Risks of Oxamyl Use to Federally Threatened California Red-legged Frog
(*Rana aurora draytonii*)

Pesticide Effects Determination

Environmental Fate and Effects Division
Office of Pesticide Programs
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Primary Authors:
Alicia Korol
Greg Orrick
Kristina Garber

Secondary Reviewers:
Marietta Echeverria
Anita Pease

Branch Chief, Environmental Risk Assessment Branch 4:
Elizabeth Behl

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1. Executive Summary

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

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

Oxamyl [(*EZ*)-N,N-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide; CAS# 23135-22-0; PC Code 103801] is an N-methyl carbamate. The mode of action of these pesticides is inhibition of the enzyme acetylcholinesterase. Oxamyl is currently registered as a restricted use plant growth regulator, acaricide, insecticide, miticide, and nematicide for the control of a broad spectrum of insects, mites, ticks, and nematodes on various field crops, vegetables, fruits, and non-bearing trees. The active ingredient is applied to treatment sites in liquid formulations by aerial, ground or chemigation application equipment or by soil injection. The following uses of oxamyl are registered in California and, therefore, considered part of the federal action evaluated in this assessment: apples, celery, cherries, citrus, clover, cotton, cucumber, eggplant, garlic, melons, onions, peaches, pears, peppers, potatoes, pumpkins, squash, tobacco, and tomatoes. Oxamyl has additional uses that are not registered for use in California (*i.e.*, bananas, carrots, ginger, mint, peanuts, pineapple, plantains, sweet potatoes, and yams). Because oxamyl is not expected to be applied for these uses within California, which is the action area for oxamyl use that is relevant to the CRLF, these uses are not considered part of the federal action evaluated in this assessment.

Oxamyl is hydrophilic, highly mobile, and relatively nonvolatile. The compound dissipates in the environment by abiotic and microbially-influenced degradation and by leaching, with estimated half-lives on the order of several hours to several weeks. Because oxamyl is relatively nonvolatile and does not bind well to soil, the major routes of off-site transport for the compound are expected to include surface water runoff and spray drift.

Major degradates of oxamyl include oxime [2-hydroxyamino-N,N-dimethyl-2-(methylthio)acetamide], DMOA [N,N-dimethyl-oxalamic acid], DMCF [cyano-methanoic acid dimethylamide], DMEA [N,N-dimethyl-oxalamide], and carbon dioxide. Similar to oxamyl parent, oxime is highly mobile; DMOA, DMCF, and DMEA are expected to be highly mobile as well. Furthermore, oxime and DMOA are more

persistent than oxamyl in certain conditions. Degradates of oxamyl are not considered to be of toxicological concern, based on limited mammalian toxicity data considered in the Reregistration Eligibility Decision (U.S. EPA 2000). Therefore, exposure to degradates of oxamyl was not considered in this assessment.

Since CRLFs exist within aquatic and terrestrial habitats, exposure of the CRLF, its prey and its habitats to oxamyl are assessed separately for the two habitats. Tier-II aquatic exposure models are used to estimate high-end exposures of oxamyl in aquatic habitats resulting from runoff and spray drift from different uses. Peak model-estimated aquatic exposure estimates resulting from different oxamyl uses range from 3.2 to 45 μg/L.

To estimate oxamyl exposures to the terrestrial-phase CRLF, and its potential prey (insects, mice and terrestrial-phase frogs), the T-REX model is used. The T-HERPS model is used to allow for further characterization of amphibian-specific dietary exposures used to represent oxamyl exposures to terrestrial-phase CRLFs. T-REX and T-HERPS are used for oxamyl uses involving applications to foliar surfaces only, not uses involving applications to soil. Exposures of small mammals consuming earthworms contaminated with oxamyl applied directly to the soil are characterized using a fugacity-based approach. AgDRIFT is used to estimate deposition of oxamyl on terrestrial habitats from spray drift. The TerrPlant model is used to estimate oxamyl exposures to terrestrial-phase CRLF habitat.

The effects determination assessment endpoints for the CRLF include direct toxic effects on the survival, reproduction, and growth of the CRLF itself. 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. The acute toxicity endpoint for the aquatic-phase CRLF is a 96-h LC_{50} of 4.2 mg a.i./L. The chronic toxicity endpoint for the aquatic-phase CRLF is a NOAEC of 0.77 mg a.i./L, with a LOAEC of 1.5 mg a.i./L based on embryo hatching and larval swim-up. In the terrestrial habitat, direct effects are based on toxicity information for birds, which are used as a surrogate for terrestrial-phase amphibians. The acute and sub-acute endpoints for the terrestrial-phase CRLF are LD_{50} = 3.16 mg/kg-bw and LC_{50} = 340 mg/kg-diet, respectively. The chronic endpoint for the terrestrial-phase CRLF is a NOAEC of 10 mg/kg-diet, which is based on a LOAEC of 50 mg/kg-diet, where effects to egg production and fertility were observed (in mallard ducks).

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. The toxicity endpoint for algae, representing prey of tadpole-stage CRLF is 0.12 mg a.i./L (120-h EC_{50}). The acute and chronic endpoints for aquatic invertebrates are 0.018 mg a.i./L (48-h EC_{50}) and 0.012 mg a.i./L (NOAEC derived from an acute-to-chronic ratio), respectively. The endpoints for aquatic plants are 0.12 mg a.i./L (120-h EC_{50}) and 30 mg a.i./L (14-d EC_{50}) for non-vascular and vascular plants, respectively.

In the terrestrial habitat, indirect effects due to depletion of prey are assessed by considering effects to terrestrial insects, small terrestrial mammals, and frogs. For terrestrial insects, the LD_{50} is 0.31 μg/bee. For terrestrial mammals, the acute and chronic endpoints are a 2.5 mg/kg-bw LD_{50} and a 25 mg/kg-diet NOAEC, with a LOAEC of 75 mg/kg-diet, based on decreased food consumption and altered body weight in first generation rats. The endpoints used to represent acute, sub-acute and chronic effects to the terrestrial-phase CRLF are also used to represent effects to terrestrial-phase frogs serving as prey to the CRLF (*e.g.*, Pacific tree frogs). Indirect effects due to modification of the terrestrial habitat are characterized by available data for terrestrial monocots and dicots. The endpoint for terrestrial plants is an $EC_{25} > 2.1$ lbs a.i./A.

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) to identify instances where oxamyl use within the action area has the potential to adversely affect the CRLF and its designated critical habitat via direct toxicity or indirectly based on direct effects to its food supply (*i.e.*, freshwater invertebrates, algae, fish, frogs, terrestrial invertebrates, and mammals) or habitat (*i.e.*, aquatic plants and terrestrial upland and riparian vegetation). When RQs for each particular type of effect are below LOCs, the pesticide is determined to have "no effect" on the CRLF. Where RQs exceed LOCs, a potential to cause adverse effects is identified, leading to a conclusion of "may affect." If a determination is made that oxamyl use within the action area "may affect" the CRLF and its designated critical habitat, additional information is considered to refine the potential for exposure and effects, and the best available information is used to distinguish those actions that "may affect, but are not likely to adversely affect" (NLAA) from those actions that are "likely to adversely affect" (LAA) the CRLF and its critical habitat.

Based on the best available information, the Agency makes a May Affect, and Likely to Adversely Affect (LAA) determination for the CRLF from the use of oxamyl. Additionally, the Agency has determined that there is the potential for modification of CRLF designated critical habitat from the use of the chemical. Summaries of the risk conclusions and effects determinations for the CRLF and its critical habitat are presented in Table 1 and in Table 2, respectively. These conclusions are based on potential effects of oxamyl to the terrestrial-phase CRLF and its prey, including terrestrial insects, small mammals and terrestrial-phase frogs. Further information on the results of the effects determination is included as part of the Risk Description in Section 5.2. Given the LAA determination for the CRLF and potential modification of designated critical habitat, a description of the baseline status and cumulative effects for the CRLF is provided in **Attachment 2**.

Table 1. Description of evidence supporting effects determination for oxamyl use in California. Assessment endpoint is survival, growth and reproduction of CRLF individuals.

Effects	Habitat	Basis for LAA Determination
Direct	Aquatic	Direct effects to aquatic-phase CRLF resulting from acute and chronic exposures of oxamyl are not expected. - RQs for acute and chronic exposures resulting from all uses of oxamyl are below the levels of concern.
Direct	Terrestrial	Oxamyl has the potential to directly affect the terrestrial-phase CRLF. -Acute and chronic RQs for all uses of oxamyl exceed the Agency's LOCs for the terrestrial-phase CRLF. - The likelihoods of individual mortality range from 0.00034% to 100% for terrestrial-phase CRLF on a field treated with uses of oxamyl that have LOC exceedances (relevant to California). - Comparison of the LOAEC directly to chronic dietary-based EECs for CRLF consuming small insects and small herbivore mammals indicate that EECs for all uses are sufficient to exceed the concentration where reproductive effects were observed in the laboratory.
Indirect - prey	Aquatic	Indirect effects to the CRLF through effects to its prey in the aquatic habitat are discountable. - RQs representing exposures to non-vascular aquatic plants (which serve as prey to tadpole stage CRLF) are below LOCs for all uses of oxamyl. - RQs representing acute and chronic exposures to fish (which serve as prey to adult CRLF) are below LOCs for all uses of oxamyl. - Although some RQs representing acute exposures to aquatic invertebrates are above the LOC, the likelihood of individual effects chance indicates that all uses of oxamyl are expected to result in ≤0.34% chance of effects to an individual aquatic invertebrate. Therefore, potential indirect effects to the CRLF due to effects of oxamyl to aquatic invertebrates resulting from acute exposures are discountable. - RQs representing chronic exposures to aquatic invertebrates (serving as prey to juvenile and adult CRLF) are below LOCs, with the exception of 2 uses (garlic and celery). EECs for garlic and celery do not reach the NOAEC for less sensitive species of aquatic invertebrates (*i.e.*, *Daphnia magna*), suggesting that even though sensitive species of aquatic invertebrates may be affected by chronic exposures of oxamyl, less sensitive species, such as daphnids, may not be affected. Because the CRLF is an opportunistic feeder, the impact of effects to sensitive aquatic invertebrates from chronic exposures on the CRLF is discountable.
Indirect - habitat	Aquatic	Indirect effects to the CRLF through modification of its aquatic habitat are not expected. -RQs representing exposures to non-vascular and vascular aquatic plants are below LOCs. -Estimated exposures of oxamyl to riparian vegetation are above the EC_{25} values for monocots and dicots.
Indirect - prey	Terrestrial	Oxamyl has the potential to indirectly affect the terrestrial-phase CRLF through effects to its prey. -RQs representing exposures to terrestrial insects are above the LOC for all uses of oxamyl. - The likelihood of individual mortality is >99.9% for a terrestrial invertebrate on a field treated with any use of oxamyl (relevant to California). - >22% chance of mortality to individual small insects can occur within 950 feet from the edge of a field treated with 1 lb a.i./A oxamyl by aerial methods. -RQs representing acute and chronic exposures to small terrestrial mammals are above LOCs for all uses of oxamyl. - The likelihood of individual mortality is >99.9% for a small mammal consuming short grass on a field treated with any use of oxamyl (relevant to California). -Dose-based and dietary-based EECs are above levels where subacute effects to mammals were observed in chronic toxicity studies. -RQs representing exposures to terrestrial-phase frogs are above the LOC for all uses of oxamyl. -There is a >10% chance of effects to an individual terrestrial phase frog (serving as prey to CRLF) consuming small insects for all oxamyl uses, and a >10% chance of effects to an individual terrestrial phase frog consuming large insects for a majority of oxamyl uses (relevant to California). -Dose-based and dietary-based EECs are above the levels where subacute effects to birds were observed in chronic toxicity studies.
Indirect - habitat	Terrestrial	Indirect effects to the CRLF through modification of its terrestrial habitat are not expected. -Estimated exposures of oxamyl to terrestrial vegetation are above the EC_{25} values for monocots and dicots.

Table 2. Summary of effects determination for CRLF critical habitat based on uses of oxamyl in California.

Assessment Endpoint	Effects Determination	Basis for Determination
Modification of aquatic-phase primary constituent elements	**Habitat Modification**	Modification of habitat based on the aquatic-phase PCEs is discountable. - RQs for acute and chronic exposures directly to the CRLF resulting from all uses of oxamyl are below the levels of concern. - Indirect effects to the CRLF through effects to its prey in the aquatic habitat are discountable (see Table 1). -RQs representing exposures to non-vascular and vascular aquatic plants are below LOCs. -Estimated exposures of oxamyl to riparian vegetation are above the EC_{25} values for monocots and dicots.
Modification of terrestrial-phase primary constituent elements		Oxamyl has the potential to modify habitat based on the terrestrial-phase PCEs. - Oxamyl has the potential to directly affect the terrestrial-phase CRLF (See Table 1). Oxamyl has the potential to indirectly affect the terrestrial-phase CRLF through effects to its prey (see Table 1). -Estimated exposures of oxamyl to terrestrial vegetation are below the EC_{25} values for monocots and dicots.

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

When evaluating the significance of this risk assessment's direct/indirect and adverse habitat modification effects determinations, it is important to note that pesticide exposures and predicted risks to the species and its resources (*i.e.*, food and habitat) are not expected to be uniform across the action area. In fact, given the assumptions of drift and downstream transport (*i.e.*, attenuation with distance), pesticide exposure and associated risks to the species and its resources are expected to decrease with increasing distance away from the treated field or site of application. Evaluation of the implication of this non-uniform distribution of risk to the species would require information and assessment techniques that are not currently available. Examples of such information and methodology required for this type of analysis would include the following:

- Enhanced information on the density and distribution of CRLF life stages within specific recovery units and/or designated critical habitat within the action area. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the species.
- Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase frogs. While existing information provides a preliminary picture of the types of food sources utilized by the frog, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately

establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.

- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual frogs and potential modification to critical habitat.

2. Problem Formulation

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

2.1. Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the federally threatened California red-legged frog *(Rana aurora draytonii*) (CRLF) arising from FIFRA regulatory actions regarding use of oxamyl on agricultural crops. In addition, this assessment evaluates whether use on agricultural crops is expected to result in modification of the species' designated critical habitat. This ecological risk assessment has been prepared consistent with a settlement agreement in the case Center for Biological Diversity (CBD) vs. EPA et al. (Case No. 02-1580-JSW(JL)) settlement entered in Federal District Court for the Northern District of California on October 20, 2006.

In this assessment, direct and indirect effects to the CRLF and potential modification to its designated critical habitat are evaluated in accordance with the methods described in the Agency's Overview Document (U.S. EPA 2004). Screening level methods include use of standard models such as PRZM/EXAMS, T-REX, TerrPlant, and AgDRIFT, all of which are described at length in the Overview Document. Additional refinements include use of the T-HERPS model to refine estimates of exposure to terrestrial-phase CRLF as well as a fugacity based approach for estimating oxamyl concentrations in earthworms and resulting exposures to small mammals consuming earthworms. Use of such information is consistent with the methodology described in the Overview Document (U.S. EPA 2004), which specifies that "the assessment process may, on a case-by-case basis, incorporate additional methods, models, and lines of evidence that EPA finds technically appropriate for risk management objectives" (Section V, page 31 of U.S. EPA 2004).

In accordance with the Overview Document, provisions of the ESA, and the Services' *Endangered Species Consultation Handbook*, the assessment of effects associated with registrations of oxamyl is based on an action area. The action area is the area directly or indirectly affected by the federal action, as indicated by the exceedance of the Agency's Levels of Concern (LOCs). It is acknowledged that the action area for a national-level FIFRA regulatory decision associated with a use of oxamyl 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 use of oxamyl in accordance with current labels:

- "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 the 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.

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 use of oxamyl as it relates to this species and its designated critical habitat. If, however, potential direct or indirect effects to individual CRLFs are anticipated 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 oxamyl.

If a determination is made that use of oxamyl within the action area(s) associated with the CRLF "may affect" this species 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 these species depend (*e.g.,* aquatic and terrestrial vertebrates and invertebrates, aquatic plants, riparian vegetation, etc.). Additional information, including spatial analysis (to determine the geographical proximity of CRLF habitat and oxamyl use sites) and further evaluation of the potential impact of oxamyl on the PCEs is also used to determine whether modification of designated critical habitat may occur. Based on the refined information, the Agency uses the best available information to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that "may affect and are likely to adversely affect" the CRLF 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 oxamyl is expected to directly impact living organisms within the action area (defined in Section 2.7), critical habitat analysis for oxamyl 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 appreciably diminish the value of the habitat. Evaluation of actions related to use of oxamyl 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

The result of the EPA pesticide registration process (*i.e.*, the FIFRA regulatory action) is an approved product label. The label is a legal document that stipulates how and where a given pesticide may be used. Product labels (also known as end-use labels) describe the formulation type (*e.g.*, liquid or granular), acceptable methods of application, approved use sites, and any restrictions on how applications may be conducted. Thus, the use or potential use of oxamyl in accordance with the approved product labels for California is "the action" relevant to this ecological risk assessment.

Oxamyl is an N-methyl carbamate currently registered for the control of a broad spectrum of insects, mites, ticks, and nematodes on various field crops, vegetables, fruits, and non-bearing trees. Current registrations of oxamyl allow for use nationwide with many use patterns limited to specific states including or excluding California. This ecological risk assessment and effects determination addresses currently registered uses of oxamyl 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.

Major degradates of oxamyl include oxime [2-hydroxyamino-N,N-dimethyl-2-(methylthio)acetamide], DMOA [N,N-dimethyl-oxalamic acid], DMCF [cyano-methanoic acid dimethylamide], DMEA [N,N-dimethyl-oxalamide], and carbon dioxide. Similar to oxamyl parent, oxime is highly mobile; DMOA, DMCF, and DMEA are expected to be highly mobile as well. Furthermore, oxime and DMOA are more

persistent than oxamyl in certain conditions. Degradates of oxamyl are not considered to be of toxicological concern, based on limited mammalian toxicity data on oxime and DMCF that were considered in the RED (U.S. EPA 2000). Therefore, exposure to degradates of oxamyl was not considered in this assessment.

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). Nevertheless, oxamyl does not have any registered products that contain multiple active ingredients. No data were identified in the scientific literature to describe the effects of mixtures containing oxamyl on non-target organisms.

2.3. Previous Assessments

Oxamyl was first registered as an insecticide in the U.S. in 1974. The Agency issued a Registration Standard for oxamyl in 1987, which was updated in 1991. In 2000, the Agency completed an Interim Reregistration Eligibility Decision (IRED) for oxamyl (U.S EPA 2000), which was finalized in 2007.

Since then, an ecological risk assessment for the new use of oxamyl on sugar beets has been conducted (U.S. EPA 2007).

2.4. Stressor Source and Distribution

2.4.1. Environmental Fate Properties

Oxamyl [(EZ)-N,N-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide; CAS# 23135-22-0; PC Code 103801] is hydrophilic, highly mobile, and relatively nonvolatile. The compound dissipates in the environment by chemical and microbially-influenced degradation and by leaching, with estimated half-lives on the order of several hours to several weeks. Table 3 summarizes the physiochemical and environmental fate properties of oxamyl.

Table 3. Summary of Chemical Properties and Environmental Fate Parameters of Oxamyl.

Parameter	Value	Reference
Selected Physical/Chemical Parameters		
Molecular mass	219.3 g/mol	MRID 40499702
Vapor pressure (25°C)	3.84 x 10^{-7} torr	MRID 42526101
Water solubility (20°C)	2.82 x 10^{5} mg/L	MRID 40499702
n-Octanol-water partition coeff. (K_{OW})	0.36	MRID 40499702
Persistence		
Hydrolysis half-life	pH 5: >31 d pH 7: 8 d pH 9: 0.125 d	MRID 40606516
Aqueous photolysis half-life	14.2 d (pH 5)	MRID 40606515; 41058801
Soil photolysis half-life	No evidence of degradation	ACC.# 147704
Aerobic soil metabolism half-life	11 d (silt loam, pH 6.4, OM 2.8%) 17 d (silt loam, pH 6.4, OM 2.8%)	ACC.# 63012
	11 d (sandy clay loam, pH 7.7, OM 1.5%)	MRID 42820001
	2.9 d (silt loam, pH 7.0, OM 0.4%) 4.6 d (silt loam, pH 7.8, OM 2.1%) 112 d (silty clay loam, pH 4.8, OM 4.4%)	MRID 45176602
Anaerobic soil metabolism half-life	5.2 d (silt loam, pH 4.6, OM 3.7%) 5.8 d (sandy clay loam, pH 7.7, OM 1.5%)	MRID 41346201 MRID 42820001
Aerobic aquatic metabolism half-life (half-life corrected for hydrolysis at pH 7)	3.4 d (6.1 d) (sandy loam, pH 6.6-7.8) 3.5 d (6.3 d) (sandy loam, pH 6.9-8.3)	MRID 45045305
Soil Mobility		
Organic carbon partition coefficient (K_{OC})	10-60 L/kg_{OC} (5 soils) 6-10 L/kg_{OC} (3 soils) 2.5-8.7 L/kg_{OC} (6 soils)	MRID 46237301 Bilkert and Rao, 1985 Bromilow *et al.*, 1980
Column leaching (% parent in leachate; % identified residues in leachate)	<0.2-83%; 89-100% (6 unaged soils) 21-50%; 37-67% (3 aged soils)	ACC.# 141395/ MRID 40606514
Field Dissipation		
Terrestrial field dissipation half-life	Not determined (NY) Not determined (CA) 4 d (DE) 3 d (FL), 4 d (CA), 19 d (WA) 8.6 d (MS) (Oxamyl detected at deepest sample depths of each study.)	ACC.# 145302 ACC.# 149231 ACC.# 40494 MRID 41573201; 41963901 MRID 45045304

2.4.1.1. Degradation

Hydrolysis of oxamyl is pH-dependent, as oxamyl degrades rapidly in neutral to alkaline environments (half-life of 8 days and 3 hours at pH 7 and 9, respectively) and persists in acidic conditions (relatively stable at pH 5). Photolysis appears to be significant in acidic, clear, near-surface water (half-life of 14 days at pH 5), but not on soil (relatively stable). The major hydrolysis (pH 7 and 9) and aqueous photolysis transformation product is oxime, which comprised 83-93% of the applied radioactivity by the end of the hydrolysis studies (pH 7 and 9) and up to 75% of the applied by the end of the photolysis study. Although these studies were not conducted long enough to track a pattern of decline, they suggest oxime may be more persistent to abiotic degradation (*i.e.*, hydrolysis and photolysis) than oxamyl.

In aerobic aquatic systems, oxamyl degrades with a half-life of 3.4-3.5 days at pH 6.6-8.3. The biodegradation half-life corrected for hydrolysis at pH 7 is 6.1-6.3 days (*i.e.*, the pH 7 hydrolysis rate constant was subtracted from the degradation rate constants in aerobic aquatic systems in order to yield these rate constants for biodegradation alone). The major transformation products are oxime, DMOA, DMCF, DMEA, and carbon dioxide. In one study system, oxime reached 59% of the applied radioactivity after 1 day and DMOA totaled 79% of the applied after 30 days. In another study system, DMCF and DMEA were up to 55% and 14% of the applied, respectively, after 2 days. Carbon dioxide in these systems totaled 31-75% of the applied.

In aerobic soil, oxamyl degrades with a half life ranging from 2.9 to 112 days (6 soils; pH 4.8-7.8). The wide range in half-lives is likely due to variation in pH, as degradation may reflect hydrolysis as well as microbial metabolism. The major transformation products are oxime, DMOA, and carbon dioxide. In one aerobic metabolism study, oxime peaked at 24% of the applied radioactivity after 10 days, DMOA reached 20% of the applied after 21 days, and carbon dioxide comprised 45% of the applied after 51 days (MRID 42820001). In another study, oxime comprised up to 51% of the applied after 7 days; DMOA was a maximum of 35% of the applied in a separate soil after 10 days; in both soils, carbon dioxide totaled 73-76% of the applied at study termination (MRID 45176602).

In anaerobic soil, oxamyl degrades with a half-life of 5 to 6 days (2 soils; pH 4.6-7.7). In a 32-day anaerobic study, oxime peaked at 70% at 20 days of flooding, declining to 22% at the end of the study; DMOA peaked at 23% at 32 days (MRID 42820001). In another anaerobic study, oxime only formed a maximum of 2% of the applied, while DMOA peaked at 86% of the applied after 30 days of flooding, remaining 74% of the applied at study termination (MRID 41346201).

Major degradates of oxamyl include oxime [2-hydroxyamino-N,N-dimethyl-2-(methylthio)acetamide], DMOA [N,N-dimethyl-oxalamic acid], DMCF [cyano-methanoic acid dimethylamide], DMEA [N,N-dimethyl-oxalamide], and carbon dioxide. Similar to oxamyl parent, oxime is highly mobile; DMOA, DMCF, and DMEA are expected to be highly mobile as well. Furthermore, oxime and DMOA are more

persistent than oxamyl in certain conditions, such as abiotic conditions in the case of oxime.

2.4.1.2. Transport

Oxamyl has little affinity for adsorption on a variety of soils and is mobile to highly mobile according to the FAO soil mobility classification scheme (U.S. EPA 2006). In a submitted batch equilibrium study (5 soils), average soil-water partition coefficients (K_d) ranged from 0.12 to 0.80 L/kg and organic carbon partitioning coefficients (K_{OC}) ranged from 10 to 60 L/Kg_{OC} (adsorption to one soil was too low to calculate a Freundlich isotherm). Adsorption was correlated to organic carbon content, demonstrated by less variability in K_{OC} values compared to that in K_d values. Batch equilibrium studies in the open literature reported lower organic carbon partition coefficients (range of 2.5 to 10 L/Kg_{OC} for 9 soils; Bilkert and Rao, 1985; Bromilow *et al.*, 1980). Oxime has similar mobility to oxamyl parent, with K_d values ranging from 0.33 to 0.67 L/kg (5 soils) and K_{OC} values ranging from 18 to 66 L/Kg_{OC}.

Soil column leaching studies confirm the mobility of oxamyl. In a study using 2 soils, 83-100% of the unaged parent was collected in the leachate. In a second study with 4 soils, <0.2-83% of the unaged parent and 89-95% of unaged residues were collected in the leachate. While aging reduces the mobility of oxamyl residues, significant amounts were still detected; 67% of 7-day aged residues, and 37% of 18-day aged residues, compared to 95% in unaged residues (12-inch long column). Oxime and DMOA were found in both the unaged and aged residue leachate. In an 18-inch long column study, 61-63% of the applied radioactivity of oxamyl residues aged 30 days were recovered in the leachate.

Oxamyl has a relatively low partial vapor pressure (3.8×10^{-7} torr at 25°C) and is soluble in water up to 2.8×10^{5} mg/L at 20°C. This indicates that the compound will not readily volatilize from soil or water or precipitate from water. Oxamyl has a low n-octanol-water partition coefficient (K_{OW} = 0.36) and, therefore, is not expected to bioaccumulate.

2.4.1.3. Field Dissipation

In the field, half of the applied oxamyl dissipated from the surface in less than 3 weeks (DT_{50} range of 3 to 19 days) in studies from Florida, California and Washington. When both oxamyl and oxime residues are considered, the combined DT_{50} values range from 4 to 39 days. Field dissipation studies show that both oxamyl and oxime leach through the soil, confirming that these residues have a low affinity for adsorption and are mobile in soil. Oxamyl residues reached the lowest sampled soil depth within several weeks of application in a variety of crops and sites.

2.4.2. Mechanism of Action

Oxamyl is an N-methyl carbamate insecticide, acaricide, miticide, nematocide, and plant growth regulator. Carbamate toxicity (to target pests) is based on the inhibition of the enzyme acetylcholine esterase, which cleaves the neurotransmitter acetylcholine. Inhibition of acetylcholine esterase by carbamate insecticides, such as oxamyl, interferes with proper neurotransmission in cholinergic synapses and neuromuscular junctions.

In rodents and humans, which are non-target organisms, N-methyl carbamates cause neurotoxicity via the inhibition of cholinesterase by carbamylation of the serine hydroxyl group located in the active site of the enzyme, which leads to accumulation of acetylcholine and ultimately clinical signs (U.S. EPA 2007).

2.4.3. Use Characterization

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

Oxamyl is registered for 29 agricultural uses in the United States; however, not all of these uses are federally labeled for use in California. Section 3 uses of oxamyl that are federally labeled for use in California include: tree fruit (apples, cherries, citrus, peaches, pears), fruits and vegetables (celery, cucumber, eggplant, garlic, melons, onions, peppers, potatoes, pumpkins, squash and tomatoes), cotton, and tobacco. In addition, one special local need registration exists for use of oxamyl on clover grown for seed in California (SLN # CA-06-0028). Although current labels do not exclude the use of oxamyl on tobacco in California, tobacco is not grown in the State. U.S. Department of Agriculture census data confirm that tobacco has not been grown in California from at least the 1992 report, forward (USDA 2008). It is unlikely that tobacco agriculture will be initiated in California in the future. Therefore, use of oxamyl on tobacco was not quantitatively evaluated for exposure in this assessment. The 18 agricultural uses allowed in California for existing crops are evaluated for exposure in this assessment.

Oxamyl has some additional uses that are registered in other states, but prohibited (by the federal label) in California (*i.e.*, bananas, carrots, ginger, mint, peanuts, pineapple, plantains, sweet potatoes, yams). Because oxamyl is not expected to be applied to these crops within California, which is the action area for oxamyl use that is relevant to the CLRF, these additional uses are not considered part of the federal action evaluated in this assessment.

Applications of oxamyl are made to soil, foliar surfaces of crops and to transplants. Application methods for soil uses include injection, band treatment, incorporation, in-furrow, and broadcast. Foliar applications include the use of chemigation, ground and aerial equipment. Target pests of oxamyl include nematodes, mites and insects. Single maximum application rates of oxamyl range from 1-4 lb a.i./A, depending upon the specific use and application method. At this time, there are 2 approved formulated products containing oxamyl that are used in the United States (registrations 352-532 and 352-372). Both products are water soluble liquids. Table 4 and Table 5 present oxamyl uses and corresponding maximum application rates and application methods considered in this assessment.

Table 4. Oxamyl uses involving foliar[a] applications. These uses are registered for use in CA and considered part of the FIFRA regulatory action relevant to this endangered species assessment.

Use	Application Method	Maximum Single Application Rate (lb a.i./A)	Maximum # Applications per Season
Apple (bearing fruit)	Ground	2.0	1
Celery	Ground and Aerial	1.0	6
Citrus (bearing fruit)	Ground and Aerial	1.0	6
	Chemigation	2.0	3
Clover (for seed)[b]	Ground and Aerial	1.0	2
Cotton	Ground and Aerial	1.0	3
Cucumber	Ground, Aerial, Chemigation	1.0	6
Eggplant	Ground	1.0	6
Garlic	Ground and Chemigation	2.0	2.25[d]
	Aerial	1.0	4.5
Melons[c]	Ground, Aerial, Chemigation	1.0	6
Onion (dry bulb)	Ground and Chemigation	2.0	2.25[d]
	Aerial	1.0	4.5
Non-bearing fruit[e]	Ground	2.0	4
	Aerial	1.0	8
Pepper	Ground, Aerial, Chemigation	1.0	6
Potato	Ground, Aerial, Chemigation	1.0	8
Pumpkin	Ground, Aerial, Chemigation	1.0	6
Squash	Ground, Aerial, Chemigation	1.0	6
Tomato	Ground and Aerial	1.0	8
	Chemigation	2.0	4

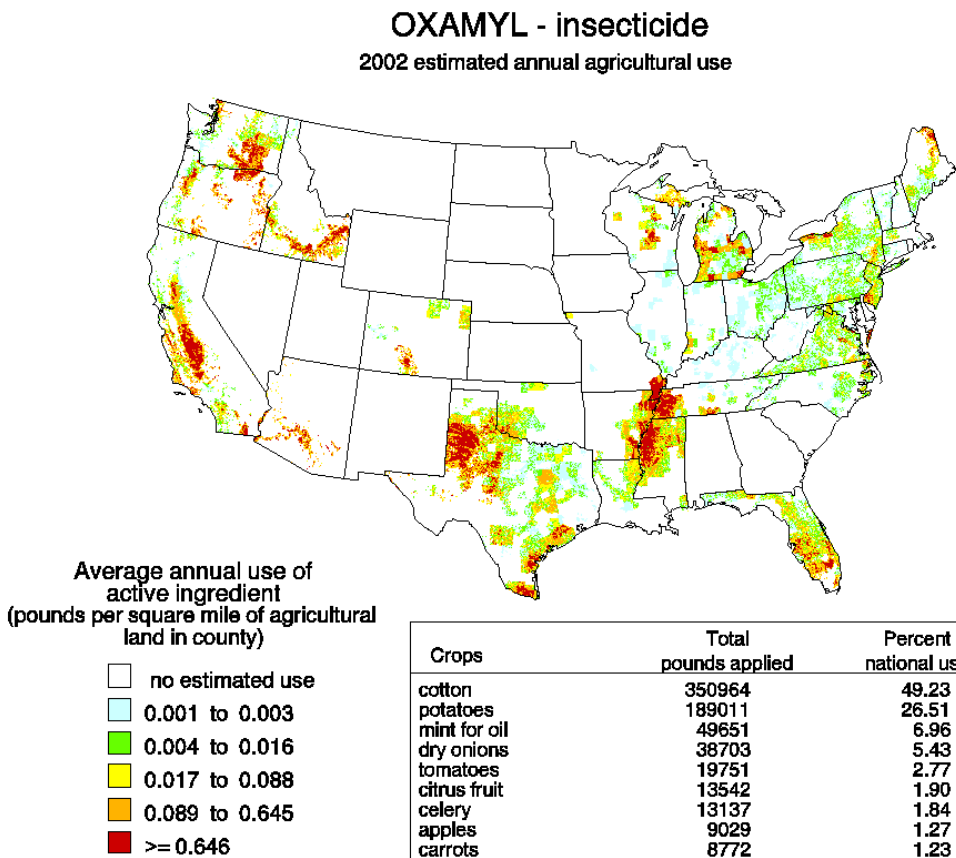
[a] Foliar application includes ground, aerial, and chemigation.
[b] Use on clover is registered under FIFRA Section 24(c).
[c] Melons includes cantaloupe, honeydew, and watermelon.
[d] Oxamyl product labels allow for a maximum of 2 applications for use on garlic and onion per season at 2.0 lb a.i./A with one additional application of 0.5 lb a.i./A.
[e] Non-bearing fruit includes apple, cherry, citrus, peach, and pear.

Table 5. Uses of oxamyl involving soil applications. These uses are registered for use in CA and considered part of the FIFRA regulatory action relevant to this endangered species assessment.

Use	**Maximum Single Application Rate (lb a.i./A)**	**Maximum # applications per season**
Apples (bearing fruit)	NA	NA
Celery	1.0	6
Citrus (bearing fruit)	NA	NA
Clover (for seed)[b]	NA	NA
Cotton	NA	NA
Cucumber	4.0	1[d]
Eggplant	NA	NA
Garlic	2.0	2.25
Melons[c]	4.0	1[d]
Onion (dry bulb)	2.0	2.25
Non-bearing fruit[e]	4.0	1[d]
Pepper	1.0	6
Potato[f]	4.0	1[d]
Pumpkin	4.0	1[d]
Squash	4.0	1[d]
Tomato	0.75-1.25[g]	3

NA = not applicable
[a] Soil applications include injection, incorporation, or in-furrow.
[b] Use on clover is registered under FIFRA Section 24(c).
[c] Melons includes cantaloupe, honeydew, and watermelon.
[d] This application is intended to be made preplant soil; therefore, it is assumed that there is one application per season.
[e] Non-bearing fruit includes apple, cherry, citrus, peach, and pear uses.
[f] Label allows for a preplant soil application of 4 lb a.i./A.
[g] For this use, maximum application rates should be as follows: the first application should be 0.75 lb a.i./A, the second should be 1.25 lb a.i./A, and the third should be 1.0 lb a.i./A.

In order to understand the extent of the use of oxamyl, national level data are considered. Figure 1 depicts estimated annual oxamyl use in the continental United States in 2002. As of 2002, approximately 700,000 pounds of oxamyl were applied annually. The highest uses of oxamyl included cotton and potatoes (76% of total use).



Crops	Total pounds applied	Percent national use
cotton	350964	49.23
potatoes	189011	26.51
mint for oil	49651	6.96
dry onions	38703	5.43
tomatoes	19751	2.77
citrus fruit	13542	1.90
celery	13137	1.84
apples	9029	1.27
carrots	8772	1.23
bell peppers	5140	0.72

Figure 1. Estimated Annual Oxamyl Usage in the U.S.

(from http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=02&map=m6045)
[The pesticide use maps available from this site show the average annual pesticide use intensity expressed as average weight (in pounds) of a pesticide applied to each square mile of agricultural land in a county. The area of each map is based on state-level estimates of pesticide use rates for individual crops that were compiled by the CropLife Foundation, Crop Protection Research Institute during based on information collected during 1999 through 2004 and on 2002 Census of Agriculture county crop acreage. The maps do not represent a specific year, but rather show typical use patterns over the five year period 1999 through 2004.]

Data describing documented uses of oxamyl in the state of California are also considered. These data were obtained form the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[1]. According to CDPR PUR data, the greatest quantity of oxamyl was applied in Fresno County with a yearly average application of 40,801 lbs a.i./year, followed by Kings County, Kern County and Ventura County with 22,642 lbs a.i./year, 11,738 lbs a.i./year, and 10,914 lbs a.i./year, respectively (Table 6).

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

Table 6. Summary of California Department of Pesticide Registration (CDPR) Pesticide Use Reporting (PUR) Data from 1999 to 2006 by County.

County*	Average Annual Application (lbs a.i./year)	% of total average annual use in CA
Fresno	40,801	36.4%
Kings	22,642	20.2%
Kern	11,738	10.5%
Ventura	10,914	9.7%
Monterey	6,393	5.7%
Tulare	3,470	3.1%
Merced	3,264	2.9%
Imperial	2,326	2.1%
Riverside	2,202	2.0%
San Diego	2,066	1.8%
Santa Barbara	1,389	1.2%
San Benito	1,159	1.0%

* Orange , Santa Clara, San Luis Obispo, Madera, San Joaquin, Modoc, Stanlius, Colusa, Yolo, Santa Cruz, Los Angeles, Sutter, Siskiyou, contra Costa, Glenn, Solano, Yuba, Sacramento, Butte and Tehama Counties have <1000 pounds applied annually, which is <1% of the total average annual use in the state of California.

According to data from the PUR database, from 1999 to 2006, oxamyl was used in greatest quantity on cotton with an average yearly application of 78,118 lbs a.i./year. Celery, tomatoes (produce), onions (dry), and peppers (fruiting) followed with 17,125 lbs a.i./year, 4,890 lbs a.i./year, 2,854 lbs a.i./year, and 2,484 lbs a.i./year, respectively (Table 7).

Table 7. Summary of California Department of Pesticide Registration (CDPR) Pesticide Use Reporting (PUR) Data from 1999 to 2006 for Currently Registered Oxamyl Uses.

Crop	Average Annual State-Wide Application (lbs a.i./ year)	Application Rate (lbs a.i./acre)	
		Mean	Maximum
Cotton	78,118	0.74	8.46
Celery	17,125	0.67	6.81
Tomato, produce	4,890	0.68	7.96
Onion, dry	2,854	0.91	9.37
Pepper, fruiting	2,484	0.69	7.47
Tomato, processing	1,672	0.73	4.98
Cantalope	1,505	0.87	3.93
Melon	1,397	0.88	14.93
Garlic	577	1.34	1.99
Apple	314	0.95	3.88
Eggplant	209	0.73	10.45
Watermelon	194	0.63	5.12
Potato	141	0.65	0.95
Cucumber	139	0.72	2.21
Squash	114	0.61	1.19
Orange	98	0.81	1.98
Squash, summer	77	0.79	1.99
Pumpkin	75	0.72	1.00
Pepper, spice	40	0.72	1.00
Pepper, pimento	19	0.43	0.50
Peach	13	10.16	10.35
Nectarine	7.5	5.04	9.96
Squash, zucchini	4.6	2.07	2.99
Lemon	3.1	0.91	1.00
Tangelo	2.5	0.66	0.66
Onion, green	2.0	0.50	0.50
Tangerine	0.62	0.50	0.50
Squash, winter	0.34	0.55	0.55

A number of maximum application rates for different uses exceeded the label-permitted rate. For example, the maximum rate given for use on eggplant was 10.45 lbs a.i./acre, an exceedance from the maximum label rate by about 1000%. However, a review of the CDPR PUR individual recorded uses for the years 2005 and 2006 demonstrate that these extremely high values are either just rare incidences of misuse, or perhaps misreported values. For 2005, the average application rate was 0.79 lbs a.i./year, the 75th %ile application rate was 1.00 lbs a.i./year, and the 95th %ile application rate was 1.00 lbs a.i./year. Similarly in 2006, the average application rate was 0.82 lbs a.i./year, the 75th %ile was 1.00 lbs a.i./year, and the 95th percentile rate was 1.01 lbs a.i./year. These values are below or just at the maximum label-permitted application rates; thus, the usage data confirm that assessing exposure of oxamyl to the CRLF based on maximum label rates is reflective of actual use rates for a majority of use sites (Table 7).

It should be noted that the uses considered in this risk assessment represent all currently registered uses according to a review of all current labels. No other uses are relevant to this assessment. Any reported use, such as may be seen in the CDPR PUR database, represent either historic uses that have been 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.

2.5. Assessed Species

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

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

2.5.1. Distribution

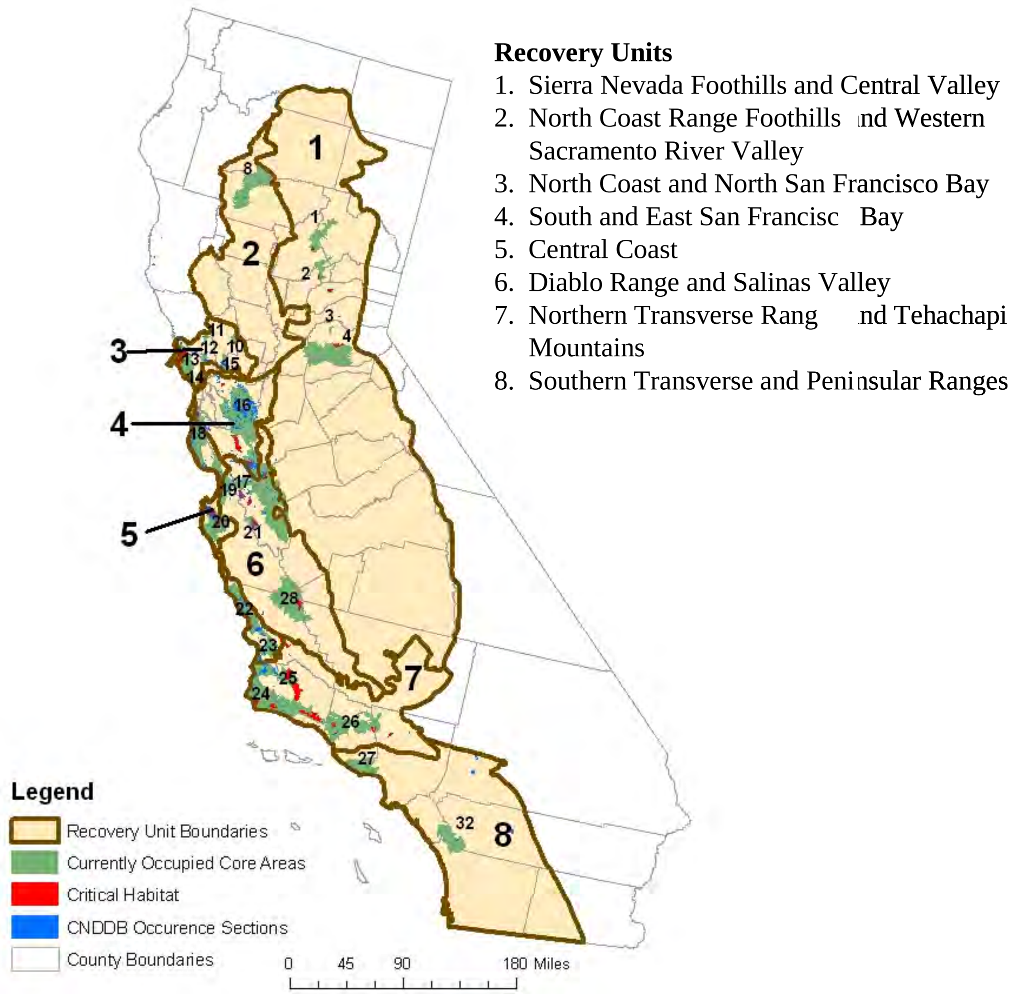
The CRLF is endemic to California and Baja California (Mexico) and historically inhabited 46 counties in California including the Central Valley and both coastal and interior mountain ranges (USFWS 1996). Its range has been reduced by about 70%, and the species currently resides in 22 counties in California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

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

The distribution of CRLFs within California is addressed in this assessment using four categories of location including recovery units, core areas, designated critical habitat, and known occurrences of the CRLF reported in the California Natural Diversity Database (CNDDB) that are not included within core areas and/or designated critical habitat (see Figure 2). Recovery units, core areas, and other known occurrences of the CRLF from the CNDDB are described in further detail in Attachment I, 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.

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.



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.

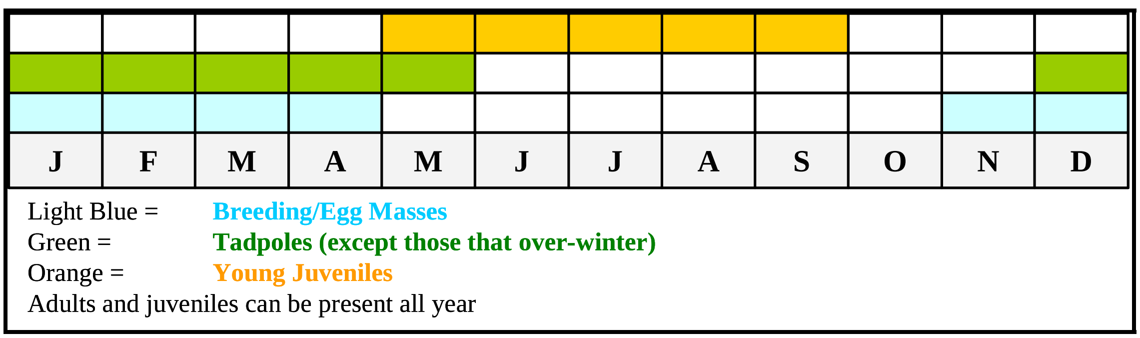


Figure 3. CRLF Reproductive Events by Month

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). Dense vegetation close to water, shading, and water of moderate depth are habitat features that appear especially important for CRLF (Hayes and Jennings 1988). Breeding sites include streams, deep pools, backwaters within streams and creeks, ponds, marshes, sag ponds (land depressions between fault zones that have filled with water), dune ponds, and lagoons. Breeding adults have been found near deep (0.7 m) still or slow moving water surrounded by dense vegetation (USFWS 2002); however, the largest number of tadpoles have been found in shallower pools (0.26 – 0.5 m) (Reis, 1999). Data indicate that CRLFs do not frequently inhabit vernal pools, as conditions in these habitats generally are not suitable (Hayes and Jennings 1988).

CRLFs also frequently breed in artificial impoundments such as stock ponds, although additional research is needed to identify habitat requirements within artificial ponds (USFWS 2002). Adult CRLFs use dense, shrubby, or emergent vegetation closely associated with deep-water pools bordered with cattails and dense stands of overhanging vegetation (http://www.fws.gov/endangered/features/rl_frog/rlfrog.html#where).

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

During dry periods, the CRLF is rarely found far from water, although it will sometimes disperse from its breeding habitat to forage and seek other suitable habitat under downed trees or logs, industrial debris, and agricultural features (UWFWS 2002). According to

Jennings and Hayes (1994), CRLFs also use small mammal burrows and moist leaf litter as habitat. In addition, CRLFs may also use large cracks in the bottom of dried ponds as refugia; these cracks may provide moisture for individuals avoiding predation and solar exposure (Alvarez 2000).

2.6. Designated Critical Habitat

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

'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 (Section 7) through prohibition against destruction or 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 destruction or 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.

Further description of these habitat types is provided in Attachment I.

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 I for a full explanation on this special rule.

USFWS has established modification standards for designated critical habitat (USFWS 2006). Activities that may destroy or adversely modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the species. Evaluation of actions related to use of oxamyl that may alter the PCEs of the CRLF's critical habitat form the basis of the critical habitat impact analysis. According to USFWS (2006), activities that may affect critical habitat and therefore result in adverse effects to the CRLF include, but are not limited to the following:

(1) Significant alteration of water chemistry or temperature to levels beyond the tolerances of the CRLF that result in direct or cumulative adverse effects to individuals and their life-cycles.
(2) 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 that could result in elimination or reduction of habitat necessary for the growth and reproduction of the CRLF by increasing the sediment deposition to levels that would adversely affect their ability to complete their life cycles.
(4) 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.
(5) Elimination of upland foraging and/or aestivating habitat or 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 (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 oxamyl is expected to directly impact living organisms within the action area, critical habitat analysis for oxamyl 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 oxamyl is likely to encompass considerable portions of the United States based on the large array of agricultural uses. However, the scope of this assessment limits consideration of the overall action area to those portions that may be applicable to the protection of the CRLF and its designated critical habitat within the state of California. The Agency's approach to defining the action area under the provisions of the Overview Document (U.S. EPA 2004) considers the results of the risk assessment process to establish boundaries for that action area with the understanding that exposures below the Agency's defined Levels of Concern (LOCs) constitute a no-effect threshold. For the purposes of this assessment, attention will be focused on the footprint of the action (*i.e.*, the area where pesticide application occurs), plus all areas where offsite transport (*i.e.*, spray drift, downstream dilution, etc.) may result in potential exposure within the state of California that exceeds the Agency's LOCs.

Deriving the geographical extent of this portion of the action area is based on consideration of the types of effects that oxamyl may be expected to have on the environment, the exposure levels to oxamyl that are associated with those effects, and the best available information concerning the use of oxamyl and its fate and transport within the state of California. Specific measures of ecological effect for the CRLF that define the action area include any direct and indirect toxic effect to the CRLF and any potential modification of its critical habitat, including reduction in survival, growth, and fecundity as well as the full suite of sublethal effects available in the effects literature. Therefore, the action area extends to a point where environmental exposures are below any measured lethal or sublethal effect threshold for any biological entity at the whole organism, organ, tissue, and cellular level of organization

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 oxamyl. An analysis of labeled uses and review of available product labels was completed (See use characterization in section 2.4.3). For those uses relevant to the CRLF, the analysis indicates that, for oxamyl, only agricultural uses are considered as part of the federal action evaluated in this assessment: apple, celery, cherry, citrus, clover, cotton, cucumber, eggplant, garlic, melons (cantaloupe, honeydew, and watermelon), onion, peach, pear, pepper, potato, pumpkin, squash, and tomato.

Following a determination of the assessed uses, an evaluation of the potential "footprint" of oxamyl use patterns (*i.e.*, the area where pesticide application occurs) is determined. This "footprint" represents the initial area of concern, based on an analysis of available land cover data for the state of California. The initial area of concern is defined as all land cover types and the stream reaches within the land cover areas that represent the labeled uses described above. A map representing all the land cover types that make up the initial area of concern for oxamyl is presented in Figure 4.

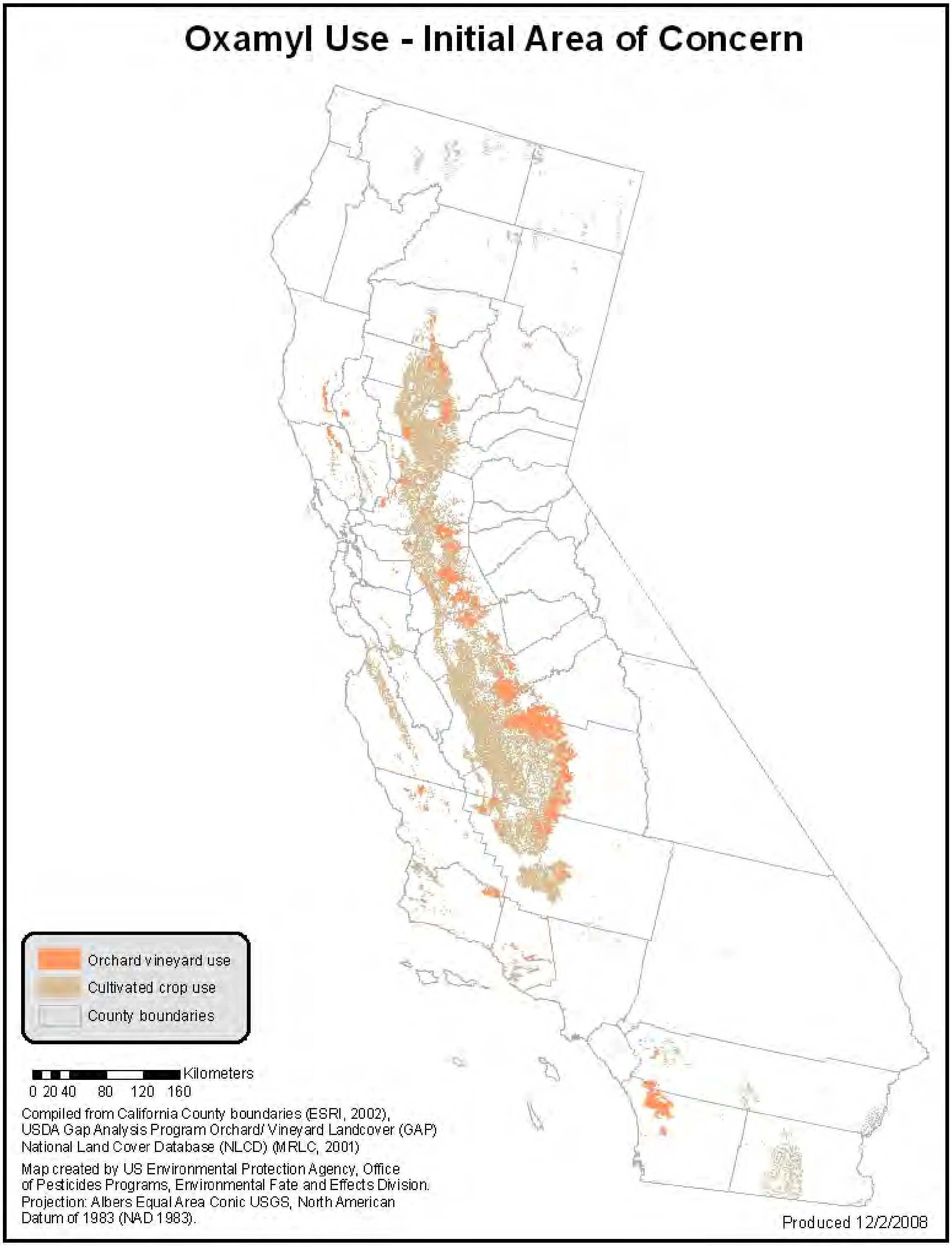


Figure 4. Initial area of concern for oxamyl use in California.

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 oxamyl through runoff and spray drift is considered in deriving quantitative estimates of oxamyl 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 oxamyl at concentrations above the Agency's Levels of Concern (LOC), there is need to expand the action area to include areas that are affected indirectly by this federal action. Because of the lack of a NOAEC in the dietary-based acute study for the bobwhite quail (MRID: 406065-11), described later in Section 4.2.1, the action area for oxamyl is established as the entire state of California. Additional analysis related to the intersection of the oxamyl action area and CRLF habitat used in determining the final action area is described in **Appendix A**.

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."[1] 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.,* waterbodies, riparian vegetation, and upland and dispersal habitats), the migration pathways of oxamyl (*e.g.,* runoff, spray drift, etc.), and the routes by which ecological receptors are exposed to oxamyl *(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 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. It should be noted that assessment endpoints are limited to direct and indirect effects associated with survival, growth, and fecundity, and do not include the full suite of sublethal effects used to define the action area. According the Overview Document (U.S. EPA 2004), the Agency relies on acute and chronic effects endpoints that are either direct measures of impairment of survival, growth, or fecundity or endpoints for which there is a scientifically robust, peer reviewed relationship that can quantify the impact of the measured effect endpoint on the assessment endpoints of survival, growth, and fecundity.

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

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 oxamyl is provided in Table 8**.**

Table 8. Assessment Endpoints and Measures of Ecological Effects.

Assessment Endpoint	**Measures of Ecological Effects**[3]
Aquatic-Phase CRLF (Eggs, larvae, juveniles, and adults)[a]	
Direct Effects	
1. Survival, growth, and reproduction of CRLF	1a. Rainbow trout (*Oncorhynchus mykiss*) LC_{50} 1b. Rainbow trout (*Oncorhynchus mykiss*) NOEC
Indirect Effects and Critical Habitat Effects	
2. Survival, growth, and reproduction of CRLF individuals via indirect effects on aquatic prey food supply (*i.e.*, fish, freshwater invertebrates, non-vascular plants)	2a. Algae (*Navicula pelliculosa*) EC_{50} 2b. Rainbow trout (*Oncorhynchus mykiss*) LC_{50} 2c. Midge (*Chironomus plumosus)* EC_{50} 2d. Rainbow trout (*Oncorhynchus mykiss*) NOEC 2e. Midge (*Chironomus plumosus)* NOEC
3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, food supply, and/or primary productivity (*i.e.*, aquatic plant community)	3a. Algae (*Navicula pelliculosa*) EC_{50} 3b. Duckweed (*Lemna Gibba)* EC_{50}
4. Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation	4a. Monocots: Seedling Emergence, Vegetative Vigor EC_{25} 4b. Dicots: Seedling Emergence, Vegetative Vigor EC_{25}
Terrestrial-Phase CRLF (Juveniles and adults)	
Direct Effects	
5. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	5a. Northern Bobwhite Quail (*Colinus virginianus*) LC_{50} 5b. Mallard duck (*Anas platyrhynchos*) NOEAC
Indirect Effects and Critical Habitat Effects	
6. Survival, growth, and reproduction of CRLF individuals via effects on terrestrial prey (*i.e.,*terrestrial invertebrates, small mammals , and frogs)	6a. Laboratory rat (*Rattus norvegicus*) Female LD_{50} and Male LD_{50} 6b. Laboratory rat (*Rattus norvegicus*) NOAEC 6c. Mallard duck (*Anas platyrhynchos*) LD_{50} 6d. Honey bee (*Apis mellifera*) LD_{50} 6e. Northern Bobwhite Quail (*Colinus virginianus*) LC_{50} 6f. Mallard duck (*Anas platyrhynchos*) NOEAC
7. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian and upland vegetation)	7a. Monocots: Seedling Emergence, Vegetative Vigor EC_{25} 7b. Dicots: Seedling Emergence, Vegetative Vigor EC_{25}

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 oxamyl 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

[3] All registrant-submitted and open literature toxicity data reviewed for this assessment are included in Appendix A.

are those that alter the PCEs and 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 oxamyl effects data are available (see Table 9). Modification to the critical habitat of the CRLF includes, but is not limited to, those listed in Section 2.6.

Measures of such possible effects by labeled use of oxamyl on critical habitat of the CRLF are described in section 2.6. 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 CRLF 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.	1a. Algae (*Navicula pelliculosa*) EC_{50} 1b. Duckweed (*Lemna Gibba)* EC_{50} 1c. Monocots: Seedling Emergence, Vegetative Vigor EC_{50} 1d. Dicots: Seedling Emergence, Vegetative Vigor EC_{25}
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.	2a. Algae (*Navicula pelliculosa*) EC_{50} 2b. Duckweed (*Lemna Gibba)* EC_{50} 2c. Monocots: Seedling Emergence, Vegetative Vigor EC_{25} 2d. Dicots: Seedling Emergence, Vegetative Vigor EC_{25}
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	3a. Rainbow trout (*Oncorhynchus mykiss*) LC_{50} 3b. Midge (*Chironomus plumosus)* EC_{50} 3c. Rainbow trout (*Oncorhynchus mykiss*) NOEC 3d. Midge (*Chironomus plumosus)* NOEC 3e. Algae (*Navicula pelliculosa*) EC_{50}
Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)	4. Algae (*Navicula pelliculosa*) EC_{50}
Terrestrial-Phase CRLF 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	5a. Monocots: Seedling Emergence, Vegetative Vigor EC_{25} 5b. Dicots: Seedling Emergence, Vegetative Vigor EC_{25} 5c. Laboratory rat (*Rattus norvegicus*) Female LD_{50} and Male LD_{50} 5d. Laboratory rat (*Rattus norvegicus*) NOAEC 5e. Mallard duck (*Anas platyrhynchos*) LD_{50} 5f. Honey bee (*Apis mellifera*) LD_{50} 5g. Northern Bobwhite Quail (*Colinus virginianus*) LC_{50} 5h. Mallard duck (*Anas platyrhynchos*) NOEAC
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.	

[a] 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 adverse effects (*i.e.,* changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (U.S. EPA, 1998). For this assessment, the risk is stressor-linked, where the stressor is the release of oxamyl to the environment. The following risk hypotheses are presumed for this endangered species assessment:

The labeled use of oxamyl within the action area may:

- directly affect the CRLF by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect the CRLF by reducing or changing the composition of food supply;
- indirectly affect the CRLF or modify designated critical habitat by reducing or changing the composition of the aquatic plant community in the ponds and streams comprising the species' current range and designated critical habitat, thus affecting primary productivity and/or cover;
- indirectly affect the CRLF or modify designated critical habitat by reducing or changing the composition of the terrestrial plant community (*i.e.*, riparian habitat) required to maintain acceptable water quality and habitat in the ponds and streams comprising the species' current range and designated critical habitat;
- 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);
- modify the designated critical habitat of the CRLF by reducing the food supply required for normal growth and viability of juvenile and adult CRLFs;
- 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.
- 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.
- 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 oxamyl release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for terrestrial and aquatic exposures are shown in Figure 5 and in Figure 6, respectively, which include the conceptual models for the aquatic and terrestrial PCE components of critical habitat.

Based on available fate and transport data for oxamyl (described in Section 2.4.1), potential transport mechanisms of this pesticide include surface water runoff, ground water leachate, spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Because oxamyl is relatively nonvolatile and does not bind well to soil, secondary drift is not expected to appreciably occur. Also, because oxamyl degrades in aquatic environments by metabolism and hydrolysis in non-acidic environments, and ground water flow tends to be attenuated relative to surface water flow, exfiltrated ground water is expected to contribute attenuated amounts of oxamyl to surface water bodies after residues in runoff have largely dissipated. Therefore, ground water discharge is not expected to contribute greater exposure to surface water bodies than surface water runoff. And, thus, the major routes of exposure for oxamyl are expected only to include surface water runoff and spray drift. Exposure routes shown in dashed lines are not quantitatively considered because the contribution of those potential exposure routes to potential risks to the CRLF and modification to designated critical habitat is expected to be appreciably less than that of potential exposure routes shown in solid lines.

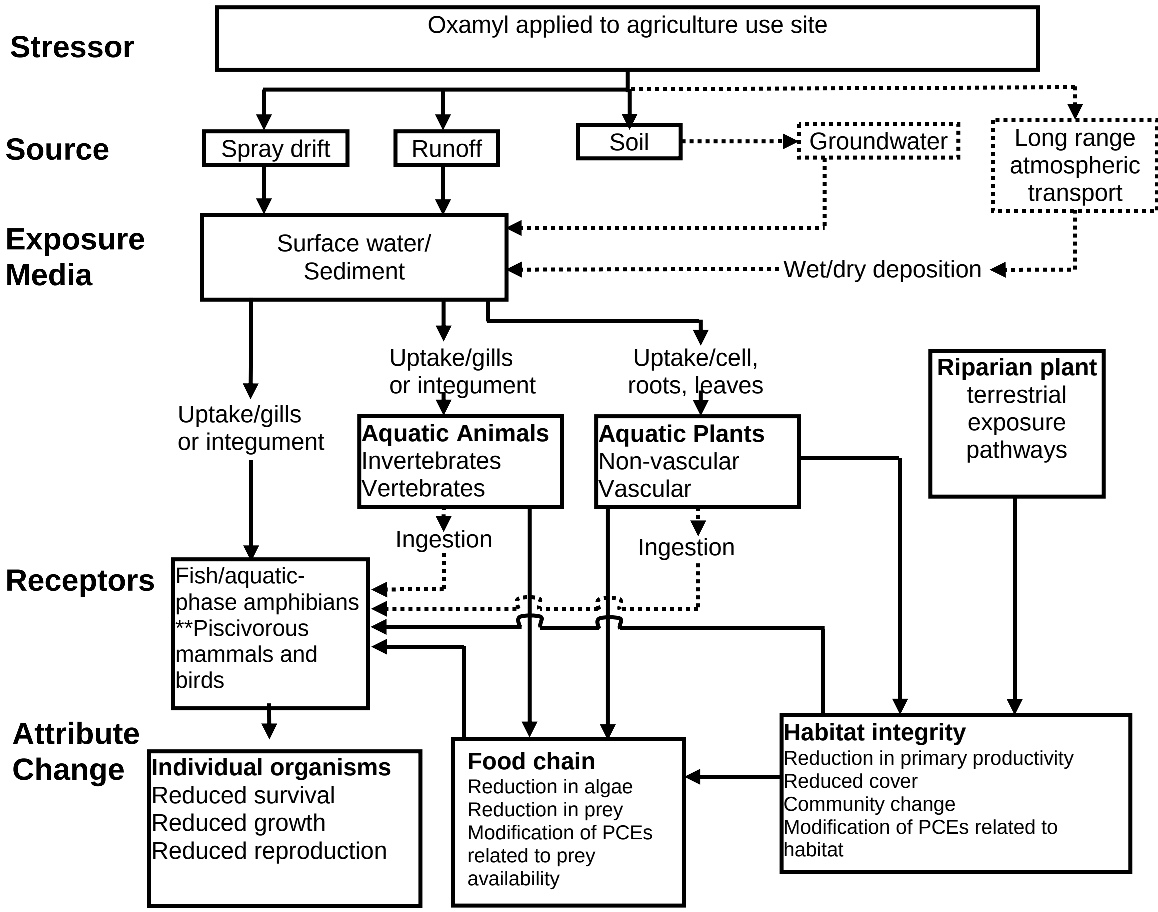


Figure 5. Conceptual Model for Pesticide effects on Aquatic-Phase of the CRLF and its Critical Habitat.

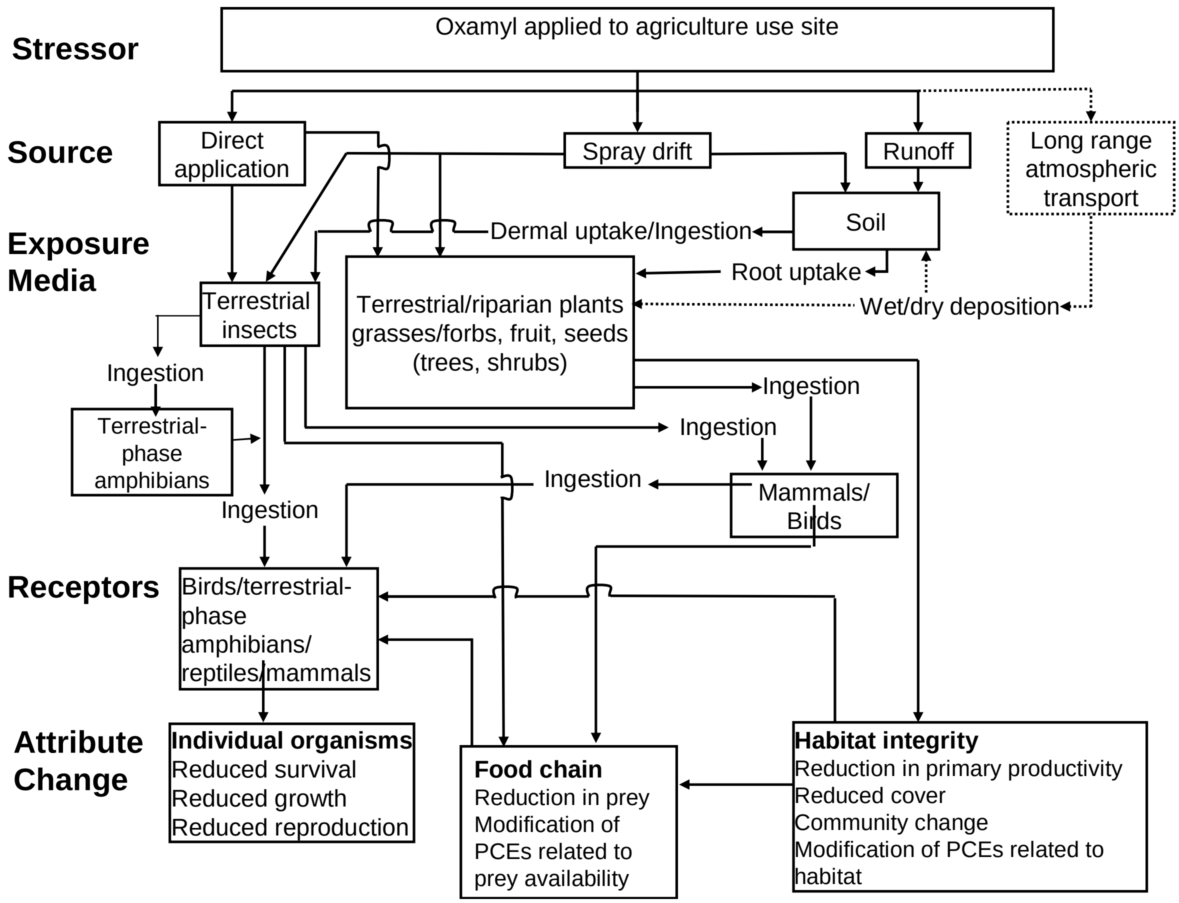


Figure 6. Conceptual Model for Pesticide Effects on Terrestrial-Phase of the CRLF and its Critical Habitat.

2.10. Analysis Plan

In order to address the risk hypothesis, the potential for direct and indirect effects to the CRLF, its prey, and its habitat is estimated. In the following sections, the use, environmental fate, and ecological effects of oxamyl are characterized and integrated to assess the risks. This is accomplished using a risk quotient (ratio of exposure concentration to effects concentration) approach. Although risk is often defined as the likelihood and magnitude of adverse ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/or magnitude of an adverse effect. However, as outlined in the Overview Document (U.S. EPA, 2004), the likelihood of effects to individual organisms from particular uses of oxamyl 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 oxamyl along with available monitoring data indicate that runoff and spray drift are the principle potential transport mechanisms of oxamyl to the aquatic and terrestrial habitats of the CRLF. In this assessment, transport of oxamyl through runoff and spray drift is considered in deriving quantitative estimates of oxamyl exposure to CRLF, its prey and its habitats.

Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EECs) of oxamyl using maximum labeled application rates and methods of application. The models used to predict aquatic EECs are the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). The model used to predict terrestrial EECs on food items is T-REX. The model used to derive EECs relevant to terrestrial and wetland plants is TerrPlant. These models are parameterized using relevant reviewed registrant-submitted environmental fate data.

PRZM (v3.12.2, May 2005; Carousel *et al.*, undated) and EXAMS (v2.98.4.6, April 2005; Burns, 2004) are screening simulation models coupled with the graphical user interface PE (v5.0, Aug 2007) to generate daily exposures and 1-in-10 year EECs of oxamyl that may occur in surface water bodies adjacent to application sites receiving oxamyl 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 oxamyl. 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 the 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 (v1.3.1, 12/07/2006; U.S. EPA. 2006*c*). 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 95th percentile of residue values from actual field measurements (Hoerger and Kenega, 1972). For modeling purposes, direct exposures of the CRLF to oxamyl through contaminated food are estimated using the EECs for the small bird (20 g) which consumes small insects. Dietary-based and dose-based exposures of potential prey (small mammals) are assessed using the small mammal (15 g) which consumes short grass. The small bird (20g) consuming small insects and the small mammal (15g) consuming short grass are used because these categories represent the largest 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 oxamyl 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 to amphibians is likely to result in an over-estimation of exposure and risk for reptiles and terrestrial-phase amphibians. Therefore, T-REX (v.1.3.1) has been refined to the T-HERPS model (v. 1.0, 5/15/2007; U.S. EPA. 2007*a*), which allows for an estimation of food intake for poikilotherms using the same basic procedure as T-REX to estimate avian food intake.

EECs for terrestrial plants inhabiting dry and wetland areas are derived using TerrPlant (version 1.2.2, 12/26/2006; (U.S. EPA. 2006*b*). This model uses estimates of pesticides in runoff and in spray drift to calculate EECs. EECs are based upon solubility, application rate and minimum incorporation depth.

In order to explore the potential exposures of mammals to oxamyl following applications involving ground application, a simple fugacity approach was employed to estimate oxamyl concentrations in earthworms and subsequent exposures to mammals consuming earthworms.

The spray drift model, AgDRIFT, is used to assess exposures of terrestrial phase CRLF and its prey to oxamyl deposited on terrestrial habitats by spray drift.

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 U.S. EPA, Office of Research and Development, and the National Health and Environmental Effects Research Laboratory's Mid-Continent Ecology Division.

The assessment of risk for direct effects to the terrestrial-phase CRLF makes the assumption that toxicity of oxamyl to birds is similar to or less than the toxicity to the terrestrial-phase CRLF. The same assumption is made for fish and aquatic-phase CRLF. Algae, aquatic invertebrates, fish, and amphibians represent potential prey of the CRLF in the aquatic habitat. Terrestrial invertebrates, small mammals, and terrestrial-phase amphibians represent potential prey of the CRLF in the terrestrial habitat. Aquatic, semi-aquatic, and terrestrial plants represent habitat of CRLF.

The acute measures of effect used for animals in this screening level assessment are the LD_{50}, LC_{50} and EC_{50}. 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. LC stands for “Lethal Concentration” and LC_{50} is the concentration of a chemical that is estimated to kill 50% of the test organisms. 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. 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).

The Agency uses the probit dose response relationship as a tool for providing additional information on the potential for acute direct effects to individual listed species and aquatic animals that may indirectly affect the listed species of concern (U.S. EPA, 2004). As part of the risk characterization, an interpretation of acute RQ for listed species is discussed. This interpretation is presented in terms of the chance of an individual event (*i.e.*, mortality or immobilization) should exposure at the EEC actually occur for a species with sensitivity to oxamyl on par with the acute toxicity endpoint selected for RQ calculation. To accomplish this interpretation, the Agency uses the slope of the dose response relationship available from the toxicity study used to establish the acute toxicity measures of effect for each taxonomic group that is relevant to this assessment. The individual effects probability associated with the acute RQ is based on the mean estimate of the slope and an assumption of a probit dose response relationship. In addition to a single effects probability estimate based on the mean, upper and lower estimates of the effects probability are also provided to account for variance in the slope, if available.

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

It is important to note that the measures of effect for direct and indirect effects to the CRLF and its designated critical habitat are associated with impacts to survival, growth, and fecundity, and do not include the full suite of sublethal effects used to define the action area. According the Overview Document (U.S. EPA 2004), the Agency relies on effects endpoints that are either direct measures of impairment of survival, growth, or fecundity or endpoints for which there is a scientifically robust, peer reviewed relationship that can quantify the impact of the measured effect endpoint on the assessment endpoints of survival, growth, and fecundity.

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 agricultural and non-agricultural uses of oxamyl, 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 adverse ecological effects on non-target species. For the assessment of oxamyl 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) (U.S. EPA, 2004) (see Appendix B).

For this endangered species assessment, listed species LOCs are used for comparing RQ values for acute and chronic exposures of oxamyl directly to the CRLF. If estimated exposures directly to the CRLF of oxamyl resulting from a particular use are sufficient to exceed the listed species LOC, then the effects determination for that use is "may affect". When considering indirect effects to the CRLF due to effects to animal prey (aquatic and terrestrial invertebrates, fish, frogs, and mice), the listed species LOCs are also used. If estimated exposures to CRLF prey of oxamyl resulting from a particular use are sufficient to exceed the listed species LOC, then the effects determination for that use is a "may affect." If the RQ being considered also exceeds the non-listed species acute risk LOC, then the effects determination is a LAA. If the acute RQ is between the listed species LOC and the non-listed acute risk species LOC, then further lines of evidence (*i.e.* probability of individual effects, species sensitivity distributions) are considered in distinguishing between a determination of NLAA and a LAA. When considering indirect effects to the CRLF due to effects to algae as dietary items or plants as habitat, the non-listed species LOC for plants is used because the CRLF does not have an obligate relationship with any particular aquatic and/or terrestrial plant. If the RQ being considered for a particular use exceeds the non-listed species LOC for plants, the effects determination is "may affect". Further information on LOCs is provided in Appendix B.

2.10.2. Data Gaps

Acceptable data regarding the anaerobic aquatic metabolism of oxamyl are not available. These data are relevant to the environmental fate of residues in anaerobic aquatic environmental compartments including saturated subsurface soils. However, submitted hydrolysis and anaerobic soil metabolism data indicate that oxamyl will not persist under anaerobic, aquatic environments, especially in neutral to alkaline conditions, due to hydrolysis.

3. Exposure Assessment

Oxamyl is formulated as a water-soluble liquid. Application methods include aerial, air-blast, and ground foliar broadcasts, chemigation, soil injection, band treatment, row treatment, incorporation, in-furrow spray or drench, and transplant water treatment. Application equipment includes various aircraft, ground booms, sprayers and irrigation equipment. Ground boom and aerial modes of application tend to use lower volumes of application applied in finer sprays than applications coincident with sprayers and spreaders and thus have a higher potential for off-target movement via spray drift. Therefore, risks from ground boom and aerial applications are expected to result in the highest off-target concentrations of oxamyl due to generally higher spray drift levels.

3.1. Label Application Rates and Intervals

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

Currently registered agricultural uses of oxamyl within California include apple, celery, cherry, citrus, clover, cotton, cucumber, eggplant, garlic, melons (cantaloupe, honeydew, and watermelon), onion, peach, pear, pepper, potato, pumpkin, squash, tobacco, and tomato. Although use of oxamyl is not prohibited on tobacco in California, this crop is not grown in the State, and is therefore not considered in this endangered species assessment. The maximum use patterns being assessed for uses of oxamyl are summarized in Table 10 and in Table 11. Current labels limit applications per season rather than per year. However, the only assessed use for which multiple seasons may occur per year is celery. Therefore, labeled limits for number of applications per season can be interpreted as annual limits for all uses except celery. In California, 2.5 crops of celery may be grown per year (USDA, 2000). Therefore, for this assessment, three seasons of celery were assumed possible per year.

Table 10. Oxamyl Uses by Foliar[1] Application Assessed for the CRLF.[2]

Use	Application Method	Maximum Single Application Rate (lbs a.i./A)	Maximum # Applications per Season	Application Interval (days)
Apple (bearing fruit)	Ground	2.0	1	ND
Celery [1 season][3]	Ground, Aerial	1.0	6	5
Celery [3 seasons][3]	Ground, Aerial	1.0	18	5
Citrus (bearing fruit)	Ground	1.0	6	14
	Aerial	1.0	6	ND
	Chemigation	2.0	3	30
Clover (for seed)	Ground, Aerial	1.0	2	14
Cotton	Ground, Aerial	1.0	3	6
Cucumber	Ground, Aerial	1.0	6	7
	Chemigation	1.0	6	14
Eggplant	Ground	1.0	6	7
Garlic	Ground, Chemigation	2.0	2.25	14
	Aerial	1.0	4.5	7
Melons[4]	Ground, Aerial	1.0	6	7
	Chemigation	1.0	6	14
Onion (dry bulb)	Ground, Chemigation	2.0	2.25	14
	Aerial	1.0	4.5	7
Non-bearing fruit[5]	Ground	2.0	4	ND
	Aerial	1.0	8	ND
Pepper	Ground, Aerial, Chemigation	1.0	6	7
Potato	Ground, Aerial, Chemigation	1.0	8	5
Pumpkin	Ground, Aerial	1.0	6	7
	Chemigation	1.0	6	14
Squash	Ground, Aerial	1.0	6	7
	Chemigation	1.0	6	14
Tomato	Ground and Aerial	1.0	8	5
	Chemigation	2.0	4	7

ND = not defined

[1] Foliar application includes ground, aerial, and chemigation.

[2] Uses assessed based on spreadsheet from BEAD dated June 10, 2008, confirmed by email from SRRD dated June 30, 2008.

[3] If one season of celery is assumed per year, then 6 applications are modeled per year with an interval of 5 days. If three seasons of celery are assumed per year, then 18 applications are modeled per year with an interval of 5 days between within-season applications and between the last application in one season and the first application in the following season.

[4] Melons include cantaloupe, honeydew, and watermelon.

[5] Non-bearing fruit includes apple, cherry, citrus, peach, and pear uses.

Table 11. Oxamyl Uses by Soil[1] Application Assessed for the CRLF.[2]

Use	Maximum Single Application Rate (lbs a.i./A)	Maximum # Applications per Season	Application Interval (days)
Apples (bearing fruit)	NA	NA	NA
Celery [1 season]	1.0	6	21
Celery [3 seasons]	1.0	18	21
Citrus (bearing fruit)	NA	NA	NA
Clover (for seed)	NA	NA	NA
Cotton	NA	NA	NA
Cucumber	4.0	1	NA
Eggplant	NA	NA	NA
Garlic	2.0	2.25	14
Melons[3]	4.0	1	NA
Onion (dry bulb)	2.0	2.25	14
Non-bearing fruit[4]	4.0	1	NA
Pepper	1.0	6	7
Potato	4.0	1	NA
Pumpkin	4.0	1	NA
Squash	4.0	1	NA
Tomato	1.3	3	21

NA = not applicable
[1] Soil applications include injection, incorporation, or in-furrow.
[2] Uses assessed based on a spreadsheet from BEAD dated June 10, 2008 that was confirmed via an email from SRRD dated June 30, 2008.
[3] Melons include cantaloupe, honeydew, and watermelon.
[4] Non-bearing fruit includes apple, cherry, citrus, peach, and pear uses.

3.2. Aquatic Exposure Assessment

3.2.1. Modeling Approach

Aquatic exposures are quantitatively estimated for all of the assessed uses using scenarios that represent high exposure sites. Each of these sites represents a 10 hectare field that drains into a 1-hectare pond that is 2 meters deep and has no outlet. Exposure estimates generated using the standard 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 first-order streams. As a group, there are factors that make these water bodies more or less vulnerable than the standard surrogate pond. Static water bodies that have larger ratios of drainage area to water body volume would be expected to have higher peak EECs than the standard pond. These water bodies will be either shallower or have large drainage areas (or both). Shallow water bodies tend to have limited additional storage capacity, and thus, tend to overflow and carry pesticide in the discharge whereas the standard pond has no discharge. As watershed size increases beyond 10 hectares, at some point, it becomes unlikely that the entire watershed is planted to a single crop, which is all treated with the pesticide. Headwater streams can also have peak concentrations higher than the standard pond, but they tend to persist for only short periods of time and are then carried downstream.

Crop-specific management practices for all of the assessed uses of oxamyl were used for modeling, including application rates, number of applications per year, application intervals, and the first application date for each crop. The date of first application was developed within the constraints of the modeled scenarios based on several sources of information including data provided by BEAD, a summary of individual applications from the CDPR PUR data, and Crop Profiles maintained by the USDA. More detail on the crop profiles and the previous assessments may be found at: http://www.ipmcenters.org/cropprofiles/index.cfm.

3.2.2. Model Inputs

The model input parameters used in PRZM to simulate oxamyl applications are provided in Table 12. These use patterns are those listed in Table 10 and in Table 11 that produce the maximum estimated aquatic exposure for each use. Because oxamyl use is not allowed on fruit-bearing cherries, pears, or peaches, a use pattern for non-bearing fruit was assessed that represents use on non-bearing apples, cherries, citrus, pears, and peaches. Uses on fruit-bearing apples and citrus were assessed separately.

Applications were modeled as applied by aircraft for all uses other than fruit-bearing apples and citrus, eggplant, and garlic for the following reasons. The use patterns for fruit-bearing apples and eggplant do not include aerial application. Estimated exposure for ground applications to fruit-bearing citrus and garlic are higher than that for aerial applications. Furthermore, the application rate labeled for in-furrow applications to garlic is higher than that for other ground applications. Therefore, garlic is the only use for which exposure was estimated assuming direct application to the ground surface [chemical application method (CAM) = 1] rather than assuming application to the foliage (CAM = 2).

Although uses of oxamyl are seasonally limited, whereas model inputs must be annually limited, all uses of oxamyl have only one season per year with the exception of celery. Therefore, for uses other than celery, seasonal use patterns were modeled as annual use patterns. Use on celery was modeled assuming a range of one to three seasons per year in order to assess the potential exposure from different annual cropping practices. However, the PRZM scenario used to model celery (CA row crop RLF) is parameterized for only one crop per year, which adds uncertainty to exposure estimates reflecting three seasons of use per year. Because the second and later seasons of use per year occur in the model on a post-harvest field with no foliar interception, exposure estimates for three seasons of oxamyl use per year are expected to be more conservative than those that would result with a scenario parameterized for three crops per year.

Table 12. PRZM Scenarios and Input Parameters Describing Oxamyl Uses in California.

Uses	**Scenario[1]**	**App. Rate (lbs a.i./A)**	**App. per Year**	**App. Interval (days)**	**Date of Initial App.**	**CAM Input**	**IPSCND Input**	**Application Efficiency/ Spray Drift**
Apple (bearing fruit)	CA fruit STD	2.0	1	N/A	May 1	2	3	0.99/0.01
Celery [1 season][2]	CA row crop RLF	1.0	6	5	Jan 15	2	1	0.95/0.05
Celery [3 seasons][2]			18	5 & 120				
Citrus (bearing fruit)	CA citrus STD	1.0	6	15	Mar 1	2	3	0.99/0.01
Clover	CA alfalfa OP	1.0	2	14	Feb 1	2	1	0.95/0.05
Cotton	CA cotton STD	1.0	3	6	Sep 19	2	1	0.95/0.05
Cucumber, melons, pumpkin, squash	CA melons RLF	1.0	6	7	May 30	2	1	0.95/0.05
Eggplant	CA melons RLF	1.0	6	7	May 30	2	1	0.99/0.01
Garlic	CA garlic RLF	2.0	2.25[3]	14	Mar 1	1	1	0.99/0.01
Non-bearing fruit	CA fruit STD	1.0	8	7	Mar 1	2	3	0.95/0.05
Onion	CA onion STD	1.0	4.5[3]	7	Feb 1	2	1	0.95/0.05
Pepper	CA row crop RLF	1.0	6	7	Feb 15	2	1	0.95/0.05
Potato	CA potato RLF	1.0	8	5	Mar 1	2	1	0.95/0.05
Tomato	CA tomato STD	1.0	8	5	Apr 15	2	1	0.95/0.05

[1] All modeled scenarios were parameterized for irrigation.
[2] If one season of celery is assumed per year, then 6 applications are modeled per year with an interval of 5 days. If three seasons of celery are assumed per year, then 18 applications are modeled per year with an interval of 5 days between within-season applications and an interval of 120 days between the last application in one season and the first application in the following season.
[3] Fractions of applications per year indicate that a final application was modeled at that fraction of the maximum application rate.

The general chemical and environmental fate data for oxamyl listed in Table 3 were used for generating model input parameters for PRZM and EXAMS (listed in Table 13). These inputs were determined in accordance with the Division's "Guidance for Chemistry and Management Practice Input Parameters for Use in Modeling the Environmental Fate and Transport of Pesticides" dated February 28, 2002. This guidance indicates that the hydrolysis rate at pH 7 (half-life of 8.0 days for oxamyl) should be modeled, which was done for risk estimation. However, oxamyl is relatively stable to hydrolysis in acidic water bodies. Therefore, stability to hydrolysis was also modeled in order to characterize potential exposure in acidic water bodies. Input/output files for PRZM/EXAMS modeling used to support risk estimation are available in Appendix C.

Table 13. PRZM and EXAMS Chemical Input Parameters for Oxamyl.

Input Parameter	Value	Comment	Source (MRID)
Molecular Mass (g/mol)	219	Product chemistry data	40499702
Vapor Pressure (torr)	3.8×10^{-7}	Product chemistry data	42526101
Solubility in Water (mg/L)	2.8×10^{5}	Product chemistry data	40499702
Organic Carbon Partition Coefficient (K_{OC}) (L/kg_{OC})	35	Represents the average K_{OC}.	46237301
Aerobic Soil Metabolism Half-life (days)	52	Represents the upper 90% confidence bound on the mean of six half-lives.	ACC.# 63012 42820001 45176602
Aerobic Aquatic Metabolism Half-life (days)	6.6	Represents the upper 90% confidence bound on the mean of two half-lives adjusted for hydrolysis at pH 7.	45045305
Anaerobic Aquatic Metabolism Half-life (days)	0	No data; assumed stable. Aqueous dissipation will be dominated by hydrolysis.	Not applicable
Hydrolysis Half-life (days)	8.0	Half-life at pH 7	40606516
Aqueous Photolysis Half-life (days)	14	Represents the maximum environmental phototransformation half-life.	40606515; 41058801

3.2.3. Results

The aquatic 1-in-10-year EECs for the various scenarios and application practices are listed in Table 14**.** The use pattern resulting in the highest potential aquatic exposure is use on celery, assuming multiple seasons occur per year. If use on celery is limited to one season per year, the use patterns of maximum aquatic exposure are garlic and celery, followed closely by tomato. The 1-in-10-year exposure estimates from all use patterns range across approximately one order of magnitude. Variability between these EECs is mainly due to variations in modeled application rates, dates of application, meteorological conditions, and soil conditions. Because California has a Mediterranean climate and receives less precipitation in the summer than in other seasons, use patterns modeled with initial application dates in May produced the lowest exposure estimates.

If oxamyl is applied adjacent to acidic water bodies, where it is expected to be relatively stable to hydrolysis, peak exposure estimates slightly increase and time-averaged exposure estimates increase by two- to three-fold. For example, 1-in-10-year peak, 21-day mean, and 60-day mean EECs increase to 53 ppb, 41 ppb, and 24 ppb, respectively, for use on celery with three seasons per year and assuming stability to hydrolysis. Respective EECs for one season of celery per year and assuming stability to hydrolysis are 37 ppb, 26 ppb, and 19 ppb.

Table 14. Aquatic 1-in-10-year EECs (µg/L) for Oxamyl Uses in California.

Uses	Scenario	Seasonal App. Rate (lbs a.i./A)	Date of Initial App.	Peak EEC	21-day average EEC	60-day average EEC
Celery (3 seasons/yr)	CA row crop RLF	18	15-Jan	45	18	9.0
Celery (1 season/yr)	CA row crop RLF	6	15-Jan	31	13	6.8
Garlic	CA garlic RLF	4.5	1-Mar	34	13	5.6
Tomato	CA tomato STD	8	15-Apr	28	8.1	4.4
Non-bearing fruit	CA fruit STD	8	1-Mar	21	8.2	4.6
Cotton	CA cotton STD	3	19-Sep	19	7.2	3.1
Pepper	CA row crop RLF	6	15-Feb	18	7.5	4.5
Citrus (bearing fruit)	CA citrus STD	6	1-Mar	12	3.4	1.2
Clover	CA alfalfa OP	2	1-Feb	7.8	3.7	1.7
Onion	CA onion STD	4.5	1-Feb	7.6	4.2	2.1
Potato	CA potato RLF	8	1-Mar	7.3	4.8	3.3
Cucumber, melons, pumpkin, squash	CA melons RLF	6	30-May	6.7	1.9	1.2
Eggplant	CA melons RLF	6	30-May	3.3	1	0.52
Apple (bearing fruit)	CA fruit STD	2	1-May	3.2	1.2	0.51

3.2.4. Existing Monitoring Data

A critical step in the process of characterizing EECs is comparing the modeled estimates with available surface water monitoring data. Included in this assessment are available data on oxamyl and its degradates from monitoring conducted in California, as reported in the U. S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) program (http://water.usgs.gov/nawqa) and in the California Department of Pesticide Regulation (CDPR) Surface Water Database (http://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm). CDPR does not provide ground water monitoring data for oxamyl or its degradates because they are not currently listed on the Ground Water Protection List (http://www.cdpr.ca.gov/docs/emon/grndwtr/). The only analysis of a degradate of oxamyl in these data was an analysis of the oxime degradate of oxamyl in ground water conducted for the NAWQA program.

3.2.4.1. USGS NAWQA Surface Water Data

NAWQA data indicate that 33 surface water sites in California were monitored for oxamyl at various times from March 1993 to September 2005. Degradates of oxamyl were not analyzed for. Oxamyl was detected once at 0.025 µg/L in Orestimba Creek in

Stanislaus Country in April, 2002. All other results are reported as less than the limit of quantitation (LOQ = 0.012-0.4 μg/L). Oxamyl was not detected in the ephemeral Orestimba Creek two weeks before or after the detection in April, 2002 (U.S. Geological Survey 2007).

3.2.4.2. USGS NAWQA Ground Water Data

NAWQA data indicate that oxamyl was analyzed in ground water at 318 sites in California at various times from August 1993 to September 2006. Oxamyl was not detected in ground water above the level of quantitation (0.012-0.54 μg/L) at any site. The oxime degradate of oxamyl was analyzed in ground water once in April 2001, yielding no detection (LOQ=0.064 μg/L).

3.2.4.3. California Department of Pesticide Regulation (CDPR) Surface Water Database

The CDPR Surface Water Database indicates that oxamyl was analyzed at 183 surface water sites in California at various times from February 1991 to October 2006. Degradates of oxamyl were not analyzed for. Oxamyl was detected at 11 of those sites at concentrations ranging from less than the level of quantitation (0.1-0.5 μg/L) to 2.8 μg/L. Detections occurred in the San Jose River and its tributaries (Stanislaus and Merced counties) in April of 1991, 1992, and 2002 and in the Pajaro River and its tributaries (Santa Cruz and Monterey counties) on December 13, 1994. The highest detection of 2.8 μg/L occurred in a drainage ditch connected to the Pajaro River. Sites with detections were often reanalyzed for oxamyl within a few weeks to a few months, resulting in no detections, which suggests that the presence of oxamyl likely correlates with upslope usage and that residues dissipate in flowing water bodies.

The NAWQA and CDPR monitoring data are not targeted to observe peak runoff from local uses of oxamyl. Therefore, the highest monitored detections of the compound are expected to reflect time-averaged concentrations, such as 21-day mean concentrations, rather than peak concentrations in the environment. Also, monitored surface water sites are generally located in flowing water bodies; whereas modeled exposure estimates are based on a static water body adjacent to the use site where dilution and flow do not occur. Therefore, the highest monitored concentrations are not expected to often exceed modeled time-average exposure estimates.

The highest detection of oxamyl (2.8 μg/L) in the NAWQA and CDPR monitoring data is consistent with or within an order of magnitude of 1-in-10-year 21-day mean EECs (1-18 μg/L) of oxamyl for uses on individual crops.

3.3. Terrestrial Animal Exposure Assessment

T-REX (Version 1.3.1) is used to calculate dietary and dose-based EECs of oxamyl for the CRLF and its potential prey (*e.g.* small mammals and terrestrial insects) inhabiting terrestrial areas. EECs used to represent the CRLF are also used to represent exposure values for frogs serving as potential prey of CRLF adults. T-REX simulates a 1-year time period. For this assessment, foliar spray applications of oxamyl are considered using T-REX. Applications directly to the soil are not modeled using T-REX.

Terrestrial EECs for foliar formulations of oxamyl were derived for the uses summarized in Table 15. Given that no suitable data on interception and subsequent dissipation from foliar surfaces is available for oxamyl, the EFED default foliar dissipation half-life of 35 days is used based on the work of Willis and McDowell (1987). Two values specific to oxamyl are available in Willis and McDowell; however, these half-lives represent data collected from dislodgable residues, and are, therefore, not representative of the foliar dissipation half-life. Use-specific input values, including number of applications, application rate and application interval are provided in Table 15. The maximum application rate for each use is modeled in T-REX and upper bound EECs are used for RQ calculations. An example output from T-REX is available in **Appendix D**.

Table 15. Input Parameters for Foliar Applications Used to Derive Terrestrial EECs for oxamyl with T-REX.

Use (Application Method)	Application Rate (lbs a.i./A)	Number of Applications	Application Interval (days)
Apple (bearing fruit) (ground)	2.0	1	NA
Celery (ground) [1season]	1.0	6	5
Celery (ground) [3 seasons]	1.0	18	5
Citrus (bearing fruit) (ground)	1.0	6	5*
Clover (for seed) (ground)	1.0	2	14
Cotton (ground)	1.0	3	6
Cucumber (ground)	1.0	6	7
Eggplant (ground)	1.0	6	7
Garlic (ground)	2.0	2.25	14
Melons (ground)	1.0	6	7
Onion (ground)	2.0	2.25	14
Non-bearing (ground)	2.0	4	5*
Pepper (ground)	1.0	6	7
Potato (ground)	1.0	8	5
Pumpkin (ground)	1.0	6	7
Squash (ground)	1.0	6	7
Tomato (chemigation)	2.0	4	7

NA = not applicable
*because application interval is undefined on product labels, a 5 day interval value is assumed for modeling purposes based on the lowest interval value listed for any use

For modeling purposes, exposures of the CRLF, as well as other frog species serving as prey to the CRLF, to oxamyl 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 are assessed using the small mammal (15 g) which consumes short grass. Upper-bound Kenega nomogram values reported by T-REX for these two organism types are used for derivation of EECs for the CRLF and its potential prey (Table 16).

As indicated above, T-REX is also used to calculate EECs for terrestrial insects exposed to oxamyl. Dietary-based EECs calculated by T-REX for small and large insects (units of µg a.i./g) are used to bound an estimate of exposure to terrestrial insects. Available acute contact toxicity data for bees exposed to oxamyl (in units of µg a.i./bee), are converted to µg a.i./g (of bee) by multiplying by 1 bee/0.128 g. Dietary-based EECs for terrestrial insects are later compared to the adjusted acute contact toxicity data for bees in order to derive RQs. Dietary-based EECs for small and large insects reported by T-REX as well as the resulting adjusted EECs are available in Table 17.

Table 16. Upper-bound Kenega Nomogram EECs for Dietary- and Dose-based Exposures of the CRLF and its Prey to Oxamyl.

Use	**EECs for CRLF**		**EECs for Prey (small mammals)**	
	Dietary-based EEC (ppm)	**Dose-based EEC (mg/kg-bw)**	**Dietary-based EEC (ppm)**	**Dose-based EEC (mg/kg-bw)**
Apple (bearing fruit)	270	308	480	458
Celery (1 season)	641	730	1140	1087
Celery (3 seasons)	1191	1356	2117	2018
Citrus (bearing fruit)	641	730	1140	1087
Clover (for seed)	237	270	421	402
Cotton	361	411	642	612
Cucumber	588	670	1047	998
Eggplant	588	670	1047	998
Garlic	629	717	1119	1274
Melons	588	670	1047	998
Onion	629	717	1119	1274
Non-bearing	936	1066	1665	1587
Pepper	588	670	1047	998
Potato	783	892	1392	1327
Pumpkin	588	670	1047	998
Squash	588	670	1047	998
Tomato	887	1011	1578	1504

Table 17. EECs (ppm) for Indirect Effects to the Terrestrial-Phase CRLF via Effects to Terrestrial Invertebrate Prey Items.

Use	Small Insect EEC	Large Insect EEC
Apple (bearing fruit)	270	30.0
Celery (1 season)	641	71.3
Celery (3 seasons)	1191	132
Citrus (bearing fruit)	641	71.3
Clover (for seed)	237	26.4
Cotton	361	40.2
Cucumber	588	65.4
Eggplant	588	65.4
Garlic	629	70.0
Melons	588	65.4
Onion	629	70.0
Non-bearing fruit	936	104
Pepper	588	65.4
Potato	783	87.1
Pumpkin	588	65.4
Squash	588	65.4
Tomato	887	98.6

3.4. Terrestrial Plant Exposure Assessment

TerrPlant (version 1.2.2) is used to calculate EECs for non-target plants inhabiting dry and semi-aquatic areas. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method A runoff value of 0.05 is utilized based on oxamyl's solubility, which is classified by TerrPlant as >100 mg/L. For aerial and ground application methods, drift is assumed to be 5% and 1%, respectively.

Terrplant was used to model EECs from soil and foliar applications relevant to terrestrial plants. These EECs are calculated in the apple scenario in Table 18. The non-bearing fruit scenario reflects the highest applications rates, and thus the highest EECs, for soil and foliar applications. All foliar applications rates (≤ 2 lbs a.i./acre) are below the exposure level at which no effects were observed (2.1 lbs a.i./acre) in the available tier 1 study; however, soil application rates at 4 lbs a.i./acre are above this exposure level. Thus, modeling for soil applications generated EECs with the potential to adversely affect terrestrial plants. Due to oxamyl's solubility, all pesticide concentrations were considered in runoff where highest exposure was expected to occur. An example output from TerrPlant v.1.2.2 is available in **Appendix E.**

Table 18. TerrPlant Inputs and Resulting EECs for Plants Inhabiting Dry and Semi-aquatic Areas Exposed to Oxamyl via Runoff and Drift.

Use	Application rate (lbs a.i./A)	Application method	Drift Value (%)	Spray drift EEC (lbs a.i./A)	Dry area EEC (lbs a.i./A)	Semi-aquatic area EEC (lbs a.i./A)
Non-bearing fruit	4.0	Soil – incorporation, injection, infurrow	0	0	0.2	2.0
	2.0	Foliar - ground	0.01	0.02	0.12	1.02
	1.0	Foliar – aerial	0.05	0.01	0.06	0.51

4. Effects Assessment

This assessment evaluates the potential for oxamyl to directly or indirectly affect the CRLF or modify its designated critical habitat. As discussed in Section 2.7, assessment endpoints for the CRLF effects determination include direct toxic effects on the survival, reproduction, and growth of CRLF, as well as indirect effects, such as reduction of the prey base or modification of its habitat. In addition, potential modification of critical habitat is assessed by evaluating effects to the PCEs, which are components of the critical habitat areas that provide essential life cycle needs of the CRLF. Direct effects to the aquatic-phase of the CRLF are based on toxicity information for freshwater fish, while terrestrial-phase effects are based on avian toxicity data, given that birds are generally used as a surrogate for terrestrial-phase amphibians. Because the frog's prey items and habitat requirements are dependent on the availability of freshwater fish and invertebrates, small mammals, terrestrial invertebrates, and aquatic and terrestrial plants, toxicity information for these taxa are 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 oxamyl.

As described in the Agency's Overview Document (U.S. EPA, 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include aquatic-phase amphibians, freshwater fish, freshwater invertebrates, aquatic plants, birds (surrogate for terrestrial-phase amphibians), mammals, terrestrial invertebrates, and terrestrial plants.

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). 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, effects data in the open literature that are more conservative than the registrant-submitted data are considered. The degree to which open literature data are quantitatively or qualitatively characterized for the effects determination is dependent on whether the information is relevant to the assessment endpoints (*i.e.*, maintenance of CRLF survival, reproduction, and growth) identified in Section 2.8. For example, endpoints such as behavior modifications are likely to be qualitatively evaluated, because quantitative relationships between modifications and reduction in species survival, reproduction, and/or growth are not available. Although the effects determination relies on endpoints that are relevant to the assessment endpoints of survival, growth, or reproduction, it is important to note that the full suite of sublethal endpoints potentially available in the effects literature (regardless of their significance to the assessment endpoints) are considered to define the action area for oxamyl.

Toxicity data for oxamyl available in the ECOTOX database on 7/31/2008 were considered for this assessment. Citations of all open literature not considered as part of this assessment because they were either rejected by the ECOTOX screen or accepted by ECOTOX but not used (*e.g.*, the endpoint is less sensitive) are included in Appendix F. Appendix F also includes a rationale for rejection of those studies that did not pass the ECOTOX screen and those that were not evaluated as part of this endangered species risk assessment. A detailed spreadsheet of the available accepted ECOTOX open literature data, including the full suite of lethal and sublethal endpoints is presented in Appendix G. Appendix H includes a summary of the human health effects data for oxamyl.

In addition to registrant-submitted and open literature toxicity information, other sources of information, including use of the acute probit dose response relationship to establish the probability of an individual effect and reviews of the Ecological Incident Information System (EIIS), are conducted to further refine the characterization of potential ecological effects associated with exposure to oxamyl. A summary of the available incident information for oxamyl is provided below.

It should be noted that where data were provided in study reports, sublethal effects observed during acute toxicity studies are described in this effects characterization. These sublethal effects raise concern about the effects of oxamyl; however, it is not possible to quantitatively link these effects to the selected assessment endpoints for the listed CRLF (*i.e.*, survival, growth, and reproduction of individuals and maintenance of critical habitat PCEs). Therefore, potential sublethal effects on specific taxa are evaluated qualitatively. Definitive endpoints, such as LC_{50}s are used for quantifying RQs in this assessment.

4.1. Toxicity of Oxamyl to Aquatic Organisms

Table 19 summarizes the most sensitive aquatic toxicity endpoints for the CRLF, based on an evaluation of the submitted studies as previously discussed. Open literature data for aquatic organisms was not considered relevant to this ecological risk assessment because none of the toxicity endpoints were more sensitive that those from submitted studies. Toxicity to aquatic fish and invertebrates is categorized using the system shown in (Table 20). Toxicity categories for aquatic plants have not been defined.

Table 19. Freshwater Toxicity Profile for Oxamyl.

Assessment Endpoint	**Species**	**Toxicity Value Used in Risk Assessment**	**Citation MRID #**	**Comment**
Acute Direct Toxicity to Aquatic-Phase CRLF	*Oncorhynchus mykiss* (Rainbow Trout)	96-hr LC_{50} = 4.2 mg a.i./L Slope = NA	400980-01	Supplemental – per EFED policy (USEPA 2006); some deviations from guideline requirements
Chronic Direct Toxicity to Aquatic-Phase CRLF	*Oncorhynchus mykiss*	NOAEC = 0.77 mg a.i./L LOAEC = 1.5 mg a.i./L Slope = NA	409011-01	Acceptable – NOEC is based on embryo hatching and larval swim-up
Indirect Toxicity to Aquatic-Phase CRLF via Acute Toxicity to Freshwater Invertebrates (*i.e.* prey items)	*Chironomus plumosus* (midge)	48-hr EC_{50} = 0.18 mg a.i./L Slope = NA	400980-01	Acceptable – NOAEC endpoint based on egg production and egg fertility
Indirect Toxicity to Aquatic-Phase CRLF via Chronic Toxicity to Freshwater Invertebrates (*i.e.* prey items)	*Chironomus plumosus* (midge)	NOAEC = 0.012 mg a.i./L Slope = NA	N/A	Based on an acute to chronic ratio using daphnid (*Daphnia magna*) endpoints [4.2/0.027 = 15.5 (ACR)]
Indirect Toxicity to Aquatic-Phase CRLF via Toxicity to Non-vascular Aquatic Plants	*Navicula pelliculosa* (algae)	120-hourEC_{50}= 0.12 mg a.i./L Slope = 0.872 (±) 0.168	455461-04	Acceptable – NOEC and EC_{50} values are based on cell density.
Indirect Toxicity to Aquatic-Phase CRLF via Toxicity to Vascular Aquatic Plants	*Lemna gibba* (duckweed)	14-day EC_{50}= 30 mg a.i./L Slope = 4.56 (±) 0.441	455461-03	Supplemental – due to lack of constant exposure of test organisms to the test material

Table 20. Categories of Acute Toxicity for Aquatic Organisms.

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

4.1.1. Toxicity to Freshwater Fish

Given that oxamyl toxicity data are not available for aquatic-phase amphibians, freshwater fish data are used as a surrogate to estimate direct acute and chronic risks to the CRLF. Freshwater fish toxicity data are also used to assess potential indirect effects of oxamyl to the CRLF. Effects to freshwater fish resulting from exposure to oxamyl could indirectly affect the CRLF via reduction in available food. As discussed in Section 2.5.3, over 50% of the prey mass of the CRLF may consist of vertebrates such as mice, frogs, and fish (Hayes and Tennant, 1985).

Oxamyl is moderately toxic to freshwater fish on an acute exposure basis. The most sensitive freshwater species tested is rainbow trout, with a 96-hour LC_{50} value of 4.2 mg a.i./L (MRID: 400980-01). Two acute studies available for bluegill sunfish (*Lepomis macrochirus*) and rainbow trout (*Salmo gairderii*) reported 96-hour LC_{50} values of 5.6 mg a.i./L (MRID: 66914) and 4.2 mg a.i./L (MRID: 66916), respectively.

Chronic toxicity data are available for the fathead minnow and the rainbow trout exposed to oxamyl. The chronic exposure involving the fathead minnow resulted in effects observed at all test concentrations and a LOAEC <1.0 mg/L (effects to larval survival were observed) (MRID: 94663). The chronic exposure involving the rainbow trout resulted in a discrete NOAEC of 0.77 mg/L and a LOAEC of 1.5 mg/L, with effects to embryo hatch and larval swim-up observed at the LOAEC (MRID 409011-01). The toxicity data from the rainbow trout study is used to represent the chronic toxicity endpoint for the aquatic-phase CRLF because both the NOAEC and the LOAEC are discrete values. By using the rainbow trout study, however, chronic risk is potentially underestimated due to lack of a NOAEC in the fathead minnow study.

4.1.2. Toxicity to Freshwater Invertebrates

Freshwater aquatic invertebrate toxicity data are used to assess potential indirect effects of oxamyl to the CRLF. Effects to freshwater invertebrates resulting from exposure to oxamyl could indirectly affect the CRLF via reduction in available food items. As discussed in Section 2.5.3, the main food source for juvenile aquatic- and terrestrial-phase CRLFs is thought to be aquatic invertebrates found along the shoreline and on the water surface, including aquatic sowbugs, larval alderflies and water striders.

Oxamyl is highly toxic (defined as: LC_{50} >0.1-1 mg a.i./L) to freshwater invertebrates on an acute exposure basis. The most sensitive species tested *is Chironomus plumosus* (midge), with a 48-hour EC_{50} value of 0.18 mg a.i./L (MRID: 400980-01). Acute toxicity data are also available for *Daphnia magna* (daphnid). Two studies on oxamyl exposure to daphnids resulted in a 48-hour LC_{50} of 0.42 mg a.i./L (MRID: 400980-01) and 5.7 mg a.i./L (MRID: 94664).

The most sensitive chronic toxicity data available indicated a NOAEC of 0.027 mg a.i./L and a LOAEC of 0.050 mg a.i./L based on effects to growth and reproduction *of Daphnia magna* (MRID: 450678-01). The 48-hour LC_{50} (0.42 mg a.i./L) from the study on daphnids is higher than the lowest acute exposure level tested in the aforementioned study on midges (MRID: 400980-01). Therefore, the chronic endpoint used in this assessment was derived using the acute-to-chronic ratio (ACR) for daphnids applied to the more sensitive acute midge endpoint (0.18 mg a.i./L). The calculated NOAEC value for midge is 0.012 mg a.i./L based on the daphnid-derived ACR of 15.5.

4.1.3. Toxicity to Aquatic Plants

Aquatic plant toxicity studies were used as one of the measures of effect to evaluate whether oxamyl could affect primary production and the availability of aquatic plants as food for CRLF tadpoles. Primary productivity is essential for indirectly supporting the growth and abundance of the CRLF.

A submitted study on algae indicated oxamyl has an EC_{50} of 120-hour EC_{50} value of for decreased cell density (MRID: 455461-04). A submitted study on aquatic vascular plants (duckweed, *Lemna gibba*) reported a 14-day EC_{50} value of 30 mg a.i./L based on decreased frond count (MRID: 455461-03).

4.2. Toxicity of Oxamyl to Terrestrial Organisms

Table 21 summarizes the most sensitive terrestrial toxicity endpoints for the CRLF, based on an evaluation of submitted studies. No additional toxicity data for terrestrial organisms exposed to oxamyl were identified in the open literature. Acute toxicity to terrestrial animals is categorized using the classification system shown in Table 22 (U.S. EPA, 2004). Toxicity categories for terrestrial plants have not been defined.

Table 21. Terrestrial Toxicity Profile for Oxamyl.

Endpoint	Species	Toxicity Value Used in Risk Assessment	Citation MRID#	Comment
Acute Direct Toxicity to Terrestrial-Phase CRLF (LD_{50})	*Anas platyrhynchos* (Mallard Duck)	LD_{50} = 3.16 mg/kg-bw Slope = NA	94660	Acceptable
Acute Direct Toxicity to Terrestrial-Phase CRLF (LC_{50})	*(Colinus virginianus)* (Northern Bobwhite Quail)	LC_{50} = 340 mg/kg-diet Slope = NA	406065-11	Acceptable – NOAEC < 39 mg/kg-diet based on signs of toxicity and reduction in body weight gain and feed consumption
Chronic Direct Toxicity to Terrestrial-Phase CRLF	*Anas platyrhynchos* (Mallard Duck)	NOAEC = 10 mg/kg-diet Slope = NA	00116609	Acceptable – NOAEC endpoint based on egg production and egg fertility
Indirect Toxicity to Terrestrial-Phase CRLF (via acute toxicity to mammalian prey items)	*Rattus norvegicus* (laboratory rat)	Male LD_{50} = 3.1 mg/kg-bw Female LD_{50} = 2.5 mg/kg-bw	63011	Acceptable -Slope for male LD_{50}=9.3 ± 4.6 -Slope for female LD_{50}=18.0 ± 8.6
Indirect Toxicity to Terrestrial-Phase CRLF (via chronic toxicity to mammalian prey items)	*Rattus norvegicus* (laboratory rat)	NOAEC = 25 mg/kg-diet Slope = NA	416608-01	Acceptable – Decreased body weight and live pups/litter during lactation observed at LOAEC (75 mg/kg-diet)
Indirect Toxicity to Terrestrial-Phase CRLF (via acute toxicity to terrestrial invertebrate prey items)	*Apis mellifera* (Honey bee)	LD_{50} = 0.31 µg/bee Slope = NA	05001991	Acceptable
Indirect Toxicity to Terrestrial- and Aquatic-Phase CRLF (via toxicity to terrestrial plants)	Seedling Emergence Monocots	21-day EC_{25} >2.1 lbs a.i./A Slope = NA	455461-01	Acceptable –Tier I Terrestrial Plant Seedling Emergence toxicity study
	Seedling Emergence Dicots	21-day EC_{25} >2.1 lbs a.i./A Slope = NA	455461-01	Acceptable –Tier I Terrestrial Plant Seedling Emergence toxicity study
	Vegetative Vigor Monocots	21-day EC_{25} >2.1 lbs a.i./A Slope = NA	455461-02	Supplemental—per EFED policy (USEPA 2006); insufficient numbers of plants per treatment group
	Vegetative Vigor Dicots	21-day EC_{25} >2.1 lbs a.i./A Slope = NA	455461-02	Supplemental—per EFED policy (USEPA 2006); insufficient numbers of plants per treatment group

Table 22. Categories of Acute Toxicity for Avian and Mammalian Studies.

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

4.2.1. Toxicity to Birds

As specified in the Overview Document, the Agency uses birds as a surrogate for terrestrial-phase amphibians when amphibian toxicity data are not available for this taxa (U.S. EPA, 2004). No terrestrial-phase amphibian data are available for oxamyl; therefore, acute and chronic avian toxicity data are used to assess the potential direct effects of oxamyl to terrestrial-phase CRLFs.

Oxamyl is considered very highly toxic to birds on an acute oral exposure basis and highly toxic to birds on a dietary exposure basis (Table 22). The oral acute LD_{50} value for mallard duck (*Anas platyrhynchos*), the most sensitive species tested, is 3.16 mg/kg-bw (MRID: 94660).

Sublethal effects were noted in the acute oral exposure studies on mallard ducks (MRID: 94660) and bobwhite quail (MRID: 406065-11). Clinical observations of oxamyl-treated mallard ducks reported the following effects: loss of coordination at 1.00 and 3.16 mg/kg-diet; ruffled feathers at 1.00 mg/kg-diet; weakness and slow movement at 3.16 mg/kg-diet; discharge from eyes and nose at 3.16 and 10.0 mg/kg-diet; and apparent leg paralysis at 3.16, 10.0, 31.6, and 100 mg/kg-diet. Reported signs of overt toxicity in bobwhite quail occurred at test concentrations of 78 ppm and higher, and included lethargy, ruffled appearance, depression, wing droop, loss of coordination, reduced reaction to external stimuli, shallow and rapid respiration, lower limb weakness, head tremors, and prostrate posture.

The dietary-based acute LC_{50} value for the bobwhite quail is 340 mg/kg-diet (MRID: 406065-11). In the acute dietary-based study, the NOAEC was < 39 mg/kg-diet, the lowest test concentration, based on signs of toxicity and reduction in body weight gain and feed consumption.

Reproduction toxicity studies are used to assess chronic avian exposure to oxamyl. A study submitted to the Agency involving mallard ducks exposed to oxamyl (MRID: 00116609) reported a NOAEC of 10 mg/kg-diet and a LOAEC of 50 mg/kg-diet. The LOAEC determination was based on effects to egg production and egg fertility.

4.2.2. Toxicity to Mammals

Mammalian toxicity data are used to assess potential indirect effects of oxamyl to the terrestrial-phase CRLF. Effects to small mammals resulting from exposure to oxamyl could indirectly affect the CRLF via reduction in available food. As discussed in Section 2.5.3, over 50% of the prey mass of the CRLF may consist of vertebrates such as mice, frogs, and fish (Hayes and Tennant, 1985).

Available data indicate that oxamyl is very highly toxic to mammals (LD_{50} <10 mg/kg) on an acute oral exposure basis. The most sensitive endpoint based on submitted studies on laboratory rats (*Rattus norvegicus*) is an LD_{50} of 2.5 mg/kg-bw for females and 3.1 mg/kg-bw for males (MRID: 63011). Sublethal effects from acute exposure were also observed, although dosage concentration was not reported: tremors, fasciculations (muscle twitches), exophthalmos (eye bulging), salivation, chromodacryorrhea (bloody tears), stained faces and perineal areas, and slight weight loss.

A two-generation reproduction study on laboratory rats was conducted to determine effects of oxamyl on mammalian reproduction. Reproductive toxicity was observed in both generations as a significantly decreased viability index and significantly decreased body weight and live pups/litter during lactation. The study reported a NOAEC of 25 mg/kg-diet (approximately 1.7 and 2.0 mg/kg/day for males and females, respectively) and a LOAEC of 75 mg/kg-diet (approximately 5.2 and 6.6 mg/kg/day for males and females, respectively) (MRID: 416608-01).

4.2.3. Toxicity to Terrestrial Invertebrates

Terrestrial invertebrate toxicity data are used to assess potential indirect effects of oxamyl to the terrestrial-phase CRLF. Effects to terrestrial invertebrates resulting from exposure to oxamyl could indirectly affect the CRLF via reduction in available food.

Oxamyl is classified as very highly toxic to beneficial insects (LD_{50} = 0.31 µg/bee) on an acute exposure basis.

A 1986 study conducted by Atkins, E.L. and D. Kellum (ECOTOX reference #70351) examined the toxicological and morphogenic effects to honeybee brood from the formulated product, Vydate® L, with a purity of 24% active ingredient oxamyl. Larvae inside of the hive of 1-2, 3-4, and 5-6 days old were exposed to varying levels of oxamyl in their food to determine LD_{50} values for each group. According to the study, oxamyl was generally much more toxic to larvae than to adults, particularly to those of 1-2 days. For larvae of 1-2 days old, LD_{50} values were reported at 0.00013 µg/individual. For larvae 3-4 and 5-6 days old, LD_{50} values were reported at 0.026 µg/individual and 0.057 µg/individual, respectively. The study resulted in an overall LD_{50} value of 0.367 µg/individual for all larvae tested. It should be noted, however, that there are several limitations associated with this study. First, no raw mortality data were provided to allow the reviewer to recalculate the reported LD_{50} values. Second, the formulation Vydate® L was used instead of the technical product. Third, dosage number and dosage levels were not reported directly.

4.2.4. Toxicity to Terrestrial Plants

Terrestrial plant toxicity data are used to evaluate the potential for oxamyl to affect riparian zone and upland vegetation within the action area for the CRLF. Impacts to riparian and upland (*i.e.*, grassland, woodland) vegetation could result in indirect effects to both aquatic- and terrestrial-phase CRLFs, as well as modification to designated critical habitat PCEs via increased sedimentation, alteration in water quality, and reduction of upland and riparian habitat that provides shelter, foraging, predator avoidance and dispersal for juvenile and adult CRLFs.

In tests involving exposures of oxamyl to terrestrial plants, effects were only observed in dicots. In a Tier I seedling emergence study (MRID: 455461-01) involving 4 monocot species and 6 dicot species, significant effects were observed in tomatoes (significant effects to height) and percent inhibition ranged from -14.3% to 11.5% compared to the control; however no effect was ≥25% relative to the control. In a Tier 1 vegetative vigor study (MRID: 455461-02) involving 4 monocot species and 6 dicot species, significant effects to height and weight were observed in soybeans with a percent inhibition of -13.1%; however, no effect was ≥25% relative to the control. This study was classified as supplemental due to insufficient numbers of plants per treatment group.

4.3. Incident Database Review

A search of the EIIS (Environmental Incident Information System) database for ecological incidents (run on December 2, 2008) identified 3 incidents involving exposures of oxamyl.

The first incident involved the death of hundreds of fish and over 100 birds in Alamance County, North Carolina, in May of 1991. Fish kills were observed in several ponds (≥1 Acre in size) near farms following high runoff events. Several pesticides (See Table 23) had recently been used in the area, and motor oil ran into the ponds. More than 100 ducks, 1 turkey, 5 cardinals and 7 blackbirds were observed dead. The certainty that the deaths of the animals were associated with exposure to oxamyl was considered probable but the legality of use was indicated as “intentional misuse” (Incident # I000799-003).

Table 23. Pesticides and their associated certainty classification associated with incident #I000799-003.

Pesticide	Use Site	Legality of Use	Certainty that incident was associated with pesticide exposure*
2,4-D	Home/lawn	Undetermined	Probable
Carbaryl	Shrubbery	Undetermined	Possible
Diazinon	Residential turf	Undetermined	Possible
Dicamba	NR	Undetermined	Unlikely
Mecoprop	NR	Undetermined	Unlikely
Oxamyl	NR	Intentional misuse**	Probable
Pentachlorophenol	NR	Undetermined	Possible

* Incidents included in EIIS are defined by a certainty index associated with the likelihood that the pesticide application described resulted in the observed incident. The certainty index defines incidents as unrelated, unlikely, possible, probable and highly probable.
**Corn was laced with oxamyl as bait for ducks.
NR = not reported

The second incident, with a certainty index of 'possible' and legality of use indicated as undetermined, involved the death of a red-cockaded woodpecker in Sussex County, Virginia, in February of 2003. The immediate cause of death was identified as head trauma. Tissue analysis identified the presence of oxamyl in the liver and gastrointestinal track at 7.3 and 1.2 ppm, respectively. Brain acetylcholine esterase levels were depressed (83% of normal) (Incident #I014344-001).

The third incident involved the deaths of 13 laughing gulls and 1 cattle egret in the British Virgin Islands in 2004. The cause of mortality was defined as "toxicosis caused by both methomyl and oxamyl." The certainty that the deaths of the birds were associated with exposure to either pesticide was considered possible and the legality of use was indicated as undetermined (Incident #I018980-010).

One source of uncertainty associated with this database is the nature of reporting of incidents. Many more incidents may have occurred due to oxamyl exposures but may not have been reported due to various factors, such as a lack of reporting, or a lack of witnessing of effects. Therefore, the lack of an incident report does not necessarily indicate a lack of an incident.

5. Risk Characterization

Risk characterization is the integration of the exposure and effects characterizations. Risk characterization is used to determine the potential for direct and/or indirect effects to the CRLF or for modification to its designated critical habitat from the use of oxamyl in CA. The risk characterization provides an estimation (Section 5.1) and a description (Section 5.2) of the likelihood of adverse effects; articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the likelihood of adverse effects to the CRLF or its designated critical habitat (*i.e.*, "no effect," "likely to adversely affect," or "may affect, but not likely to adversely affect"). The risk characterization describes some of the uncertainties associated with this endangered species assessment (Section 5.3). The risk characterization is concluded by revisiting the risk hypotheses (Section 5.4) defined in the problem formulation.

5.1. Risk Estimation

Risk is estimated by calculating the ratio of exposure to toxicity. This ratio is the risk quotient (RQ), which is then compared to pre-established acute and chronic levels of concern (LOCs) for each category evaluated (**Appendix B**). RQs representing acute and chronic exposures to the CLRF, its prey and its habitat are defined below. 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 terrestrial-phase CRLF and mammals, the LOC is 0.1. The LOC for chronic exposures to CRLF and its prey, as well as acute exposures to plants is 1.0.

5.1.1. Exposures in the Aquatic Habitat

5.1.1.1. Direct Effects to Aquatic-Phase CRLF

Direct acute effects to the aquatic-phase CRLF are based on peak 1-in-10-year EECs in the standard pond and the lowest acute toxicity value for freshwater fish. In order to assess direct chronic risks to the CRLF, 1-in-10-year 60-day-mean EECs and the lowest chronic toxicity value for freshwater fish are used. These EECs are divided by acute and chronic toxicity data for the rainbow trout (Table 19), a surrogate species for the aquatic-phase CRLF.

RQs are derived based on the highest aquatic EEC, which corresponds to 3 seasons of oxamyl applications to celery per year (Table 14). The resulting RQs representing acute and chronic exposures to the aquatic-phase CRLF (both 0.01; Table 24) are less than the acute and chronic LOCs (0.05 and 1.0, respectively). All other EECs would result in lower RQs. Therefore, all uses of oxamyl relevant to California result in RQ values that are below LOCs for acute and chronic exposures of the aquatic-phase CRLF to oxamyl.

Table 24. Summary of Direct Effect RQs for the Aquatic-phase CRLF.

Exposure	1-in-10-year EEC (µg/L)[a]	Toxicity Value (µg/L)[b]	RQ
Acute	45 (Peak)	LC_{50} = 4,200	0.01
Chronic	9 (60-d mean)	NOAEC = 770	0.01

[a] The highest 1-in-10-year EECs based on 3 applications per year of oxamyl to celery, (Table 14).
[b] Based on data for the rainbow trout, a surrogate species for the aquatic-phase CRLF.

5.1.1.2. Indirect Effects to Aquatic-Phase CRLF via Reduction in Prey

Non-vascular Aquatic Plants

Indirect effects of oxamyl to the aquatic-phase CRLF (tadpole stage) via reduction in non-vascular aquatic plants in its diet are based on 1-in-10-year peak EECs from the standard pond and the lowest toxicity value (EC_{50}) for aquatic non-vascular plants. **The highest RQ for non-vascular aquatic plants is 0.38,** calculated by dividing the highest peak EEC (45 µg/L; Table 14) by the lowest toxicity value for non-vascular aquatic plants (120 µg/L; Table 19). RQs generated for all other uses of oxamyl are <0.38. Therefore, RQs representing exposures of non-vascular aquatic plants to oxamyl applied at maximum label rates to all uses relevant to California are less than the LOC for aquatic plants (1.0).

Aquatic Invertebrates

Indirect acute effects to the aquatic-phase CRLF via effects to aquatic invertebrates (prey of juvenile and adult aquatic-phase CRLF) are based on 1-in-10-year peak EECs in the standard pond and the lowest acute toxicity value for freshwater invertebrates. For chronic risks, 1-in-10-year 21-day-mean EECs and the lowest chronic toxicity value for invertebrates are used to derive RQs.

RQ values representing acute oxamyl exposures to aquatic invertebrates indicate that the majority of oxamyl uses result in RQs (Table 25) that are sufficient to exceed the listed species LOC (0.05). Celery, modeled with three seasons, has the highest acute RQ with a value of 0.25.

RQ values representing chronic oxamyl exposures to aquatic invertebrates indicate that two uses of oxamyl (specifically celery and garlic) result in RQs (Table 25) that are sufficient to exceed the listed species LOC (1.0). The highest RQ for chronic exposures of aquatic invertebrates to oxamyl is 1.5, calculated by dividing the highest 1-in-10 year 21-day mean (18 µg/L; Table 14) by the lowest chronic toxicity value for aquatic invertebrates (12 µg/L; Table 19).

Table 25. Acute and Chronic RQs for aquatic invertebrates exposed to oxamyl.

Use	1-in-10-year Peak EEC (µg/L)	Indirect Effects Acute RQ[1]	Individual Chance of Effects[3]	1-in-10-year 21-day-mean (µg/L)	Indirect Effects Chronic RQ[4]
Celery (3 seasons)	45	**0.25**[2]	0.34%	18	**1.5**[5]
Celery (1 season)	31	**0.17**[2]	0.03%	13	**1.1**[5]
Garlic	34	**0.19**[2]	0.06%	13	**1.1**[5]
Tomato	28	**0.16**[2]	0.02%	8.1	0.7
Non-bearing fruit	21	**0.12**[2]	<0.01%	8.2	0.7
Pepper	18	**0.10**[2]	<0.01%	7.5	0.6
Cotton	19	**0.11**[2]	<0.01%	7.2	0.6
Citrus (bearing fruit)	12	**0.07**[2]	<0.01%	3.4	0.3
Potato	7.3	0.04	<0.01%	4.8	0.4
Clover	7.8	0.04	<0.01%	3.7	0.3
Onion	7.6	0.04	<0.01%	4.2	0.4
Cucumber, melons, pumpkin, squash	6.7	0.04	<0.01%	1.9	0.2
Apple (bearing fruit)	3.2	0.02	<0.01%	1.2	0.1
Eggplant	3.3	0.02	<0.01%	1.0	0.1

[1] Acute RQ = use-specific 1-in-10-year peak EEC / acute freshwater invertebrate endpoint (EC_{50} = 180 µg/L).
[2]Exceeds listed species LOC for acute exposures (0.05).
[3]Calculated using default slope = 4.5.
[4] Chronic RQ = use-specific 1-in-10-year 21-day-mean EEC / chronic freshwater ACR endpoint (NOAEC = 12 µg/L).
[5]Exceeds listed species LOC for chronic exposures (1.0).

Fish and Frogs

Fish and frogs also represent potential prey items of adult aquatic-phase CRLFs. RQs associated with acute and chronic direct toxicity to the CRLF are used to assess potential indirect effects to the CRLF based on a reduction in freshwater fish and frogs as food items. Acute and chronic RQs (≤0.01) are less than the acute and chronic LOCs for fish and frogs representing potential prey of CRLF (0.05 and 1.0, respectively).

5.1.1.3. Indirect Effects to CRLF via Reduction in Habitat and/or Primary Productivity (Freshwater Aquatic Plants)

Indirect effects to the aquatic-phase CRLF via reduction in habitat resulting from oxamyl exposures are based on 1-in-10-year peak EECs from the standard pond and the lowest toxicity value (EC_{50}) for aquatic non-vascular and vascular plants. Because there are no obligate relationships between the CRLF and any aquatic plant species, the most sensitive EC_{50} values, rather than NOAEC values, are used to derive RQs

The highest RQ for non-vascular aquatic plants is 0.38, calculated by dividing the highest peak EEC (45 µg/L; Table 14) by the lowest toxicity value for non-vascular aquatic plants (120 µg/L; Table 19). Non-vascular plant RQs generated for all other uses of oxamyl relevant to California are <0.38. Therefore, RQs for representing exposures of non-vascular aquatic plants to oxamyl applied to all labeled uses relevant to California are less than the LOC for aquatic plants (1.0).

The highest RQ for vascular aquatic plants is <0.01, calculated by dividing the highest peak EEC (45 µg/L; Table 14) by the lowest toxicity value for vascular aquatic plants (30,000 µg/L; Table 19). Vascular plant RQs generated for all other uses of oxamyl are <0.01. Therefore, RQs for representing exposures of vascular aquatic plants to oxamyl applied to all labeled uses relevant to California are less than the LOC for aquatic plants (1.0).

5.1.2. Exposures in the Terrestrial Habitat

5.1.2.1. Direct Effects to Terrestrial-phase CRLF

As discussed in Section 3.3, potential direct effects to terrestrial-phase CRLFs are based on foliar (ground, aerial, chemigation) applications of oxamyl. Only foliar applications are modeled, because T-REX is not appropriate for modeling soil applications with incorporation.

Potential direct acute effects to the terrestrial-phase CRLF are derived by considering dose- and dietary-based EECs modeled in T-REX for a small bird (20 g) consuming small invertebrates (Table 16) and acute oral and subacute dietary toxicity endpoints for avian species (Table 21). Available exposure and effects data for birds exposed to oxamyl are used as surrogates for the terrestrial-phase CRLF. Resulting acute dietary- and dose-based RQs for all assessed uses of oxamyl exceed the Agency's acute endangered species LOC of 0.1 for the CRLF (Table 26).

Potential direct chronic effects of oxamyl to the terrestrial-phase CRLF are derived by considering dietary-based exposures modeled in T-REX for a small bird (20g) consuming small invertebrates (Table 16). Chronic effects are estimated using the lowest available toxicity data for birds. EECs are divided by toxicity values to estimate chronic dietary-based RQs. The chronic dietary-based RQs for the terrestrial-phase CRLF exceed the Agency's chronic LOC of 1.0 (Table 26) for all assessed uses of oxamyl.

Table 26. RQs for the terrestrial-phase CRLF based on acute and chronic exposures from foliar applications of oxamyl at maximum use rates. These RQs were generated using T-REX.

Use	Dosed-based Acute RQ	Dietary-based Acute RQ	Dietary-based Chronic RQ
Apple (bearing fruit)	**187**	**0.79**	**27**
Celery (1 season)	**445**	**1.9**	**64**
Celery (3 seasons)	**827**	**3.5**	**119**
Citrus (bearing fruit)	**445**	**1.9**	**64**
Clover (for seed)	**164**	**0.70**	**24**
Cotton	**250**	**1.1**	**36**
Cucumber	**408**	**1.7**	**59**
Eggplant	**408**	**1.7**	**59**
Garlic	**437**	**1.9**	**63**
Melons	**408**	**1.7**	**59**
Onion	**437**	**1.9**	**63**
Non-bearing fruit	**650**	**2.8**	**94**
Pepper	**408**	**1.7**	**59**
Potato	**643**	**2.3**	**78**
Pumpkin	**408**	**1.7**	**59**
Squash	**408**	**1.7**	**59**
Tomato	**616**	**2.6**	**89**

5.1.2.2. Indirect Effects to Terrestrial-Phase CRLF via Reduction in Prey

<u>Terrestrial Invertebrates</u>

In order to assess the risks of oxamyl exposures to terrestrial invertebrates, which are prey of CRLF in terrestrial habitats, the honey bee is used to represent terrestrial invertebrates. The toxicity value for terrestrial invertebrates is based on the weight of an adult honey bee and is calculated by multiplying the lowest available acute contact LD_{50} of 0.31 µg a.i./bee by 1 bee/0.128g, which equals 2.4 ppm (µg a.i./g) of bee. EECs (µg a.i./g of bee) calculated by T-REX for small and large insects (Table 17) are divided by the toxicity value for terrestrial invertebrates to generate RQs for terrestrial invertebrates. For all uses of oxamyl, RQ values exceed the LOC (0.05) for acute exposures to terrestrial invertebrates by several orders of magnitude (Table 27).

Table 27. RQs for acute exposures to small and large terrestrial insects from foliar applications of oxamyl at maximum use rates.

Use	Small Insect RQ	Large Insect RQ
Apple (bearing fruit)	**113**	**13**
Celery (1 season)	**267**	**30**
Celery (3 seasons)	**496**	**55**
Citrus (bearing fruit)	**267**	**30**
Clover (for seed)	**98.7**	**11**
Cotton	**150**	**9.6**
Cucumber	**245**	**27**
Eggplant	**245**	**27**
Garlic	**262**	**29**
Melons	**245**	**27**
Onion	**262**	**29**
Non-bearing fruit	**390**	**43**
Pepper	**245**	**27**
Potato	**326**	**36**
Pumpkin	**245**	**27**
Squash	**245**	**27**
Tomato	**369**	**41**

Mammals

In order to assess the risks of oxamyl exposures to small mammals, which are prey of CRLF in terrestrial habitats, dietary-based and dose-based exposures are modeled in T-REX for a small mammal (15g) consuming short grass (Table 16). Acute and chronic effects are estimated using the most sensitive mammalian toxicity data (Table 21). EECs are divided by the toxicity value to estimate acute and chronic dose-based RQs as well as chronic dietary-based RQs (Table 28). RQs representing acute and chronic exposures of small mammals consuming short grass on the treated field contaminated with oxamyl exceed the LOCs for all uses of oxamyl relevant to California.

Table 28. RQs for acute and chronic exposures of small mammals consuming short grass to oxamyl from foliar applications at maximum use rates.

Use	Chronic RQ		Acute RQ
	Dose-based[1]	Dietary-based [2]	Dose-based[3]
Apple (bearing fruit)	**167**	**19**	**83**
Celery (1 season)	**395**	**46**	**197**
Celery (3 seasons)	**735**	**85**	**367**
Citrus (bearing fruit)	**395**	**46**	**197**
Clover (for seed)	**146**	**17**	**73**
Cotton	**222**	**26**	**111**
Cucumber	**363**	**42**	**181**
Eggplant	**363**	**42**	**181**
Garlic	**388**	**45**	**194**
Melons	**363**	**42**	**181**
Onion	**388**	**45**	**194**
Non-bearing fruit	**577**	**67**	**288**
Pepper	**363**	**42**	**181**
Potato	**483**	**56**	**241**
Pumpkin	**363**	**42**	**181**
Squash	**363**	**42**	**181**
Tomato	**547**	**63**	**273**

[1] Based on dose-based EEC and oxamyl rat NOAEL = 1.25 mg/kg-bw.
[2] Based on dietary-based EEC and oxamyl rat NOAEC = 25 mg/kg-diet.
[3] Based on dose-based EEC and oxamyl female rat acute oral LD_{50} = 2.5 mg/kg-bw.

Frogs

An additional prey item of the adult terrestrial-phase CRLF is other species of frogs (*e.g.*, the Pacific tree frog). In order to assess risks to these prey organisms, dietary-based and dose-based exposures modeled in T-REX for a small bird (20g) consuming small invertebrates are used (Table 26). As noted in Section 5.1.2.1, acute and chronic RQs representing exposures from all uses of oxamyl that are relevant to California exceed LOCs.

5.1.2.3. Indirect Effects to CRLF via Reduction in Terrestrial Plant Community (Riparian and Upland Habitat)

Potential indirect effects to the CRLF resulting from effects on riparian and upland vegetation are assessed using RQs from terrestrial plant seedling emergence and vegetative vigor studies. Based on all RQs from soil and foliar applications (represented by the non-bearing fruit scenario) being below the LOC of 1.0 (Table 29), oxamyl will have no effect on the CRLF via reduction in terrestrial plants. Example output from TerrPlant v.1.2.2 is provided in **Appendix E.**

Table 29. RQs for monocots and dicots inhabiting dry and semi-aquatic areas exposed to oxamyl via spray drift and runoff.

Plant type	Application rate (lbs a.i./A)	Application method	Drift Value (%)	Spray drift RQ	Dry area RQ	Semi-aquatic area RQ
Monocot	4.0	Soil – incorporation, infurrow, injection	0	< 0.1	< 0.1	<0.95
	2.0	Foliar – ground	0.05	< 0.1	< 0.1	<0.52
	1.0	Foliar – aerial	0.01	< 0.1	< 0.1	<0.24
Dicot	4.0	Soil – incorporation, infurrow, injection	0	< 0.1	< 0.1	<0.95
	2.0	Foliar – ground	0.05	< 0.1	< 0.1	<0.52
	1.0	Foliar – aerial	0.01	< 0.1	< 0.1	<0.24

5.1.3. Primary Constituent Elements of Designated Critical Habitat

5.1.3.1. Aquatic-Phase (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)

Three 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 terrestrial 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.
- Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae).

RQs used to determine potential effects to these assessment endpoints are provided in Sections 5.1.1.2, 5.1.1.3, and 5.1.2.3. As described in these sections, none of the RQs for aquatic or riparian plants exceed the LOC.

The remaining aquatic-phase PCE is "alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source." To assess the impact of oxamyl on this PCE, acute and chronic freshwater fish and invertebrate toxicity endpoints, as well endpoints for aquatic non-vascular plants, are used as measures of effects. RQs for these endpoints were calculated in Sections 5.1.1.1 and 5.1.1.2. As discussed in these sections, RQs for direct effects to CRLF are below LOCs for acute and chronic exposures. RQs for non-vascular plants, representing dietary items of the tadpole stage of the CRLF are below the LOC. Some RQs for acute exposures of aquatic invertebrates to oxamyl exceed the LOC (Table 25).

5.1.3.2. Terrestrial-Phase (Upland Habitat and Dispersal Habitat)

Two 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 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
- 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

RQs used to determine potential effects to these assessment endpoints are provided in Section 5.1.2.3. These RQs do not exceed the LOC for plants (Table 29).

The third terrestrial-phase PCE is "reduction and/or modification of food sources for terrestrial phase juveniles and adults." To assess the impact of oxamyl on this PCE, acute and chronic toxicity endpoints for frogs, mammals, and terrestrial invertebrates are used as measures of effects. RQs for these endpoints were calculated in Section 5.1.2.2. RQs for these endpoints exceed the LOCs for all uses of oxamyl (Table 26, Table 27 and Table 28).

The fourth terrestrial-phase PCE is based on alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source. Direct acute and chronic RQs for terrestrial-phase CRLFs are presented in Section 5.2.1.2. RQs for these endpoints exceed the LOCs for all uses of oxamyl (Table 26).

5.2. Risk Description

The risk description synthesizes an overall conclusion regarding the likelihood of adverse 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.

If the RQs presented in the Risk Estimation (Section 5.1) show no direct or indirect effects for the CRLF (*i.e.*, there are no LOC exceedances), and no modification to PCEs of the CRLF's designated critical habitat, a "no effect" determination is made, based on oxamyl's use within the action area. However, if direct or indirect effect LOCs are exceeded or effects may modify the PCEs of the CRLF's critical habitat, the Agency concludes a preliminary "may affect" determination for the FIFRA regulatory action regarding oxamyl.

Because some RQs exceeded their respective LOCs, the preliminary effects determination for exposures of oxamyl to the CLRF is "May Affect" based on direct and indirect effects and effects to the CRLF's critical habitat. A summary of the results of the risk estimation results are provided in Table 30 for direct and indirect effects to the CRLF and in Table 31 for the PCEs of designated critical habitat for the CRLF.

Table 30. Risk Estimation Summary for Oxamyl - Direct and Indirect Effects to CRLF.

Assessment Endpoint	**LOC Exceedances (Y/N)**	**Description of Results of Risk Estimation**
Aquatic Phase (eggs, larvae, tadpoles, juveniles, and adults)		
Direct Effects Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases	No	RQs for acute and chronic exposures to fish resulting from all uses of oxamyl are below LOCs.
Indirect Effects Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants)	Yes	RQs are above the LOC for acute and chronic exposures to aquatic invertebrates RQs are below the LOC for exposures to non-vascular aquatic plants, acute and chronic exposures to fish
Indirect Effects Survival, growth, and reproduction of CRLF individuals via effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community)	No	RQs for exposures of non-vascular and vascular aquatic plants are below aquatic plant LOC.
Indirect Effects 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.	No	EECs are below level where no effects to plants were observed in Tier 1 test.
Terrestrial Phase (Juveniles and adults)		
Direct Effects Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	Yes	Acute and chronic RQs for all uses exceed LOCs for the CRLF.
Indirect Effects Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial mammals and terrestrial phase amphibians)	Yes	Acute and chronic RQs for terrestrial invertebrates, small terrestrial mammals, and terrestrial phase amphibians, exceed LOCs for all uses.
Indirect Effects Survival, growth, and reproduction of CRLF individuals via effects on habitat (*i.e.*, riparian vegetation)	No	EECs are below level where no effects to terrestrial plants were observed in Tier 1 test.

Table 31. Risk Estimation Summary for Oxamyl – PCEs of Designated Critical Habitat for the CRLF.

Assessment Endpoint	LOC Exceedances (Y/N)	Description of Results of Risk Estimation
Aquatic Phase PCEs (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)		
Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.	No	RQs for non-vascular and vascular aquatic plants are below aquatic plant LOC. EECs are below level where no effects to terrestrial plants were observed in Tier 1 test.
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.	No	RQs for non-vascular and vascular aquatic plants are below aquatic plant LOC. EECs are below level where no effects to terrestrial plants were observed in Tier 1 test.
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	Yes	RQs for acute and chronic exposures to fish resulting from all uses of oxamyl are below LOCs. Acute RQs for some uses of oxamyl exceed the LOC for aquatic invertebrates. RQs for non-vascular plants are below aquatic plant LOC.
Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)	No	RQs for non-vascular plants are below aquatic plant LOC.
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	EECs are below level where no effects to plants were observed in Tier 1 test.
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal	No	EECs are below level where no effects to plants were observed in Tier 1 test.
Reduction and/or modification of food sources for terrestrial phase juveniles and adults	Yes	Acute and chronic RQs for terrestrial invertebrates, small terrestrial mammals, and terrestrial phase amphibians, exceed the LOCs for all uses.
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	Yes	Avian acute and chronic RQs exceed the LOCs for all uses.

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 (*e.g.*, habitat range, feeding preferences) of the CRLF. 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 and its designated critical habitat.

The criteria used to make determinations that the effects of an action are “not likely to adversely affect” the CRLF and its designated critical habitat include the following:

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

A description of the risk and effects determination for each of the established assessment endpoints for the CRLF and its designated critical habitat is provided in **Sections 5.2.1 through 5.2.4**.

5.2.1. Direct Effects

5.2.1.1. Aquatic-Phase CRLF

The aquatic-phase of the CRLF’s life cycle is relevant to stages that require that CRLF individuals inhabit aquatic areas. Relevant aquatic-phase life stages include eggs and larvae, as well as submerged juveniles and adults, which spend a portion of their time in water bodies that may receive runoff and spray drift containing oxamyl.

For all uses of oxamyl that are relevant to California, acute and chronic exposures to CRLF in the aquatic habitat are insufficient to result in RQs exceeding the LOC. For acute exposures, the probability of individual mortality to an aquatic phase CLRF is 1 in $\geq 8.9 \times 10^{18}$ (assuming default slope of 4.5). While the available fathead minnow chronic toxicity endpoint was not used definitively to measure direct effects to the CRLF, the reported LOAEC value of < 1000 µg a.i./L is a source of uncertainty in making a direct effects determination. However, this LOAEC value would have to be reduced by a factor of 100 to result in an LOC exceedance for chronic effects (1000 / 100 = 10 µg /L). Therefore, the determination for direct effects to the CRLF in aquatic habitats is “No Effect” for all uses of oxamyl that are relevant to California.

5.2.1.2. Terrestrial-Phase CRLF

RQs representing acute dose-based, acute dietary-based and chronic dietary-based exposures to the terrestrial-phase CRLF exceeded their respective LOCs, resulting in a “may affect” determination for all uses of oxamyl (Table 26). These RQs were derived using the T-REX model, which estimates exposures that are specific to food intake equations for birds. RQs generated for birds are used as surrogates to represent RQs for the terrestrial-phase CRLF. The RQs generated by T-REX are based on the maximum application rates and exceeded the LOC of 0.1 by 7 to 6500 times.

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 oxamyl, 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). The dose-based and dietary-based EECs generated by T-HERPS are provided in Table 32 and in Table 33, respectively. An example output from T-HERPS is available in **Appendix I**.

Table 32. Upper-bound Kenega Nomogram T-HERPS EECs (mg/kg-bw) for Dose-based Exposures of the CRLF and its Prey to Oxamyl.

Scenario	CRLF Size (g)	Small Insects	Large Insects	Small Herbivore Mammals[1]	Small Insectivore Mammals[1]	Small Terrestrial-Phase Amphibians
Apple (bearing fruit)	1.4	10.5	1.17	NA	NA	NA
	37	10.3	1.15	299	18.7	0.358
	238	6.76	0.751	46.5	2.91	0.235
Celery [1 season], Citrus (bearing fruit)	1.4	24.9	2.77	NA	NA	NA
	37	24.5	2.72	711	44.4	0.850
	238	16.1	1.78	111	6.91	0.557
Celery [3 seasons]	1.4	46.3	5.14	NA	NA	NA
	37	45.5	5.05	1320	82.5	1.58
	238	29.8	3.31	205	12.8	1.04
Clover	1.4	9.22	1.02	NA	NA	NA
	37	9.06	1.01	263	16.4	2.55
	238	5.94	0.660	40.9	0.315	0.206
Cotton	1.4	14.0	1.56	NA	NA	NA
	37	13.8	1.53	400	25.0	0.479
	238	9.04	1.01	62.2	3.89	0.314
Cucumber, Melons, Pumpkin, Squash, Eggplant, Pepper	1.4	22.9	2.54	NA	NA	NA
	37	22.5	2.50	653	40.8	0.781
	238	14.7	1.64	101	6.31	0.512
Garlic, Onion	1.4	24.5	2.72	NA	NA	NA
	37	24.0	2.67	698	43.6	0.83
	238	15.8	1.75	108	6.78	0.55
Non-bearing fruit	1.4	36.4	4.04	NA	NA	NA
	37	35.8	3.97	1037	64.9	1.24
	238	23.4	2.60	161	10.1	0.814
Potato	1.4	27.7	3.07	NA	NA	NA
	37	16.6	1.85	483	30.2	0.577
	238	8.24	0.916	56.7	3.55	0.286
Tomato	1.4	34.5	3.83	NA	NA	NA
	37	33.9	3.77	984	61.5	1.18
	238	22.2	2.47	153	9.56	0.77

[1]weight of small herbivore and insectivore mammals is 35g

Table 33. Upper-bound Kenega Nomogram T-HERPS EECs (mg/kg-diet) for Dietary-based Exposures of the CRLF and its Prey to Oxamyl.

Scenario	Small Insects	Large Insects	Small Herbivore Mammals[1]	Small Insectivore Mammals[1]	Small Terrestrial-Phase Amphibians
Apple (bearing fruit)	270	30.0	316	19.8	9.37
Celery [1 season], Citrus (bearing fruit)	641	71.3	751	47.0	22.3
Celery [3 seasons]	1191	132	1395	87.2	41.3
Clover	237	26.4	278	17.4	8.24
Cotton	361	40.1	423	26.5	12.5
Cucumber, Melons, Pumpkin, Squash, Eggplant, Pepper	589	65.4	690	43.1	20.4
Eggplant, Pepper	589	65.4	690	43.1	20.4
Garlic, Onion	630	70.0	738	46.1	21.9
Non-bearing fruit	937	104	1097	68.6	32.5
Potato	785	87.1	918	57.4	27.2
Tomato	888	98.6	1040	65	30.8

[1]weights of small herbivore and insectivore mammals are 35g

Acute RQs

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.

Refined dose-based RQs for small sized (1.4g) CRLF consuming small and large insects exceed the acute listed species LOC (0.1) for all uses of oxamyl (Table 34), with larger exceedances for CRLF consuming small insects. RQs range from 0.39 to 42, suggesting that small CRLF consuming small and large insects are potentially affected by acute exposures to oxamyl.

Table 34. Dose-based RQs for 1.4g CRLF consuming different food items (calculated using T-HERPS).

Scenario	Small Insects	Large Insects
Apple (bearing fruit)	**9.5**	**1.1**
Celery [1 season], Citrus (bearing fruit)	**9.4**	**1.1**
Celery [3 seasons]	**42**	**4.7**
Clover	**3.5**	**0.39**
Cotton	**5.3**	**0.59**
Cucumber, Melons, Pumpkin, Squash, Eggplant, Pepper	**8.7**	**0.96**
Garlic, Onion	**22**	**2.5**
Non-bearing fruit	**33**	**3.7**
Potato	**28**	**3.1**
Tomato	**31**	**3.5**

Refined dose-based RQs for medium sized (37g) CRLF consuming small insects, large insects, small herbivore mammals, small insectivore mammals, and small terrestrial-phase amphibians exceed the acute listed species LOC (0.1) for all uses of oxamyl (Table 35). LOC exceedances for all uses of oxamyl relevant to California indicate that the medium sized CRLF could potentially be affected by acute exposures to oxamyl.

Table 35. Refined Dose-based RQs for 37g CRLF consuming different food items (calculated using T-HERPS).

Scenario	Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial-Phase Amphibians
Apple (bearing fruit)	**5.7**	**0.64**	**166**	**10**	**0.20**
Celery [1 season], Citrus (bearing fruit)	**14**	**1.5**	**395**	**25**	**0.47**
Celery [3 seasons]	**25**	**2.8**	**733**	**46**	**0.88**
Clover	**5.0**	**0.56**	**146**	**9.1**	**0.18**
Cotton	**7.7**	**0.85**	**222**	**14**	**0.27**
Cucumber, Melons, Pumpkin, Squash, Eggplant, Pepper	**13**	**1.4**	**362**	**23**	**0.43**
Garlic, Onion	**13.**	**1.5**	**388**	**24**	**0.46**
Non-bearing fruit	**20**	**2.2**	**58**	**36**	**0.69**
Potato	**17**	**1.9**	**483**	**30**	**0.58**
Tomato	**19**	**2.1**	**547**	**34**	**0.65**

Refined dose-based RQs for large sized (238g) CRLF consuming small insects, large insects, small herbivore mammals, small insectivore mammals, and small terrestrial-phase amphibians all exceed the acute listed species LOC (0.1) for all uses of oxamyl, except for clover (Table 36). Only for the application rate specified for clover, the scenario of CRLF (238g) consuming small terrestrial-phased amphibians did not exceed the LOC (0.087). Due to exceedances for almost all uses, acute exposures to oxamyl have the potential to adversely affect the medium sized CRLF.

Table 36. Refined Dose-based RQs for 238g CRLF consuming different food items (calculated using T-HERPS).

Scenario	Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial-Phase Amphibians
Apple (bearing fruit)	**2.8**	**0.32**	**20**	**1.2**	**0.10**
Celery [1 season], Citrus (bearing fruit)	**6.8**	**0.75**	**47**	**2.9**	**0.23**
Celery [3 seasons]	**13**	**1.4**	**86**	**5.4**	**0.43**
Clover	**2.5**	**0.28**	**17**	**1.1**	0.09
Cotton	**3.8**	**0.42**	**26**	**1.6**	**0.13**
Cucumber, Melons, Pumpkin, Squash, Eggplant, Pepper	**6.2**	**0.69**	**43**	**2.7**	**0.22**
Garlic, Onion	**6.6**	**0.74**	**46**	**2.9**	**0.23**
Non-bearing fruit	**9.9**	**1.1**	**68**	**4.2**	**0.34**
Potato	**8.2**	**0.92**	**57**	**3.6**	**0.29**
Tomato	**9.3**	**1.0**	**64**	**4.0**	**0.32**

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 small herbivorous mammals meet or exceed the acute listed species LOC (0.1) for all uses of oxamyl (Table 37**).** For CLRF consuming large insects in the apple (bearing) and clover scenario, and for CRLF consuming small insectivore mammals in the scenarios of apple (bearing fruit), celery [1 season], citrus, clover, cotton, cucumber, melons, pumpkin, squash, eggplant, or pepper, RQs do not exceed the listed species acute dietary-based LOC.

While the CRLF consuming small terrestrial-amphibians may only be affected by acute dietary-based exposures from oxamyl uses on apple, cherry, citrus, peach, and pear, the range of RQs from the other food items indicates that CRLF consuming small and large insects, and small herbivore and insectivore mammals could potentially be affected by acute dietary-based exposures to oxamyl at maximum application rates.

Table 37. Refined Acute Dietary-based RQs for CRLF consuming different food items (calculated using T-HERPS).

Scenario	**Small Insects**	**Large Insects**	**Small Herbivore Mammals**	**Small Insectivore Mammals**	**Small Terrestrial-Phase Amphibians**
Apple (bearing fruit)	**0.79**	0.09	**0.93**	0.06	0.03
Celery [1 season], Citrus (bearing fruit)	**1.9**	**0.21**	**2.2**	**0.14**	0.07
Celery [3 seasons]	**3.5**	**0.39**	**4.1**	**0.26**	**0.12**
Clover	**0.70**	0.08	**0.82**	0.05	0.02
Cotton	**1.1**	**0.12**	**1.3**	0.08	0.04
Cucumber, Melons, Pumpkin, Squash, Eggplant, Pepper	**1.7**	**0.19**	**2.0**	**0.13**	0.06
Garlic, Onion	**1.9**	**0.21**	**2.1**	**0.14**	0.06
Non-bearing fruit	**2.8**	**0.31**	**3.2**	**0.20**	**0.10**
Potato	**2.3**	**0.26**	**2.7**	**0.17**	0.08
Tomato	**2.6**	**0.29**	**3.1**	**0.19**	0.09

Based on an analysis of the likelihood of individual mortality considering the range of refined acute dose-based RQs for terrestrial-phase CRLFs (Table 34 - Table 36) and a probit dose-response of 4.5 (slope), the chance of mortality for RQs which meet or exceed the LOC (0.1) range from 1 in 294,000 individuals to 1 in 1 individual. Considering alternate probit dose-responses of 9 and 2, the chance of mortality for RQs which exceed the LOC range from 1 in 8 $E^{+}18$ to 1 in 1 individual, and 1 in 44 to 1 in 1 individual, respectively (**Figure 7**). This range of RQs is relevant to all sizes of CRLF consuming small and large insects, small herbivore and insectivore mammals, and small terrestrial-phase amphibians. This range is not relevant to large CRLF consuming small terrestrial-phase amphibians modeled by the clover scenario, for which there was no LOC exceedance.

The graph in Figure 7 shows the chance of individual mortality for the terrestrial-phase CRLF considering three probit dose-responses of 4.5, 9, and 2. These dose-responses converge at an RQ of 1, equivalent to a chance of mortality of 1 in 2 individuals. All small sized CRLFs consuming small insects exceed this RQ of 1, and thus exceed an individual chance of mortality of 50%, as do all medium and large sized CRLF consuming small insects, small herbivore mammals, and small insectivore mammals. For medium and large sized frogs consuming small herbivorous mammals, the chance of individual mortality is approximately 1 in 1 individual for all uses of oxamyl. The range of acute dose-based RQs indicates that most applications at maximum labeled rates pose risks of mortality to the CRLF. In exploring lower applications rates that result in reduced risks to the CRLF and do not cause LOC exceedances, a single application rate of 0.01 lbs a.i./acre was found to be the highest application rate that would not incur acute dosed-based LOC exceedances for any sized frog consuming all food items.

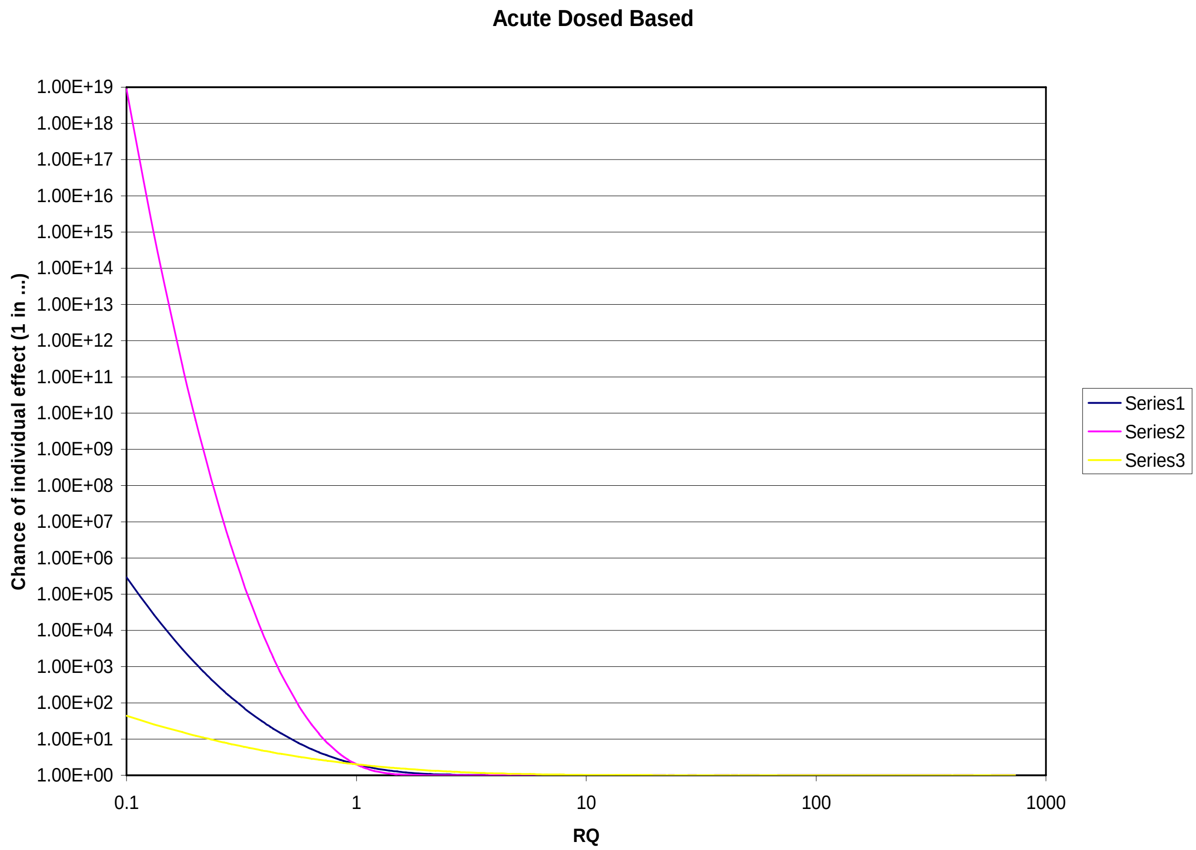


Figure 7. Chance of individual mortality to terrestrial-phase CRLF when considering dose-based RQs.

Considering acute dietary-based RQs for the terrestrial phase CRLF **(**Table 37**)** and a probit dose-response of 4.5 (slope), the chance for mortality of RQs exceeding the LOC (0.1) range from 1 in 294,000 individuals to 1 in 1 individual **(Figure 8)**. A probit dose-response of 9 indicates that the chance for mortality ranges from 1 in 8 $E^{+}18$ individuals to 1 in 1 individual; considering a probit dose-response of 2, the chance for mortality ranges from 1 in 44 individuals to 1 in 1.12 individuals (**Figure 8)**.

The graph in Figure 8 shows the chance of individual mortality for the terrestrial-phase CRLF considering three probit dose-responses of 4.5, 9, and 2. These dose-responses converge at an RQ of 1, equivalent to a chance of mortality of 1 in 2 individuals. For the CRLF consuming small terrestrial-phase amphibians for all uses of oxamyl, all RQs are below the convergence point of an RQ of 1, and thus the chance of individual mortality is less than 50%. In exploring lower applications rates that present reduced risks to the CRLF and do not cause LOC exceedances, a single application rate of 0.21 lbs a.i./acre was found to be the highest application rate that would not cause acute dietary-based LOC exceedances for any exposure based on any food item.

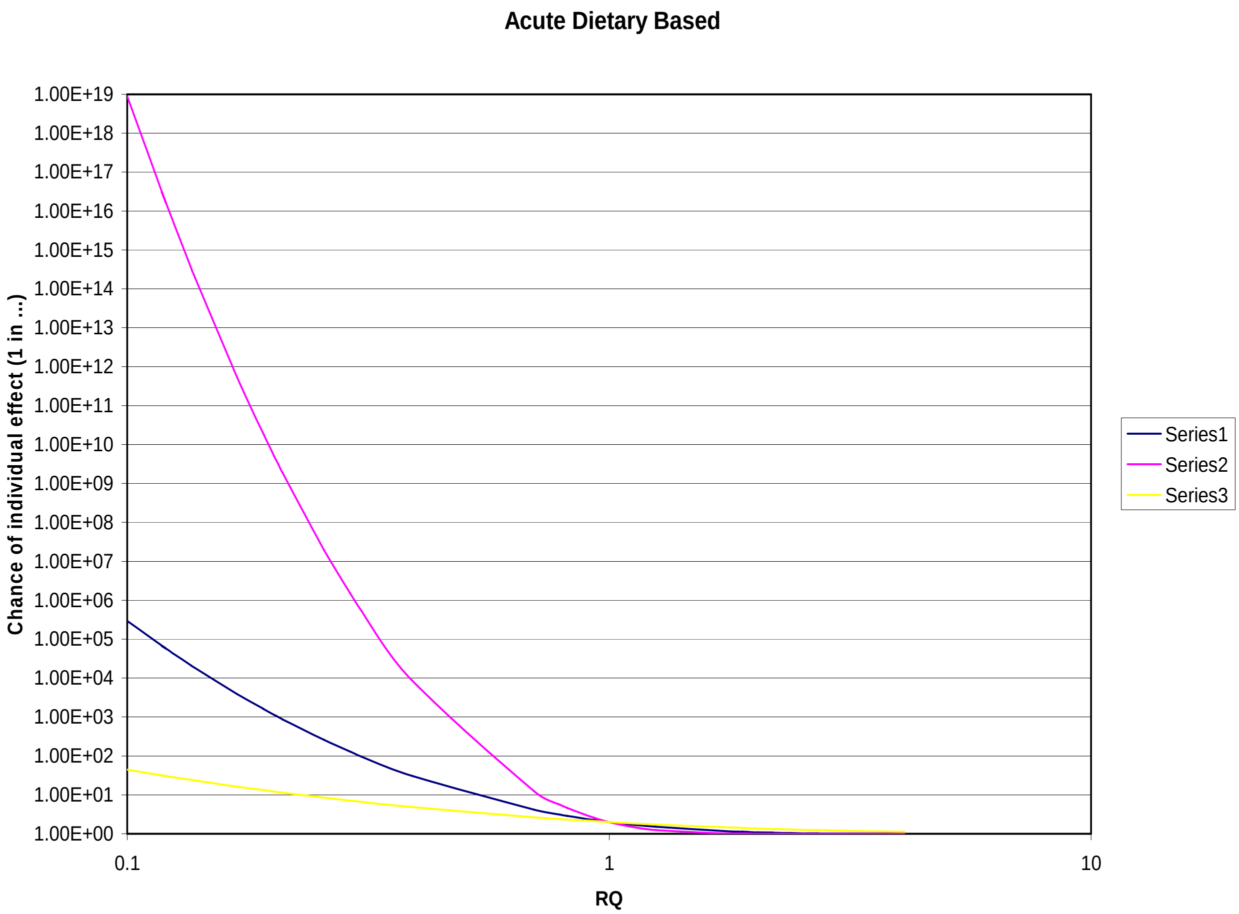


Figure 8. Chance of individual mortality to terrestrial-phase CRLF when considering acute dietary-base RQs.

Sublethal effects are an indicator of direct effects from oxamyl exposure to the terrestrial-phase CRLF. Two oral acute exposure studies on mallard ducks (MRID: 94660) and bobwhite quail (MRID: 406065-11) recorded sublethal effects. Clinical observations of oxamyl-treated mallard ducks reported the following effects: loss of coordination at 1.00 and 3.16 mg/kg-diet; ruffled feathers at 1.00 mg/kg-diet; weakness and slow movement at 3.16 mg/kg-diet; discharge from eyes and nose at 3.16 and 10.0 mg/kg-diet; and apparent leg paralysis at 3.16, 10.0, 31.6, and 100 mg/kg-diet. Reported signs of overt toxicity in bobwhite quail occurred at test concentrations of 78 mg/kg-diet and higher, and included lethargy, ruffled appearance, depression, wing droop, loss of coordination, reduced reaction to external stimuli, shallow and rapid respiration, lower limb weakness, head tremors, and prostrate posture. The dose of 31.6 mg/kg-diet corresponds to the EEC value of 30.0 ppm in T-HERPS, and causes an LOC exceedance with an RQ value of 3.0. This indicates that oxamyl concentrations at which some of these sublethal effects occur at (>30 mg/kg-diet), have the potential to cause effects to survival, growth and reproduction of the CRLF.

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

Chronic RQs

Refined chronic dietary-based RQs for CRLFs consuming insects and mammals using the T-HERPS model exceed the chronic listed species LOC (1.0) for all uses of oxamyl. The chronic listed species LOC is exceeded for CRLF consuming terrestrial-phase amphibians for every use except clover (Table 38**)**.

Table 38. Revised Chronic Dietary-based RQs for CRLF consuming different food items (RQs calculated using T-HERPS).

Scenario	**Small Insects**	**Large Insects**	**Small Herbivore Mammals**	**Small Insectivore Mammals**	**Small Terrestrial-Phase Amphibians**
Apple (bearing fruit)	**27**	**3.0**	**32**	**2.0**	0.94
Celery [1 season], Citrus (bearing fruit)	**64.1**	**7.13**	**75.1**	**4.70**	**2.23**
Celery [3 seasons]	**119**	**13**	**140**	**8.7**	**4.13**
Clover	**23.7**	**2.64**	**27.8**	**1.74**	0.824
Cotton	**36.1**	**4.02**	**42.3**	**2.65**	**1.25**
Cucumber, Melons, Pumpkin, Squash, Eggplant, Pepper	**58.9**	**6.54**	**69.0**	**4.31**	**2.04**
Garlic, Onion	**63.0**	**7.00**	**73.8**	**4.61**	**2.19**
Non-bearing fruit	**93.7**	**10.4**	**110**	**6.86**	**3.25**
Potato	**78.3**	**8.71**	**91.8**	**5.74**	**2.72**
Tomato	**88.8**	**9.86**	**104**	**6.50**	**3.08**

In the available chronic study where Northern bobwhite quail were exposed to oxamyl, the NOAEC was 10 mg/kg-diet, and the LOAEC was 50 mg/kg-diet, based on effects to egg production and egg fertility. Comparison of the LOAEC directly to chronic dietary-based EECs for CRLF consuming small insects and small herbivore mammals indicate that EECs for all uses are sufficient to exceed the concentration where reproductive effects were observed in the laboratory. For CRLF consuming large insects, the majority of the oxamyl uses have EECs which are insufficient to exceed the LOAEC. Therefore, for some CRLF feeding categories, oxamyl EECs are at levels where reproductive effects were observed in birds, which serve as surrogates for the CRLF.

In exploring lower applications rates that present reduced risks to the CRLF and do not cause LOC exceedances, a single application rate of 2.13 lbs a.i./acre was found to be the highest application rate that would not cause chronic dietary-based LOC exceedances for any exposure based on any food item.

Based on this information, the effects determination for chronic effects from all oxamyl uses to the terrestrial-phase CRLF is “LAA” based on potential for effects to reproduction.

5.2.2. Indirect Effects (via Reductions in Prey Base)

5.2.2.1. Algae (non-vascular plants)

As discussed in Section 2.5.3, the diet of CRLF tadpoles is composed primarily of non-vascular aquatic plants (*i.e.*, algae and diatoms) and detritus. For all uses of oxamyl relevant to California, exposures in the aquatic habitat to non-vascular aquatic plants are insufficient to result in RQs exceeding the LOC. Therefore, there is no effect to tadpole-stage CRLFs via effects on aquatic non-vascular plants from exposures resulting from any use of oxamyl.

5.2.2.2. Aquatic Invertebrates

RQ values representing acute exposures to aquatic invertebrates indicate that several uses of oxamyl can potentially result in effects to invertebrates. Therefore, indirect effects are may affect CRLF juveniles and adults, through decreases in prey base. The results of an analysis of the likelihood of individual mortality using acute RQs for aquatic invertebrates and a probit dose-response of 4.5 (based on default) are displayed in Table 39**.** Based on this analysis, all uses of oxamyl result in ≤0.34% chance of effects to an individual aquatic invertebrate. Therefore, although acute oxamyl exposures may affect individual CRLF through indirect effects caused by effects to aquatic invertebrates, the impact of these effects on the CRLF is discountable for all uses. Therefore, effects to aquatic invertebrates resulting from acute exposures are not likely to adversely affect the CRLF.

For the majority of uses of oxamyl relevant to California, chronic exposures in the aquatic habitat to aquatic invertebrates are insufficient to result in RQs exceeding the LOC. Chronic exposures for the uses of garlic and celery resulted in RQs exceeding the LOC. The chronic RQs are based on a derived chronic NOAEC for aquatic invertebrate (0.012 mg a.i./L) from an ACR. If the ACR method was used to derive an adjusted LOAEC for chironomids, that value would be 0.027 mg a.i./L. This adjusted LOAEC is above the chronic EECs for aquatic invertebrates (max EEC = 0.018 mg a.i./L). In addition, EECs are below the available NOAEC value for daphnids (NOAEC=0.027 mg a.i./L and LOAEC=0.050 mg a.i./L, MRID: 450678-01), suggesting that even though sensitive species of aquatic invertebrates may be affected by chronic exposures of oxamyl, less sensitive species, such as daphnids are unlikely to be affected. Given that the CRLF is an opportunistic feeder, the impact of effects to sensitive aquatic invertebrates from chronic exposures on the CRLF is discountable. Therefore, although chronic oxamyl exposures may affect individual CRLF through indirect effects caused by effects to aquatic invertebrates, the impact of these effects on the CRLF is discountable for all uses. Therefore, effects to aquatic invertebrates resulting from chronic exposures are not likely to adversely affect the CRLF.

Table 39. Acute RQs and corresponding likelihood of individual effects and chronic RQs for aquatic invertebrates exposed to oxamyl.

Use	Indirect Effects Acute RQ[1]	Individual Chance of Effects[3]	Indirect Effects Chronic RQ[4]
Celery (3 seasons)	**0.25**[2]	0.34%	**1.5**[5]
Celery (1 season)	**0.17**[2]*****	0.03%	**1.1**[5]
Garlic	**0.19**[2]*****	0.06%	**1.1**[5]
Tomato	**0.16**[2]	0.02%	0.7
Non-bearing fruit	**0.12**[2]	<0.01%	0.7
Pepper	**0.10**[2]	<0.01%	0.6
Cotton	**0.11**[2]	<0.01%	0.6
Citrus (bearing fruit)	**0.07**[2]	<0.01%	0.3
Potato	0.04	<0.01%	0.4
Clover	0.04	<0.01%	0.3
Onion	0.04	<0.01%	0.4
Cucumber, melons, pumpkin, squash	0.04	<0.01%	0.2
Apple (bearing fruit)	0.02	<0.01%	0.1
Eggplant	0.02	<0.01%	0.1

[1] Acute RQ = use-specific 1-in-10-year peak EEC / acute freshwater invertebrate endpoint (EC_{50} = 180 µg/L).
[2]Exceeds listed species LOC for acute exposures (0.05).
[3]Calculated using default slope = 4.5.
[4] Chronic RQ = use-specific 1-in-10-year 21-day-mean EEC / chronic freshwater ACR endpoint (NOAEC = 12 µg/L).
[5] Exceeds listed species LOC for chronic exposures (1.0).

5.2.2.3. Fish and Aquatic-phase Frogs

For all uses of oxamyl acute and chronic exposures in the aquatic habitat to fish and aquatic-phase frogs (serving as prey to adult CRLF) are insufficient to result in RQs exceeding the LOC. Therefore, indirect effects of oxamyl 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 oxamyl. Therefore, there is no effect to aquatic-phase CRLFs via effects on fish and aquatic-phase amphibians from aquatic exposures arising from any use of oxamyl that is relevant to California.

5.2.2.4. Terrestrial Invertebrates

When the terrestrial-phase CRLF reaches juvenile and adult stages, its diet is mainly composed of terrestrial invertebrates. RQs representing acute exposures of terrestrial invertebrates are represented by oxamyl exposures to small and large terrestrial insects located on the treatment field. Resulting RQ values exceed the acute LOC (0.05) by several orders of magnitude, with values ranging 9.57-390 (Table 27).

An analysis of the likelihood of individual mortality indicates that an RQ of 5 or greater results in a >99.9% probability of mortality to an individual terrestrial invertebrate located on a field treated with oxamyl (assuming a default probit dose-response value of 4.5) Table 25**.** Since all RQs for terrestrial invertebrates are >5, the likelihood of individual mortality to a terrestrial invertebrate on a field treated with any use of oxamyl (relevant to California) is >99.9%.

Based on the lowest acute toxicity value for terrestrial invertebrates (LD_{50} = 2.4 ppm), exposure concentrations <0.12 ppm would be below levels of concern for this taxa. For large and small insects, this exposure would be expected at single applications of <0.008 and <0.0009 lbs a.i./A, respectively. These exposure concentrations are well below maximum single application rates allowed on product labels, as well as several orders of magnitude below estimated average single application rates of oxamyl in California, which range 0.43-10 lbs a.i./A (Table 7).

A spray drift exposure analysis (using AgDRIFT) indicates that oxamyl concentrations resulting from a single aerial application of 1 lb a.i./A would be at levels sufficient to exceed the LOC for large and small terrestrial insects at <990 feet from the edge of the treated field (assuming the default ASAE fine to medium droplet size distribution). A likelihood of individual mortality analysis (using IEC v. 1.1) indicates that >10% chance of mortality to individual large insects can occur <120 ft from the edge of the field and >22% chance of mortality to individual small insects can occur <950 feet from the edge of the field (Figure 9).

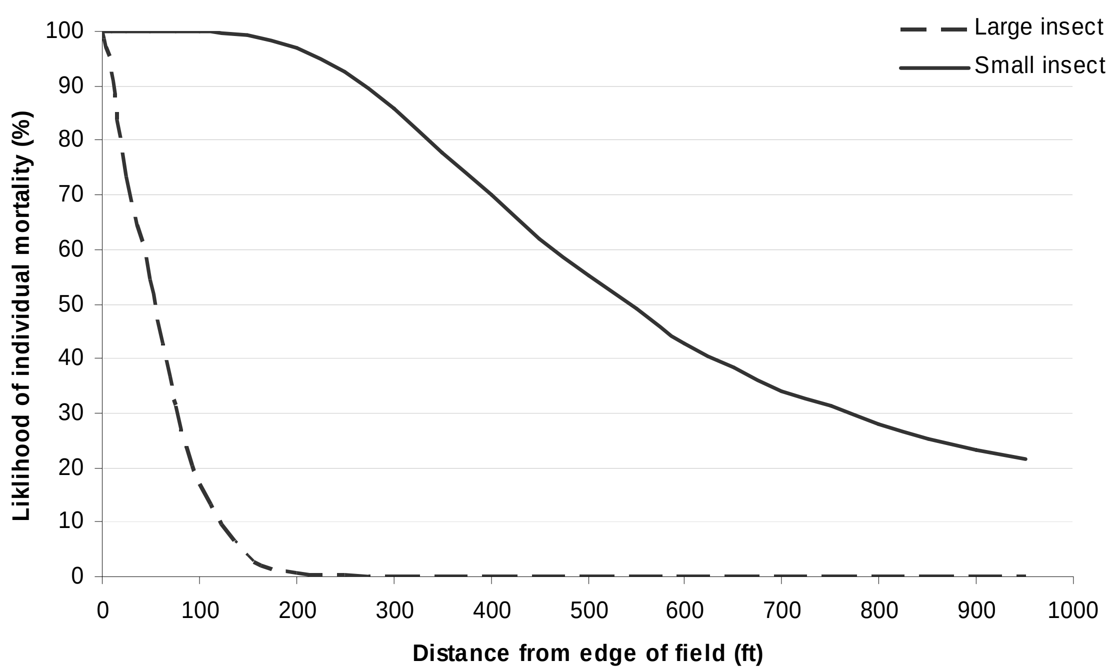


Figure 9. Likelihood of individual mortality to terrestrial invertebrates at different distances from the edge of a field treated with a single aerial application of oxamyl at 1 lb a.i./A.

A spray drift exposure analysis (using AgDRIFT) indicates that oxamyl concentrations resulting from a single ground application of 2 lb a.i./A would be at levels sufficient to exceed the LOC for large and small terrestrial insects at 209 and <990 feet from the edge of the treated field (assuming low boom, ASAE very fine to fine droplet size distribution). A likelihood of individual mortality analysis (using IEC v. 1.1) indicates that >10% chance of mortality to individual large and small insects can occur within approximately 20 ft and 250 feet, respectively, from the edge of the field (Figure 10).

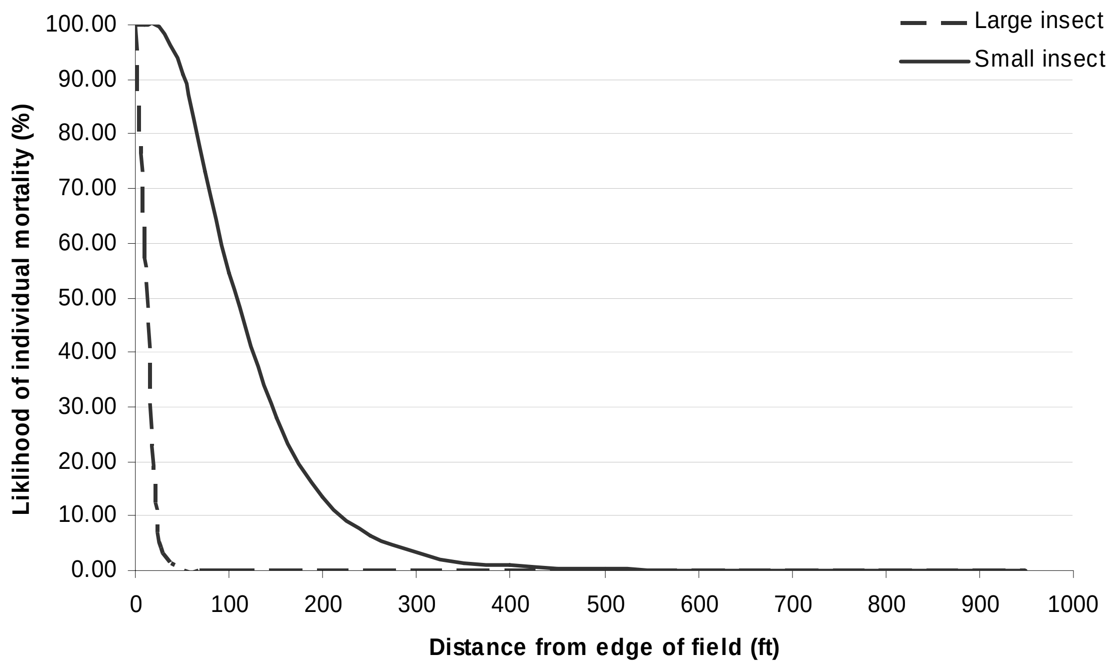


Figure 10. Likelihood of individual mortality to terrestrial invertebrates at different distances from the edge of a field treated with a single ground application of oxamyl at 2 lb a.i./A.

Therefore, it is possible that there will be indirect effects to terrestrial-phase CRLFs via effects on terrestrial insects from oxamyl exposures arising from any use of oxamyl that is relevant to California. The extent of effects is unknown because a range of sensitivities of invertebrates is expected to exist.

5.2.2.5. Mammals

Life history data for terrestrial-phase CRLFs indicate that large adult frogs consume terrestrial mammals, including mice. RQs representing acute and chronic exposures of terrestrial mammals are represented by oxamyl exposures to animals located on the treatment field.

Acute Exposures

Acute dose-based RQ for small mammals consuming short grass exceed the acute LOC (0.1) by several orders of magnitude for all uses of oxamyl, with values ranging 73.2-288 (Table 28). Single applications of 1 or 2 lbs a.i./A of oxamyl result in acute, dose-based RQs which are sufficient to exceed the LOC for small mammals consuming other food items, including tall grass, broadleaf plants, small insects, fruits, pods, large insects and seeds (Table 40).

Table 40. Acute, dose-based RQ values for small mammals (15 g) exposed to oxamyl through consumption of food items on the treated field. RQs correspond to single applications of oxamyl at 1 lb a.i./A and 2 lb a.i./A.

Diet	1 lb a.i./A	2 lb a.i./A
Short Grass	41.64	83.29
Tall Grass	19.09	38.17
Broadleaf plants/small insects	23.43	46.85
Fruits/pods/large insects	2.60	5.21
Seeds	0.58	1.16

An analysis of the likelihood of individual mortality indicates that an RQ of 3 or greater results in a >99.9% probability of mortality to an individual mammal located on a field treated with oxamyl (assuming a probit dose-response value of 9.3 and 18.0, MRID 00063011) Table 25**.** Since all acute, dose-based RQs for small mammals consuming short grass are >3, the likelihood of individual mortality to a terrestrial mammal on a field treated with any use of oxamyl (relevant to California) is >99.9%. In addition, the likelihood of individual mortality to mammals consuming other food items, besides short grass, is also >99.9%, based on RQs>3 (Table 40).

Based on the lowest acute toxicity value for mammals (LD_{50} = 2.5 mg/kg-bw), exposure concentrations <0.0025 lbs a.i./A would be below levels of concern for small mammals. This exposure concentration is below maximum single application rates allowed on product labels, as well as several orders of magnitude below estimated average single application rates of oxamyl in California, which range 0.43-1.34 lb a.i./A (Table 7). A spray drift exposure analysis (using AgDRIFT) indicates that oxamyl concentrations resulting from a single aerial application of 1 lb a.i./A would be at levels sufficient to exceed the LOC for small mammals at >990 feet from the edge of the treated field. Exposure concentrations up to 801 feet from the edge of a field treated by ground methods with 2 lb a.i./A oxamyl would be at levels sufficient to exceed the LOC for small mammals (Table 41).

Table 41. Concentration where LOC is not exceeded for small mammals (15 g) receiving acute, dose-based exposures of oxamyl through consumption of contaminated food items and distance from edge of treatment field where LOC is not exceeded.

Diet	Concentration (lb a.i./A) where acute LOC is not exceeded*	Distance (ft) from edge of field where LOC is not exceeded	
		Single aerial application of 1 lb a.i./A	Single ground application of 2 lb a.i./A
Short Grass	0.0025	>990**	801
Tall Grass	0.0050	>990**	423
Broadleaf plants/small insects	0.0044	>990**	479
Fruits/pods/large insects	0.0400	236	46
Seeds	0.1700	52	13

* Based on the lowest acute toxicity value for mammals (LD_{50} = 2.5 mg/kg-bw) and LOC of 0.1
**The limit of AgDRIFT's predictability is 990 ft from the edge of the treated field.

The T-REX model is useful for assessing exposures of terrestrial animals to pesticides applied to foliar surfaces of crops. The model cannot be used to assess pesticide exposures to terrestrial animals resulting from applications involving soil incorporation. In order to explore the potential exposures of mammals to oxamyl following applications involving ground application, a simple fugacity approach was employed to estimate oxamyl concentrations in earthworms and subsequent exposures to mammals consuming earthworms. This approach is explained in detail in Appendix K. If it is assumed that the small mammal being assessed eats only earthworms on the day of treatment (meaning that there would be no degradation of oxamyl), the acute dose of oxamyl to a 20 g mammal would be 0.024 to 0.078 mg/kg-bw. This range of exposure values is 2 orders of magnitude below the LD_{50} values for rats (2.5-3.1 mg/kg-bw; MRID 00063011) exposed to oxamyl. The likelihood of individual mortality to a small mammal consuming only earthworms from a treated field would be <0.01%.

Chronic Exposures

Dose-based chronic RQ values for small mammals (15 g) consuming short grass exceed the chronic LOC (1.0) by several orders of magnitude, with values ranging 146-577. Dietary-based chronic RQ values also exceed the chronic LOC (1.0) by several orders of magnitude, with values ranging 16.8-66.6 (Table 28). Single applications of 1 or 2 lbs a.i./A of oxamyl result in chronic, dose-based and dietary-based RQs which are sufficient to exceed the LOC for small mammals consuming other food items, including tall grass, broadleaf plants, small insects, fruits, pods, large insects and seeds (Table 42 and Table 43).

Chronic RQ values are derived with available NOAEC data. If chronic, dose-based and dietary-based EECs (Table 16) were compared to the LOAEC and LOAEL values for mammals exposed to oxamyl, the EECs exceed these levels (75 mg/kg-diet) where effects to mammals were observed in the laboratory. Observed effects include decreased body weight during lactation (MRID 416608-01).

Table 42. Chronic, dose-based RQ values for small mammals (15 g) exposed to oxamyl through consumption of food items on the treated field. RQs correspond to single applications of oxamyl at 1 lb a.i./A and 2 lb a.i./A.

Diet	1 lb a.i./A	2 lb a.i./A
Short Grass	83.29	166.58
Tall Grass	38.17	76.35
Broadleaf plants/small insects	46.85	93.70
Fruits/pods/large insects	5.21	10.41
Seeds	1.16	2.31

Table 43. Chronic, dietary-based RQ values for small mammals (15 g) exposed to oxamyl through consumption of food items on the treated field. RQs correspond to single applications of oxamyl at 1 lb a.i./A and 2 lb a.i./A.

Diet	1 lb a.i./A	2 lb a.i./A
Short Grass	9.60	19.20
Tall Grass	4.40	8.80
Broadleaf plants/small insects	5.40	10.80
Fruits/pods/large insects	0.60	1.20
Seeds	0.60	1.20

<u>Summary</u>

Based on this information, there are potential indirect effects to terrestrial-phase CRLFs via effects on small mammals from oxamyl exposures arising from any use of oxamyl that is relevant to California.

5.2.2.6. 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 oxamyl, 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 and large insects, the acute LOC (0.1) is exceeded for all uses of oxamyl (Table 44).

Based on an analysis of the likelihood of individual mortality using acute dose-based RQs for terrestrial phase frogs and a default probit dose-response of 4.5, the likelihood of individual mortality for each use is available in Table 44**.** Based on this analysis all of uses of oxamyl result in >10% chance of effects to an individual terrestrial phase frog consuming small insects. The majority of uses of oxamyl also result in >10% chance of effects to an individual terrestrial phase frog consuming large insects. 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 oxamyl exposures from all uses.

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

Use	Frogs consuming Small Insects		Frogs consuming Large Insects	
	RQ	Likelihood of individual acute effect (%)	RQ	Likelihood of individual acute effect (%)
Apple (bearing fruit)	2.97	98	0.33	2
Celery [1 season], Citrus (bearing fruit)	7.05	~100	0.78	31
Celery [3 seasons]	13.1	~100	1.45	77
Clover	2.61	97	0.29	1
Cotton	3.97	~100	0.44	5
Cucumber, Melons, Pumpkin, Squash, Eggplant, Pepper	6.47	~100	0.72	26
Garlic, Onion	6.92	~100	0.77	30
Non-bearing fruit	10.3	~100	1.14	60
Potato	8.61	~100	0.96	47
Tomato	9.75	~100	1.08	56

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 exceed the acute LOC (0.1) for all oxamyl uses. For frogs which consume large insects, the acute LOC is exceeded for all uses of oxamyl, with the exception of oxamyl use on clover.

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 38). Refined dietary-based RQs indicate that, for all oxamyl uses, there is potential for chronic effects to terrestrial frogs feeding on small and large insects. Chronic RQs are exceeded by factors ranging 2.6X to 94X.

Summary

Based on this information, there are potential indirect effects to terrestrial-phase CRLFs via effects on small terrestrial phase frogs from oxamyl exposures arising from any use of oxamyl that is relevant to California.

5.2.3. Indirect Effects (via Habitat Effects)

5.2.3.1 Aquatic Plants (Vascular and Non-vascular)

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

Potential indirect effects to the CRLF based on impacts to habitat and/or primary production were assessed using RQs from freshwater aquatic vascular and non-vascular plant data. RQs for both aquatic vascular and non-vascular plants are below the LOC, indicating that exposures of oxamyl to aquatic plants will not result in effects to plants. In addition exposures of oxamyl to riparian vegetation are below levels where no effects to terrestrial plants were observed in greenhouse studies. Therefore, the determination for indirect effects to the CRLF caused by effects to aquatic plants resulting from use of oxamyl is “No Effect.”

5.2.3.2. Terrestrial Plants

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

Potential indirect effects to the CRLF based on impacts to habitat and/or primary production were assessed using RQs from monocot and dicot plant data. RQs for both monocots and dicots were below the Agency’s LOC, indicating that exposures of oxamyl to terrestrial plants will not result in effects to plants. While effects to height and weight were observed in dicots in the vegetative vigor and seedling emergence studies, these effects were ≤25% relative to the control. Based on the supplemental nature of the vegetative vigor study, the ≤25% effects relative to the controls, and no RQ exceedances, the determination for indirect effects to the CRLF caused by effects to terrestrial plants resulting from use of oxamyl is “No Effect.”

5.2.4. Modification to Designated Critical Habitat

5.2.4.1. Aquatic-Phase PCEs

Three 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 terrestrial 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.
- Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae).

Based on the risk estimation for potential effects to aquatic and terrestrial plants provided in Sections 5.1.1.2, 5.1.1.3, and 5.1.2.3 (*i.e.*, a lack of LOC exceedances by RQs) o**xamyl is not likely to affect aquatic-phase PCEs of designated habitat related to effects on aquatic and/or terrestrial plants.**

The remaining aquatic-phase PCE is "alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source." Other than impacts to algae as food items for tadpoles (discussed above), this PCE is assessed by considering direct and indirect effects to the aquatic-phase CRLF via acute and chronic freshwater fish and invertebrate toxicity endpoints as measures of effects. RQs for these endpoints were calculated in Sections 5.1.1.1 and 5.1.1.2. As discussed in these sections, RQs for direct effects to CRLF are below LOCs for acute and chronic exposures. RQs for non-vascular plants, representing dietary items of the tadpole stage of the CRLF are below the LOC. Although some RQs for acute exposures of aquatic invertebrates to oxamyl exceed the LOC, these effects are considered discountable. Therefore, **oxamyl may affect, but is not likely to adversely affect aquatic-phase PCEs of designated habitat related to effects of alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.**

5.2.4.2. Terrestrial-Phase PCEs

Two 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 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
- 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

Based on the risk estimation for terrestrial-phase PCEs of designated habitat related to potential effects on terrestrial plants is provided in Section 5.1.2.3, **oxamyl is not likely to affect terrestrial-phase PCEs of designated habitat related to effects on terrestrial plants.**

The third terrestrial-phase PCE is "reduction and/or modification of food sources for terrestrial phase juveniles and adults." To assess the impact of oxamyl on this PCE, acute and chronic toxicity endpoints for birds, mammals, and terrestrial invertebrates are used as measures of effects. RQs for these endpoints were calculated in Section 5.1.2.2. Based on RQ exceedances for acute and chronic exposure to frogs, mammals, and terrestrial invertebrates, **oxamyl is likely to result in habitat modification based on potential impacts to the third terrestrial-phase PCE**.

The fourth terrestrial-phase PC is based on alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source. Direct acute and chronic RQs for terrestrial-phase CRLFs are presented in Section 5.2.1.2. Based on RQ exceedances for acute and chronic exposure to birds, mammals, and terrestrial invertebrates, **oxamyl is likely to result in habitat modification based on potential impacts to the fourth terrestrial-phase PCEs**.

5.3. Uncertainties

5.3.1. Exposure Assessment Uncertainties

From 1994 to 2006 oxamyl was not used on cherries, based on the CDPR PUR data. While the lack of use indicates that oxamyl most likely was not used in the past decade on cherries, it is still a registered crop and has the potential to be used in the future. Thus, risk to CRLF from use on cherries is considered in this assessment.

In contrast, U.S. Department of Agriculture census data confirm that tobacco has not been grown in California from at least the 1992 report, forward (USDA 2008) and it is unlikely that tobacco agriculture will be initiated in California in the future. Therefore, use of oxamyl on tobacco was not quantitatively evaluated for exposure in this assessment.

5.3.1.1. Maximum Use Scenario

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

5.3.1.2. Aquatic Exposure Modeling of Oxamyl

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

The Agency acknowledges that there are some unique aquatic habitats that are not accurately captured by this modeling scenario and modeling results may, therefore, under- or over-estimate exposure, depending on a number of variables. For example, aquatic-phase CRLFs may inhabit water bodies of different size and depth and/or are located adjacent to larger or smaller drainage areas than the EXAMS pond. The Agency does not currently have sufficient information regarding the hydrology of these aquatic habitats to develop a specific alternate scenario for the CRLF. CRLFs prefer habitat with perennial (present year-round) or near-perennial water and do not frequently inhabit vernal (temporary) pools because conditions in these habitats are generally not suitable (Hayes and Jennings 1988). Therefore, the EXAMS pond is assumed to be representative of exposure to aquatic-phase CRLFs. In addition, the Services agree that the existing EXAMS pond represents the best currently available approach for estimating aquatic exposure to pesticides (USFWS/NMFS 2004).

Furthermore, if aquatic-phase CRLFs inhabit acidic water bodies that are exposed to oxamyl, the duration of exposure may be longer than was estimated using the standard aquatic modeling guidance, as oxamyl is relatively stable to hydrolysis at pH 5. In this case, aquatic invertebrates used as prey may be at higher risk to chronic exposure and at slightly higher risk to acute exposure than was assessed. Although this is an uncertainty in the assessment, the increase in risk is relatively small and potential indirect effects to the aquatic-phase CRLF due to effects of oxamyl to aquatic invertebrates are not expected.

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

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

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

In order to account for uncertainties associated with modeling, available monitoring data were compared to PRZM/EXAMS estimates of peak EECs for the different uses. As discussed above, several data values were available from NAWQA for oxamyl 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 oxamyl use areas.

5.3.1.3. Action Area Uncertainties

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

Three-tiered forest < agroforestry < suburban < row-crop agriculture < urban.

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

5.3.1.4. Usage Uncertainties

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

5.3.1.5. Terrestrial Exposure Modeling of Oxamyl

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

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

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

For the terrestrial exposure analysis of this risk assessment, a generic bird or mammal was assumed to occupy either the treated field or adjacent areas receiving a treatment rate on the field. Actual habitat requirements of any particular terrestrial species were not considered, and it was assumed that species occupy, exclusively and permanently, the modeled treatment area. Spray drift model predictions suggest that this assumption leads to an overestimation of exposure to species that do not occupy the treated field exclusively and permanently.

5.3.1.6. Spray Drift Modeling

Although there may be multiple oxamyl applications at a single site, it is unlikely that the same organism would be exposed to the maximum amount of spray drift from every application made. In order for an organism to receive the maximum concentration of oxamyl from multiple applications, each application of oxamyl would have to occur under identical atmospheric conditions (*e.g.*, same wind speed and – for plants – same wind direction) and (if it is an animal) the animal being exposed would have to be present directly downwind at the same distance after each application. Although there may be sites where the dominant wind direction is fairly consistent (at least during the relatively quiescent conditions that are most favorable for aerial spray applications), it is nevertheless highly unlikely that plants in any specific area would receive the maximum amount of spray drift repeatedly. It appears that in most areas (based upon available meteorological data) wind direction is temporally very changeable, even within the same day. Additionally, other factors, including variations in topography, cover, and meteorological conditions over the transport distance are not accounted for by the AgDRIFT model (*i.e.*, it models spray drift from aerial and ground applications in a flat area with little to no ground cover and a steady, constant wind speed and direction). Therefore, the drift estimates from AgDRIFT may overestimate exposure even from single applications, especially as the distance increases from the site of application, since the model does not account for potential obstructions (*e.g.*, large hills, berms, buildings, trees, *etc*.). Furthermore, conservative assumptions are often made regarding the droplet size distributions being modeled ('ASAE Very Fine to Fine' for orchard uses and 'ASAE Very Fine' for agricultural uses), the application method (*e.g.*, aerial), release heights and wind speeds. Alterations in any of these inputs would change the area of potential effect.

5.3.1.7. Location of Wildlife Species

For the terrestrial exposure analysis of this risk assessment, a generic bird or mammal was assumed to occupy either the treated field or adjacent areas receiving a treatment rate on the field. Actual habitat requirements of any particular terrestrial species were not considered, and it was assumed that species occupy, exclusively and permanently, the modeled treatment area. Spray drift model predictions suggest that this assumption leads to an overestimation of exposure to species that do not occupy the treated field exclusively and permanently.

5.3.2. Effects Assessment Uncertainties

5.3.2.1. Age Class and Sensitivity of Effects Thresholds

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

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

5.3.2.2. Use of Surrogate Species Effects Data

CRLF

Guideline toxicity tests and open literature data on oxamyl are not available for frogs or any other aquatic-phase amphibian; therefore, freshwater fish are used as surrogate species for aquatic-phase amphibians. Endpoints based on freshwater fish ecotoxicity data are assumed to be protective of potential direct effects to aquatic-phase amphibians including the CRLF, and extrapolation of the risk conclusions from the most sensitive tested species to the aquatic-phase CRLF is likely to overestimate the potential risks to those species. Efforts are made to select the organisms most likely to be affected by the type of compound and usage pattern; however, there is an inherent uncertainty in extrapolating across phyla. In addition, the Agency's LOCs are intentionally set very low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

Terrestrial Plants

Plant toxicity data from both registrant-submitted studies and studies in the scientific literature were reviewed for this assessment. Registrant-submitted studies are conducted under conditions and with species defined in EPA toxicity test guidelines. Sub-lethal endpoints such as plant growth, dry weight, and biomass are evaluated for both monocots and dicots, and effects are evaluated at both seedling emergence and vegetative life stages. Guideline studies generally evaluate toxicity to ten crop species. A drawback to these tests is that they are conducted on herbaceous crop species only, and extrapolation of effects to other species, such as the woody shrubs and trees and wild herbaceous species, contributes uncertainty to risk conclusions.

Commercial crop species have been selectively bred, and may be more or less resistant to particular stressors than wild herbs and forbs. The direction of this uncertainty for specific plants and stressors, including oxamyl, is largely unknown. Homogenous test plant seed lots also lack the genetic variation that occurs in natural populations, so the range of effects seen from tests is likely to be smaller than would be expected from wild populations.

5.3.2.3. Sublethal Effects

When assessing acute risk, the screening risk assessment relies on the acute mortality endpoint as well as a suite of sublethal responses to the pesticide, as determined by the testing of species response to chronic exposure conditions and subsequent chronic risk assessment. Consideration of additional sublethal data in the effects determination t is exercised on a case-by-case basis and only after careful consideration of the nature of the sublethal effect measured and the extent and quality of available data to support establishing a plausible relationship between the measure of effect (sublethal endpoint) and the assessment endpoints. However, the full suite of sublethal effects from valid open literature studies is considered for the purposes of defining the action area. To the extent to which sublethal effects are not considered in this assessment, the potential direct and indirect effects of oxamyl on CRLF may be underestimated.

5.3.2.4. Reproductive effects to plants

Potential reproductive effects to plants are not considered as endpoints in this assessment. The toxicity data used in this assessment indicate that 2.1 lb a.i./A of oxamyl causes less than 25% effects to the vegetative vigor and seedling emergence of tested (crop) species. However, oxamyl is used to thin apples at single application rates of 0.5-1.0 lb a.i./A (registration # 352-372). Based on this information, it is possible that oxamyl applications could result in reproductive effects to non-target plants.

5.4. 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 results of this assessment, several hypotheses can be rejected, meaning that they are not of concern for the CRLF. However, several of the original hypotheses cannot be rejected, meaning that the statements represent concerns in terms of effects of oxamyl on the CRLF.

Based on the results of this assessment, the following hypotheses can be rejected:

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

Based on the results of this assessment, the following hypotheses can not be rejected.

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

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

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

6. Risk Conclusions

In fulfilling its obligations under Section 7(a)(2) of the Endangered Species Act, the information presented in this endangered species risk assessment represents the best data currently available to assess the potential risks of oxamyl to the CRLF and its designated critical habitat.

Based on the best available information, the Agency makes a May Affect, and Likely to Adversely Affect (LAA) determination for the CRLF from the use of oxamyl. Additionally, the Agency has determined that there is the potential for modification of CRLF designated critical habitat from the use of the chemical. These conclusions are based on potential effects of oxamyl to the terrestrial-phase CRLF and its prey, including terrestrial insects, small mammals and terrestrial-phase frogs. Summaries of the risk conclusions and effects determinations for the CRLF and its critical habitat are presented in Table 45 and Table 46, respectively. Analysis related to the intersection of the oxamyl action area and CRLF habitat used in determining use patterns that result in LAA determinations are described in **Appendix A**. The LAA determination for the CRLF and potential modification of designated critical habitat is described in the baseline status and cumulative effects for the CRLF and is provided in **Attachment 2**.

Table 45. Description of evidence supporting effects determination for oxamyl use in California.

Effects	Habitat	Basis for LAA Determination
Direct	Aquatic	Direct effects to aquatic-phase CRLF resulting from acute and chronic exposures of oxamyl are not expected. - RQs for acute and chronic exposures resulting from all uses of oxamyl are below the levels of concern.
Direct	Terrestrial	Oxamyl has the potential to directly affect the terrestrial-phase CRLF. -Acute and chronic RQs for all uses of oxamyl exceed the Agency's LOCs for the terrestrial-phase CRLF. - The likelihoods of individual mortality range from 0.00034% to 100% for terrestrial-phase CRLF on a field treated with uses of oxamyl that have LOC exceedances (relevant to California). - Comparison of the LOAEC directly to chronic dietary-based EECs for CRLF consuming small insects and small herbivore mammals indicate that EECs for all uses are sufficient to exceed the concentration where reproductive effects were observed in the laboratory.
Indirect - prey	Aquatic	Indirect effects to the CRLF through effects to its prey in the aquatic habitat are not expected. - RQs representing exposures to non-vascular aquatic plants (which serve as prey to tadpole stage CRLF) are below LOCs for all uses of oxamyl. - RQs representing acute and chronic exposures to fish (which serve as prey to adult CRLF) are below LOCs for all uses of oxamyl. - Although some RQs representing acute exposures to aquatic invertebrates are above the LOC, the likelihood of individual effects chance indicates that all uses of oxamyl are expected to result in ≤0.34% chance of effects to an individual aquatic invertebrate. Therefore, potential indirect effects to the CRLF due to effects of oxamyl to aquatic invertebrates resulting from acute exposures are discountable. - RQs representing chronic exposures to aquatic invertebrates (serving as prey to juvenile and adult CRLF) are below LOCs, with the exception of 2 uses (garlic and celery). EECs for garlic and celery do not reach the NOAEC for less sensitive species of aquatic invertebrates (*i.e.*, *Daphnia magna*), suggesting that even though sensitive species of aquatic invertebrates may be affected by chronic exposures of oxamyl, less sensitive species, such as daphnids, may not be affected. Because the CRLF is an opportunistic feeder, the impact of effects to sensitive aquatic invertebrates from chronic exposures on the CRLF is discountable.
Indirect - habitat	Aquatic	Indirect effects to the CRLF through modification of its aquatic habitat are not expected. -RQs representing exposures to non-vascular and vascular aquatic plants are below LOCs. -Estimated exposures of oxamyl to riparian vegetation are above the EC_{25} values for monocots and dicots.
Indirect - prey	Terrestrial	Oxamyl has the potential to indirectly affect the terrestrial-phase CRLF through effects to its prey. -RQs representing exposures to terrestrial insects are above the LOC for all uses of oxamyl. - The likelihood of individual mortality is >99.9% for a terrestrial invertebrate on a field treated with any use of oxamyl (relevant to California). - >22% chance of mortality to individual small insects can occur within 950 feet from the edge of a field treated with 1 lb a.i./A oxamyl by aerial methods. -RQs representing acute and chronic exposures to small terrestrial mammals are above LOCs for all uses of oxamyl. - The likelihood of individual mortality is >99.9% for a small mammal consuming short grass on a field treated with any use of oxamyl (relevant to California). -Dose-based and dietary-based EECs are above levels where subacute effects to mammals were observed in chronic toxicity studies. -RQs representing exposures to terrestrial-phase frogs are above the LOC for all uses of oxamyl. -There is a >10% chance of effects to an individual terrestrial phase frog (serving as prey to CRLF) consuming small insects for all oxamyl uses, and a >10% chance of effects to an individual terrestrial phase frog consuming large insects for a majority of oxamyl uses (relevant to California). -Dose-based and dietary-based EECs are above the levels where subacute effects to birds were observed in chronic toxicity studies.
Indirect - habitat	Terrestrial	Indirect effects to the CRLF through modification of its terrestrial habitat are not expected. -Estimated exposures of oxamyl to terrestrial vegetation are above the EC_{25} values for monocots and dicots.

Table 46. Summary of effects determination for CRLF critical habitat based on uses of oxamyl in California.

Assessment Endpoint	Effects Determination	Basis for Determination
Modification of aquatic-phase primary constituent elements	Habitat Modification	Modification of the aquatic-phase PCE is not expected. - RQs for acute and chronic exposures directly to the CRLF resulting from all uses of oxamyl are below the levels of concern. - Indirect effects to the CRLF through effects to its prey in the aquatic habitat are not expected (see Table 1). -RQs representing exposures to non-vascular and vascular aquatic plants are below LOCs. -Estimated exposures of oxamyl to riparian vegetation are above the EC_{25} values for monocots and dicots.
Modification of terrestrial-phase primary constituent elements		Oxamyl has the potential to modify the terrestrial-phase PCE. - Oxamyl has the potential to directly affect the terrestrial-phase CRLF (See Table 1). Oxamyl has the potential to indirectly affect the terrestrial-phase CRLF through effects to its prey (see Table 1). -Estimated exposures of oxamyl to terrestrial vegetation are below the EC_{25} values for monocots and dicots.

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

When evaluating the significance of this risk assessment's direct/indirect and habitat modification effects determinations, it is important to note that pesticide exposures and predicted risks to the species and its resources (*i.e.*, food and habitat) are not expected to be uniform across the action area. In fact, given the assumptions of drift and downstream transport (*i.e.*, attenuation with distance), pesticide exposure and associated risks to the species and its resources are expected to decrease with increasing distance away from the treated field or site of application. Evaluation of the implication of this non-uniform distribution of risk to the species would require information and assessment techniques that are not currently available. Examples of such information and methodology required for this type of analysis would include the following:

- Enhanced information on the density and distribution of CRLF life stages within specific recovery units and/or designated critical habitat within the action area. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the species.
- Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase frogs. While existing information provides a preliminary picture of the types of food sources utilized by the frog, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information

could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.

- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual frogs and potential modification to critical habitat.

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