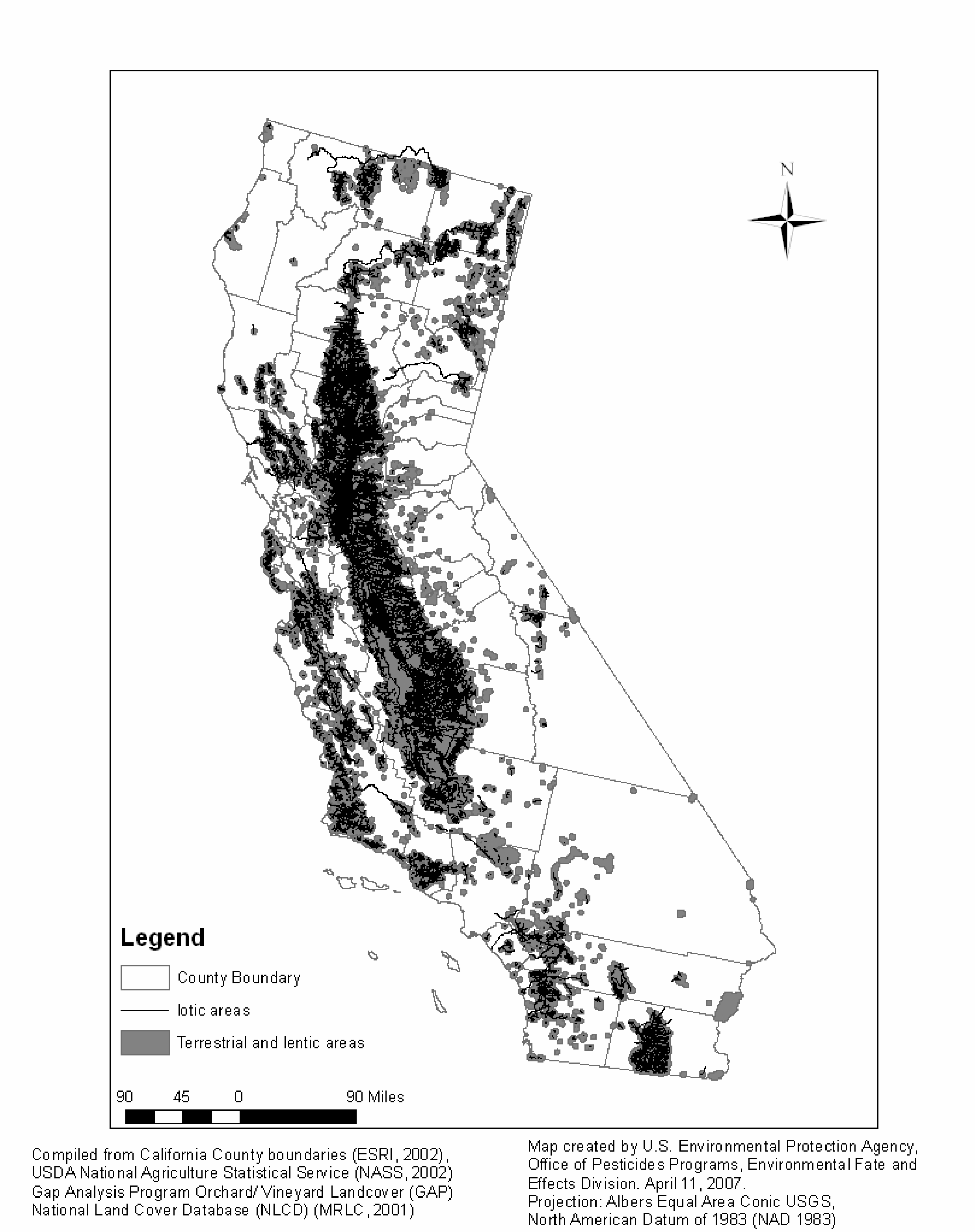
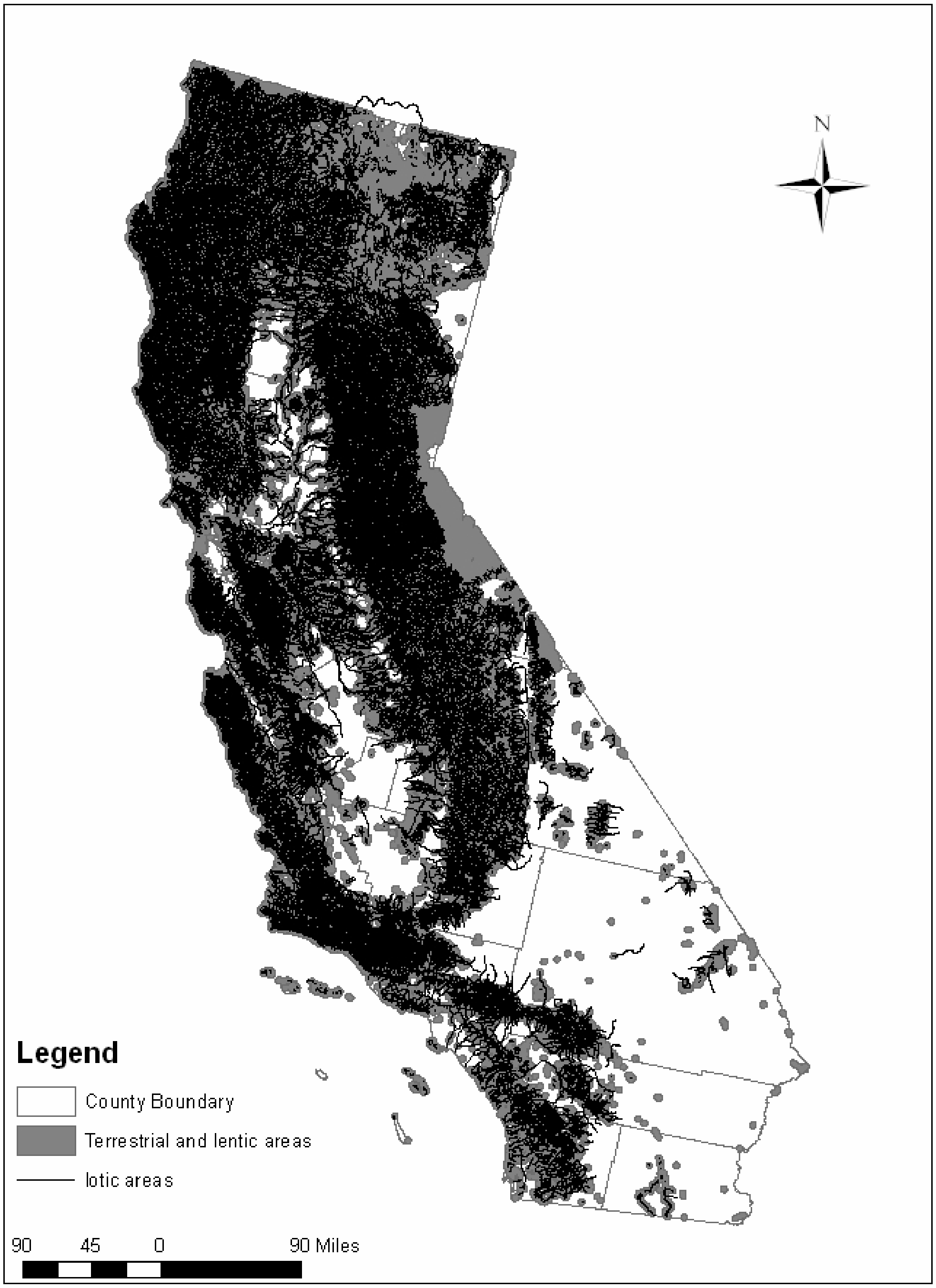


Figure 13. Final action area for crops described by agricultural landcover which corresponds to potential dimethoate use sites. This map represents the area potentially directly and indirectly affected by the federal action.



Compiled from California County boundaries (ESRI, 2002),
USDA National Agriculture Statistical Service (NASS, 2002)
Gap Analysis Program Orchard/ Vineyard Landcover (GAP)
National Land Cover Database (NLCD) (MRLC, 2001)

Map created by U.S. Environmental Protection Agency,
Office of Pesticides Programs, Environmental Fate and
Effects Division. April 11, 2007.
Projection: Albers Equal Area Conic USGS,
North American Datum of 1983 (NAD 1983)

Figure 14. Final action area for crops described by orchard, vineyard and forest landcover which corresponds to potential dimethoate use sites. This map represents the area potentially directly and indirectly affected by the federal action. *Within recovery units.

5.2.5.3. Overlap between CRLF habitat and final action area

In order to confirm that uses of dimethoate have the potential to affect CRLF through direct applications to target areas and runoff and spray drift to non-target areas, it is necessary to determine whether the final action areas for dimethoate uses overlap with CRLF habitats. Spatial analysis using ArcGIS 9.2 indicates that lotic aquatic habitats within the CRLF core areas and critical habitats potentially contain concentrations of dimethoate sufficient to result in RQ values that exceed LOCs. In addition, terrestrial habitats (and potentially lentic aquatic habitats) of the final action areas overlap with the core areas and critical habitat of each recovery unit (see **Table 7**) and available occurrence data for CRLF (**Tables 49 and 50**). Thus, uses of dimethoate could result in exposures of dimethoate to CRLF in aquatic and terrestrial habitats. Additional analysis related to the intersection of the dimethoate action areas and CRLF habitat is described in **Appendix C**.

Table 49. Overlap between CRLF habitat (core areas and critical habitat) and agricultural action area by recovery unit (RU#).

Measure	RU1	RU2	RU3	RU4	RU5	RU6	RU7	RU8	Total
CRLF habitat (km^2)*	3654	2742	1323	3279	3650	5306	4917	3326	28,197
Overlapping area of CRLF habitat and terrestrial/lentic aquatic action area (km^2)	930	59	239	1609	2250	1921	2407	393	9811
% CRLF habitat overlapping with terrestrial/lentic aquatic Action Area	*32%*	*5%*	*19%*	*50%*	*61%*	*39%*	*50%*	*29%*	*42%*
# Occurrences overlapping with terrestrial/lentic aquatic action area (total per area)	3 (of 13)	0 (of 3)	29 (of 70)	210 (of 328)	243 (of 281)	84 (of 122)	80 (of 92)	27 (of 33)	679 (of 942)

*Area occupied by core areas and/or critical habitat.

Table 50. Overlap between CRLF habitat (core areas and critical habitat) and orchard, vineyard and forestry action area by recovery unit (RU#).

Measure	RU1	RU2	RU3	RU4	RU5	RU6	RU7	RU8	Total
CRLF habitat (km^2)*	3654	2742	1323	3279	3650	5306	4917	3326	28,197
Overlapping area of CRLF habitat and terrestrial/lentic aquatic action area (km^2)	2817	1186	1238	3132	3668	4297	4801	1374	22,520
% CRLF habitat overlapping with terrestrial/lentic aquatic Action Area	*97%*	*97%*	*100%*	*97%*	*99%*	*87%*	*99%*	*100%*	*96%*
# Occurrences overlapping with terrestrial/lentic aquatic action area (total per area)	13 (of 13)	3 (of 3)	70 (of 70)	325 (of 328)	281 (of 281)	121 (of 122)	92 (of 92)	33 (of 33)	942 (of 942)

*Area occupied by core areas and/or critical habitat.

Available pesticide use data from California indicate that dimethoate has been used in counties which contain CRLF habitat. Out of 58 counties in California, 33 contain some portion of CRLF critical habitat or core areas. According to use data for 2002-2005, 29 of the 33 counties containing CRLF areas have reported past uses of dimethoate. In these counties, an annual average of 214,765 lbs of dimethoate were applied. This represents 69% of the average annual application of dimethoate in the state of California over 2002-2005. Reported county level uses of dimethoate for each county and their relation to the presence or absence of CRLF critical habitat or core areas is available in **Table 51**. In this table, counties which contain CRLF critical habitat or core areas are highlighted.

Table 51. Reported county level uses of dimethoate in California during 2002-2005 and their relation to presence or absence of CRLF critical habitat or core areas within the county.

County	Are CRLF habitat/core areas present?	Reported uses of dimethoate in county during 2002-2005	Average annual lbs applied (over 2002-2005)	% of total annual applied lbs in CA*
Monterey	yes	alfalfa, bean, bok choy, broccoli, Brussels sprouts, cabbage cauliflower, celery, chervil, Chinese cabbage, collard, endive (escarole), grape, kale, lettuce, melon, greenhouse, outdoor ornamental, peas, pepper, pimento, research commodity, rights-of-way, spinach, strawberry, Swiss chard, tomato, uncultivated	40,711	13.1%
Imperial	no	alfalfa, bean, broccoli, cabbage, melon, cauliflower, celery, corn, cotton, endive (escarole), citrus, kale, lettuce, mustard, potato, tomato, turnip, wheat	38,156	12.3%
Tulare	no	alfalfa, bean, Christmas tree, citrus, corn, cotton, grape, lettuce, outdoor ornamental, pecan, pepper, safflower, sorghum, spinach, tangelo, tangerine, wheat	37,384	12.0%
Fresno	yes	alfalfa, bean, broccoli, cabbage, melon, cauliflower, citrus, collard, corn, cotton, grape, kohlrabi, landscape maintenance, lettuce, mustard, greenhouse, peas, pecan, peppers, safflower, sorghum, spinach, Swiss chard, tomato, turnip, wheat	29,474	9.5%
Kern	yes	alfalfa, beans, melons, citrus, corn, cotton, grape, landscape maintenance, lettuce, greenhouse, outdoor ornamental, pepper, potato, rights-of-way, safflower, sorghum, tomato, vertebrate control, wheat	27,248	8.8%
Stanislaus	yes	alfalfa, animal premise, apple, bean, broccoli, cabbage, melon, cauliflower, celery, collard, corn, kale, landscape maintenance, lettuce, mustard, pecan, pepper, poultry, spinach, structural pest control, Swiss chard, tomato, turnip, wheat	24,464	7.9%
San Joaquin	yes	alfalfa, apple, beans, broccoli, cabbage, Christmas tree, corn, cotton, grape, landscape maintenance, lettuce, greenhouse, pear, pepper, potato, safflower, sorghum, structural pest control, tomato, melon, wheat	23,083	7.4%
Riverside	yes	alfalfa, animal premise, beans, broccoli, cabbage, melons, Chinese greens, Christmas trees, citrus, corn, cotton, date, grape, landscape maintenance, lettuce, greenhouse, outdoor ornamental, pepper, sorghum, tomato, watermelon	13,932	4.5%
Santa Barbara	yes	alfalfa, apple, beans, bok choy, broccoli, Brussels sprout, cabbage, cauliflower, celery, Chinese cabbage, endive (escarole), grape, kale, landscape maintenance, lettuce, outdoor ornamental, peas, pepper, potato, spinach, tomato, uncultivated, vertebrate control	13,489	4.3%
Merced	yes	alfalfa, animal premise, beans, broccoli, cabbage, cauliflower, corn, cotton, grape, greenhouse, outdoor ornamental, safflower, tomato, melon, wheat	12,278	3.9%
Kings	yes	alfalfa, beans, collard, corn, cotton, grape, lettuce, safflower, sorghum, tomato, melons, wheat	9,625	3.1%
Yolo	no	alfalfa, bean, broccoli, melon, corn, grape, pepper, research commodity, sorghum, tomato, uncultivated, wheat	6,603	2.1%
San Luis Obispo	yes	alfalfa, bean, bok choy, broccoli, Brussels sprouts, cabbage, cauliflower, celery, Chinese cabbage, endive (escarole), grape, kale, landscape maintenance, lettuce, greenhouse, outdoor ornamental, peas, pepper, potato, spinach, squash, tomatillo, tomato	4,287	1.4%
Solano	yes	alfalfa, beans, melons, corn, grape, landscape maintenance, outdoor ornamentals, pear, pepper, safflower, sorghum, soybean, tomato, uncultivated, wheat	3,953	1.3%
Sutter	no	beans, cabbage, corn, cotton, landscape maintenance, melon, pear, sorghum, tomato, uncultivated, wheat	3,871	1.2%
Madera	no	alfalfa, animal premise, beans, corn, cotton, forage hay/silage, grape, greenhouse, citrus, safflower, tomato, wheat	2,769	0.9%
Modoc	no	alfalfa, animal premise, forage hay/silage, pastureland, peas, potato, structural pest control, wheat	2,483	0.8%
San Benito	yes	bean, broccoli, cabbage, cauliflower, celery, corn, endive (escarole), grape, kale, lettuce, mustard, pepper, research commodity, spinach,	2,409	0.8%

County	Are CRLF habitat/core areas present?	Reported uses of dimethoate in county during 2002-2005	Average annual lbs applied (over 2002-2005)	% of total annual applied lbs in CA*
		tomato		
Sacramento	yes	alfalfa, barley, bean, corn, pear, pepper, sorghum, squash, sudangrass, tomato, uncultivated, wheat	1,897	0.6%
Santa Cruz	yes	broccoli, Brussels sprouts, cabbage, cauliflower, celery, endive (escarole), lettuce, greenhouse, outdoor ornamental, spinach, Swiss chard, tomato	1,728	0.6%
Ventura	yes	bean, broccoli, cabbage, cauliflower, celery, collard, kale, landscape maintenance, lettuce, melon, mustard greenhouse, outdoor ornamentals, pepper, rights-of-way, Swiss chard, tomato	1,526	0.5%
Colusa	no	beans, cotton, landscape maintenance, melons, rights-of-way, safflower, sorghum, tomato, wheat	1,153	0.4%
Lassen	no	alfalfa, uncultivated	1,094	0.4%
San Bernardino	no	alfalfa, animal premise, Christmas tree, landscape maintenance, greenhouse, outdoor ornamental, citrus, public health	1,029	0.3%
Santa Clara	yes	apple, beans, broccoli, cabbage, cauliflower, Chinese cabbage, Chinese greens, corn, grape, landscape maintenance, lettuce, greenhouse, outdoor ornamental, peas, pepper, research commodity, spinach, structural pest control, tomato, melon	816	0.3%
Siskiyou	no	alfalfa, potato, research commodity, structural pest control, wheat	793	0.3%
Contra Costa	yes	alfalfa, bean, corn, landscape maintenance, greenhouse plants, tomato, wheat	739	0.2%
Los Angeles	yes	alfalfa, cucumber, fumigation, herb/spice, landscape maintenance, greenhouse, outdoor ornamentals, rights-of-way	703	0.2%
Orange	yes	beans, Christmas tree, landscape maintenance greenhouse, outdoor ornamental, pepper	679	0.2%
Glenn	no	alfalfa, beans, melons, corn, cotton, citrus, peas, wheat	619	0.2%
Sonoma	yes	apple, grape, greenhouse, rights-of-way, uncultivated	607	0.2%
San Diego	yes	apple, beans, Brussels sprout, chicken, grape, citrus, landscape maintenance, lemon, greenhouse, outdoor ornamental, pear, pepper, poultry, structural pest control, tomato, watermelon	401	0.1%
San Mateo	yes	bean, Brussels sprouts, landscape maintenance, greenhouse, peas, vertebrate control	347	0.1%
Mendocino	no	grape	207	0.1%
Napa	yes	grape, landscape maintenance, rights-of-way	132	<0.1%
Yuba	yes	landscape maintenance, melon, pear, structural pest control	103	<0.1%
Butte	yes	alfalfa, bean, melons, cucumber, wheat	51	<0.1%
Tehama	yes	alfalfa, bean, corn	49	<0.1%
Alameda	yes	alfalfa, beans, landscape maintenance, structural pest control	31	<0.1%
Shasta	yes	apple, pear, structural pest control	3	<0.1%
El Dorado	yes	grape, structural pest control	<1	<0.1%
Amador	yes	none	0	<0.1%
Marin	yes	none	0	<0.1%
Nevada	yes	none	0	<0.1%
Plumas	yes	none	0	<0.1%
Mono	no	alfalfa, pastureland, structural pest control	140	<0.1%
Del Norte	no	outdoor ornamental	100	<0.1%
Lake	no	apple, grape, pear	31	<0.1%
Tuolumne	no	rights-of-way	13	<0.1%
Placer	no	landscape maintenance, structural pest control	2	<0.1%
Humboldt	no	apple, grape	1	<0.1%
San Francisco	no	landscape maintenance	<1	<0.1%
Trinity	no	none	0	0.0%
Alpine	no	none	0	0.0%
Calaveras	no	none	0	0.0%
Inyo	no	none	0	0.0%
Mariposa	no	none	0	0.0%
Sierra	no	none	0	0.0%

*Total annual average pounds of dimethoate applied in CA during 2002-2005 = 311,213.

5.2.6. Description of Assumptions, Limitations, Uncertainties, Strengths and Data Gaps

5.2.6.1. Exposure Assessment

Aquatic exposure modeling of dimethoate

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 (assuming that contributing waters to the downstream areas do not contribute pesticide mass).

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 and in **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 2004a).

In order to account for this uncertainty, available monitoring data were compared to PRZM/EXAMS estimates of peak EECs for the different uses. As discussed above, several data values were available from NAWQA for dimethoate concentrations measured in surface waters receiving runoff from agricultural areas. The specific use patterns (e.g. application rates and timing, crops) associated with the agricultural areas are unknown, however, they are assumed to be representative of potential dimethoate use areas. Peak model-estimated aquatic environmental concentrations, resulting from different dimethoate uses, range from 0.1 to 20.3 µg/L. The maximum concentration of dimethoate reported by NAWQA from 2001-2006 for California surface waters is 0.158 µg/L. This value is two orders of magnitude less than the maximum model-estimated environmental concentration, but is within the range of environmental concentrations estimated for different uses. The maximum concentration of dimethoate reported by the California Department of Pesticide Regulation surface water database from 1991-2005 was 11.31 µg/L, which is on the same order of magnitude when compared to the highest peak model-estimated environmental concentration.

Differences between modeled EECs and monitoring results are generally attributable to three sources: 1) simulation modeling estimates are made using maximum label rates, monitoring data reflects typical use, 2) modeled values represent a small static water body, the vast majority of monitoring data is for streams and rivers which tend to be less vulnerable as high concentration tend to be of short duration as they pesticide is carried downstream more rapidly; 3) simulation modeling represents a small watershed near the area of application; 4) monitoring data usually represents higher order streams with large basins and multiple land uses; 5: modeled values are 1 in 10 year exceedance values. Since most monitoring data is from one or two year studies at any one site, it represents 1 in 2 year values.

There is uncertainty in the PRZM/EXAMS application timing relative to rainfall/runoff events. Label instructions do not cite specific application dates. Consideration of the meteorological data associated with the California PRZM scenarios indicates that the largest rainfall events occur in January. In general, the greater amount of rainfall in a single event, the greater the EEC in the receiving aquatic habitat. In order to select application dates that are relevant to times when dimethoate is actually applied, pesticide use data were considered (**Appendix B**). Selection of application dates during high rainfall periods would result in higher estimates of exposure of aquatic habitats to dimethoate. Since EECs are already sufficient to exceed acute and chronic LOCs for aquatic invertebrates, higher EECs would not alter the overall conclusion that potential effects to aquatic invertebrates is likely to adversely affect the CRLF through indirect effects. For direct effects to the aquatic-phase CRLF, current EECs result in the conclusion that dimethoate exposures in the aquatic environment have “no effect” on the CRLF. In order to be of concern for direct exposures to the CRLF, EECs would have to be at least one order of magnitude larger. Even EECs which correspond to application timing which corresponds to the rainy period (*e.g.* cottonwood, cauliflower, Chinese cabbage, kohlrabi, kale, mustard greens, and broccoli) are insufficient to result in RQs which would exceed LOCs for direct effects to the aquatic-phase CRLF.

Labels do not define a maximum number of applications allowed per year for use of dimethoate on citrus. For the purposes of this assessment, only one application per year was modeled. This single application is sufficient to exceed the LOC for several taxonomic groups of interest to this assessment, including LOCs for direct effects to the terrestrial-phase CRLF. Any additional applications of dimethoate to citrus would be expected to increase EECs and related RQs; however, additional applications would not be expected to alter the overall conclusions of the “LAA” determinations for direct and indirect effects to the CRLF resulting from dimethoate applications to citrus.

Deposition of dimethoate in precipitation

Dimethoate has been detected in precipitation samples in California. According to Majewski et al. 2006, dimethoate was detected in 5% of rainfall samples (n=136) at a maximum concentration of 0.102 µg/L. Based on these data, it is possible that dimethoate can be deposited on land in precipitation. Estimates of exposure of the CRLF, its prey and its habitat to dimethoate included in this assessment are based only on transport of dimethoate through runoff and spray drift from application sites. Current estimates of exposures of CRLF and its prey to dimethoate through runoff and spray drift, which are already sufficient to exceed the LOC, would be only be greater if consideration is given to deposition in precipitation.

In an attempt to estimate the amount of dimethoate deposited into aquatic and terrestrial habitats, the maximum measured dimethoate concentration measured in rain samples taken in California (0.102 µg/L; Majewski et al. 2006) was considered in combination with California specific precipitation data and runoff estimates from PRZM. Precipitation and runoff data associated with the PRZM scenarios used to model aquatic EECs were used to determine relevant 1-in-10 year peak runoff and rain events. The scenarios included were: CA almond, CA lettuce, CA wine grape, CA row crop, CA fruit, CA nursery, and CA onion. The corresponding meteorological data were from the following locations: Sacramento, Santa Maria, San Francisco, Monterey County, Fresno, San Diego, and Bakersfield, respectively.

To estimate concentrations of dimethoate in the aquatic habitat resulting from deposition in rain, the daily PRZM-simulated volume of runoff from a 10 ha field is combined with an estimate of daily precipitation volumes over the 1 ha farm pond relevant to the EXAMS environment. This volume is multiplied by the maximum concentration of dimethoate in precipitation reported in monitoring data (0.102 µg/L). The result is a daily mass load of dimethoate into the farm pond. This mass is then divided by the volume of water in the farm pond (2.0×10^7 L) to achieve a daily estimate of dimethoate concentration in the farm pond, which represents the aquatic habitat. From the daily values, the 1-in-10 year peak estimate of the concentration of dimethoate in the aquatic habitat is determined for each PRZM scenario (**Table 52**). There are several assumptions associated with this approach, including: 1) the concentration of dimethoate in the rain event is spatially and temporally homogeneous (e.g. constant over the 10 ha field and 1 ha pond for the entire rain event); 2) the entire mass of dimethoate contained in the precipitation runs off to the pond or is deposited directly into the pond; 3) there is no degradation of dimethoate between the time it leaves the air and the time it reaches the pond.

To estimate deposition of dimethoate on the terrestrial habitat resulting from deposition in rain, the daily volume of water deposited in precipitation on 1 acre of land is estimated. This volume is multiplied by the maximum concentration of dimethoate in precipitation reported in monitoring data, which is 0.102 µg/L. The result is a mass load of dimethoate per acre (converted to units of lbs a.i./A). From the daily values, the 1-in-10 year peak estimate of the deposition of dimethoate on the terrestrial habitat is estimated for each PRZM scenario (**Table 52**). In this approach, it is assumed that the concentration of dimethoate in the rain event is spatially and temporally homogeneous (e.g. constant over the 1 A of terrestrial habitat for the entire rain event).

Table 52. 1-in-10 year peak estimates of dimethoate concentrations in aquatic and terrestrial habitats resulting from deposition of dimethoate at 0.102 μg/L dimethoate in rain.

Met Station	Scenario(s)	Concentration in aquatic habitat (μg/L)	Deposition on terrestrial habitat (lbs a.i./A)
Sacramento	CA almond	0.019	0.0001
Santa Maria	CA lettuce, CA colecrop, CA strawberry	0.020	0.0001
San Francisco	CA winegrape	0.018	0.0001
Monterey Co.	CA row crop	0.016	0.0001
Fresno	CA fruit, CA tomato, CA melon	0.007	<0.0001
San Diego	CA nursery	0.014	<0.0001
Bakersfield	CA onion, CA potato	0.005	<0.0001

Degradates

Dimethoate degrades into omethoate, which is as toxic or more toxic to non-target animals when compared to the parent. As discussed in section 2.4.1, omethoate was not detected as a degradate in available laboratory fate studies, but was detected in terrestrial field dissipation and foliar residue studies. Registrant submitted studies indicate that omethoate can comprise significant portions (up to 96%) of applied dimethoate residues detected on foliar surfaces (MRID 466780-09). Based on this information, potential exposures of animals to omethoate in terrestrial environments are of concern.

In estimating EECs on food items of terrestrial phase CRLF and its prey, a foliar degradation half-life of 2.88 days is used in T-REX and T-HERPS to represent degradation of dimethoate. As noted above, this foliar degradation half-life represents an analysis of data from Willis and McDowell (1987) (**Table 4**). While the selection of this half life value does not affect estimates of acute EECs, it can affect estimates of chronic exposures, with longer half-lives resulting in greater EECs and greater risks. The selected half-life relies upon data measuring the disappearance of dimethoate from leaf surfaces, without regard for the formation of omethoate. The use of 2.88 days as a foliar dissipation half-life represents an uncertainty, since the half-life could result in an underestimation of chronic exposure and effects resulting from the formation of omethoate.

Registrant submitted studies which included dissipation of dimethoate and omethoate from foliar surfaces indicated that foliar dissipation half-lives of the sum of the two chemicals ranged 0.98-7.4 days. These values fall within the range of data cited in Willis and McDowell (0.9-7.2 days) for dimethoate. If the foliar dissipation half-life were extended to account for formation of omethoate, estimates of chronic exposure to terrestrial-phase CRLF and its amphibian and mammalian prey would increase, resulting in higher RQs. Since RQs already exceed the chronic LOCs for exposures to these organisms resulting from all uses of dimethoate, this will not influence the LAA effects determinations for direct and indirect effects of dimethoate to the CRLF and its prey in terrestrial habitats.

Since the action area for dimethoate is derived using acute exposures to terrestrial invertebrates, inclusion of omethoate will not alter the action area described above. As noted in Section 4.3, the toxicities of omethoate and dimethoate to honey bees are roughly equivalent. The action area is derived using estimates of acute exposures to honey bees, therefore, the use of the foliar dissipation half life that considers only dimethoate will not affect estimates of acute exposures to terrestrial invertebrates. Terrestrial invertebrate RQs and the extent of the area indirectly affected by spray drift from treatment sites will be the same with or without consideration of omethoate.

Mixture Effects

This assessment considers only the single active ingredient of dimethoate. However, the assessed species and its environments may be exposed to multiple pesticides simultaneously. Interactions of other toxic agents with dimethoate could result in additive effects, synergistic effects or antagonistic effects. Evaluation of pesticide mixtures is beyond the scope of this assessment because of the myriad factors that cannot be quantified based on the available data. Those factors include identification of other possible co-contaminants and their concentrations, differences in the pattern and duration of exposure among contaminants, and the differential effects of other physical/chemical characteristics of the receiving waters (*e.g.* organic matter present in sediment and suspended water). Evaluation of factors that could influence additivity/synergism is beyond the scope of this assessment and is beyond the capabilities of the available data to allow for an evaluation. However, it is acknowledged that not considering mixtures could over- or under-estimate risks depending on the type of interaction and factors discussed above.

5.2.6.2. Effects Assessment

Direct Effects

Toxicity data for aquatic-phase and terrestrial-phase amphibians is not available for use in this assessment. Therefore, fish and avian toxicity data are used as a surrogates for CRLF. There is uncertainty regarding the relative sensitivity of amphibians and their surrogates to dimethoate. If the surrogates are substantially more or less sensitive than the CRLF, then risk would be over or under estimated, respectively.

Sublethal Effects

Open literature is useful in identifying sublethal effects associated with exposure to dimethoate. However, no data are available to link the sublethal measurement endpoints to direct mortality or diminished reproduction, growth and survival that are used by OPP as assessment endpoints. OPP acknowledges that a number of sublethal effects have been associated with diemthaote exposure; however, at this point there are insufficient data to definitively link the measurement endpoints to assessment endpoints.

Indirect Effects

Indirect effects on the aquatic-phase CRLF are estimated based on the most sensitive invertebrate tested, *i.e.* stonefly. Other, less sensitive, aquatic invertebrates may be part of the diet of the aquatic-phase CRLF. Therefore, risk to stonefly, may not be equivalent to risk to organisms comprising the diet of the CRLF and its use in this assessment may result in an overestimation of risk.

5.2.7. Addressing the Risk Hypotheses

In order to conclude this risk assessment, it is necessary to address the risk hypotheses defined in section 2.9.1. Based on the conclusions of this assessment, none of the hypotheses can be rejected, meaning that the stated hypotheses represent concerns in terms of direct and indirect effects of dimethoate on the CRLF and its designated critical habitat.

6. Conclusions

Based on terrestrial estimated environmental concentrations for the currently registered uses of dimethoate, RQ values exceed the Agency's LOC for direct acute and chronic effects on the CRLF; this represents a "may affect" determination. RQs exceed the LOC for acute and chronic exposures to aquatic invertebrates and for acute exposures to terrestrial invertebrates. Therefore, there is a potential to indirectly affect juvenile and adult CRLF due to effects to the invertebrate prey base in aquatic and terrestrial habitats. The effects determination for indirect effects to the CRLF due to effects to its prey base is "may affect." When considering the prey of larger CRLF in aquatic and terrestrial habitats (*e.g*. frogs, fish and small mammals), RQs for terrestrial-phase frogs and small mammals also exceed the LOC for acute and chronic exposures, resulting in a "may affect" determination. RQ values for unicellular plants in aquatic habitats do not exceed the LOC. Risk of dimethoate use on riparian and terrestrial vegetation cannot be discounted. Therefore, the determination for indirect effects to the CRLF through effects to its habitat is "may affect."

Refinement of all "may affect" determinations results in: a "LAA" determination based on direct effects to the terrestrial-phase CRLF, a "LAA" determination for indirect effects to the CRLF based on effects to its prey and an "LAA" determination for indirect effects to the CRLF based on effects to its habitat. Consideration of CRLF critical habitat indicates a determination of "habitat modification" for aquatic and terrestrial habitats. **The overall CRLF effects determination for dimethoate use is "LAA."**

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. **Attachment 2**, which includes information on the baseline status and cumulative effects for the CRLF, can be used during this consultation to provide background information on past US Fish and Wildlife Services biological opinions associated with the CRLF.

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 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.

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