# Risks of Oryzalin Use to Federally Threatened California Red-legged Frog

(*Rana aurora draytonii*)

**Pesticide Effects Determination**

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

**6/19/08**

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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 oryzalin on agricultural and non-agricultural sites. In addition, this assessment evaluates whether these actions can be expected to result in modification of the species' designated critical habitat. This assessment was completed in accordance with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998) and procedures outlined in the Agency's Overview Document (U.S. EPA, 2004).

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

Oryzalin is a dinitroaniline herbicide that is registered nationally for the control of annual grasses and certain broadleaf weeds in fruit and nut crops, vineyards, Christmas tree plantations, ornamentals, turf, and several other non-crop sites. Its herbicidal action is through inhibition of microtubule polymerization/function of cell division process leading to adverse effects on seed germination and cellular respiration. Oryzalin is formulated as granules (0.4 to 1% ai), wettable powder (75% ai), water dispersible granules (60 - 85%), emulsifiable concentrate (2.84 to 40.4% ai), flowable concentrate (40.4% ai), and formulation intermediate/liquid (40.4% ai). Depending on the formulation, the registered products are applied to the soil surface prior to the emergence of weeds as broadcast spray or band treatment for liquid formulations (using low pressure ground equipment) or broadcast for granular formulations (using spreaders). To facilitate activation and movement of the chemical to the weed seed germination zone, a single ½ to 1 inch of rainfall or sprinkler irrigation is required.

Depending on the environmental conditions, the major route of oryzalin dissipation is aqueous photolysis (half-life = 0.06 days), photo-degradation on soil surface (half-life = 3.8 days), and degradation under anaerobic soil condition (half-life = 10 days). Oryzalin appears to degrade slowly under aerobic soil conditions (half-life = 63 days) and is stable to hydrolysis. Under field conditions oryzalin appeared to be moderately persistent, with a half-life of about two months. Based on its low vapor pressure (1.0 x $10^{-7}$ mm Hg at 25°C) and Henry's Law Constant (1.8 x $10^{-8}$ atm·$m^3$/mol), volatilization loss of oryzalin from soil and water systems is expected to be insignificant compared to dissipation by abiotic and biotic degradation. For this assessment, transport of oryzalin from initial application sites via runoff and spray drift are considered in evaluating quantitative estimates of oryzalin exposure to CRLF, its prey and its habitats.

Several degradates have been identified for oryzalin in various environmental fate studies. There is no evidence in the Reregistration Eligibility Decision (RED) document or in public literature identified through ECOTOX that any of these degradates are of toxicological concern, and none of them are found in significant amounts (>10.0%) except 2-ethyl-7-nitro-1-propyl-5-sulfonylaminobenzimidazole 3-oxide (UN-2) at 14% in an aquatic photodegradation study. Since 2-ethyl-7-nitro-1-propyl-5-sulfonylamino benzimidazole 3-oxide is a minor (<2.4%) degradate in aerobic soil metabolism study and not of toxicological concern, this assessment is based on parent oryzalin only.

Since CRLFs exist in both aquatic and terrestrial habitats, exposure of the CRLF, its prey and its habitats to oryzalin are assessed separately for the two habitats. Due to relatively low volatility and greater sensitivity to photolytic degradation, oryzalin is not expected to move by long-range transport. There is also no data for oryzalin in the California Pesticide Air Monitoring database. Tier-II aquatic exposure models are used to estimate high-end exposures of oryzalin in aquatic habitats resulting from runoff and spray drift from different uses. Peak model-estimated environmental concentrations resulting from different oryzalin uses range from 3.5 to 149.5 µg/L. These estimates are supplemented with analysis of available California surface water monitoring data from U. S. Geological Survey's National Water Quality Assessment (NAWQA) program and the California Department of Pesticide Regulation. The maximum concentration of oryzalin reported by NAWQA from 1993 to the present for California surface waters with agricultural watersheds is 1.51 µg/L. This value is approximately 99 times lower than the maximum model-estimated environmental concentration.

To estimate oryzalin exposures to the terrestrial-phase CRLF, and its potential prey resulting from uses involving oryzalin applications, the T-REX model is used for both foliar and granular uses. The T-HERPS model is used to allow for further characterization of dietary exposures of terrestrial-phase CRLFs relative to birds. The TerrPlant model is used to estimate oryzalin exposures to terrestrial-phase CRLF habitat, including plants inhabiting semi-aquatic and dry areas, resulting from uses involving foliar oryzalin applications. AgDRIFT model is also used to estimate deposition of oryzalin on terrestrial and aquatic habitats from spray drift.

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

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 oryzalin 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 a particular type of effect are below LOCs, the pesticide is determined to have "no effect" on the subject species. 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 use of oryzalin 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 "Likely to Adversely Affect" determination for the CRLF from the use of oryzalin. Oryzalin is not likely to adversely affect the aquatic-phase CRLF by direct toxic effects or by indirect effects resulting from effects to aquatic invertebrates, fish, and other aquatic-phase frogs as food items. In addition, direct acute effects and indirect effects via reduction of terrestrial invertebrates as prey are not expected for terrestrial-phase CRLFs. However, an "LAA" determination was concluded for the aquatic-phase CRLF, based on indirect effects related to a reduction in algae as food items for the tadpole, and based on effects to aquatic non-vascular plants and sensitive herbaceous terrestrial plants that comprise its habitat. For the terrestrial-phase CRLF, an "LAA" determination was concluded for chronic direct effects and indirect effects related to a reduction in mammals and terrestrial-phase frogs as food items, and herbaceous terrestrial plants as habitat. Given these direct and indirect effects to the CRLF, modification of critical habitat is also expected for both aquatic and terrestrial primary constituent elements (PCEs).

A summary of the risk conclusions and effects determinations for the CRLF and its critical habitat is presented in **Tables 1.1 and 1.2**, respectively. Further information on the results of the effects determination is included as part of the Risk Description in Section 5.2. Oryzalin use-specific direct effects determinations for the CRLF and indirect effects determinations for the prey items can be found in **Tables 1.3 and 1.4,** respectively.

| **Table 1.1 Effects Determination Summary for Direct and Indirect Effects of Oryzalin on the CRLF** | | |
|---|---|---|
| **Assessment Endpoint** | **Effects Determination[1]** | **Basis for Determination** |
| ***Aquatic-Phase CRLF (Eggs, Larvae, and Adults)*** | | |
| Direct Effects:<br>Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases | NLAA | Using freshwater fish as a surrogate, no chronic LOCs are exceeded; acute LOCS are exceeded for 1 use only (rights-of-ways) for which the probability of individual mortality is very low (1 in 1.9E+33 to 3.05E+26). |
| Indirect Effects:<br>Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants, fish, and frogs) | Freshwater invertebrates: NLAA | Oryzalin may affect sensitive aquatic invertebrates, such as the water flea; however, the low probability (1 in 1.03E+47 to 9.53E+20) of an individual effect to the water flea is not likely to indirectly affect the CRLF, given the wide range of other types of freshwater invertebrates and food items that the species consumes during its aquatic phase. Based on the non-selective nature of feeding behavior in the aquatic-phase CRLF, the low magnitude of anticipated acute individual effects to preferred aquatic invertebrate prey species, and low measured concentrations of oryzalin in California watersheds, oryzalin is not likely to indirectly affect the CRLF via reduction in freshwater invertebrate food items. |
| | Non-vascular aquatic plants: LAA | Oryzalin (in liquid form) uses in avocado, berries, olives, tree nuts, vineyards, non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals (excluding bulbs) and granular uses in non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals (excluding bulbs) exceeded LOCs. Indirect effects to tadpoles that feed on algae, therefore, are possible. |
| | Fish and frogs: NLAA | Using freshwater fish as a surrogate, no chronic LOCs are exceeded; acute LOCS exceeded for only 1 scenario (rights-of-ways) for which the probability of individual mortality is very low. |
| Indirect Effects:<br>Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community) | Non-vascular aquatic plants: LAA | LOCs are exceeded for non-vascular aquatic plants for broadcast spray applications of oryzalin in avocado, berries, olives, tree nuts, vineyards, non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals (excluding bulbs) and granular applications in non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals (excluding bulbs). |
| | Vascular aquatic plants: LAA | RQs for vascular plants are higher than LOCs for almost all oryzalin use patterns except citrus fruits, warm season turf grass, and residential areas. |
| Indirect Effects:<br>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. | Direct effects to forested riparian vegetation: NLAA<br><br>Direct effects to grassy/herbaceous riparian vegetation: LAA (ground applications): <164 ft (monocots); <79 ft | Riparian vegetation may be affected because terrestrial plant RQs are above LOCs. However, woody plants (other than species such as Douglas fir) are generally not sensitive to oryzalin; therefore, effects of riparian areas in the action area are not expected.<br><br>Aquatic-phase CRLFs may be indirectly affected by adverse effects to sensitive herbaceous vegetation (based on all oryzalin liquid spray and granular uses), which provides habitat and cover for the CRLF and attachment sites for its egg masses. |

| | | |
|---|---|---|
| | (dicots)<br>NLAA (ground applications): >164 ft (monocots); >79 ft (dicots) | |
| ***Terrestrial-Phase CRLF (Juveniles and adults)*** | | |
| Direct Effects:<br>Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles | Acute: NLAA | The acute avian effects data was used as a surrogate for the terrestrial-phase CRLF. Dose-based acute avian RQs, refined based on amphibian dietary intake using the T-HERPS model, did not exceed LOCs for any of the modeled uses. |
| | Chronic: LAA | Chronic reproductive effects are possible based on non-granular uses of oryzalin. |
| Indirect Effects:<br>Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial vertebrates, including mammals and terrestrial phase amphibians) | Terrestrial invertebrates: NLAA | Oryzalin is non-toxic to terrestrial invertebrates at environmentally relevant concentrations. At the expected levels of oryzalin exposure, the effects on vertebrates are small and thus a reduction in terrestrial invertebrates as food items is unlikely. |
| | Mammals: LAA | Chronic RQs for non-granular formulations exceed LOCs. |
| | Frogs: LAA | Chronic risks for terrestrial-phase frogs exposed to broadcast spray applications of oryzalin may occur. |
| Indirect Effects:<br>Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian vegetation) | Direct effects to forested riparian vegetation: NLAA<br><br>Direct effects to grassy/herbaceous riparian vegetation:<br>LAA (ground applications): <164 ft (monocots); <79 ft (dicots)<br>NLAA (ground applications): >164 ft (monocots); >79 ft (dicots) | Riparian vegetation may be affected because terrestrial plant RQs are above LOCs. However, woody plants (other than species such as Douglas fir) are generally not sensitive to oryzalin; therefore, effects of riparian areas in the action area are not expected.<br><br>Aquatic-phase CRLFs may be indirectly affected by adverse effects to sensitive herbaceous vegetation (based on all oryzalin liquid spray and granular uses), which provides habitat and cover for the CRLF and attachment sites for its egg masses. |
| [1]NE = no effect; NLAA = may affect, but not likely to adversely affect; LAA = likely to adversely affect | | |

| Table 1.2 Effects Determination Summary for the Critical Habitat Impact Analysis | | |
|---|---|---|
| **Assessment Endpoint** | **Effects Determination[1]** | **Basis for Determination** |
| ***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. | Habitat modification | Both liquid and granular formulations of oryzalin may affect sensitive riparian seedlings. As a result, critical habitat may be modified by an increase in sediment deposition and reduction in herbaceous riparian vegetation that provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult aquatic-phase 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.[1] | Habitat modification | Both liquid and granular formulations of oryzalin may affect sensitive seedlings. As a result, critical habitat may be modified via turbidity and reduction in oxygen content necessary for normal growth and viability of juvenile and adult aquatic-phase CRLFs. |
| Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source. | Effects on growth and viability of CRLF<br><br>Habitat modification based on alteration of food source | Direct effects to the aquatic-phase CRLF, via mortality are expected.<br><br>Critical habitat of the CRLF may be modified via oryzalin-related impacts (both formulations) to non-vascular aquatic plants as food items for tadpoles. |
| Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae) | Habitat modification | Based on the results of the effects determinations for aquatic plants, critical habitat of the CRLF may be modified via oryzalin-related impacts to non-vascular aquatic plants as food items for tadpoles. |
| ***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 | Habitat modification | Modification to critical habitat may occur via impacts of oryzalin on sensitive seedlings which provide habitat and cover for the terrestrial-phase CRLF and its prey. |
| 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 | Habitat modification | |
| Reduction and/or modification of food sources for terrestrial phase juveniles and adults | Habitat modification | Based on the characterization of indirect effects to terrestrial-phase CRLFs via reduction in the prey base, critical habitat may be modified via a reduction in mammals and terrestrial-phase amphibians as food items. |

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

| | | |
|---|---|---|
| Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source. | Habitat modification | Direct acute effects, via mortality, are not expected for the terrestrial-phase CRLF; however, chronic reproductive effects are possible for all non-granular uses of oryzalin. Therefore, oryzalin may adversely affect critical habitat by altering chemical characteristics necessary for normal growth and viability of terrestrial-phase CRLFs and their mammalian and amphibian food sources. |
| 1 NE = No effect; HM = Habitat modification | | |

**Table 1.3 Oryzalin Use-specific Direct Effects Determinations[1] for the CRLF**

| Use(s) | APPLICATION Method | Aquatic Phase | | Terrestrial Phase | |
|---|---|---|---|---|---|
| | | Acute | Chronic | Acute | Chronic |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards – | Ground Broadcast | NE | NE | NLAA | LAA |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards – | Ground Broadcast | NE | NE | NLAA | LAA |
| | Granular | NE | NE | NLAA | - |
| Ornamentals (Excluding Bulbs) | Ground Broadcast | NE | NE | NLAA | LAA |
| | Granular | NE | NE | NLAA | - |
| Ornamental Bulbs | Ground Broadcast | NE | NE | NLAA | LAA |
| | Granular | NE | NE | NLAA | - |
| Christmas Tree Plantations | Ground Broadcast | NE | NE | NLAA | LAA |
| | Granular | NE | NE | NLAA | - |
| Warm Season Turf | Ground Broadcast | NE | NE | NLAA | LAA |
| | Granular | NE | NE | NLAA | - |
| Rights-of-ways | Ground Broadcast | NLAA | NE | NLAA | LAA |
| | Granular | NLAA | NE | NLAA | - |
| Residential areas | Granular | NE | NE | NLAA | LAA |

[1]NE = No effect; NLAA = May affect, but not likely to adversely affect; LAA = Likely to adversely affect

-Not applicable

## Table 1.4 Oryzalin Use-specific Indirect Effects Determinations[1] Based on Effects to Prey

| Use(s) | Application Method | Algae | Aquatic Invertebrates | | Terrestrial Invertebrates (Acute) | Aquatic-phase frogs and fish | | Terrestrial-phase frogs | | Small Mammals | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Acute | Chronic | | Acute | Chronic | Acute | Chronic | Acute | Chronic |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards – | Ground Broadcast | LAA | NE | NE | NLAA | NE | NE | NLAA | LAA | NLAA | LAA |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards – | Ground Broadcast | LAA | NE | NE | NLAA | NE | NE | NLAA | LAA | NLAA | LAA |
| | Granular | LAA | NE | NE | NLAA | NE | NE | NLAA | - | NLAA | LAA |
| Ornamentals (Excluding Bulbs) | Ground Broadcast | LAA | | NE | NLAA | NE | NE | NLAA | LAA | NLAA | LAA |
| | Granular | LAA | LAA | NE | NLAA | NE | NE | NLAA | - | NLAA | LAA |
| Ornamental Bulbs | Ground Broadcast | NE | NE | NE | NLAA | NE | NE | NLAA | LAA | NLAA | LAA |
| | Granular | NE | NE | NE | NLAA | NE | NE | NLAA | - | NLAA | LAA |
| Christmas Tree Plantations | Ground Broadcast | NE | NE | NE | NLAA | NE | NE | NLAA | LAA | NLAA | LAA |
| | Granular | NE | NE | NE | NLAA | NE | NE | NLAA | - | NLAA | LAA |
| Warm Season Turf | Ground Broadcast | NE | NE | NE | NLAA | NE | NE | NLAA | LAA | NLAA | LAA |
| | Granular | NE | NE | NE | NLAA | NE | NE | NLAA | - | NLAA | LAA |
| Rights-of-ways | Ground Broadcast | LAA | LAA | NE | NLAA | NLAA | NE | NLAA | LAA | NLAA | LAA |
| | Granular | LAA | LAA | NE | NLAA | NLAA | NE | NLAA | - | NLAA | LAA |
| Residential areas | Granular | NE | NE | NE | NLAA | NE | NE | NLAA | LAA | NLAA | LAA |

[1]NE = No effect; NLAA = May affect, but not likely to adversely affect; LAA = Likely to adversely affect

-Not applicable

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.

## 2. Problem Formulation

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

### 2.1 Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the federally threatened California red-legged frog *(Rana aurora draytonii*) (CRLF) arising from FIFRA regulatory actions regarding use of the herbicide oryzalin for both agricultural (for weed control in crops such as avocado, fig, olives, berries, citrus, stone fruits, pome fruits, tree nuts, wine and table grapes, ornamentals including bulbs) and non-agricultural (for weed control in Christmas tree plantations, warm season turf grass, non-cropland and industrial sites including roadsides and rights-of-ways (referred to together as rights-of-ways) purposes. In addition, this assessment evaluates whether use on these sites 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 an analysis of California Pesticide Use Reporting (CA PUR) data and the use of the T-HERPS model to predict daily dietary intake specifically by the CRLF of oryzalin residues in terrestrial invertebrates and small mammal dietary items. Use of such information is consistent with the methodology described in the Overview Document, 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 oryzalin 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 oryzalin 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 oryzalin 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 oryzalin 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 oryzalin.

If a determination is made that use of oryzalin 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 oryzalin use sites) and further evaluation of the potential impact of oryzalin 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 oryzalin is expected to directly impact living organisms within the action area (defined in Section 2.7), critical habitat analysis for oryzalin 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 oryzalin 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

Oryzalin, applied to the soil surface prior to the emergence of weeds, is a herbicide used to control seedling grasses and some annual broadleaf weeds in a variety of food crops such as avocado, fig, olives, berries, citrus fruits, pome fruits, tree nuts, stone fruits, and vineyards. Other labeled non-food uses for oryzalin include non-bearing orchards, vineyards, and berries, ornamentals, Christmas tree plantations, warm season turf grass, residential and non-croplands such as rights-of-ways.

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

Although current registrations of oryzalin allow for use nationwide, this ecological risk assessment and effects determination addresses currently registered uses of oryzalin 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.

Several degradates have been identified for oryzalin of which the main degradate is 4-hydroxy-3, 5-dinitrobenzenesulfonamide (OR 20). There is no evidence that any of these degradates are of toxicological concern, and none of them are found in significant amounts (>10.0%) except 2-ethyl-7-nitro-1-propyl-5-sulfonylaminobenzimidazole 3-oxide at 14% in an aquatic photodegradation study. Since 2-ethyl-7-nitro-1-propyl-5-sulfonylamino benzimidazole 3-oxide is not of toxicological concern and formed in negligible amount (<2.4%) in an aerobic soil metabolism study, this assessment is based on parent oryzalin only.

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 multiple 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).

Oryzalin has ten registered products that contain multiple active ingredients (**Appendix B**). Based on a review of the available studies on oryzalin mixtures, it appears that the information presented in the papers pertain to efficacy and phytotoxicity of the mixtures for weed control. No information is available on the toxicity of individual components of oryzalin mixtures (**Appendix B**).

### 2.3 Previous Assessments

Oryzalin was first registered in the United States in 1974 as a preemergence herbicide in fruits, nuts, vineyards, orchards, forestry, rights-of-ways, and agricultural crops. A Registration Standard was issued in 1987 (NTIS# PB89-102396) which evaluated the studies submitted on oryzalin to that date. Prior to the issuance of the Registration Standard, several agricultural crops were deleted. The only food crop groups remaining on oryzalin labels are berries, vine and orchard crops (i.e., citrus fruits, pome fruits, stone fruits, and tree nuts). In addition, oryzalin has many non-food uses including ornamentals, Christmas trees, non-bearing fruit and nut trees, non-bearing vineyards and berries, and established warm season turf and rights-of-ways. A Data Call-In was issued in 1991 requiring additional phytotoxicity data, plant and animal analytical methods, and non-dietary exposure data. The Environmental Protection Agency issued the Registration Eligibility Decision (RED) for oryzalin in September of 1994 by determining that all of the then registered oryzalin products were eligible for re-registration except for products labeled for use on residential lawns and turf. The results of the Agency's 1994 ecological risk assessment for oryzalin, which was conducted as part of the RED, suggest the potential for adverse acute effects to non-target aquatic animals in shallow waters (6 inches deep) and terrestrial and aquatic plants. No acute or sub-lethal chronic effects to birds were reported due to exposure to oryzalin. The Tolerance Reassessment Progress and Risk Management Decision (TRED) for oryzalin, dated 26 May 2006, determined that the lawn and turf uses for oryzalin are eligible for re-registration based on the submitted new studies on exposure monitoring on residential lawns and turf.

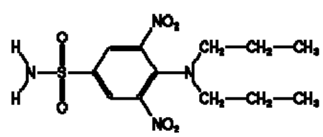
The Agency also completed an effects determination for the threatened and endangered Pacific anadromous salmon and steelhead in 2003 based on oryzalin uses in grapes and almonds in the Pacific Northwest as part of the settlement for the petition filed against EPA by Washington Toxics Coalition (filed November 26, 2002). The results of this endangered species risk assessment showed that oryzalin may affect but is not likely to adversely affect 17 ESUs (Evolutionarily Significant Units) and will have no effect on nine ESUs. These determinations were based on possible indirect effects to listed salmonids from loss of aquatic plant cover in spawning and rearing habitats.

## 2.4 Stressor Source and Distribution

### 2.4.1 Environmental Fate Properties

The major route of oryzalin dissipation is aqueous photolysis, photodegradation on soil surface, and degradation under anaerobic conditions. Oryzalin appears to degrade slowly under aerobic soil conditions and is stable to hydrolysis. Under field conditions oryzalin appeared to be moderately persistent, with a half-life of about two months. Based on its low vapor pressure (1.0 x $10^{-7}$ mm Hg at 25°C) and Henry's Law Constant (1.8 x $10^{-8}$ atm·$m^3$/mol), volatilization loss of oryzalin from soil and water systems is expected to be insignificant compared to dissipation by abiotic and biotic degradation. **Table 2.1** lists selected physical, chemical and environmental fate properties of oryzalin.

**Table 2.1 Summary of Oryzalin Environmental Fate Properties**

| Parameter | Value | Major Degradates *Minor Degradates* | Source/ MRID # | Study Status |
|---|---|---|---|---|
| Common name | Oryzalin | --- | U.S. EPA, 1994 | --- |
| Chemical name | 3,5-dinitro-N4,N4-dipropylsulfanilamide | --- | U.S. EPA, 1994 | --- |
| Chemical family | Dinitroaniline | --- | U.S. EPA, 1994 | --- |
| Empirical formula | $C_{12}H_{18}N_4O_6S$ | --- | U.S. EPA, 1994 | --- |
| Structure |  | --- | U.S. EPA, 1994 | --- |
| Molecular mass | 346.35 | --- | U.S. EPA, 1994 | |
| Water solubility (20°C) | 2.5 mg/L | --- | MRID 41208101-2 | Acceptable |
| Vapor pressure (25°C) | 1.0 x $10^{-7}$ mm Hg | --- | MRID 40454801 | Acceptable |
| Henry's Law Constant | 1.82 x $10^{-8}$ atm $m^3$/mol | --- | Calculated[1] | --- |
| Octanol/water partition coefficient (Log $K_{ow}$) | 3.73 at pH 7 | --- | U.S. EPA, 1994 | --- |
| Hydrolysis | Stable | --- | MRID 41378401 | Acceptable |
| Direct Aqueous Photolysis | 0.06 days | UN-2, 14.0% *OR-5, 2.9%, OR-3, 5.7%* | MRID 40863401 | supplemental |
| Soil Photolysis | 3.8 days | *OR-3, 2.6%, OR-15, 3.2% OR-21, 4.6%.* | MRID 41050001 | Acceptable |
| Aerobic Soil | 63 days | *OR-20, 4.7 %, UN-1, UN-2, OR-4,* | MRID 41322801 | Acceptable |

| Table 2.1 Summary of Oryzalin Environmental Fate Properties | | | | |
|---|---|---|---|---|
| **Parameter** | **Value** | **Major Degradates** ***Minor Degradates*** | **Source/ MRID #** | **Study Status** |
| Metabolism | | *OR-9, OR-13, OR-15 OR-20 and OR-4, < 2.4%* | | |
| Anaerobic Soil Metabolism | 10 Days | *UN-1, OR-3 and OR-20* | MRID 413228-02 | Acceptable |
| Soil Partition Coefficient $K_{oc}$)[1] | 840, 700, 933, and 1290 L kg o.c.$^{-1}$ | --- | MRID 41479802 | Acceptable |
| Terrestrial Field Dissipation | 77-146 days<br>58-136 days | --- | MRID 42138001 | Acceptable |
| Fish bioconcentration | 32x (edible)<br>105x (viscera)<br>66x (whole fish) | --- | MRID 40787501 | Acceptable |

Laboratory studies indicate that oryzalin is stable to hydrolysis at pHs 5, 7 and 9. (MRID 41378401) but exhibits susceptibility to rapid direct aqueous photolysis; the aqueous photolytic half-life is 1.4 hours (MRID 41288701). The degradates of aqueous photolysis are OR-5 (2.9%), OR-3 (5.7%), and UN-2 (14%). The chemical also readily photodegrades on the soil surface with an estimated half-life of 3.8 days, and the degradates are OR-3 (2.6%), OR-15 (3.2%) and OR-21 (4.6) (MRID 41050001).

Oryzalin degrades aerobically with a half-life of 63 days in sandy loam soil (MIRD 41322801). The main degradate is 4-hydroxy-3,5-dinitrobenzenesulfonamide (OR 20), which accounted for a maximum of 4.7% of radioactivity at 1 month post treatment in the soil aerobic metabolism study. Eight other degradates were identified, each accounting for < 2.4% of the applied radioactivity (**Table 2.1**). The benzenesulfonamide ring remained intact in all of the identified metabolites. By the end of the experiment at 6.1 months, 63.1% of the applied radioactivity was nonextractable and 5.7% had been mineralized to CO2. Under anaerobic conditions oryzalin nitro groups undergo reduction to amines, dealkylation, and ring formation to produce benzimidazoles, with a half-life of 10 days (MRID 41322802). Anaerobic metabolites that accounted for < 0.2% are UN-1, UN-2, OR-3, and OR-20. **Table 2.2** provides names, structures and the occurrence of various degradates detected in environmental fate studies.

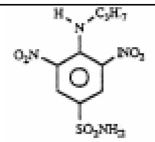
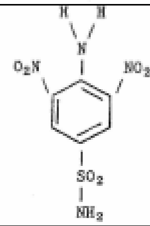
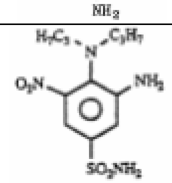
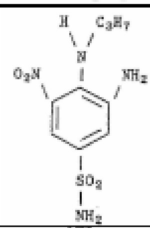
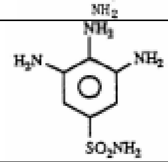
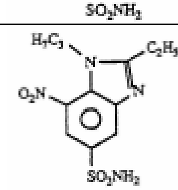
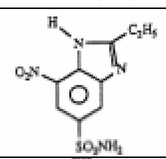
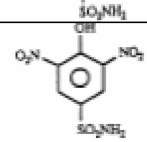
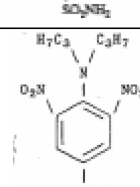
In the field, oryzalin appears to dissipate slowly with a half-life of 68 days in Florida sand soil and a first phase half-life of 58 days in California loam soil and 77 days in Michigan silty clay loam soil. The second phase half-lives were 138 days in California loam soil and 146 days in Michigan silty clay loam soil. Parent oryzalin did not appear to be mobile under field conditions. The parent was undetectable and always less than detection limits (i.e., 0.01 ppm; MRID 42138001) below 12 inches of soil depth. Oryzalin degradates were not monitored in the field dissipation studies submitted. Although oryzalin does not appear to be mobile under field conditions, the soil partition coefficients ($K_{oc}$ = 700 to 1290 L $Kg^{-1}$ , MRID 41479802 ) indicate that chemical mobility will vary from moderately mobile to slightly mobile according to FAO Classification Scheme (FAO 2000) depending on soil type and organic matter content.

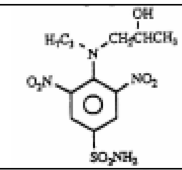
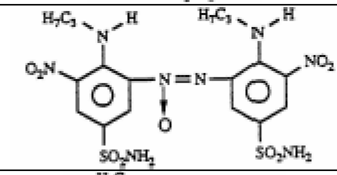
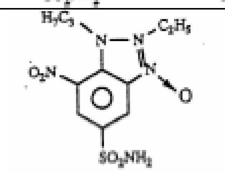
Oryzalin has potential to contaminate surface water via spray drift and runoff. Substantial quantities of oryzalin could be available for runoff for a few days to months post-application depending on the degree of exposure to sunlight (photodegradation on soil half-life of 3.8 days; aerobic soil half-life of 63 days; terrestrial field dissipation half-lives of 77-146 and 58-138 days). The soil partitioning coefficients of oryzalin indicates that fractions of oryzalin could be transported via both dissolution in runoff water and adsorption to eroding soil in the event of significant rainfall occurring after application prior to soil incorporation. Based upon its $K_{oc}$, significant fractions of the oryzalin in receiving surface waters should exist both dissolved in the water column and adsorbed to suspended sediment. The susceptibility of oryzalin to direct photolysis in water (half-life = 1.4 hours) should limit its persistence in clear shallow waters with low light attenuation. However, its resistance to abiotic hydrolysis coupled with only a moderate susceptibility to aerobic biodegradation indicate that it will be somewhat more persistent in receiving surface waters that are deeper, have high light attenuation, low microbiological activities and long hydrological resident times.

Oryzalin is less likely to contaminate ground water resources due to reduction in the anaerobic soil layer. However, in sandy soils under some environmental conditions, such as excess precipitation, or where soil preferential flow conditions exist and exposure to sunlight is minimal, oryzalin residues may leach into ground water and undergo reduction to more polar compounds.

Based solely on the log $K_{ow}$ value of 3.73 of oryzalin, there is some potential for bioconcentration in aquatic organisms. However, based on a laboratory bioaccumulation study (MRID 40787501), oryzalin did not significantly bioconcentrate in bluegill sunfish. The BCFs were 32X in edible tissue, 105X in nonedible tissue, and 66X in whole fish. Depuration ranged from 79.2 to 80.8% after 24 hours and 88.7 to 95.1% after 14 days.

Nine degradates have been identified for oryzalin in the soil aerobic metabolism study. Three other degradates were also identified in various fate studies (**Table 2.2**). The main degradate is 4-hydroxy-3,5-dinitrobenzenesulfonamide, which accounted for a maximum of 4.7% of radioactivity at 1 month post-treatment in the soil aerobic metabolism study. Eight other degradates were isolated, but each comprised <2.4% of the applied radioactivity. The available data on degradates of oryzalin are insufficient to assess their runoff characteristics or persistence in surface waters. The registrant conducted a mobility/adsorption/desorption study to determine the mobility of nine oryzalin degradates and whether or not degradate leaching is a major route of dissipation. Out of nine metabolites formed, three (OR-20, UN-2, and the unidentified compound UN-3; (MRID 43433202) appeared to be very mobile.

| Table 2.2 Oryzalin Degradates Identified in Environmental Fate Studies | | | |
|---|---|---|---|
| **Code** | **Structure** | **IUPAC Name** | **Reference** |
| OR-2 |  | 3,5-dinitro-4-(propyl-amino) benzenesulfonamide | MRID 41322801[1]<br>MRID 41322802[2] |
| OR-3 |  | 3,5-dinitro-4-amino-benzenesulfonamide | MRID 41278701[3]<br>MRID 41050001[4] |
| OR-4 |  | 3-amino-4-(dipropylamino)-5-nitrobenzenesulfonamide | MRID 41322801<br>MRID 41322802 |
| OR-5 |  | 3-amino-4-propylamino)- 5-nitrobenzenesulfonamide | MRID 41278701 |
| OR-9 |  | 3,4,5-triaminobenzene-sulfonamide | MRID 41322801 |
| OR-13 |  | 2-ethyl-7-nitro-1-propyl-1H-benzimidazole-5-sulfonamide | MRID 41322801<br>MRID 41322802 |
| OR-15 |  | 2-ethyl-7-nitro-1H-benzimidazole-5-sulfonamide | MRID 41322801<br>MRID 41322802<br>MRID 41050001 |
| OR-20 |  | 4-hydroxy-3,5-dinitro-benzenesulfonamide | MRID 41322801<br>MRID 41322802 |
| OR-21 |  | 3,4-dinitro-4-dipropylamineo-sulfanalic acid | MRID 41050001 |

| Table 2.2 Oryzalin Degradates Identified in Environmental Fate Studies | | | |
|---|---|---|---|
| **Code** | **Structure** | **IUPAC Name** | **Reference** |
| OR-41 |  | 4-[(2-hydroxypropy-amino)]-3,5-dinitro-benzenesulfonamide | MRID 41322801 |
| UN-1 |  | 3,3'-azoxybis[(4-propylamino]-5-nitro]-benzenesulfonamide | MRID 41322801<br>MRID 41322802 |
| UN-2 |  | 2-ethyl-7-nitro-1-propyl-1H-benzimidazole-5-sulfonamide-3-oxide | MRID 41322801<br>MRID 41322802<br>MRID 41278701 |
| [1]Aerobic soil metabolism; [2]Anaerobic soil metabolism; [3]Aquatic photolysis; [4]Soil photolysis | | | |

Field trials were conducted on papaya, banana, and guava to determine the magnitude of oryzalin residues on crops. Oryzalin residues were not detected in any samples of papaya or papaya puree (MRIDS 411155-01) as well as banana and guava (MRIDS 416337-00 and 416337-01). Since no residue was detected in crops, the dissipation of transferable residues of oryzalin on turf was used to determine foliar half-life. The study on the dissipation of isoxaben and oryzalin transferable residues on residential turf was conducted at three sites in California, Indiana, and Mississippi (MRID 450407-01). Two typical end-use formulations containing oryzalin (Surflan® AS as liquid), isoxaben and oryzalin (Turf Fertilizer contains Gallery® Plus Surflan® as granules) were applied using a drop granular spreader and a spray boom liquid applicator.

No turf transferable residue (TTR) value of oryzalin was greater than 6.1% of applied active ingredient, even at DAT 0 (immediately after application). Maximum TTRs were found at the CA location for all typical end-use products tested. The liquid broadcast application of Surflan® AS generally demonstrated a higher transfer of residues from the turf surface than the granular applications (Gallery® Turf Fertilizer and Turf Fertilizer contains Gallery® Plus Surflan®). The registrant corrected all TTR values using the average procedural recoveries for the day of analysis. All overall percent field fortification recoveries were >90%. For TTR values < LOQ (but > LOD), the registrant reported the values as estimated values. Reviewer used a value of ½ the LOQ for TTR values < LOQ (D235659). TTR values <LOD were not included in the regression analysis. All half-life determinations were calculated using a log linear regression and a comparison summary of the half-life estimations and the registrant's half-life estimations is provided in **Table 2.3**.

The upper 90$^{th}$ percentile confidence bound on the mean foliar dissipation half-life was determined as 4.6 days based on the half-life values calculated by HED. This value of 4.6 days was used for all subsequent runs of the T-REX model. The default foliar half-life period of 35 days was also used in the T-REX modeling to bound risk estimates.

| Table 2.3 Summary of Half-Life Determinations for Oryzalin at Various Sites | | | | |
|---|---|---|---|---|
| Product | Active Ingredient | Site | HED Calculated | Registrant Calculated |
| | | | Half-Life (days) | Half-Life (days) |
| Surflan AS | Oryzalin | CA | 1.5 | 1.5 |
| | | IN | 6.9 | 6.6 |
| | | MS | 3.4 | 3.4 |
| Turf Fertilizer containing Gallery Plus Surflan | Oryzalin | CA | 1.1 | 1.1 |
| | | IN | 2.1 | 2.1 |
| | | MS | NA[1] | 3.7 |

[1]NA = Half-life not calculated because active ingredient TTR values dropped below the LOQ (0.003 µg/cm$^2$)

### 2.4.1 Environmental Transport Mechanisms

Potential transport mechanisms for oryzalin include surface water runoff, spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Surface water runoff and spray drift are expected to be the major routes of exposure for oryzalin. Based on its low vapor pressure (1.0 x $10^{-7}$ mm Hg at 25°C) and Henry's Law Constant (1.8 x $10^{-8}$ atm·m$^3$/mol), volatilization loss of oryzalin from soil and water systems is expected to be insignificant compared to dissipation by abiotic and biotic degradation. Based on low volatility and high sensitivity to photolytic degradation, oryzalin is not expected to continue long-range transport.

In general, deposition of drifting pesticides is expected to be greatest close to the site of application. A computer model of spray drift (AgDRIFT) is used to determine potential exposures to aquatic and terrestrial organisms via spray drift. Seedling emergence toxicity studies show that oryzalin is equally toxic to monocot and dicot terrestrial plants, thus the distance of potential impact away from the use sites (action area) is determined by the distance required to fall below the LOC for these non-target plants.

### 2.4.2 Mechanism of Action

Oryzalin is a broad spectrum herbicide that is used to control seedling grasses and some annual broadleaf weeds in both agricultural and non-agricultural settings. Depending on the formulation, the registered products of oryzalin are applied to the soil surface prior to the emergence of weeds as broadcast spray or band treatment for liquid formulations (using low pressure ground equipment) or soil broadcast for granular formulations (using spreaders). To facilitate activation and movement of the chemical to the weed seed germination zone, a single ½ to 1 inch of rainfall or sprinkler irrigation is required. Depending on the rate of application, the soil residual activity of oryzalin ranges between 4 to 10 months.

Oryzalin is mainly absorbed by roots, has little or no foliar activity, and is not translocated within the plant. Thus the primary effect of oryzalin is on root development. Roots of affected plants are relatively few in number, short, thick, and club shaped. The inhibited root growth causes tops of plants to be stunted and demonstrate a dark green color.

Oryzalin, similar to the other members of the chemical family dinitroanilines, acts by disrupting the assembly of microtubules. As a result, mitosis or cell division of plants, ranging from single-celled algae to higher plants, is inhibited. Oryzalin, however, is ineffective against vertebrate and fungal microtubules.

### 2.4.3 Use Characterization

Analysis of label use information is the critical first step in evaluating the federal action. The current label for oryzalin represents the FIFRA regulatory action; therefore, 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.

Oryzalin is a dinitroaniline herbicide that is registered nationally for control of annual grasses and certain broadleaf weeds in fruit and nut crops, vineyards, Christmas tree plantations, ornamentals, turf, and several other non-crop sites. Oryzalin is formulated as granules (0.4 to 1% ai), wettable powder (75% ai), water dispersible granules (60 - 85% ai), emulsifiable concentrate (2.84 to 40.4% ai), flowable concentrate (40.4%), and formulation intermediate/liquid (40.4% ai). Depending on the formulation, oryzalin is typically applied using low pressure ground equipment or spreaders. The labels for oryzalin caution not to apply this herbicide to Douglas fir, slender deutzia, Techny arborvitae, eastern hemlock, begonia, and coleus due to phytotoxicity on the above species.

The following current labeled uses for oryzalin are considered as part of the federal action evaluated in this assessment: avocado, fig, olives, berries, pome fruits, stone fruits, citrus, tree nuts, wine and table grapes, ornamentals (landscape gardens, containers, production fields, ornamental bulbs, and ground covers/perennials), Christmas tree plantations, warm season turf grass, residential areas, and rights-of-ways. There are no new pending uses for oryzalin which are active at this time.

**Table 2.4** presents the uses and corresponding application rates (single and maximum), application interval, and methods of application considered in this assessment.

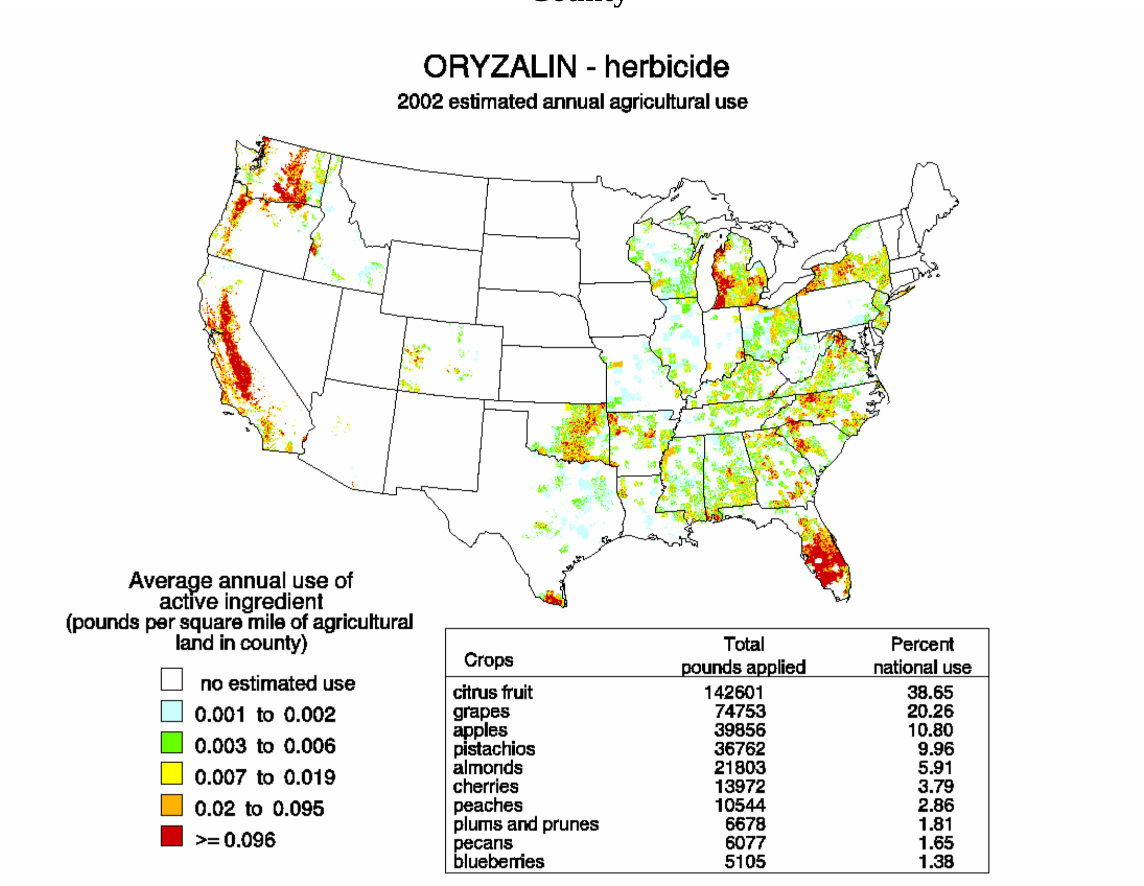
| Table 2.4 Oryzalin Uses Assessed for the CRLF | | | | | | |
|---|---|---|---|---|---|---|
| **Use** | **Formulation Code[1]** | **Application Method** | **Maximum Single Application Rate (lb ai/A)** | **Maximum Number of Applications per Year (#)** | **Maximum Seasonal Application Rate (lb ai/A)** | **Application Interval (days)** |
| **Berries** Blackberry, blueberries, boysenberry, currant, dewberry, elderberry, gooseberry, loganberry and raspberry **Citrus Fruits** Grapefruit, kumquat, kiwi, lime, lemon, mandarin, tangerine, orange, pummelo, nectarine, orange **Pome Fruits** Apple, apricot, crabapple, Figs, loquat, mayhaw, pomegranate, and quince **Tree Nuts** Almonds, chestnut chinquapin, filbert, hickory nut, macadamia nut, pecan, pistachio walnut **Stone Fruits** Avocado, Cherry, Nectarine, olive, peach, pear, plum, prune **Vineyards** Wine and table grapes | EC/DF | Low pressure ground sprayer/ Sprinkler irrigation /Broadcast/ Chemigation/ Soil broadcast treatment | 6 | 2 | 12 | 75 |
| | G | Granules by Spreader/ Broadcast | 4 | 4 | 15 | 60 |
| **Non-bearing trees/vineyards** | EC/DF/WP/L | Low pressure ground sprayer/ Sprinkler irrigation /Broadcast/ Chemigation/ Soil broadcast treatment | 4 | 3 | 12 | 90 |
| | Granular | Granule applicator Spreader, /Broadcast | 4 | 4 | 15 | 60 |
| **Ornamentals[2]** | EC/DF/WP/L | Low pressure ground sprayer/ Sprinkler irrigation /Broadcast/ Chemigation/ Soil broadcast treatment | 4 | 3 | 12 | 90 |

| Table 2.4 Oryzalin Uses Assessed for the CRLF | | | | | | |
|---|---|---|---|---|---|---|
| **Use** | **Formulation Code[1]** | **Application Method** | **Maximum Single Application Rate (lb ai/A)** | **Maximum Number of Applications per Year (#)** | **Maximum Seasonal Application Rate (lb ai/A)** | **Application Interval (days)** |
| | G | Granule applicator Spreader, /Broadcast | 4 | 4 | 15 | 60 |
| **Christmas Tree Plantation** | EC/DF/L/WP | Low pressure ground sprayer/ Sprayer/ Spreader /Broadcast/ Directed spray/ Soil broadcast treatment | 4 | 2 | 8 | 60 |
| | G | Granule applicator Spreader, /Broadcast | 4 | 4 | 15 | 60 |
| **Ornamental bulbs** | EC/L | Low pressure ground sprayer/ Sprayer | 1.5 | 2 | 2.25 | 90 |
| | G | Granule applicator Spreader, /Broadcast | 1.5 | 2 | 2.25 | 90 |
| **Warm Season Turf Grass** | EC/L | Low pressure ground sprayer/ Sprayer | 2 | 3 | 6 | 90 |
| | G | Granule applicator Spreader, /Broadcast | 1.5 | 4 | 6 | 90 |
| **Rights-of-ways** | EC/L/WP | Low pressure ground sprayer/ Sprayer | 6.1 | 2 | 12.2 | 240 |
| | G | Granule applicator Spreader, /Broadcast | 4 | 4 | 15.0 | 60 |
| **Residential areas** | G | Granule applicator Spreader | 2 | 3 | 6 | 56 |

[1]Formulation codes: DF- Water Dispersible Granules (Dry Flowable); EC-Emulsifiable Concentrate; G-Granular; L-Liquid; WP-Wettable Powder
[2]Use in landscape gardens, container and field grown ornamentals, drainage areas under shadehouse benches, ground covers/perennials

A national map (**Figure 2.1**) showing the extent of estimated annual oryzalin uses across the United States as of 2002 is provided below. The map was downloaded from U.S. Geological Survey (USGS), National Water Quality Assessment Program (NAWQA) website. As of 2002, over 93% of total agricultural uses for oryzalin are in the crops listed in **Figure 2.1**. The highest poundage (142,601 lbs) of oryzalin was applied to citrus fruits. Grapes (74,753 lbs) and apples (39,855 lbs) represented the second and third highest total pounds of oryzalin applied.

**Figure 2.1 Oryzalin Use in Total Pounds per County**




| Crops | Total pounds applied | Percent national use |
|---|---|---|
| citrus fruit | 142601 | 38.65 |
| grapes | 74753 | 20.26 |
| apples | 39856 | 10.80 |
| pistachios | 36762 | 9.96 |
| almonds | 21803 | 5.91 |
| cherries | 13972 | 3.79 |
| peaches | 10544 | 2.86 |
| plums and prunes | 6678 | 1.81 |
| pecans | 6077 | 1.65 |
| blueberries | 5105 | 1.38 |

The Agency's Biological and Economic Analysis Division (BEAD) provides an analysis of both national- and county-level usage information (Kaul and Jones, 2006) using state-level usage data obtained from USDA-NASS[2], Doane (www.doane.com; the full dataset is not provided due to its proprietary nature) and the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[3] . CDPR PUR is considered a more comprehensive source of usage data than USDA-NASS or proprietary databases,

[2]United States Depart of Agriculture (USDA), National Agricultural Statistics Service (NASS) Chemical Use Reports provide summary pesticide usage statistics for select agricultural use sites by chemical, crop and state. See http://www.usda.gov/nass/pubs/estindx1.htm#agchem.
[3]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.

and thus the usage data reported for oryzalin by county in this California-specific assessment were generated using CDPR PUR data. Four years (2002-2005) of usage data were included in this analysis. Data from CDPR PUR were obtained for every pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system. BEAD summarized these data to the county level by site, pesticide, and unit treated. Calculating county-level usage involved summarizing across all applications made within a section and then across all sections within a county for each use site and for each pesticide. The county level usage data that were calculated include: average annual pounds applied, average annual area treated, and average and maximum application rate across all four years. The units of area treated are also provided where available.

During the period 2002 to 2005 oryzalin was reportedly used in 54 counties in California. Of the 54 counties, 36 counties listed in **Figure 2.2** used more than 1000 pounds of oryzalin during 2002-2005. The principal use was on orchard and vineyard crops including almonds, pistachio, grapes, apples, apricots, cherries, citrus, lemon, nectarine, orange, peach, pear, plum, prune, quince, avocado, figs, olive and walnuts. Non-orchard uses included berries. In addition, non-agricultural applications were reported as rights-of ways, nursery and ornamentals, landscape maintenance, Christmas trees, greenhouse flowers, structural pest control as well as several applications as research commodities (also limited to a few counties for each use).

During 2002 - 2005, the percentage of total oryzalin use in California was highest on tree nuts (42.5% of total use) followed by grapes (24.8%), right-of ways (10.7%), stone fruits (8.7%), landscape maintenance (5.8%), pome fruits (2.9%), citrus (2.5%) and other uses (2.1%) (**Figure 2.3**). The total annual average for reported uses over this four-year period was 465,153 lbs. The greatest average usage (average of pounds applied per commodity across all four years) was to almonds in Stanislaus county at 17,580 lbs. Use data from 2002 - 2005 for California indicate that oryzalin is applied throughout the year, with the majority of applications occurring during the late winter to early spring months (December -March). A summary of oryzalin usage for all California use sites is provided in **Table 2.5.**

**Figure 2.2 Oryzalin Usage in California (2002 - 2005) by County**

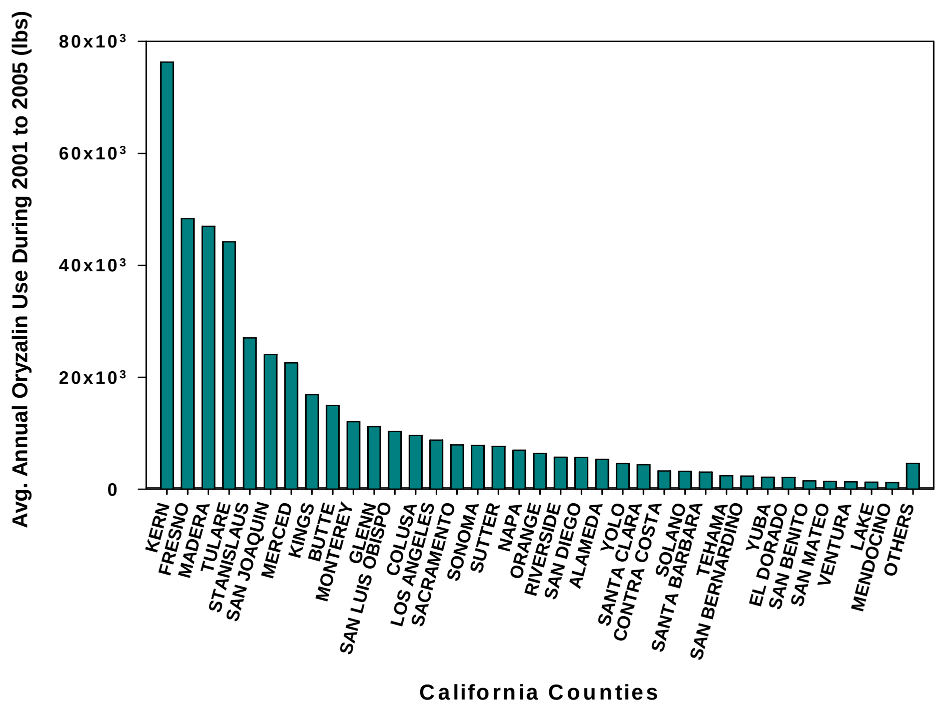
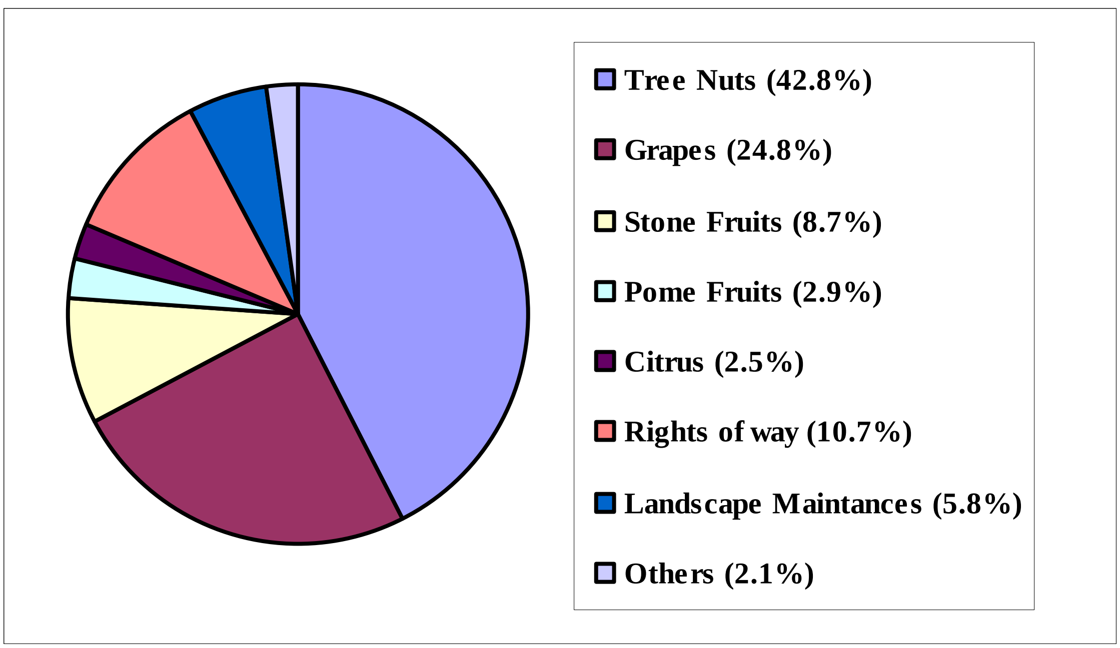



**Figure 2.3 Major Uses of Oryzalin in California During 2002 - 2005**



| Table 2.5 Summary of California Department of Pesticide Regulation (CDPR)'s Pesticide Use Reporting (PUR[1]) Data from 2002 to 2005 for Currently Registered Oryzalin Uses | | | | | |
|---|---|---|---|---|---|
| **Site Name[1]** | **Average Pounds All Uses** | **Average Application Rate All Uses** | **Average 95th % Application Rate** | **Average 99th % Application Rate** | **Average Maximum Application Rate** |
| Tree nut (almond, chestnut, pecan, pistachio, and walnut | 197,607 | 2.04 | 3.42 | 4.01 | 5.90 |
| Grape (table and wine) | 115,123 | 1.79 | 3.32 | 4.26 | 5.96 |
| Rights-of Way | 49,941 | NA[2] | NA | NA | NA |
| Stone fruits (avocado, cherry, nectarine, olive, peach, plum, prune, | 42,043 | 2.21 | 3.45 | 3.84 | 4.43 |
| Landscape maintenance | 26,970 | NA | NA | NA | NA |
| Pome fruits (apple, apricot, figs, pear pomegranate, quince | 13,311 | 2.09 | 3.41 | 3.80 | 3.80 |
| Citrus (citrus, kiwi, lemon, orange, tangerine, tangelo, | 11,711 | 2.37 | 3.17 | 3.76 | 3.82 |
| Outdoor container | 5,792 | 1.58 | 2.00 | 2.05 | 2.05 |
| Structural pest control[3] | 732 | NA | NA | NA | NA |
| Berries (blueberry, | 725 | 2.02 | 2.61 | 2.61 | 2.61 |
| Non-outdoor transplants | 668 | 2.53 | 2.98 | 2.98 | 2.98 |
| Uncultivated Agriculture | 290 | 3.03 | 4.38 | 4.38 | 4.38 |
| Non-Greenhouse plants in container | 266 | 2.38 | 4.55 | 4.85 | 5.90 |
| Non outdoor flowers | 197 | 2.23 | 5.59 | 5.87 | 5.87 |
| Uncultivated non-agriculture | 122 | 1.69 | 2.22 | 2.22 | 2.22 |
| Research Commodity[3] | 94 | NA | NA | NA | NA |
| Christmas Plantation | 87 | 1.58 | 2.00 | 2.05 | 2.05 |
| Non-greenhouse flower and transplants | 85 | 3.38 | 4.49 | 11.82 | 11.82 |

[1]Use reports in CDPR PUR that represent misuse or misreporting are not included in this table
[2]Not available
[3]Uses excluded in this assessment because they will not affect CRLF

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

*Recovery Units*

Eight recovery units have been established by USFWS for the CRLF. These areas are considered essential to the recovery of the species, and the status of the CRLF "may be considered within the smaller scale of the recovery units, as opposed to the statewide range" (USFWS 2002). Recovery units reflect areas with similar conservation needs and population statuses, and therefore, similar recovery goals. The eight units described for the CRLF are delineated by watershed boundaries defined by US Geological Survey hydrologic units and are limited to the elevational maximum for the species of 1,500 m above sea level. The eight recovery units for the CRLF are listed in **Table 2.4** and shown in **Figure 2.2**.

*Core Areas*

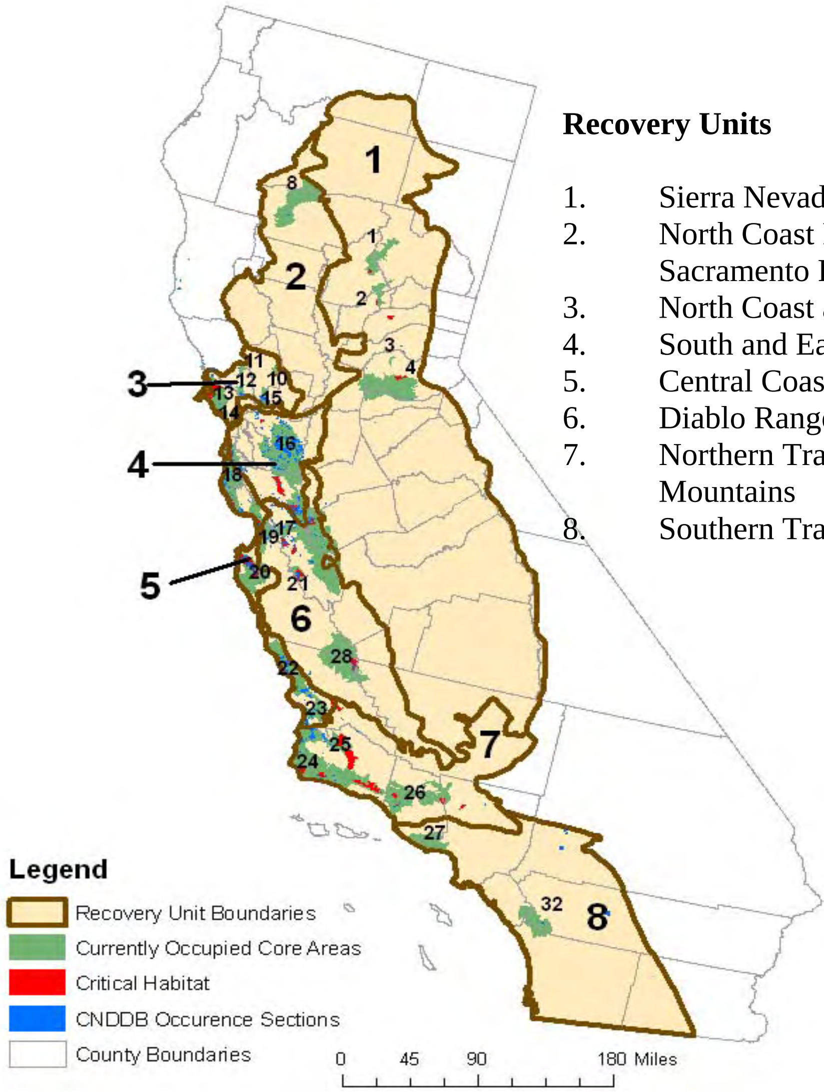
USFWS has designated 35 core areas across the eight recovery units to focus their recovery efforts for the CRLF (see **Figure 2.4**). **Table 2.6** summarizes the geographical relationship among recovery units, core areas, and designated critical habitat. The core areas, which are distributed throughout portions of the historic and current range of the species, represent areas that allow for long-term viability of existing populations and reestablishment of populations within historic range. These areas were selected because they: 1) contain existing viable populations; or 2) they contribute to the connectivity of other habitat areas (USFWS 2002). Core area protection and enhancement are vital for maintenance and expansion of the CRLF's distribution and population throughout its range.

For purposes of this assessment, designated critical habitat, currently occupied (post-1985) core areas, and additional known occurrences of the CRLF from the CNDDB are considered. Historically occupied sections of the core areas are not evaluated as part of this assessment because the USFWS Recovery Plan (USFWS 2002) indicates that CRLFs are extirpated from these areas. A summary of currently and historically occupied core areas is provided in **Table 2.6** (currently occupied core areas are bolded). While core areas are considered essential for recovery of the CRLF, core areas are not federally-designated critical habitat, although designated critical habitat is generally contained within these core recovery areas. It should be noted, however, that several critical habitat units are located outside of the core areas, but within the recovery units. The focus of this assessment is currently occupied core areas, designated critical habitat, and other known CNDDB CRLF occurrences within the recovery units. Federally-designated critical habitat for the CRLF is further explained in Section 2.6.

| Table 2.6 California Red-legged Frog Recovery Units with Overlapping Core Areas and Designated Critical Habitat | | | | |
|---|---|---|---|---|
| **Recovery Unit [1] (Figure 2.a)** | **Core Areas [2,7] (Figure 2.a)** | **Critical Habitat Units [3]** | **Currently Occupied (post-1985) [4]** | **Historically Occupied [4]** |
| Sierra Nevada Foothills and Central Valley (1) (eastern boundary is the 1,500m elevation line) | **Cottonwood Creek (partial) (8)** | -- | ✓ | |
| | **Feather River (1)** | BUT-1A-B | ✓ | |
| | **Yuba River-S. Fork Feather River (2)** | YUB-1 | ✓ | |
| | -- | NEV-1[6] | | |
| | **Traverse Creek/Middle Fork American River/Rubicon (3)** | -- | ✓ | |
| | **Consumnes River (4)** | ELD-1 | ✓ | |
| | S. Fork Calaveras River (5) | -- | | ✓ |
| | Tuolumne River (6) | -- | | ✓ |
| | Piney Creek (7) | -- | | ✓ |
| | **East San Francisco Bay (partial)(16)** | -- | ✓ | |
| North Coast Range Foothills and Western Sacramento River Valley (2) | **Cottonwood Creek (8)** | -- | ✓ | |
| | Putah Creek-Cache Creek (9) | -- | | ✓ |
| | **Jameson Canyon – Lower Napa Valley (partial) (15)** | -- | ✓ | |
| | **Belvedere Lagoon (partial) (14)** | -- | ✓ | |
| | **Pt. Reyes Peninsula (partial) (13)** | -- | ✓ | |
| North Coast and North San Francisco Bay (3) | Putah Creek-Cache Creek (partial) (9) | -- | | ✓ |
| | **Lake Berryessa Tributaries (10)** | NAP-1 | ✓ | |
| | **Upper Sonoma Creek (11)** | -- | ✓ | |
| | **Petaluma Creek-Sonoma Creek (12)** | -- | ✓ | |
| | **Pt. Reyes Peninsula (13)** | MRN-1, MRN-2 | ✓ | |
| | **Belvedere Lagoon (14)** | -- | ✓ | |
| | **Jameson Canyon-Lower Napa River (15)** | SOL-1 | ✓ | |
| South and East San Francisco Bay (4) | -- | CCS-1A[6] | | |
| | **East San Francisco Bay (partial) (16)** | ALA-1A, ALA-1B, STC-1B | ✓ | |
| | -- | STC-1A[6] | | |
| | **South San Francisco Bay (partial) (18)** | SNM-1A | ✓ | |
| Central Coast (5) | **South San Francisco Bay (partial) (18)** | SNM-1A, SNM-2C, SCZ-1 | ✓ | |
| | **Watsonville Slough- Elkhorn Slough (partial) (19)** | SCZ-2 [5] | ✓ | |
| | **Carmel River-Santa Lucia (20)** | MNT-2 | ✓ | |

| | | | | |
|---|---|---|---|---|
| | **Estero Bay (22)** | -- | ✓ | |
| | -- | SLO-8[6] | | |
| | **Arroyo Grande Creek (23)** | -- | ✓ | |
| | **Santa Maria River-Santa Ynez River (24)** | -- | ✓ | |
| Diablo Range and Salinas Valley (6) | **East San Francisco Bay (partial) (16)** | MER-1A-B, STC-1B | ✓ | |
| | -- | SNB-1[6], SNB-2[6] | | |
| | **Santa Clara Valley (17)** | -- | ✓ | |
| | **Watsonville Slough- Elkhorn Slough (partial)(19)** | MNT-1 | ✓ | |
| | **Carmel River-Santa Lucia (partial)(20)** | -- | ✓ | |
| | **Gablan Range (21)** | SNB-3 | ✓ | |
| | **Estrella River (28)** | SLO-1A-B | ✓ | |
| Northern Transverse Ranges and Tehachapi Mountains (7) | -- | SLO-8[6] | | |
| | **Santa Maria River-Santa Ynez River (24)** | STB-4, STB-5, STB-7 | ✓ | |
| | **Sisquoc River (25)** | STB-1, STB-3 | ✓ | |
| | **Ventura River-Santa Clara River (26)** | VEN-1, VEN-2, VEN-3 | ✓ | |
| | -- | LOS-1[6] | | |
| Southern Transverse and Peninsular Ranges (8) | **Santa Monica Bay-Ventura Coastal Streams (27)** | -- | ✓ | |
| | San Gabriel Mountain (29) | -- | | ✓ |
| | Forks of the Mojave (30) | -- | | ✓ |
| | Santa Ana Mountain (31) | -- | | ✓ |
| | **Santa Rosa Plateau (32)** | -- | ✓ | |
| | San Luis Rey (33) | -- | | ✓ |
| | Sweetwater (34) | -- | | ✓ |
| | Laguna Mountain (35) | -- | | ✓ |

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




**Recovery Units**

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

## 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

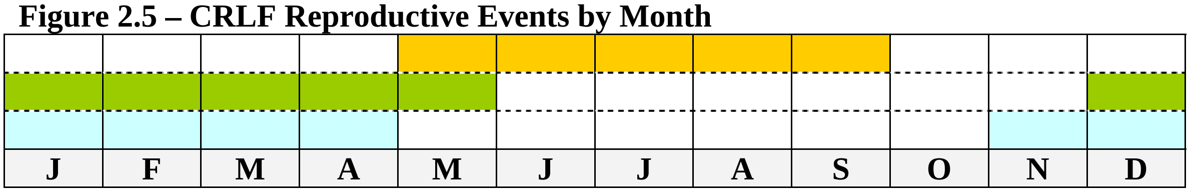
*Other Known Occurrences from the CNDBB*

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.

### 2.5.2 Reproduction

CRLFs breed primarily in ponds; however, they may also breed in quiescent streams, marshes, and lagoons (Fellers 2005a). According to the Recovery Plan (USFWS 2002), CRLFs breed from November through late April. Peaks in spawning activity vary geographically; Fellers (2005b) reports peak spawning as early as January in parts of coastal central California. Eggs are fertilized as they are being laid. Egg masses are typically attached to emergent vegetation, such as bulrushes (*Scirpus* spp.) and cattails (*Typha* spp.) or roots and twigs, and float on or near the surface of the water (Hayes and Miyamoto 1984). Egg masses contain approximately 2000 to 6000 eggs ranging in size between 2 and 2.8 mm (Jennings and Hayes 1994). Embryos hatch 10 to 14 days after fertilization (Fellers 2005a) depending on water temperature. Egg predation is reported to be infrequent and most mortality is associated with the larval stage (particularly through predation by fish); however, predation on eggs by newts has also been reported (Rathburn 1998). Tadpoles require 11 to 28 weeks to metamorphose into juveniles (terrestrial-phase), typically between May and September (Jennings and Hayes 1994, USFWS 2002); tadpoles have been observed to over-winter (delay metamorphosis until the following year) (Fellers 2005b, USFWS 2002). Males reach sexual maturity at 2 years, and females reach sexual maturity at 3 years of age; adults have been reported to live 8 to 10 years (USFWS 2002). **Figure 2.5** depicts CRLF annual reproductive timing.

**Figure 2.5 – CRLF Reproductive Events by Month**




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

### 2.5.3 Diet

Although the diet of CRLF aquatic-phase larvae (tadpoles) has not been studied specifically, it is assumed that their diet is similar to that of other frog species, with the aquatic phase feeding exclusively in water and consuming diatoms, algae, and detritus

(USFWS 2002). Tadpoles filter and entrap suspended algae (Seale and Beckvar, 1980) via mouthparts designed for effective grazing of periphyton (Wassersug, 1984, Kupferberg *et al.*; 1994; Kupferberg, 1997; Altig and McDiarmid, 1999).

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

### 2.5.4 Habitat

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

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

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

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

### 2.6 Designated Critical Habitat

In a final rule published on April 13, 2006, 34 separate units of critical habitat were designated for the CRLF by USFWS (USFWS 2006; FR 51 19244-19346). A summary of the 34 critical habitat units relative to USFWS-designated recovery units and core areas (previously discussed in Section 2.5.1) is provided in **Table 2.6**.

'Critical habitat' is defined in the ESA as the geographic area occupied by the species at the time of the listing where the physical and biological features necessary for the conservation of the species exist, and there is a need for special management to protect the listed species. It may also include areas outside the occupied area at the time of listing if such areas are 'essential to the conservation of the species.' All designated critical habitat for the CRLF was occupied at the time of listing. Critical habitat receives protection under Section 7 of the ESA through prohibition against destruction or adverse modification with regard to actions carried out, funded, or authorized by a federal Agency. Section 7 requires consultation on federal actions that are likely to result in the destruction or adverse 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 1.

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

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

(1) Significant alteration of water chemistry or temperature to levels beyond the tolerances of the CRLF that result in direct or cumulative adverse effects to individuals and their life-cycles.
(2) Significant increase in sediment deposition within the stream channel or pond or disturbance of upland foraging and dispersal habitat that could result in elimination or reduction of habitat necessary for the growth and reproduction of the CRLF by increasing the sediment deposition to levels that would adversely affect their ability to complete their life cycles.
(3) Significant alteration of channel/pond morphology or geometry that may lead to changes to the hydrologic functioning of the stream or pond and alter the timing, duration, water flows, and levels that would degrade or eliminate the CRLF and/or its habitat. Such an effect could also lead to increased sedimentation and degradation in water quality to levels that are beyond the CRLF's tolerances.
(4) Elimination of upland foraging and/or aestivating habitat or dispersal habitat.
(5) Introduction, spread, or augmentation of non-native aquatic species in stream segments or ponds used by the CRLF.
(6) Alteration or elimination of the CRLF's food sources or prey base (also evaluated as indirect effects to the CRLF).

As previously noted in Section 2.1, the 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 oryzalin is expected to directly impact living organisms within the action area, critical habitat analysis for oryzalin 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 oryzalin 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 (USEPA 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 could occur), 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 oryzalin may be expected to have on the environment, the exposure levels to oryzalin that are associated with those effects, and the best available information concerning the use of oryzalin 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. In situations where it is not possible to determine the threshold for an observed effect, the action area is not spatially limited and is assumed to be the entire state of California.

The definition of action area requires a stepwise approach that begins with an understanding of the federal action. The federal action is defined by the currently labeled uses for oryzalin. An analysis of labeled uses and review of available product labels was completed. Several of the currently labeled uses are special local needs (SLN) uses or are restricted to specific states and are excluded from this assessment. In addition, a distinction has been made between food use crops and those that are non-food/non-agricultural uses. For those uses relevant to the CRLF, the analysis indicates that, for oryzalin, the following agricultural uses are considered as part of the federal action evaluated in this assessment:

- Berries
    - Blackberries
    - Blueberries
    - Boysenberries
    - Current
    - Dewberry
    - Elderberry
    - Gooseberry
    - Loganberries
    - Raspberries
    - Kiwi

- Citrus
    - Grapefruit
    - Kumquat
    - Lime
    - Lemon
    - Mandarin
    - Tangerine
    - Orange
    - Pummelo
    - Orange

- Grapes
    - Grapes (wine)
    - Grape (table)

- Pome Fruits
    - Apples
    - Apricot
    - Crabapple
    - Figs
    - Loquat
    - Mayhaw
    - Pear

- Stone Fruits
    - Avocados
    - Cherries
    - Nectarine
    - Olive
    - Peach
    - Plum

    - Prune
    - Pomegranate
    - Quince

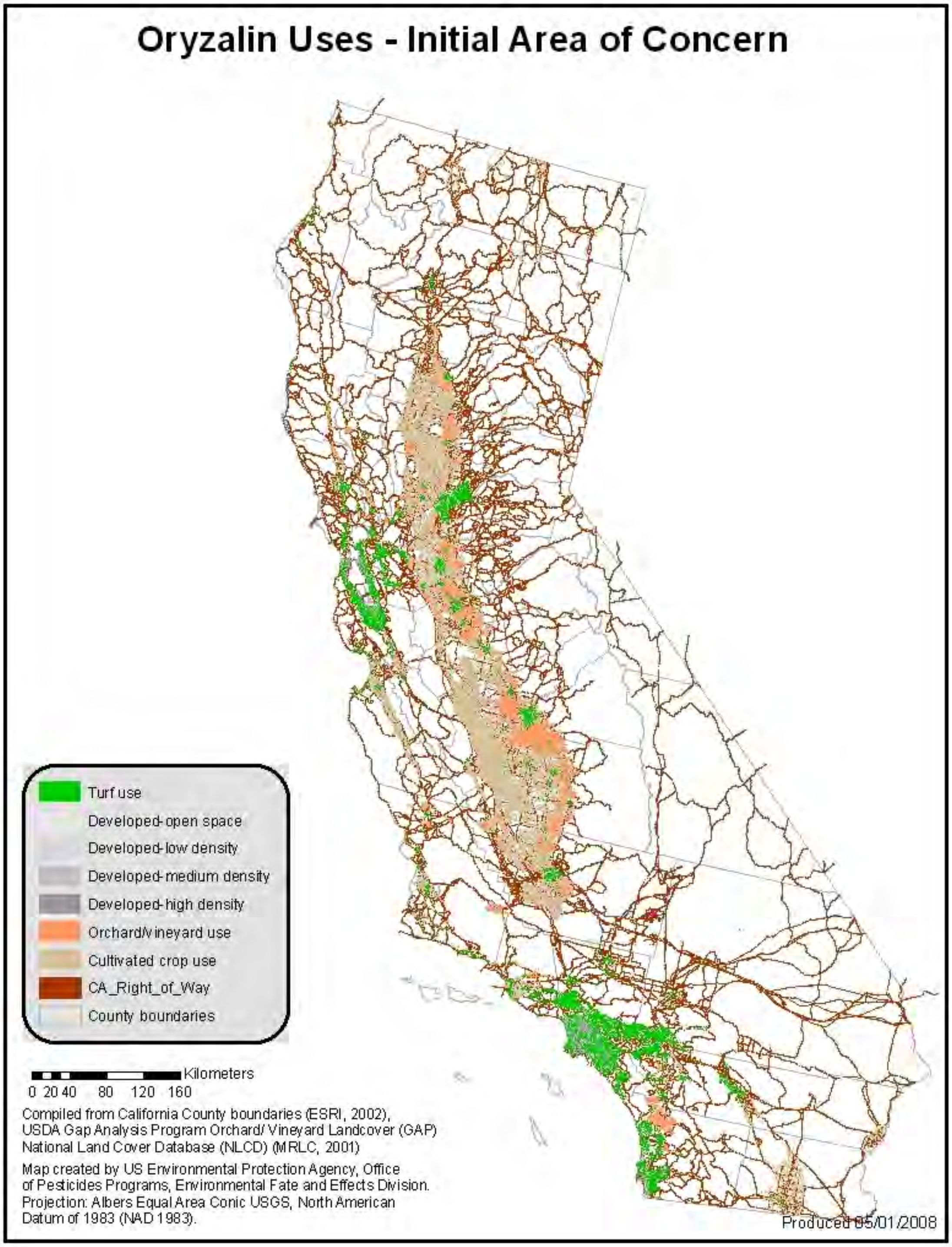
- Tree nuts
    - Almonds
    - Chestnut
    - Chinquapin
    - Filbert
    - Macadamia nut
    - Pecan
    - Pistachio
    - Walnut

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

- Christmas Tree Plantations
- Landscape maintenance
- Non-bearing trees/vineyards
- Rights-of-ways
- Residential areas/lawns
- Ornamentals
- Ornamentals bulbs
- Warm Season Turf Grass

Following a determination of the assessed uses, an evaluation of the potential "footprint" of oryzalin use patterns (i.e., the area where pesticide application could occur) is determined. This "footprint" represents the initial area of concern, based on an analysis of available land cover data for the state of California. The initial area of concern is defined as all land cover types and the stream reaches within the land cover areas that represent the labeled uses described above. A map representing all the land cover types that make up the initial area of concern for oryzalin is presented in **Figure 2.6**. Additional GIS maps and related details are presented in **Appendix D**.

**Figure 2.6 Initial area of concern or "footprint" of potential uses for Oryzalin**




Once the initial area of concern is defined, the next step is to define the potential boundaries of the action area by determining the extent of offsite transport via spray drift and runoff where exposure of one or more taxonomic groups to the pesticide exceeds the listed species LOCs.

As previously discussed, the action area is defined by the most sensitive measure of direct and indirect ecological toxic effects including reduction in survival, growth, reproduction, and the entire suite of sublethal effects from valid, peer-reviewed studies.

Due to the positive results in both the carcinogenicity and mutagenicity tests [HED's Risk Assessment for Tolerance Reassessment Eligibility Decision (TRED) dated 5/18/2004, D300962; **Appendix J**], the spatial extent of the action area (i.e., the boundary where exposures and potential effects are less than the Agency's LOC) for oryzalin cannot be determined. Therefore, it is assumed that the action area encompasses the entire state of California, regardless of the spatial extent (i.e., initial area of concern or footprint) of the pesticide use(s).

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

[4] From 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 oryzalin is provided in **Table 2.7**.

| Table 2.7 Assessment Endpoints and Measures of Ecological Effects | |
|---|---|
| **Assessment Endpoint** | **Measures of Ecological Effects**[5] |
| *Aquatic-Phase CRLF* *(Eggs, larvae, juveniles, and adults)*[1] | |
| *Direct Effects* | |
| 1. Survival, growth, and reproduction of CRLF | 1a. Bluegill sunfish $LC_{50}$<br>1b. Fathead minnow chronic NOAEC |
| *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. Bluegill sunfish $LC_{50}$<br>2b. Fathead minnow chronic NOAEC<br>2c. Water flea $LC_{50}$<br>2d. Water flea NOAEC<br>2e. Non-vascular plant (green algae) $EC_{50}$ |
| 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. Vascular plant acute $EC_{50}$ (duckweed)<br>3b. Non-vascular plant acute $EC_{50}$ (green algae) |
| 4. Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation | 4a. Monocot and dicot $EC_{25}$ values<br>4b. Monocot and dicot NOAEC values |
| *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. Bobwhite quail[2] acute $LC_{50}$ and $LD_{50}$<br>5b. Bobwhite quail chronic NOAEC |
| *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. Honey bee oral acute $LD_{50}$<br>6b. Rat acute $LD_{50}$<br>6c. Rat chronic NOAEC<br>6d. Bobwhite quail[b] acute $LC_{50}$ and $LD_{50}$<br>6e. Bobwhite quail chronic NOAEC |
| 7. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian and upland vegetation) | 7a. Monocot $EC_{25}$ values (seedling emergence)<br>7b. Dicot $EC_{25}$ values (seedling emergence) |
| [1]Adult frogs are no longer in the "aquatic phase" of the amphibian life cycle; however, submerged adult frogs are considered "aquatic" for the purposes of this assessment because exposure pathways in the water are considerably different that exposure pathways on land; [2]Birds are used as surrogates for terrestrial phase amphibians. | |

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

### 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 oryzalin that may alter the PCEs of the CRLF's critical habitat. PCEs for the CRLF were previously described in Section 2.6. Actions that may modify critical habitat are those that alter the PCEs and 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 oryzalin effects data are available.

Adverse modification to the critical habitat of the CRLF includes, but is not limited to, the following, as specified by USFWS (2006):

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

Measures of such possible effects by labeled use of oryzalin on critical habitat of the CRLF are described in **Table 2.8**. Some components of these PCEs are associated with physical abiotic features (e.g., presence and/or depth of a water body, or distance between two sites), which are not expected to be measurably altered by use of pesticides. Assessment endpoints used for the analysis of designated critical habitat are based on the adverse modification standard established by USFWS (2006).

| Table 2.8 Summary of Assessment Endpoints and Measures of Ecological Effect for Primary Constituent Elements of Designated Critical Habitat[1] | |
|---|---|
| **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. | a. Non-vascular green algae $EC_{50}$<br>b. $EC_{25}$ values for terrestrial monocots<br>c. $EC_{25}$ values for terrestrial dicots |
| 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. | a. Non-vascular green algae $EC_{50}$<br>b. $EC_{25}$ values for terrestrial monocots<br>c. $EC_{25}$ values for terrestrial dicots |
| Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source. | a. Bluegill sunfish $LC_{50}$<br>b. Fathead minnow chronic NOAEC<br>c. Water flea $LC_{50}$<br>d. Water flea NOAEC<br>e. Non-vascular plant (green algae) $EC_{50}$ |
| Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae) | a. Non-vascular green algae $EC_{50}$ |
| ***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 | a. $EC_{25}$ values for monocots<br>b. $EC_{25}$ values for dicots<br>c. Honey bee oral acute $LD_{50}$<br>d. Rat acute $LD_{50}$<br>e. Rat chronic NOAEC<br>f. Bobwhite quail acute $LC_{50}$ and $LD_{50}$<br>g. Bobwhite quail chronic NOAEC |
| 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. | |

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

## 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 oryzalin to the environment. The following risk hypotheses are presumed for this endangered species assessment:

The labeled use of oryzalin 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 oryzalin release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for aquatic and terrestrial phases of the CRLF are shown in **Figures 2.7 and 2.8**, respectively, and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in **Figures 2.9 and 2.10**, respectively. 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 negligible.

**Figure 2.7 Conceptual Model for Aquatic-Phase of the CRLF**

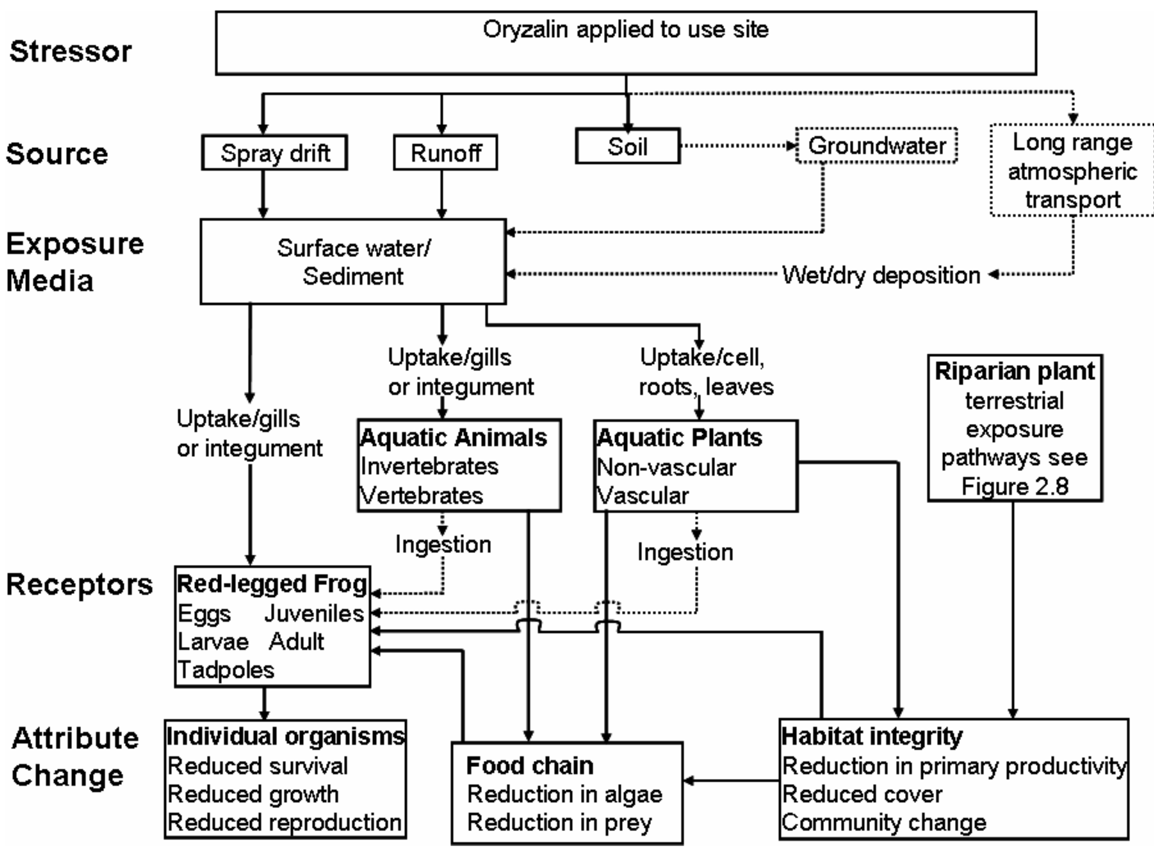


**Figure 2.8 Conceptual Model for Terrestrial-Phase of the CRLF**

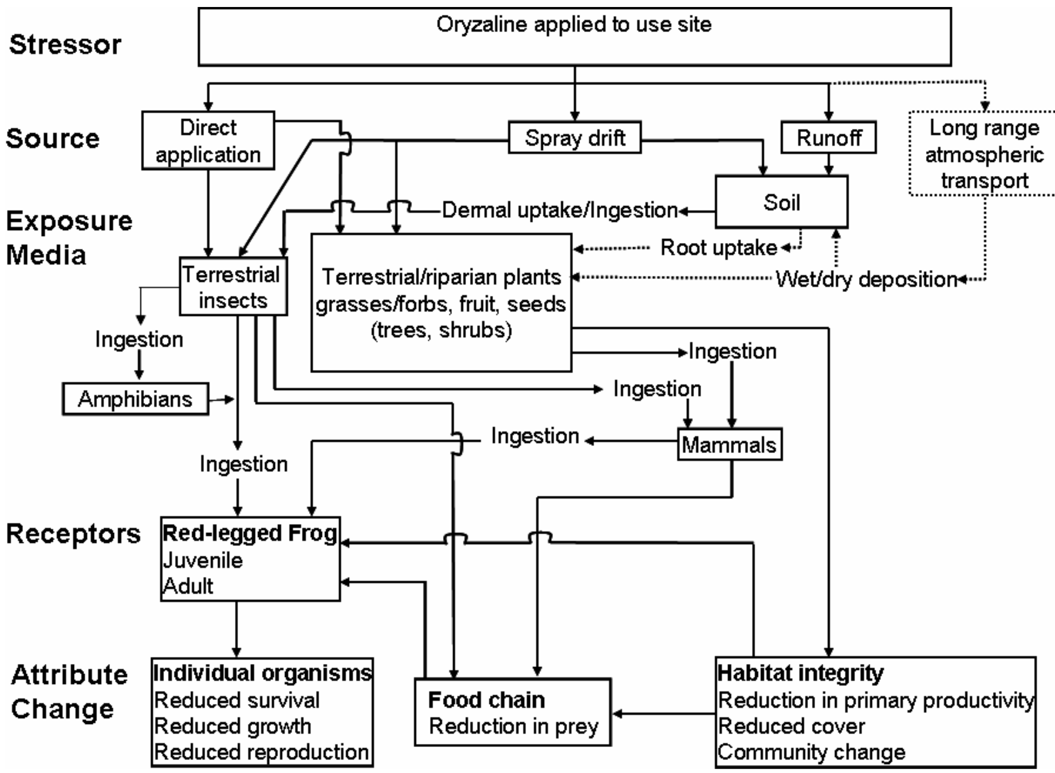



**Figure 2.9 Conceptual Model for Pesticide Effects on Aquatic Component of CRLF Critical Habitat**

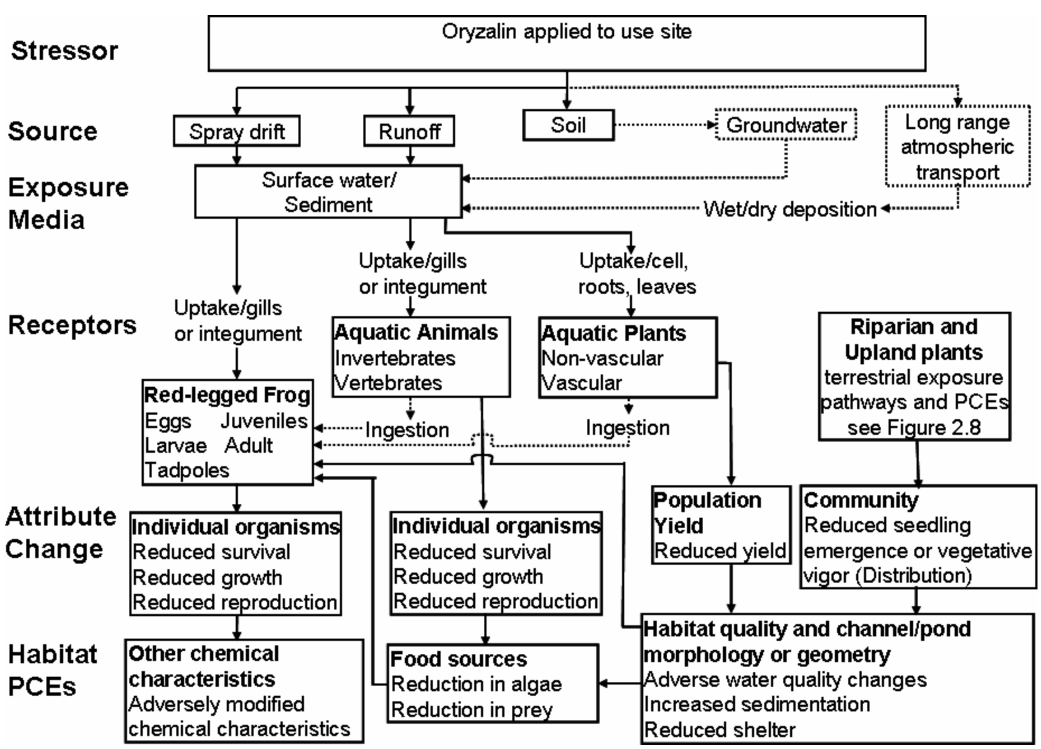
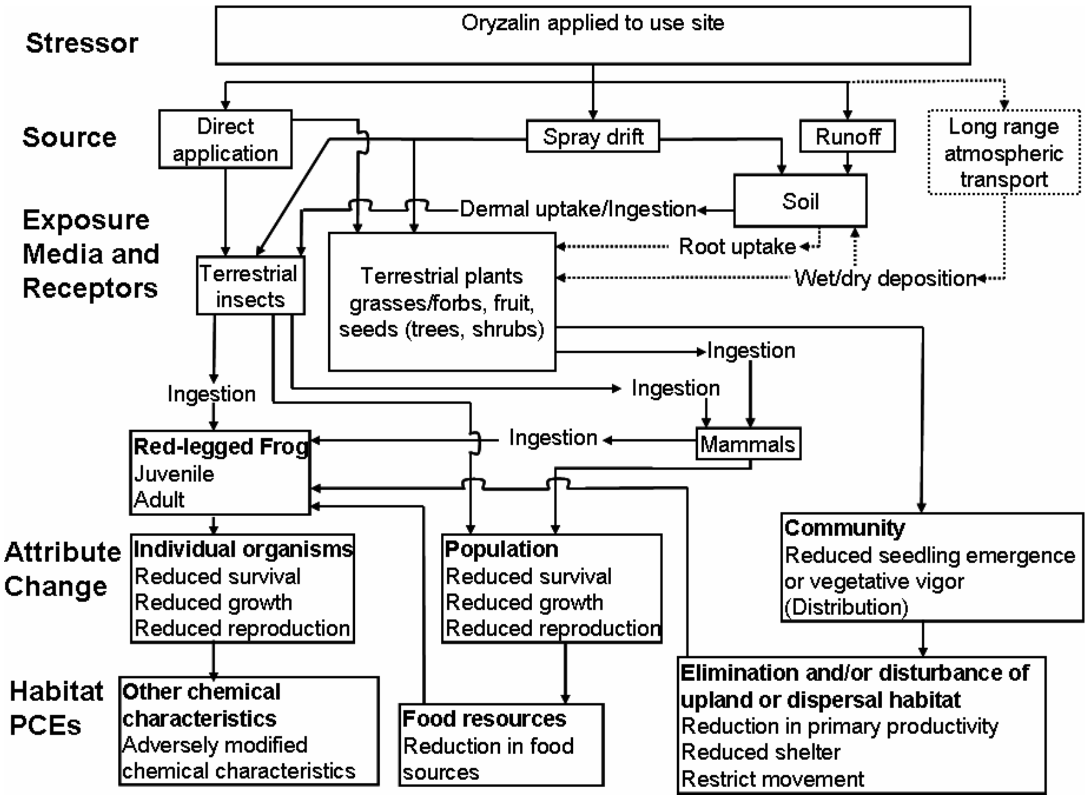


**Figure 2.10 Conceptual Model for Pesticide Effects on Terrestrial Component of CRLF Critical Habitat**




## 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 oryzalin 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 oryzalin 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 oryzalin along with available monitoring data indicate that runoff and spray drift are the principle potential transport mechanisms of oryzalin to the aquatic and terrestrial habitats of the CRLF. Based on the relatively low volatility and greater sensitivity to photolytic degradation, oryzalin has low potential for long-range transport. There is also no data for oryzalin in the California Pesticide Air Monitoring database. Therefore, in this assessment, transport of oryzalin through runoff and spray drift is considered in deriving quantitative estimates of oryzalin 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 oryzalin 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) and EXAMS (v2.98.4.6, April 2005) are screening simulation models coupled with the input shell pe5.pl (Aug 2007) to generate daily exposures and 1-in-10 year EECs of oryzalin that may occur in surface water bodies adjacent to application sites receiving oryzalin 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 oryzalin. 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 (version 1.3.1, 12/07/2006). This model incorporates the Kenaga 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 Kenaga, 1972). For modeling purposes, direct exposures of the CRLF to oryzalin 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 oryzalin 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 (version 1.3.1) has been refined to the T-HERPS model (v. 1.0), which allows for an estimation of food intake for poikilotherms using the same basic procedure as T-REX to estimate avian food intake.

EECs for terrestrial plants inhabiting dry and wetland areas are derived using TerrPlant (version 1.2.2, 12/26/2006). 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.

The spray drift model AgDRIFT was used to assess exposures of terrestrial phase CRLF and its prey to oryzalin deposited on terrestrial habitats by spray drift. In addition to the buffered area from the spray drift analysis, the downstream extent of oryzalin that exceeds the LOC for the effects determination is also considered.

#### 2.10.1.2 Measures of Effect

Data identified in Section 2.8 are used as measures of effect for direct and indirect effects to the CRLF. Data were obtained from registrant submitted studies or from literature studies identified by ECOTOX. The ECOTOXicology database (ECOTOX) was searched in order to provide more ecological effects data and in an attempt to bridge existing data gaps. ECOTOX is a source for locating single chemical toxicity data for aquatic life, terrestrial plants, and wildlife. ECOTOX was created and is maintained by the USEPA, Office of Research and Development, and the National Health and Environmental Effects Research Laboratory's Mid-Continent Ecology Division.

The assessment of risk for direct effects to the terrestrial-phase CRLF makes the assumption that toxicity of oryzalin to birds is similar to 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).

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 (USEPA 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 oryzalin, 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 oryzalin risks, the risk quotient (RQ) method is used to compare exposure and measured toxicity values. EECs are divided by acute and chronic toxicity values. The resulting RQs are then compared to the Agency’s levels of concern (LOCs) (USEPA, 2004) (see **Appendix C**).

For this endangered species assessment, listed species LOCs are used for comparing RQ values for acute and chronic exposures of oryzalin directly to the CRLF. If estimated exposures directly to the CRLF of oryzalin 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 oryzalin 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 C**.

### 2.10.2 Data Gaps

A major data gap in this assessment is the lack of toxicity data on amphibians. No studies are identified in the open literature that documented the acute or chronic exposure effects of oryzalin on amphibians. Therefore, acute and chronic toxicity data on fish and birds (which served as surrogate species for aquatic and terrestrial phase amphibians, respectively) were used. No other data gaps were identified for oryzalin in this assessment.

## 3. Exposure Assessment

Oryzalin is formulated as liquid, granular, water dispersible granules, wettable powder, and emulsifiable concentrate. Formulated products of oryzalin are applied pre-emergence to weeds as liquid spray (broadcast and band treatment using low pressure ground equipment or through irrigation water) or granular applications (using spreaders). Risks from both broadcast spray and granular applications are considered in this assessment because they are expected to result in greatest off-target levels of oryzalin due to spray drift and runoff. Broadcast spray applications made to ground tend to have a higher potential for off-target movement via spray drift compared to granular applications. Therefore, it is expected that direct and indirect effects to aquatic and terrestrial-phase CRLF will be greater from broadcast spray applications (i.e., liquid formulations) compared to granular applications of oryzalin.

### 3.1 Label Application Rates and Intervals

Oryzalin labels may be categorized into two types: labels for manufacturing uses (including technical grade oryzalin and its formulated products) and end-use products. While technical products, which contain oryzalin 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 weeds. The formulated product labels legally limit oryzalin's potential use to only those sites that are specified on the labels. Currently registered uses for oryzalin within California include agricultural (**Table 3.1**) and non-agricultural uses (**Table 3.2**). The uses being assessed are summarized in **Table 3.1 and Table 3.2**.

<table>
<tr><th colspan="4">Table 3.1. Oryzalin Application Information For Food Uses[1]</th></tr>
<tr><th>Use</th><th>Bearing and Non-Bearing Trees/Vineyards<br><br>Broadcast Spray Application</th><th>Non-Bearing Trees/Vineyards* –<br><br>Granular Application</th><th>Non-Bearing Trees/Vineyards –<br><br>Broadcast Spray Application</th></tr>
<tr><td>Berries<br>Blackberry, blueberries, boysenberry, currant, dewberry, elderberry, gooseberry, loganberry, raspberry, and kiwi</td><td rowspan="6">6 lb aiA,<br>2 applications,<br>75-day interval,<br>12 lb ai/A/ year</td><td rowspan="6">4 lb ai/A,<br>4 applications,<br>60-day interval,<br>15 lb ai/A/ year</td><td rowspan="6">4 lb ai/A,<br>3 applications,<br>90-day interval,<br>12 lb ai/A/ year</td></tr>
<tr><td>Citrus Fruits<br>Grapefruit, kumquat, lime, lemon, mandarin, tangerine, orange, pummelo, nectarine, orange</td></tr>
<tr><td>Pome Fruits<br>Apple, apricot, crabapple, figs, loquat, mayhaw, pomegranate, and quince</td></tr>
<tr><td>Tree Nuts<br>Almonds, chestnut chinquapin, filbert, hickory nut, macadamia nut, pecan, pistachio walnut</td></tr>
<tr><td>Stone Fruits<br>Avocado, Cherry, nectarine, olive, peach, pear, plum, prune</td></tr>
<tr><td>Vineyards<br>Wine and table grapes</td></tr>
<tr><td colspan="4">[1]Uses assessed based on memorandum from SRRD dated 12/19/2007</td></tr>
</table>

<table>
<tr><th colspan="3">Table 3.2. Oryzalin Application Information For Non-Food Uses[1]</th></tr>
<tr><th>Use</th><th>Granular Application</th><th>Broadcast Spray Application</th></tr>
<tr><td>Ornamentals*</td><td rowspan="2">4 lb ai/A,<br>4 applications,<br>60-day interval,<br>15.03 lb aiA/ year</td><td>4 lb ai/A,<br>3 applications,<br>90-day interval,<br>12 lb ai/A/ year</td></tr>
<tr><td>Christmas Tree Plantation</td><td>4 lb ai/A,<br>2 applications,<br>60-day interval,<br>8 lb ai/A/ year</td></tr>
<tr><td>Ornamental bulbs</td><td>1.5 lb ai/A,<br>2 application,<br>90-day interval,<br>2.25 lb ai/A/ yr</td><td>1.5 lb ai/A,<br>2 application,<br>90-day interval,<br>2.25 lb ai/A/ yr</td></tr>
<tr><td>Warm Season Turf Grass</td><td>1.5 lb ai/A,<br>4 applications,<br>90-day interval,<br>6 lb ai/A/ year</td><td>2 lb ai/A,<br>3 applications,<br>90-day interval,<br>6 lb ai/A/ year</td></tr>
<tr><td>Rights-of-ways</td><td>4 lb ai/A,<br>4 applications,<br>60-day interval,<br>15.03 lb ai/A/ year</td><td>6.1 lb ai/A,<br>2 applications,<br>8-month interval,<br>12.2 lb ai/A/ yr</td></tr>
<tr><td>Residential areas</td><td>2 lb ai/A,<br>3 applications,<br>56-day interval,<br>6 lb ai/A/ year</td><td>-</td></tr>
<tr><td colspan="3">[1]Uses assessed based on memorandum from SRRD dated 12/19/2007<br>*Use in landscape gardens, container and field grown ornamentals, drainage areas under shadehouse benches, ground covers/perennials</td></tr>
</table>

## 3.2 Aquatic Exposure Assessment

### 3.2.1 Modeling Approach

Aquatic exposures are quantitatively estimated for all of assessed uses using scenarios that represent high exposure sites for oryzalin use. 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 oryzalin were used for modeling, including application rates, number of applications per year, application intervals and the first application date for each crop. Since oryzalin is a pre-emergence herbicide to control annual grasses and certain broadleaf weeds, the date of first application was based on late winter (January 1st) to accommodate multiple applications and extended periods between application intervals for all crop and non-crop scenarios.

#### 3.2.2 Model Inputs

The physical, chemical and environmental fate data of oryzalin used for generating model parameters are listed in **Table 2.1**. The input parameters used in simulating PRZM and EXAMS are listed in **Table 3.3**.

The CA rights-of-ways and CA impervious scenarios are used in tandem in order to model EECs resulting from use of oryzalin on non-cropland areas. The rights-of-ways scenario was developed specifically for the San Francisco Bay region using the conceptual approach developed for the Barton Springs salamander atrazine endangered species risk assessment (U.S. EPA, 2006). The San Francisco area was selected to be representative of urbanized areas with CRLF habitat present in the general vicinity. The impervious scenario was developed to represent the paved areas within a watershed. The EECs derived by PRZM/EXAMS for the two scenarios are further refined to be more representative of non-cropland areas, specifically rights-of-ways. These refinements, termed “post-processing” are described below.

| Table 3.3 Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs for Oryzalin Endangered Species Assessment for the CRLF | | |
|---|---|---|
| **Fate Property** | **Value (unit)** | **MRID (or source)** |
| Molecular Weight | 346.35 | Registrant data |
| Henry's constant | 1.82 x $10^{-8}$ atm·$m^3$/mol | Calculated from solubility and vapor pressure |
| Vapor Pressure | 1 x $10^{-7}$ mm Hg at 25 $^oC$ | MRID 40454801 |
| Solubility in Water[1] | 2.5 mg/l at 25 $^oC$ x 10 | MRID 41208101-2 |
| Photolysis in Water | 0.06 days | MRID 41278701 |
| Aerobic Soil Metabolism Half-lives[2] | 189 days (63 x 3) | MRID 41322801 |
| Hydrolysis | Stable | MRID 41378401 |
| Aerobic Aquatic Metabolism[3] | 378 days | See comments below |
| Anaerobic Aquatic Metabolism[4] | 60 days | See comments below |
| Koc | 941 L kg o.c.$^{-1}$ ( mean of 4 values) | MRID 41479802 |
| Application rate and frequency | Variable | Table 3.1 and Table 3.2 |
| Application intervals | Variable | Table 3.1 and Table 3.2 |
| Chemical Application Method (CAM) | 1 (Soil application) | According to oryzalin labels |
| Application Efficiency | 99% for ground application<br>100% for granular application | Default, EFED guidance |
| Spray Drift Fraction[5] | 1% for ground application<br>Non for granular application | Default, EFED guidance |

[1]Water solubility was multiplied by 10 according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides Version II. February 27, 2002.
[2]Multiplied by 3, according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides Version II. February 27, 2002.
[3]Assumed 2X of aerobic soil metabolism input value, according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides Version II. February 27, 2002
[4]Assumed 2X anaerobic soil metabolism half-life multiplied by three ($T_{1/2}$ = 10 days, MRID 41322802), according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides Version II. February 27, 2002.
[5]Spray drift not included in final EEC due to edge-of-field estimation approach

#### 3.2.2.1. Post-processing of PRZM/EXAMS outputs to develop EECs for non-cropland areas

Available data for California indicate that use of oryzalin on rights-of-ways represents a significant portion of the past (2002 - 2005) use of oryzalin (10.7% of total use). Of uses of oryzalin on non-cropland areas, 81.0% was applied to rights-of-ways (CPUR 2007a).

Rights-of-ways include roads, highways, railroads, utilities and pipelines. These areas contain both impervious (i.e. cement, asphalt, metal surfaces) and pervious surfaces. It is assumed that oryzalin will be applied to the pervious surfaces, where weeds are expected to grow. It is also assumed that oryzalin is not applied to impervious surfaces in rights-of ways, but that there is a 1% incidental spray and 0.5% granular release onto impervious surfaces in the right-of-ways. Further details on how these values were derived and characterization of alternative assumptions are provided in the Barton Springs salamander endangered species risk assessment for atrazine (U.S. EPA, 2006).

In a standard PRZM scenario, it is assumed that an entire 10 ha field is composed only of the identified crop, and that the field has uniform surface properties throughout the field. In a right-of-way, this is not a reasonable assumption, since a right-of-way contains both impervious and pervious surfaces. Since the two surfaces have different properties (especially different curve numbers influencing the runoff from the surfaces) and different masses of applied oryzalin, the standard approach for deriving aquatic EECs is revised using the following approach:

1 Aquatic EECs are derived for the pervious portion of the right-of-way, using the maximum use rate of oryzalin on the CArightofway scenario. At this point, it is assumed that 100% of the right-of-way is composed of pervious surface. Specific inputs for this modeling are defined below.
2 Aquatic EECs are derived for the impervious portion of the right-of-way, using 1% for liquid formulation and 0.5% for granular formulation of the maximum use rate of oryzalin on the CAimpervious scenario. At this point, it is assumed that 100% of the right-of-way is composed of impervious surface.
3 The daily aquatic EECs (contained in the PRZM/EXAMS output file with the suffix “TS”) are input into a Microsoft® Excel® worksheet.
4 Daily aquatic EECs for the impervious surface are multiplied by 50%. Daily aquatic EECs for the pervious surface are multiplied by 50%. The resulting EECs for impervious and pervious surfaces are added together to get an adjusted EEC for each day of the 30-year simulation period (**Equation 1**).

$$\text{Equation 1:} \quad \text{Revised EEC} = (imperviousEEC * 50\%) + (perviousEEC * 50\%)$$

5 Rolling averages for the relevant durations of exposure (21-day, and 60-day averages) are calculated. The 1-in-10 year peak, 21-day and 60-day values are used to define the acute and chronic EECs for the aquatic habitat.

In this approach, it is assumed that rights-of-way are composed of equal parts pervious and impervious surfaces (i.e. in steps 4, the EECs of both surfaces are multiplied by 50%). This is more likely to be representative of a highway or road rights-of-way. It is likely that rights-of-way contain different ratios of the two surfaces. In general, incorporation of impervious surfaces into the exposure assessment results in increasing runoff volume in the watershed, which tends to reduce overall pesticide exposure (when assuming 1% and 0.5% overspray to the impervious surface).

### 3.2.3 Results

The aquatic EECs for the various scenarios and application practices are listed in **Table 3.4.** Oryzalin use resulted in both the highest and lowest estimated aquatic exposures for non-food uses. The calculated highest peak oryzalin exposure concentration was 149.5 ppb for rights-of-ways and the lowest exposure concentration was 3.5 ppb for residential areas, both using granular formulations. Among the food uses modeled, oryzalin use resulted in highest peak exposure concentration of 53 ppb in berries and wine grapes and lowest peak exposure concentration of 9.7 ppb in citrus fruits. Only liquid oryzalin formulations are labeled for food uses where as both liquid and granular formulations are labeled for non-food uses. With liquid formulations, oryzalin use resulted in the highest estimated aquatic exposures for rights-of-ways (141.9 ppb) and lowest exposures for warm season turf grass (5.42 ppb).

**Table 3.4 Aquatic EECs for Oryzalin Uses in California**

| Crops Represented | PRZM/EXAMS Scenarios | Single Application Rate[1] (lb ai/A) | Application Interval (days) | Peak EEC | 21-day Average EEC | 60-Day Average EEC |
|---|---|---|---|---|---|---|
| | | | | ----------------μg/L -------------- | | |
| **Food Uses** | | | | | | |
| **Avocado** | CAavocado_V2 | 6 (L) | 2 | 39.10 | 19.1 | 9.59 |
| **Berries**<br>Blackberry, blueberries, boysenberry, currant, dewberry, elderberry, gooseberry, loganberry kiwi, and raspberry | CAwinegrapes RLF_V2 | 6 (L) | 2 | 52.98 | 29.24 | 15.87 |
| **Citrus Fruits**<br>Grapefruit, kumquat, lime, lemon, mandarin, tangerine, orange, pummelo, nectarine, orange | CAcitrusSTD | 6 (L) | 2 | 9.74 | 5.39 | 2.68 |
| **Pome Fruits**<br>Apple, pear, apricot, crabapple, Fig, loquat, mayhaw, pomegranate, and quince<br>**Stone Fruits**<br>Cherry, Nectarine, peach, plum, prune | CAfruitsSTD | 6 (L) | 2 | 22.85 | 12.48 | 6.23 |
| **Olive** | CAOliveRLF_V2 | 6 (L) | 2 | 21.65 | 11.98 | 6.39 |
| **Tree Nuts**<br>Almonds, chestnut chinquapin, filbert, hickory nut, macadamia nut, pecan, pistachio walnut | CAalmondSTD | 6 (L) | 2 | 49.36 | 26.28 | 14.15 |

| Table 3.4 Aquatic EECs for Oryzalin Uses in California | | | | | | |
|---|---|---|---|---|---|---|
| **Crops Represented** | **PRZM/EXAMS Scenarios** | **Single Application Rate[1] (lb ai/A)** | **Application Interval (days)** | **Peak EEC** | **21-day Average EEC** | **60-Day Average EEC** |
| | | | | ----------------µg/L -------------- | | |
| **Vineyards** Table Grapes Wine Grapes | CAGrapesSTD CAwinegrapesRLF_V2 | 6 (L) 6 (L) | 2 2 | 21.45 52.98 | 11.34 29.24 | 5.84 15.87 |
| **Non-Food Uses** | | | | | | |
| **All non-bearing fruits, nuts, and vineyards crops[2]** | CANurserySTD | 4 (L) 4 (G) | 3 4 | 47.64 72.61 | 26.27 36.73 | 15.03 21.03 |
| **Christmas Tree Plantation** | CA forestry RLF | 4 (L) 4 (G) | 2 4 | 33.5 33.58 | 19.37 19.72 | 9.90 11.27 |
| **Rights-of-ways** | CArightofways RLF_V2 | 6.1 (L) 4 (G) | 2 4 | 141.89 149.48 | 84.92 83.47 | 38.52 37.69 |
| **Ornamentals[3]** | CANursery STD | 4 (L) 4 (G) | 3 4 | 47.64 72.61 | 26.27 36.73 | 15.03 21.03 |
| **Ornamental Bulbs** | CANursery STD | 1.5 (L) 1.5 (G) | 2 2 | 16.44 16. 32 | 8.48 8.49 | 4.37 4.31 |
| **Warm Season Turf Grass** | CAturfRLF | 2 (L) 1.5 (G) | 3 4 | 5.42 8.21 | 2.75 4.16 | 1.65 1.92 |
| **Residential Areas** | CA Residential RLF | 2 (G) | 3 | 3.5 | 1.82 | 1.21 |

[1]G = Granular formulation; L = liquid formulation
[2]Non-bearing fruit and nut trees and non-bearing vineyards are defined as plants that will not bear fruit for at least one year after treatment
[2]Use in landscape gardens, containers and field grown ornamentals, and ground covers/perennials

### 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. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture oryzalin concentrations in high use areas). Included in this assessment are oryzalin data from the USGS NAWQA program (http://water.usgs.gov.nawqa) and data from the California Department of Pesticide Regulation (CDPR). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with pesticide application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment. These monitoring data are characterized in terms of general statistics including number of samples, frequency of detection, maximum concentration, and mean from all detections, where that level of detail is available.

#### 3.2.4.1 USGS NAWQA Surface Water Data

Surface water monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on February10, 2008 and all data for the State of California were downloaded. A total of 347 water samples were analyzed for oryzalin. Of these samples, 27 (7.82%) had positive detections of oryzalin. The maximum concentration detected was 1.51 µg/L in the Arcade Creek near Del Paso Heights, Sacramento and the Warm Creek near San Bernardino, CA. Oryzalin was detected in the Arcade Creek in 7 samples with concentrations ranging 0.08 -1.51 µg/L and in the Warm Creek in 5 samples with concentrations ranging from 0.05 -1.51 µg/L. Oryzalin was also detected in the Merced residential Area River Road Bridge near Newman, CA (8 samples ranging in concentration 0.13 – 0.57 µg/L). Seven more samples were detected at various areas with concentrations ranging 0.02 -0.71µg/L. No clear pattern in oryzalin detections from different use sites is evident because oryzalin was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information.

#### 3.2.4.2 USGS NAWQA Groundwater Data

Groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program were accessed on February 10, 2008 and all data for the state of California was downloaded. A total of 450 water samples were analyzed for oryzalin. Of these samples, oryzalin was not detected in any samples (below the range of quantitation).

#### 3.2.4.3 California Department of Pesticide Regulation (CDPR) Data

Pesticide monitoring studies in surface water were primarily carried out by the California Department of Pesticide Regulation (CDPR), Environmental Hazard Assessment Program (EHAP), United States Geological Survey (USGS), and the Central Valley Regional Water Quality Control Board. Data from these and other studies are documented in EHAP’s surface water database (SURF). Surface water monitoring data was accessed from the CDPR on June 28, 2007 and all data with analysis for oryzalin were extracted. A total of 174 samples were available. Of these samples, oryzalin was detected in 5 samples for a frequency of detection of <3.0 %. The maximum concentration was 1.51 µg/L at Arcade Creek near Norwood, Sacramento, CA. All oryzalin residues were detected at the same site in Sacramento County at concentrations ranging between 0.08 –1.51µg/L.

#### 3.2.4.4 Atmospheric Monitoring Data

Based on its low vapor pressure (1.0 x $10^{-7}$ mm Hg at 25°C) and Henry's Law Constant (1.8 x $10^{-8}$ atm·$m^3$/mol), volatilization loss of oryzalin from soil and water systems is expected to be insignificant. Based on relatively low volatility and high sensitivity to photolytic degradation, oryzalin is not expected to continue long-range transport. There is also no data for oryzalin in the California Pesticide Air Monitoring database.

## 3.3 Terrestrial Animal Exposure Assessment

T-REX (Version 1.3.1) is used to calculate dietary and dose-based EECs of oryzalin 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, both broadcast spray and granular applications of oryzalin are considered, as discussed in Section 3.3.1 and 3.3.2 below.

### 3.3.1 Spray Applications

Terrestrial EECs for broadcast spray formulations of oryzalin were derived for the uses summarized in **Tables 3.1 and 3.2**. A foliar dissipation half-life period could not be established from the papaya, banana, and guava studies submitted for oryzalin as no residues were detected throughout the study periods. Furthermore, non-detection of residues at zero days after application rendered these studies invalid. However, based on the study entitled "Dissipation of Transferable Residues of Isoxaben and Oryzalin on Turf Treated with Formulations of the Pesticides" (MRID 450407-01), the calculated 90th percentile of half-life is 4.6 days. Since the above half-life period is very close to the soil photolysis half-life of 3.8 days, this value (4.6 days) is used in T-REX calculations. The T-REX default foliar dissipation half-life period of 35 days was also used to bound the estimates for risk.

Use specific input values, including number of applications, application rate and application interval are provided in **Table 3.5**. An example output from T-REX is available in **Appendix E**.

**Table 3.5 Input Parameters for Foliar Applications Used to Derive Terrestrial EECs for Oryzalin with T-REX**

| Use Category | Application Rate (lb ai/A) | Number of Applications (#) | Maximum Application Rate (lb ai/A/year) | Application Interval (Days) |
|---|---|---|---|---|
| **Food Uses** | | | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards | 6 | 2 | 12 | 75 |
| **Non-Food Uses** | | | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 4 | 3 | 12 | 90 |
| Ornamental Bulbs | 1.5 | 2 | 2.25 | 90 |
| Christmas Tree Plantations | 4 | 2 | 8 | 60 |
| Warm Season Turf | 2 | 3 | 6 | 90 |
| Rights-of-ways | 6.1 | 2 | 12.2 | 240 |

T-REX is also used to calculate EECs for terrestrial insects exposed to oryzalin. Dietary-based EECs calculated by T-REX for small and large insects (units of a.i./g) are used to bound an estimate of exposure to bees. Available acute contact toxicity data for bees exposed to oryzalin (in units of µg a.i./bee), are converted to µg a.i./g (of bee) by multiplying by 1 bee/0.128 g (i.e., dividing µg a.i./g (of bee) by 0.128 g). The EECs are later compared to the adjusted acute contact toxicity data for bees in order to derive RQs.

For modeling purposes, exposures of the CRLF to oryzalin 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 Kenaga 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 3.6**). Dietary-based EECs for small and large insects reported by T-REX as well as the resulting adjusted EECs are available in **Table 3.7**.

**Table 3.6 Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of the CRLF and its Prey to Oryzalin**

| 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) |
| **Food Uses** | | | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards | 810 | 923 | 1440 | 1373 |
| **Non-Food Uses** | | | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 540 | 615 | 960 | 915 |
| Ornamental Bulbs | 203 | 231 | 360 | 343 |
| Christmas Tree Plantations | 540 | 615 | 960 | 915 |
| Warm Season Turf | 270 | 308 | 480 | 458 |
| Rights-of-ways | 826 | 941 | 1469 | 1400 |

| Table 3.7 EECs (ppm) for Indirect Effects to the Terrestrial-Phase CRLF via Effects to Terrestrial Invertebrate Prey Items | | |
|---|---|---|
| **Use** | **Small Insect** | **Large Insect** |
| **Food Uses** | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards | 810 | 90 |
| **Non-Food Uses** | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 540 | 60 |
| Ornamental Bulbs | 203 | 23 |
| Christmas Tree Plantations | 540 | 60 |
| Warm Season Turf | 270 | 30 |
| Rights-of-ways | 826 | 92 |

The upper bound Kenaga Nomogram-based EECs for terrestrial phase CRLF and small mammal prey items suggests that exposure concentrations (both dose and dietary-based) were lowest and highest for non-food uses of oryzalin. Specifically, terrestrial EECs were lowest for ornamental bulbs (**Table 3.6**). This is due to oryzalin's lowest use rate/application and lowest use rate/A/year for ornamental bulbs compared to the other modeled uses. Highest exposure concentrations, on the other hand, were noted for oryzalin use on rights-of-ways. A similar trend was also noted for terrestrial invertebrate exposure concentrations (**Table 3.7**).

### 3.3.2 Granular Applications

Estimated environmental concentrations from granular applications (mg ai/square foot) for the CRLF are also estimated using T-REX (1.3.1). T-REX assumes that 100% of the applied oryzalin granules are left on the ground unincorporated. Additionally, T-REX also assumes that no residual exposure is associated with granular applications and thus calculates EECs based on single application of oryzalin.

Risk to terrestrial animals from ingesting granules is based on $LD_{50}/ft^2$ values. Although the habitat of the CRLF and its prey items are not limited to a square foot, there is presumably a direct correlation between the concentration of a pesticide in the environment ($mg/ft^2$) and the chance that an animal will be exposed to a concentration that could adversely affect its survival. Further description of the $mg/ft^2$ index is provided in U.S. EPA (1992 and 2004).

In order to derive an estimate of the granular exposure per square foot, the granular application rates for oryzalin were converted from lb ai/A to mg/ft$^2$ in **Table 3.8** using the following equation: EEC in mg/ft$^2$ = (application rate in lb ai/A x 453,590 mg/lb) / 43,560 ft$^2$/A). The $LD_{50}$/ft$^2$ values are calculated using the avian toxicity value (adjusted $LD_{50}$ of the assessed animal and its weight classes) as a surrogate for the terrestrial-phase CRLF. Risk quotients were calculated by comparing the granular EECs (mg ai/ft$^2$) with adjusted avian toxicity values.

| **Table 3.8 Input Parameters and Estimated Environmental Concentrations (EECs) for Terrestrial Animals for Non-Food Granular Uses of Oryzalin** | | |
|---|---|---|
| **Use Category** | **Application Rate (lb ai/A)** | **EEC (mg/ft$^2$)** |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 4 | 41.7 |
| Ornamental Bulbs | 1.5 | 15.6 |
| Christmas Tree Plantations | 4.01 | 41.7 |
| Warm Season Turf | 1.5 | 15.6 |
| Rights-of-ways | 4.01 | 41.7 |
| Residential Areas | 2 | 20.8 |

Estimated environmental concentrations for terrestrial animals from granular uses of oryzalin are lowest for ornamental bulbs and warm season turf (15.6 mg/ft$^2$ for both). All other modeled uses, except residential areas (20.8 mg/ft$^2$), resulted in terrestrial EECs of 41.7 mg/ft$^2$**.**

### 3.4 Terrestrial Plant Exposure Assessment

TerrPlant (Version 1.1.2) is used to calculate EECs for non-target plant species inhabiting dry and semi-aquatic areas. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and application method (**Table 3.9**). A runoff value of 0.01 is utilized based on oryzalin's solubility, which is classified by TerrPlant as <10 mg/L. For ground broadcast and granular application methods, drift is assumed to be 1% and 0%, respectively. EECs relevant to terrestrial plants consider pesticide concentrations in drift and in runoff. These EECs are listed by use in **Table 3.9**. An example output from TerrPlant v.1.2.2 is available in **Appendix G.**

Spray drift EECs are calculated for liquid formulations of oryzalin only as no drift is associated with granular formulations and were highest (0.06 lb ai/A) for all food uses and 1 non-food use (rights-of-ways) (**Table 3.9**). Runoff EECs, in general, were greater for semi-aquatic areas compared to dry areas. Also, runoff EECs were lower for granular applications compared to broadcast spray applications.

| Table 3.9 TerrPlant Inputs and Resulting EECs for Plants Inhabiting Dry and Semi-aquatic Areas Exposed to Oryzalin via Runoff and Drift | | | | | | |
|---|---|---|---|---|---|---|
| **Use Category** | **Type of Application** | **Single Application Rate (lb ai/A)** | **Drift Value (%)** | **Spray drift EEC (lb ai/A)** | **Dry area EEC (lb ai/A)** | **Semi-aquatic area EEC (lb ai/A)** |
| **Food Uses** | | | | | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards – | Ground Broadcast | 6 | 1 | 0.06 | 0.12 | 0.66 |
| **Non-Food Uses** | | | | | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | Ground Broadcast | 4 | 1 | 0.04 | 0.08 | 0.44 |
| | Granular | 4 | 0 | 0 | 0.04 | 0.4 |
| Ornamental Bulbs | Ground Broadcast | 1.5 | 1 | 0.02 | 0.03 | 0.17 |
| | Granular | 1.5 | 0 | 0 | 0.02 | 0.15 |
| Christmas Tree Plantations | Ground Broadcast | 4 | 1 | 0.04 | 0.08 | 0.44 |
| | Granular | 4 | 0 | 0 | 0.04 | 0.40 |
| Warm Season Turf | Ground Broadcast | 2 | 1 | 0.02 | 0.04 | 0.22 |
| | Granular | 1.5 | 0 | 0 | 0.02 | 0.15 |
| Rights-of-ways | Ground Broadcast | 6.1 | 1 | 0.06 | 0.12 | 0.67 |
| | Granular | 4 | 0 | 0 | 0.04 | 0.4 |
| Residential areas | Granular | 2 | 0 | 0 | 0.02 | 0.2 |

## 4. Effects Assessment

This assessment evaluates the potential for oryzalin to directly or indirectly affect the CRLF or modify its designated critical habitat. As previously 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 oryzalin.

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). Open literature data presented in this assessment were obtained from Reregistration Eligibility Decision document for oryzalin as well as ECOTOX information obtained on 30 September, 2007. In order to be included in the ECOTOX database, papers must meet the following minimum criteria:

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

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, unless quantitative relationships between modifications and reduction in species survival, reproduction, and/or growth are 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 for oryzalin.

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

Open literature studies deemed relevant but classified invalid for use in this assessment and the rationale for their exclusion are presented in Table A-10 of **Appendix A**. **Appendix A** also includes a summary of the human health effects data for oryzalin.

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 oryzalin. A summary of the available aquatic and terrestrial ecotoxicity information, use of the probit dose response relationship, and the incident information for oryzalin are provided in Sections 4.1 through 4.4, respectively.

No ecotoxicity information is available for oryzalin degradates, formulated products, or mixtures.

### 4.1 Toxicity of Oryzalin to Aquatic Organisms

**Table 4.1** summarizes the most sensitive aquatic toxicity endpoints for the CRLF, based on an evaluation of the registrant-submitted studies. No valid open literature studies were identified for oryzalin for use in the current assessment. A brief summary of submitted data considered relevant to this ecological risk assessment for the CRLF is presented in Table 4.1 below and also in **Appendix A (Table A-1).**

| Table 4.1 Freshwater Aquatic Toxicity Profile for Oryzalin | | | | |
|---|---|---|---|---|
| **Assessment Endpoint** | **Species** | **Toxicity Value Used in Risk Assessment** | **Citation MRID # (Author & Date)** | **Comment** |
| Acute Direct Toxicity to Aquatic-Phase CRLF | Bluegill sunfish | 96-hour $LC_{50}$ = 2.88 mg/L<br>NOAEC = 1 mg/L<br>Slope = 9.3 | 00072595<br>Sleight, 1971 | Core<br>TGAI |
| Chronic Direct Toxicity to Aquatic-Phase CRLF | Fathead minnow | NOAEC = 0.22 mg/L<br>LOAEC = 0.43 mg/L | 00126841<br>Lilly Research Lab, 1982 | Core<br>TGAI<br>Mean larval weight is the most sensitive endpoint |
| Indirect Toxicity to Aquatic-Phase CRLF via Acute Toxicity to Freshwater Invertebrates (i.e. prey items) | Water flea | 48-hour $EC_{50}$ = 1.5 mg/L<br>NOAEC = 1 mg/L<br>Slope = 9.5 | 00072596<br>Carter et al., 1980 | Core<br>TGAI |
| Indirect Toxicity to Aquatic-Phase CRLF via Chronic Toxicity to Freshwater Invertebrates (i.e. prey items) | Water flea | NOAEC = 0.358 mg/L<br>LOAEC = 0.608 mg/L | 43986901<br>Kirk et al., 1996 | Core<br>TGAI<br>Most sensitive endpoint is the dry weight of the first generation daphnid |
| Indirect Toxicity to Aquatic-Phase CRLF via Acute Toxicity to Non-vascular Aquatic Plants | Green algae | 5-day $EC_{50}$ = 42 ppb<br>NOAEC = 13.8 ppb | 43136901<br>Hughes and Williams, 1994 | Core<br>TGAI |
| Indirect Toxicity to Aquatic-Phase CRLF via Acute Toxicity to Vascular Aquatic Plants | Duckweed | 14-day $EC_{50}$ = 15.4 ppb<br>NOAEC = 5.48 ppb | 43136905<br>Hughes and Williams, 1994 | Core<br>TGAI |

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

| Table 4.2 Categories of Acute Toxicity for Aquatic Organisms | |
|---|---|
| **$LC_{50}$ (mg/L or ppm)** | **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 no oryzalin toxicity data are available for aquatic-phase amphibians, freshwater fish data were used as a surrogate to estimate direct acute and chronic risks to the CRLF. Freshwater fish toxicity data were also used to assess potential indirect effects of oryzalin to the CRLF. Effects to freshwater fish resulting from exposure to oryzalin 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).

A summary of acute and chronic freshwater fish data is provided below in Sections 4.1.1.1 through 4.1.1.3.

#### 4.1.1.1 Freshwater Fish: Acute Exposure (Mortality) Studies

Three freshwater fish studies (two on rainbow trout and one on bluegill sunfish), as shown in **Appendix A (Table A-2)**, are available to document the acute exposure effects of oryzalin on freshwater fish. Based on these studies, the 96-hour acute toxicity of oryzalin to the rainbow trout (MRID TN1078), rainbow trout (MRID 00072595) and the bluegill sunfish (MRID 00072595) were 3.45, 3.26 (NOAEC = 3.2 mg/L), and 2.88 (NOAEC = 1 mg/L) mg/L, respectively. The acute toxicity values for the above freshwater fish exceeded the expected water solubility for oryzalin of 2.5 mg/L at 20 C. The above three studies tested the technical grade active ingredient, concluded that oryzalin is moderately toxic to both fish species, and were classified as Core.

The bluegill sunfish $LC_{50}$ of 2.88 mg/L was selected as the surrogate freshwater fish toxicity endpoint to assess the direct acute effects of oryzalin to the CRLF as it is the most sensitive endpoint. No additional valid data on the acute toxicity of oryzalin degradates to freshwater fish were located in the open literature.

#### 4.1.1.2 Freshwater Fish: Chronic Exposure (Growth/Reproduction) Studies

Two scientifically sound freshwater fish chronic toxicity tests, conducted using technical grade oryzalin, were submitted (**Appendix A, Table A-3**). Species tested were rainbow trout (MRID 00126842) and fathead minnow (MRID 00126841). The rainbow trout study was a 66-day early life stage test whereas the fathead minnow study was a 34-day early life stage study. The reported NOAEC/LOAEC values were >0.46/>0.46 and 0.22/0.43 mg/L for rainbow trout and fathead minnow, respectively, suggesting that fathead minnow is more sensitive to oryzalin than rainbow trout. Both studies were classified as Core.

No adverse effects were noted at any concentration tested in the rainbow trout study. As a result, a definitive NOAEC value could not be established in the study. In the chronic exposure study using fathead minnow, mean larval weights were affected at the highest oryzalin dose tested. The NOAEC value (0.22 µg/L) reported in the fathead minnow study was used in this assessment as this is the definitive and the most sensitive endpoint.

#### 4.1.1.3 Freshwater Fish: Sublethal Effects and Additional Open Literature Information

No valid studies were located in the open literature that report endpoints on sublethal effects to freshwater fish that are less sensitive than the selected measures of effect summarized in **Table 4.2**. In addition, no laboratory freshwater fish early life-stage or life-cycle tests using oryzalin and/or its formulated products were located in the open literature.

### 4.1.2 Toxicity to Freshwater Invertebrates

Freshwater aquatic invertebrate toxicity data were used to assess potential indirect effects of oryzalin to the CRLF. Effects to freshwater invertebrates resulting from exposure to oryzalin 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.

A summary of acute and chronic freshwater invertebrate data is provided below in Sections 4.1.2.1 through 4.1.2.3.

#### 4.1.2.1 Freshwater Invertebrates: Acute Exposure Studies

Data on the acute exposure effects of oryzalin on aquatic invertebrates are available for the water flea (*Daphnia magna*) (MRID 00072596). Oryzalin toxicity to other freshwater invertebrates is not available. Results of acute toxicity tests with freshwater invertebrates are tabulated in **Appendix A (Table A-2)**.

The 48-hr test on water flea reported an $EC_{50}$ of 1.5 mg/L and a slope of 9.5. At test concentrations greater than1.6 mg/L, hypoactivity, prostration, and immobility were the effects noted. Reported NOAEC value was 0.62 mg/L based on immobility (mortality). Based on this data, oryzalin is categorized as moderately toxic to freshwater invertebrates on an acute basis. No additional data on the acute toxicity of oryzalin or its degradates to freshwater invertebrates were located in the open literature.

#### 4.1.2.2 Freshwater Invertebrates: Chronic Exposure Studies

An aquatic invertebrate (*Daphnia magna*) lifecycle study (MRID 43986901) submitted for oryzalin (**Appendix A, Table A-3**) reported a NOAEC value of 0.358 mg/L and a LOAEC value of 0.608 mg/L. The above endpoints were based on the dry weights of the first generation daphnid. This study was classified as Core.

#### 4.1.2.3 Freshwater Invertebrates: Open Literature Data

No freshwater invertebrate studies, based on acute or chronic exposure, were located for oryzalin from the open literature.

### 4.1.3 Toxicity to Aquatic Plants

Aquatic plant toxicity studies were used as one of the measures of effect to evaluate whether oryzalin may 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.

#### 4.1.3.1 Aquatic Plants: Acute Exposure Studies

Tier II toxicity data for technical grade oryzalin is available for the vascular plant duckweed (*Lemna gibba*) and the following four non-vascular plants: blue-green algae (*Anabaena flos-aquae*), marine diatom (*Skeletonema costatum*), freshwater alga (*Selenastrum capricornutum*), and freshwater diatom (*Navicula pelliculosa)*. A summary of acute toxicity of oryzalin to aquatic plants is provided in **Appendix A (Table A-4)**.

In the14-day acute toxicity study with the aquatic vascular plant duckweed, the $EC_{50}$ and NOAEC were determined to be >15.4 and 5.48 ppb a.i., respectively. The above endpoints were based on mean frond counts.

Results for non-vascular plants indicate that the marine diatom, *Skeletonema costatum.* is the most sensitive plant to oryzalin (MRID 43136904). Cell density or growth-based $EC_{50}$ values for the non-vascular plants were 42 ppb for green algae, 24,000 ppb for blue-green algae, 72 ppb for freshwater diatom, and 41 ppb for marine diatom. The respective NOAEC values for the above non-vascular plant species were 13.8 ppb, 8100 ppb, 15.4 ppb, and 30.6 ppb.

Due to the non-obligatory relationship between the CRLF and the aquatic non-vascular plants, the $EC_{50}$ values are used as measurement endpoints to determine risk. The $EC_{50}$ values for *Selenastrum capricorutum* and *Lemna gibba* of 42 ppb and 15.4 ppb, respectively, were used to assess indirect effects to CRLF. The endpoint for green algae was used in this assessment as it is a freshwater non-vascular plant on which CRLF feeds.

No valid aquatic plant studies were located for oryzalin in the open literature that reported an endpoint less than the selected measures of effect summarized in **Table 4.2**.

## 4.2 Toxicity of Oryzalin to Terrestrial Organisms

**Table 4.3** summarizes the most sensitive terrestrial toxicity endpoints for the CRLF, based on an evaluation of the submitted studies. No studies on terrestrial organisms were identified for oryzalin in the open literature. A brief summary of submitted data considered relevant to this ecological risk assessment for the CRLF is presented below.

| Table 4.3 Terrestrial Toxicity Profile for Oryzalin | | | | |
|---|---|---|---|---|
| **Endpoint** | **Species** | **Toxicity Value Used in Risk Assessment** | **Citation MRID# (Author & Date)** | **Comment** |
| Acute Direct Toxicity to Terrestrial-Phase CRLF ($LD_{50}$) | Bobwhite quail | $LD_{50}$ = 506.7 mg ai/kg-bw<br><br>Slope = 4.5 | 00098462<br>Cochrane et al., 1982 | Core<br>Effects noted include lethargy, ataxia, ruffled appearance, emaciation, and yellow colored loose feces; dose-related decline in food consumption and body weight loss were also noted |
| Acute Direct Toxicity to Terrestrial-Phase CRLF ($LC_{50}$) | Bobwhite quail/mallard duck | $LC_{50}$ = >5000 mg ai/kg-diet | 00072593/<br>00072594<br>Lilly Research Lab, 1980 | Supplemental |
| Chronic Direct Toxicity to Terrestrial-Phase CRLF | Bobwhite quail | NOAEC = 132 mg ai/kg<br><br>LOAEC = 311 mg ai/kg | 44162201<br>Gallagher et al., 1996 | Core<br>Female bodyweight |
| Indirect Toxicity to Terrestrial-Phase CRLF (via acute toxicity to mammalian prey items) | Rat | $LD_{50}$ = >10 g ai/kg | 00026592<br>Lilly Research Lab, 1975 | Core |
| Indirect Toxicity to Terrestrial-Phase CRLF (via chronic toxicity to mammalian prey items) | Rat | NOAEL = 13.8 mg ai/kg bw<br>LOAEL = 42.89 mg ai/kg/day | 00026779<br>Elanco Products Company, 1979<br>00044332<br>Carter et al., 1980<br>00070569<br>Todd, 1981 | Core<br>Females more sensitive than males; decreased body weight gain, decreased hematology parameters, and increased microscopic findings in the thyroid were the noted effects |
| Indirect Toxicity to Terrestrial-Phase CRLF (via acute toxicity to terrestrial invertebrate prey items) | Honey bee | $LD_{50}$ = >11 µg/bee | 00066220 | A summary study that evaluated toxicity of various pesticides to honey bees |
| Indirect Toxicity to Terrestrial- and Aquatic-Phase CRLF (via toxicity to terrestrial plants) | <u>Seedling Emergence</u><br>Monocots<br>Dicots | <br><br>$EC_{25}$ = 0.0285 lb ai/A<br>$EC_{25}$ = 0.0506 lb ai/A | 42602401<br>Feutz, 1992 | Core<br>TEP<br>ryegrass shoot length<br>tomato shoot length |
| | <u>Vegetative Vigor</u><br>Monocots<br>Dicots | <br>$EC_{25}$ = 0.174 lb ai/A<br>$EC_{25}$ = 0.0828 lb ai/A | 42602401<br>Feutz, 1992 | Core<br>TEP<br>ryegrass shoot length<br>tomato shoot length |

Acute toxicity to terrestrial animals is categorized using the classification system shown in **Table 4.4** (U.S. EPA, 2004). Toxicity categories for terrestrial plants have not been defined.

**Table 4.4 Categories of Acute Toxicity for Avian and Mammalian Studies**

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

### 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 (U.S. EPA, 2004). No terrestrial-phase amphibian data are available for oryzalin; therefore, acute and chronic avian toxicity data are used to assess the potential direct effects of oryzalin to terrestrial-phase CRLFs.

#### 4.2.1.1 Birds: Acute Exposure (Mortality) Studies

Acute oral toxicity data (MRID 00098462) available on a single avian species, bobwhite quail (*Colinus virginianus*), is summarized in **Appendix A (Table A-5)**. Based on the $LD_{50}$ of 506.7 mg ai/kg bw reported in this study, oryzalin is classified as slightly toxic to birds on an acute exposure basis. Toxic effects noted include lethargy, ataxia, ruffled appearance, emaciation, and yellow colored loose feces. Dose-related decline in food consumption and body weight loss were also noted. This study was classified as Core.

The results of the subacute dietary studies for the preferred test species, bobwhite quail and mallard duck (*A. platyrhynchos*), are summarized in **Appendix A (Table A-5).** Subacute avian dietary toxicity values indicate that oryzalin is practically non-toxic to birds. Dietary studies on both the bobwhite quail (MRID# 00072593) and the mallard duck (MRID# 00072594) reported $LC_{50}$s > 5000 ppm (the highest concentration tested). In the bobwhite quail study, there was one mortality at the 5000 ppm concentration but it was attributed to mechanical injury and was not considered a toxicant-related death. Even though there was no mortality observed, the bobwhite quail study did show reduced food consumption and reduction in body weight gain at all concentrations tested including the lowest concentration of 625 ppm. In the mallard duck study, there were no mortalities and no observable effects at any of the concentrations tested.

Based on a review of the open literature, no additional information on the acute and subacute toxicity of oryzalin to birds is available that indicates greater avian sensitivity than the registrant-submitted studies.

#### 4.2.1.2 Birds: Chronic Exposure (Growth, Reproduction) Studies

Four avian reproduction studies, two on bobwhite quail (MRID 00129050 and MRID 44162201) and two on mallard duck (MRID 00126843 and MRID 44162202), are submitted for oryzalin. These studies are summarized in **Appendix A (Table A-6)**.

The bobwhite quail (MRID 00129050) and the mallard duck (MRID 00126843) studies submitted in 1982 were classified as supplemental. While the bobwhite quail study did not fulfill guideline requirements due to mortality of birds in the control treatment, the mallard duck study determined a NOAEC of 1000 ppm, which is the highest dose tested in the study. The mallard duck study was classified as core at the time the study was first reviewed in 1982; however, it was classified as supplemental in the RED because the application rates for a single application have increased 4-fold from 1.5 lbs a.i./A to 6.0 lb a.i./A. To bridge this data gap and to satisfy the data requirements for avian reproduction, two new studies were submitted in 1996.

The most sensitive avian reproductive endpoint used in this assessment is based on the bobwhite quail study submitted in 1996 (MRID 44162201). The NOAEC was determined to be 132 mg/kg, based on reduction in the female body weight. No other reproductive effects were noted in this study. The reported LOAEC was 311 mg/kg.

In the mallard duck reproduction study of 1996 (MRID 44162202), oryzalin did not cause adverse effect on any of the endpoints evaluated even at the highest dose tested. The NOAEC/LOAEC values were determined to be >311 mg/kg. This study was classified as supplemental as mallard ducks were exposed to treatment for only 8 weeks prior to egg-hatching period, as opposed to the 10 week period stipulated in the guidelines.

Based on a review of the open literature, no additional information on the chronic toxicity of oryzalin to birds is available that suggests greater sensitivity than the registrant-submitted data.

### 4.2.2 Toxicity to Mammals

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

#### 4.2.2.1 Mammals: Acute Exposure (Mortality) Studies

The acute mammalian toxicity data for oryzalin is summarized in **Appendix A (Table A-7)**. Rats exposed orally to technical grade oryzalin showed no mortality at the highest doses tested (MRID 00026592). The corresponding $LD_{50}$ value for the TGAI is >10,000 mg/kg-bw, which classifies technical grade oryzalin as practically non-toxic to mammals on an acute basis.

Based on a review of the open literature, no additional information on the acute toxicity of oryzalin to mammals is available that indicates greater sensitivity than the study discussed above.

#### 4.2.2.2 Mammals: Chronic Exposure (Growth, Reproduction) Studies

Data on chronic developmental and reproductive effects of oryzalin on mammals are reported in **Appendix A (Table A-7)**. Chronic studies (MRID 000026779, 00044332, 00070569) that tested oryzalin toxicity on laboratory rats reported a NOAEL/LOAEL value of 13.82/42.89 mg/kg/day based on symptoms in females. The studies showed consistent reductions in body weight gain, decreased hematology parameters, increased microscopic findings in the thyroid in females, decreased survival, increased thyroid weight, increased incidence of skin lesions, follicular cell thyroid tumors in both sexes, skin tumors in both sexes, and mammary gland tumors in females. Overall, female rats were more sensitive to oryzalin than males.

Based upon female rat thyroid follicular cell combined adenoma and carcinoma tumor rates of 7.79 x 10-3 in human equivalents, oryzalin is classified as **"**Likely to be Carcinogenic to Humans" [HED's Risk Assessment for Tolerance Reassessment Eligibility Decision (TRED) dated 5/18/2004, D300962; Appendix J]. Oryzalin is mutagenic in the sister chromatid exchange by intraperitoneal injection, but not oral intubation, and is also positive in the DNA repair test, but negative in the Ames assay and UDS assay. Based on the above, HED classified oryzalin as a mutagen (D300962; Appendix J).

Based on a review of the open literature, no additional information on the chronic toxicity of oryzalin or its degradates to mammals is available that suggests greater sensitivity than the submitted data.

### 4.2.3 Toxicity to Terrestrial Invertebrates

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

#### 4.2.3.1 Terrestrial Invertebrates: Acute Exposure (Mortality) Studies

Non-target beneficial insects, such as the honey bee (*Apis mellifera*), could be exposed to oryzalin due to applications in crops such as citrus fruits and certain tree nuts and stone fruits that are frequented and pollinated by bees. The results of acute contact toxicity test (MRID 00066220) using formulated oryzalin on the honey bee are summarized in **Appendix A (Table A-8)**. The $LD_{50}$ value for the contact test is >11 µg/bee. As a result, oryzalin is categorized as practically non-toxic to honeybees on an acute contact basis.

The acute contact honey bee $LD_{50}$ of >11 µg/bee is used to assess potential indirect effects to the terrestrial-phase CRLF.

No open literature studies that documented adverse effects on non-target insects were located for oryzalin.

#### 4.2.4 Toxicity to Terrestrial Plants

Terrestrial plant toxicity data are used to evaluate the potential for oryzalin to affect riparian zone and upland vegetation within the action area for the CRLF. Impacts to riparian and upland (i.e., grassland, woodland) vegetation may 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 in of upland and riparian habitat that provides shelter, foraging, predator avoidance and dispersal for juvenile and adult CRLFs.

Plant toxicity data from the registrant-submitted studies were only reviewed as no valid plant studies were found in the scientific literature. 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 oryzalin, 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.

The results of the Tier II seedling emergence and vegetative vigor toxicity tests (MRID 42602401) on non-target plants (four monocots including corn, oats, onion, and ryegrass and six dicots including cabbage, cucumber, lettuce, tomato, soybean, and radish) are summarized in **Table 4.5** and also in **Appendix A (Table A-9)**. In both the seedling emergence and vegetative vigor tests, technical grade oryzalin was evaluated at 0.008, 0.025, 0.074, 0.222, 0.667, 2.0, and 6.0 lb a/i/A on the above plants. Shoot length was found to be the most sensitive endpoint in both the tests.

In both the seedling emergence and vegetative vigor tests, the most sensitive monocot and dicot species were ryegrass and tomato, respectively. The $EC_{25}$ values for ryegrass and tomato, which are based on a reduction in shoot length, were 0.0285 lb ai/A and 0.0506 lb ai/A, respectively, in the seedling emergence test and 0.174 lb ai/A and 0.0828 lb ai/A, respectively, in the vegetative vigor test. The NOAEC values for ryegrass and tomato in the seedling emergence study were 0.008 lb ai/A and undetermined (as the NOAEC value was the lowest dose tested), respectively. The NOAEC values for ryegrass and tomato in the vegetative vigor study were 0.0253 and 0.0740 lb ai/A, respectively.

**Table 4.5 Non-target Terrestrial Plant Seedling Emergence and Vegetative Vigor Toxicity (Tier II) Data**

| Crop | Type of Study Species | NOAEC (lb ai/A) | $EC_{25}$ (lb ai/A) | Most sensitive parameter |
|---|---|---|---|---|
| **Seedling Emergence** | | | | |
| Monocots | Oats | 0.222 | 0.278 | Shoot length |
| | Corn | >6.0 | ND | - |
| | Ryegrass | 0.008 | **0.0285** | Shoot length |
| | Onion | 0.222 | 0.318 | Shoot length |
| Dicots | Cabbage | 0.222 | 0.656 | Shoot length |
| | Cucumber | 0.667 | 1.7 | Shoot length |
| | Lettuce | 0.222 | 0.152 | Shoot length |
| | Tomato | [1]ND | **0.0506** | Shoot length |
| | Soybean | >6.0 | ND | - |
| | Radish | >6.0 | ND | - |
| **Vegetative Vigor** | | | | |
| Monocots | Corn | 0.222 | 0.244 | Shoot length |
| | Oats | 0.222 | 0.445 | Shoot length |
| | Ryegrass | 0.0253 | **0.174** | Shoot length |
| | Onion | >6.0 | ND | - |
| Dicots | Lettuce | 0.0740 | 0.144 | Shoot length |
| | Tomato | 0.0740 | **0.0828** | Shoot length |
| | Cabbage | >6.0 | ND | - |
| | Cucumber | >6.0 | ND | - |
| | Radish | >6.0 | ND | - |
| | Soybean | >6.0 | ND | - |

[1]ND = not determined due to significant inhibition at all treatment levels; ND = not determined due to no significant inhibition at any treatment level

Based on a review of the open literature, no additional information is available that indicates greater non-target terrestrial plant sensitivity to oryzalin than the registrant-submitted studies discussed above.

### 4.2.5 Sublethal Effects

No valid studies on aquatic and terrestrial organisms were located in the open literature that documented sub-lethal effects (other than the assessment endpoints: growth, survival, and reproduction) associated with exposure to oryzalin.

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

The Agency uses the probit dose response relationship as a tool for providing additional information on the potential for acute direct effects to individual listed species (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 oryzalin 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.

As presented in the **Appendix A**, slope information is available for the acute toxicity tests on fresh water fish, freshwater invertebrates, and birds. A review of the reported slopes available for bluegill sunfish, water flea, and bobwhite quail indicates a range of 4.5 (not a default value) to 9.3 (**Table 4.6**). In general, the reported slope for aquatic organisms is high compared to the terrestrial organisms.

**Table 4.6 Probit Slope Information for Acute Toxicity Studies on Oryzalin**

| Species Name | mg/L or mg/kg ai | Confidence Limits | Slope of the Dose-Response Curve | MRID and Study Classification |
|---|---|---|---|---|
| Bluegill sunfish *Lepomis macrochirus* | 2.88 | 2.23 – 3.7 | 9.3 at 95% CI[1] | 00072595 Core |
| Water flea *Daphnia magna* | 1.5 | 14 – 1.6 | 9.5 at 95% CI | 00072596 Core |
| Bobwhite quail *Colinus virginianus* | 506.7 | 391 – 656 | 4.5 at 95% CI (not a default value) | 00098462 Core |

[1]CI = confidence interval

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.

## 4.4 Incident Database Review

A review of the EIIS database for ecological incidents involving oryzalin was completed on 28 February 2008. The results of this review for terrestrial wildlife, terrestrial plant, and aquatic incidents are discussed below in Sections 4.4.1 through 4.4.3, respectively. Associated uncertainties are included in **Appendix I**.

### 4.4.1 Terrestrial Animal Incidents

No ecological incidents involving terrestrial animals were reported for oryzalin.

### 4.4.2 Terrestrial Plant Incidents

The Washington Department of Agriculture reported that 13 acres of merlot wine grapes in Grant county were damaged on April 3, 1998 due to direct application of oryzalin. The legality of use for this incident was listed as "registered use". The certainty index for this incident (I013884-027) is UNLIKELY as oryzalin is a registered pesticide in grape. The damage to grapes is possibly due to the application of norflurazon, the legality of which was listed as "misuse".

A plant incident (7/3/1992) that resulted in damage to trees and shrubs (specific plants not reported) was reported from Benton county, Washington in 1992. The incident resulted due to applicator error of mixing oryzalin with bromacil/diuron. The legality of this use was reported as "undetermined". The certainty index for this incident (I014409-062) is POSSIBLE.

A nursery in the Washington county of Oregon reported on February 2, 2002 that six acres of tulips were damaged by exhibiting twisting of leaves. The certainty index for this incident (I013636-027) is POSSIBLE. The legality of this use was reported as "registered use". The report mentions that isoxaben was used along with glyphosate, diclofop-methyl, fenhexamid, iprodione, and oryzalin and that diclofop-methyl was used previously in the sprayer.

Dow Elanco reported an incident in 1994 that 676,000 Douglas fir seedlings treated with Snapshot herbicide (a mixture of isoxaben and oryzalin) had to be discarded as they turned chlorotic and swollen. The certainty index for this incident (I001485-001) is Possible and the legality was reported as "undetermined". The incident report noted that little information was provided to determine which herbicide in the mixture caused the damage.

An acre of Idaho strain fir trees experienced loss of turgidity, necrosis, stem brittleness, fissures, and death in Washington state in 1989/90. Pesticide application history indicated use of oxyfluorfen at planting, napropamide one month after planting, oxyfluorfen five months after planting, and oryzalin eleven months after planting. The legality of use for this incident was listed as "intentional misuse" as the label for Surflan (oryzalin) clearly states "do not apply to Douglas fir". The certainty index for this incident (I001734-001) is PROBABLE.

### 4.4.3 Aquatic Incidents

Approximately 450 bluegill sunfish and largemouth bass were killed between April 6 and 13, 2001 in Georgia, following the application of a formulated product of oryzalin (Surflan) on March 31. Rain fell on 4 April and it is possible that the pond was contaminated by either spray drift or runoff. The legality of use for this incident was listed as "misuse". Residues in fish tissue were not measured. The certainty index for this incident (I011444-011) is POSSIBLE.

## 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 oryzalin 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").

## 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 C**). For acute exposures to the CRLF and its animal prey in aquatic habitats, as well as terrestrial invertebrates, the LOC is 0.05. For acute exposures to the CRLF and mammals in the terrestrial habitat, 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.

Risk to the aquatic-phase CRLF is estimated by calculating the ratio of exposure to toxicity using 1-in-10 year EECs based on the label-recommended oryzalin usage scenarios summarized in **Table 3.4** and the appropriate aquatic toxicity endpoint from **Table 4.1**. Risks to the terrestrial-phase CRLF and its prey (*e.g.* terrestrial insects, small mammals and terrestrial-phase frogs) are estimated based on exposures resulting from broadcast spray and granular applications of oryzalin (**Tables 3.6, 3.7, and 3.8**) and the appropriate toxicity endpoint from **Table 4.3**. Exposures are also derived for terrestrial plants, as summarized in **Table 3.9**, based on the highest application rates of oryzalin use within the action area.

### 5.1.1 Exposures in the Aquatic Habitat

#### 5.1.1.1 Direct Effects to Aquatic-Phase CRLF

Direct effects to the aquatic-phase CRLF are based on peak EECs in the standard pond and the lowest acute toxicity value for freshwater fish. In order to assess direct chronic risks to the CRLF, 60-day EECs and the lowest chronic toxicity value for freshwater fish are used.

Acute RQs exceeded the endangered species LOC of 0.05 only from use on rights-of-ways (**Table 5.1**). Risk quotients for all other modeled uses that did not exceed Agency LOC were not presented in the **Table 5.1** below. Direct effects associated with acute exposure are expected to occur for the aquatic-phase CRLF based on the highest yearly oryzalin use rate. Chronic RQs, on the other hand, are well below the Agency's LOC of 1.0 for all the modeled uses. Direct effects associated with chronic exposure to oryzalin are not expected to occur for the aquatic-phase CRLF. Chronic RQs were calculated only for the use that resulted in the highest EEC (non-food use – rights-of-ways at 12.2 lb ai/A/year). The preliminary effect determination is "may affect" based on direct acute effects to aquatic phase CRLF from rights-of-way uses only.

**Table 5.1 Summary of Direct Effect RQs[1] for the Aquatic-phase CRLF**

| Use Scenario | Surrogate Species | Toxicity Value (µg/L) | EEC (µg/L)[2] | RQ | Probability of Individual Effect[3] | LOC Exceedance and Risk Interpretation |
|---|---|---|---|---|---|---|
| **Acute Direct Toxicity** | | | | | | |
| Rights-of-ways (granular at 15.0 lb ai/A/year) | Bluegill sunfish | $LC_{50}$ = 2,880 | Peak: 149.5 | **0.052** | 1 in 2.77E+32 | **Yes[4]** |
| Rights-of-ways (broadcast spray at 12.2 lb ai/A/year) | Bluegill sunfish | $LC_{50}$ = 2,880 | Peak: 141.9 | **0.05** | 1 in 1.88E+33 | **Yes[4]** |
| **Chronic Direct Toxicity** | | | | | | |
| Rights-of-ways (broadcast spray at 12.2 lb ai/A/year) | Fathead minnow | NOAEC = 220 | 60-day: 51.38 | 0.23 | Not calculated for chronic endpoints | No[5] |

[1]RQs associated with acute and chronic direct toxicity to the CRLF are also used to assess potential indirect effects to the CRLF based on a reduction in freshwater fish and frogs as food items.
[2]The highest EEC based on oryzalin use on rights-of-ways (see Table 3.3).
[3]The probit slope value for the acute bluegill sunfish toxicity test is 9.3.
[4]RQ > acute endangered species LOC of 0.05.
[5]RQ < chronic LOC of 1.0.

#### 5.1.1.2 Indirect Effects to Aquatic-Phase CRLF via Reduction in Prey (non-vascular aquatic plants, aquatic invertebrates, fish, and frogs)

**Non-vascular Aquatic Plants**

Indirect effects of oryzalin to the aquatic-phase CRLF (tadpoles) via reduction in non-vascular aquatic plants in its diet are based on peak EECs from the standard pond and the lowest acute toxicity value for aquatic non-vascular plants. Risk quotients exceeded the non-endangered/endangered risk LOC (RQ $\geq$1.0) for aquatic plants due to liquid broadcast spray applications of oryzalin to some food crops such as avocado, berries, tree nuts, olives, and wine grapes (**Table 5.2**). Regarding non-food uses, acute risk quotients exceeded the Agency's LOC from applications to non-bearing fruits, tree nuts, vineyards, rights-of-ways, and ornamentals (excluding bulbs) for both liquid and granular formulations. Regardless the formulation type, no acute risk LOCs were exceeded for warm season turf grass, ornamental bulbs, residential areas, and Christmas tree plantations. Thus, the preliminary effects determination is "may affect", based on indirect effects to aquatic-phase CRLFs through a reduction in non-vascular aquatic plants as food items.

**Table 5.2 Summary of Acute RQs Used to Estimate Indirect Effects to the CRLF via Effects to Non-Vascular Aquatic Plants (diet of CRLF in tadpole life stage and habitat of aquatic-phase CRLF)**

| Uses | Single Application Rate[1] (lb ai/A) | Application Interval | Peak EEC (µg/L) | Indirect Effects RQ[2] (Food and Habitat) |
|---|---|---|---|---|
| **Food Uses** | | | | |
| Avocado | 6 (L) | 2 | 39.1 | **1.0** |
| Berries | 6 (L) | 2 | 52.98 | **1.3** |
| Citrus fruits | 6 (L) | 2 | 9.74 | 0.2 |
| Pome and stone fruits | 6 (L) | 2 | 22.85 | 0.6 |
| Olives | 6 (L) | 2 | 21.65 | **1.4** |
| Tree nuts | 6 (L) | 2 | 49.36 | **1.2** |
| Vineyards | 6 (L) | 2 | 21.45 (table grapes)<br>52.98 (wine grapes) | 0.5<br>**1.3** |
| **Non-Food Uses** | | | | |
| Non-bearing fruits, nuts, and vineyards and ornamentals excluding bulbs | 4 (L)<br>4 (G) | 3<br>4 | 47.64<br>72.61 | **1.2**<br>**1.8** |
| Christmas tree plantations | 4 (L)<br>4.01 (G) | 2<br>4 | 33.5<br>33.6 | 0.8<br>0.8 |
| Rights-of-ways | 6.12 (L)<br>4.01 (G) | 2<br>4 | 141.9<br>149.5 | **3.5**<br>**3.6** |
| Ornamental bulbs | 1.5 (L)<br>1.5 (G) | 2<br>2 | 16.4<br>16.3 | 0.4<br>0.4 |
| Warm season turf grass | 2 (L)<br>1.5 (G) | 3<br>4 | 5.4<br>8.2 | 0.1<br>0.2 |
| Residential areas | 2 (G) | 3 | 3.5 | 0.1 |

[1]L = liquid formulation; G = granular formulation
[2]LOC exceedances (RQ $\geq$ 1) are bolded; RQ = use-specific peak EEC/42 ppb (most sensitive endpoint for non-vascular aquatic plant (green algae)

## Aquatic Invertebrates

Indirect acute effects to the aquatic-phase CRLF via effects to prey (invertebrates) in aquatic habitats are based on peak EECs in the standard pond and the lowest acute toxicity value for freshwater invertebrates. For chronic risks, 21-day EECs and the lowest chronic toxicity value for invertebrates are used to derive RQs. A summary of the acute and chronic RQ values for exposure to aquatic invertebrates (as prey items of aquatic-phase CRLFs) is provided in **Table 5.3**.

**Table 5.3 Summary of Acute and Chronic RQs Used to Estimate Indirect Effects to the CRLF via Direct Effects on Aquatic Invertebrates as Dietary Food Items (prey of CRLF juveniles and adults in aquatic habitats)**

| Uses | Application Rate[1] (lb ai/A) | Peak EEC (µg/L) | 21-day EEC (µg/L) | Indirect Effects Acute RQ* | Indirect Effects Chronic RQ* |
|---|---|---|---|---|---|
| **Food Uses** | | | | | |
| Avocado | 6 (L) | 39.1 | 76.17 | 0.03 | 0.05 |
| Berries | 6 (L) | 52.48 | 29.24 | 0.04 | 0.08 |
| Citrus fruits | 6 (L) | 9.74 | 5.39 | 0.01 | 0.02 |
| Pome and stone fruits | 6 (L) | 22.85 | 12.48 | 0.02 | 0.03 |
| Olives | 6 (L) | 21.65 | 11.98 | 0.01 | 0.03 |
| Tree nuts | 6 (L) | 49.36 | 26.28 | 0.03 | 0.07 |
| Vineyards | 6 (L) | 21.45 (table grapes)<br>52.98 (wine grapes) | 11.34 (table grapes)<br>29.24 (wine grapes) | 0.01<br>0.04 | 0.03<br>0.08 |
| **Non-Food Uses** | | | | | |
| Non-bearing fruits, nuts, and vineyards and ornamentals excluding bulbs | 4 (L)<br>4 (G) | 47.64<br>72.61 | 26.27<br>36.73 | 0.03<br>**0.05** | 0.07<br>0.1 |
| Christmas tree plantations | 4 (L)<br>4.01 (G) | 33.5<br>33.6 | 19.37<br>19.72 | 0.02<br>0.02 | 0.05<br>0.06 |
| Rights-of-ways | 6.12 (L)<br>4.01 (G) | 141.9<br>149.5 | 115.97<br>90.79 | **0.09**<br>**0.1** | 0.24<br>0.23 |
| Ornamental bulbs | 1.5 (L)<br>1.5 (G) | 16.4<br>16.3 | 8.48<br>8.49 | 0.01<br>0.01 | 0.02<br>0.02 |
| Warm season turf grass | 2 (L)<br>1.5 (G) | 5.4<br>8.2 | 2.75<br>4.16 | 0.004<br>0.01 | 0.01<br>0.01 |
| Residential areas | 2 (G) | 3.5 | 1.82 | 0.002 | 0.01 |

[1]L = liquid formulation; G = granular formulation
*LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded. Acute RQ = use-specific peak EEC/1500 ppb (most sensitive acute freshwater invertebrate endpoint). Chronic RQ = use-specific 21-day EEC/358 ppb (most sensitive chronic freshwater invertebrate endpoint)

Acute RQs for various modeled oryzalin uses ranged between 0.002 and 0.1 and were less than LOCs (RQ = 0.5) for non-listed species. However, acute RQs exceeded the

LOCs for listed species (RQ $\geq$ 0.05) due to broadcast spray applications of oryzalin in rights-of-ways and granular applications in nonbearing fruits, ornamentals (excluding bulbs), and rights-of-ways. Regardless the type of formulation, acute RQs exceeded the listed species LOC for rights-of-ways. Chronic RQs are less than the chronic LOC (RQ $\geq$ 1.0) for aquatic invertebrates for all modeled oryzalin uses. The preliminary effects determination is "may affect" for indirect effects to aquatic-phase CRLFs based on a reduction of freshwater invertebrates as prey (via direct acute toxicity to freshwater invertebrates). However, reduction in the freshwater invertebrate prey base via chronic toxicity is not expected.

**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 (**Table 5.1**) are used to assess potential indirect effects to the CRLF based on a reduction in freshwater fish and frogs as food items. Given that acute RQs for direct toxicity to the CRLF exceeded the Agency's LOCs for oryzalin uses on rights-of-ways, indirect effects based on a reduction of fish and frogs as prey items are expected.

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

Indirect effects to the CRLF via direct toxicity to aquatic plants are estimated using the most sensitive non-vascular and vascular plant toxicity endpoints. Because there are no obligate relationships between the CRLF and any aquatic plant species, the most sensitive $EC_{50}$ values, rather than NOAEC values, were used to derive RQs.

Except for oryzalin application in citrus fruits (liquid formulation), warm season turf grass (both liquid and granular formulations), and residential areas (granular formulations), endangered/non-endangered species RQs exceeded the LOC of 1 for vascular aquatic plants for all other modeled scenarios (**Table 5.4**). Therefore, the preliminary effects determination is "may affect", based on indirect effects to habitat and/or primary productivity for the aquatic-phase CRLF.

| Table 5.4 Summary of Acute RQs Used to Estimate Indirect Effects to the CRLF via Effects to Vascular Aquatic Plants (habitat of aquatic-phase CRLF)[1] | | | |
|---|---|---|---|
| **Uses** | **Application Rate[2](lb ai/A)** | **Peak EEC (µg/L)** | **Indirect effects RQ[3] (food and habitat)** |
| **Food Uses** | | | |
| Avocado | 6 (L) | 39.1 | **2.5** |
| Berries | 6 (L) | 52.98 | **3.4** |
| Citrus fruits | 6 (L) | 9.74 | 0.6 |
| Pome and stone fruits | 6 (L) | 22.85 | **1.5** |
| Olives | 6 (L) | 21.65 | **1.4** |
| Tree nuts | 6 (L) | 49.36 | **3.2** |
| Vineyards | 6 (L) | 21.45 (table grapes)<br>52.98 Wine grapes) | **1.4**<br>**3.4** |
| **Non-Food Uses** | | | |
| Non-bearing fruits, nuts, and vineyards and Ornamentals excluding bulbs | 4 (L)<br>4 (G) | 47.64<br>72.61 | **3.1**<br>**4.7** |
| Christmas tree plantations | 4 (L)<br>4.01 (G) | 33.5<br>33.6 | **2.2**<br>**2.2** |
| Rights-of-ways | 6.12 (L)<br>4.01 (G) | 141.9<br>149.5 | **9.2**<br>**9.7** |
| Ornamental bulbs | 1.5 (L)<br>1.5 (G) | 16.4<br>16.3 | **1.1**<br>**1.1** |
| Warm season turf grass | 2 (L)<br>1.5 (G) | 5.4<br>8.2 | 0.4<br>0.5 |
| Residential areas | 2 (G) | 3.5 | 0.2 |

[1]RQs used to estimate indirect effects to the CRLF via toxicity to non-vascular aquatic plants are summarized in Table 5.2; [2]L = liquid formulation; G = granular formulation; [3]LOC exceedances (RQ ≥ 1) are bolded. RQ = use-specific peak EEC/15.4 ppb (most sensitive endpoint for vascular aquatic plant)

### 5.1.2 Exposures in the Terrestrial Habitat

#### 5.1.2.1 Direct Effects to Terrestrial-phase CRLF

As previously discussed in Section 3.3, potential direct effects to terrestrial-phase CRLFs are based on broadcast spray and granular applications of oryzalin. Though two foliar half-life periods (4.6 and 35 days) were modeled in T-REX, results were presented for the analysis that utilized 4.6 days only as risk conclusions were similar for both.

#### 5.1.2.1.1 Broadcast Spray Applications

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 3.6**) and acute oral and subacute dietary toxicity endpoints for avian species.

Risk quotients calculated using the bobwhite quail oral $LD_{50}$ value of 506.7 mg/kg ai suggests that acute RQs exceeded the LOCs for listed species (RQ $\geq$ 0.1) for all use categories (**Table 5.5**). The range for dose-based avian acute RQs is 0.6 to 2.6. On the other hand, definitive dietary-based acute RQ values for terrestrial-phase CRLFs could not be derived because the acute avian effects data, which are used as a surrogate for terrestrial-phase amphibians, showed no mortality to both the mallard duck and bobwhite quail at the highest tested level of oryzalin ($LC_{50}$ >5,000 mg/kg-diet). Since the predicted dietary-based EECs (which ranged between 270 and 1101 ppm) were several fold lower than the avian $LC_{50}$ value of >5,000 mg/kg-diet, dietary-based acute avian and terrestrial-phase CRLF mortality is unlikely. The preliminary effects determination for direct acute effects to the terrestrial-phase CRLF is "may affect" based on exposure to oryzalin doses.

**Table 5.5 Summary of Acute RQs[1] Used to Estimate Direct Effects to the Terrestrial-Phase CRLF (Broadcast Spray Application)**

| Use Category | Dose-based EEC | Dose-based Acute RQ[2] | Probability of Individual Effect[3] |
|---|---|---|---|
| **Food Uses** | | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards | 923 | **2.5** | 1 in 104 |
| **Non-Food Uses** | | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 615 | **1.7** | 1 in 118 |
| Ornamental Bulbs | 231 | **0.6** | 1 in 629 |
| Christmas Tree Plantations | 615 | **1.7** | 1 in 118 |
| Warm Season Turf | 308 | **0.8** | 1 in 302 |
| Rights-of-ways | 941 | **2.6** | 1 in 103 |

[1]LOC exceedances (acute RQ $\geq$ 0.5 and acute endangered species RQ $\geq$ 0.1) are bolded.
[2]Based on bobwhite quail oral $LD_{50}$ of 506.7 ppm; [3]The probit slope value for the acute bobwhite quail toxicity test is 4.5 (not a default value)

Potential direct chronic effects of oryzalin to the terrestrial-phase CRLF are derived by considering dietary-based exposures modeled in T-REX for a small bird (20g) consuming small invertebrates. Chronic effects are estimated using the lowest available toxicity data for birds. EECs are divided by toxicity values to estimate chronic dietary-based RQs. As shown in **Table 5.6**, chronic RQs, which ranged from 1.5 to 6.3, exceed LOCs for all modeled broadcast spray applications of oryzalin. Therefore, the preliminary effects determination is "may affect" for direct chronic effects to the terrestrial-phase CRLF.

| Table 5.6 Summary of Chronic RQs Used to Estimate Direct Effects to the Terrestrial-Phase CRLF (Broadcast Spray Application) | | |
|---|---|---|
| **Use (Application Rate)** | **Dietary-based EEC** | **Dietary-based Chronic RQ[1]** |
| **Food Uses** | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards | 810 | **6.1** |
| **Non-Food Uses** | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 540 | **4.1** |
| Ornamental Bulbs | 203 | **1.5** |
| Christmas Tree Plantations | 540 | **4.1** |
| Warm Season Turf | 270 | **2.1** |
| Rights-of-ways | 826 | **6.3** |
| [1]LOC exceedances (chronic RQ ≥ 1) are bolded and are based on bobwhite quail NOAEC of 132 ppm. | | |

#### 5.1.2.1.2 Granular applications

As previously discussed in Section 3.3.2, direct effects to the terrestrial-phase CRLF via exposure to oryzalin granules are derived based on $LD_{50}/ft^2$ values. A comparison of EECs derived for granular applications of oryzalin with adjusted avian $LD_{50}$ values for two weight classes of 20g and 100g (representative of juvenile and adult terrestrial-phase CRLFs) suggests that the predicted granular EECs (mg ai/$ft^2$) do not exceed or approach the adjusted $LD_{50}$ values for any of the uses (**Table 5.7**).

| Table 5.7 Comparison of Granular EECs to Adjusted $LD_{50}$[1] Value Used to Estimate Direct Effects to the Terrestrial-phase CRLF (Granular Non-Food Uses) | | | | |
|---|---|---|---|---|
| **Use** | **Application Rate (lb ai/A)** | **EEC (mg/$ft^2$)** | **RQ[2]** | |
| | | | **20 g (juvenile)** | **100g (adult)** |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 4 | 41.7 | **0.11** | 0.09 |
| Ornamental Bulbs | 1.5 | 15.6 | 0.04 | 0.03 |
| Christmas Tree Plantations | 4.01 | 41.8 | **0.11** | 0.09 |
| Warm Season Turf | 1.5 | 15.6 | 0.04 | 0.03 |
| Rights-of-ways | 4.01 | 41.8 | **0.11** | 0.09 |
| Residential areas | 2 | 20.8 | 0.06 | 0.04 |
| [1]Adjusted Avian $LD_{50} = LD_{50}(AW/TW)^{(1.15-1)}$ ; Actual Avian (bobwhite quail) $LD_{50}$ = 507 mg/kg-bw; Weight of tested species (TW) (bobwhite quail) = 178 gm; Assessed weight of juvenile and adult frogs (AW) = 20 and 100 g, respectively; Adjusted $LD_{50}$ Value (mg/kg-bw) for 20 g juvenile and 100 g adult was calculated to be 365 and 466, respectively [2]LOC exceedances (acute RQ ≥ 0.5 and acute endangered species RQ ≥ 0.1) are bolded. | | | | |

With acute RQs ranging between 0.04 and 0.11, endangered species acute risk (0.1) was exceeded for granular applications for juvenile CRLF. None of the modeled scenarios'

RQs exceeded endangered species risk LOCs for the adult CRLF. Overall, the preliminary effects determination for direct effects to the terrestrial-phase CRLF via granular application of oryzalin is “may affect”. Further qualitative discussion of potential acute risks to birds associated with exposure to granular oryzalin is provided in Section 5.2.1.2.

#### 5.1.2.2 Indirect Effects to Terrestrial-Phase CRLF via Reduction in Prey (terrestrial invertebrates, mammals, and frogs)

##### 5.1.2.2.1 Terrestrial Invertebrates

In order to assess the risks of oryzalin to terrestrial invertebrates, which are considered prey of CRLF in terrestrial habitats, the honey bee is used as a surrogate for terrestrial invertebrates. The toxicity value for terrestrial invertebrates is calculated by multiplying the lowest available acute contact $LD_{50}$ of >11µg a.i./bee by 1 bee/0.128g, which is based on the weight of an adult honey bee. EECs (µg a.i./g of bee) calculated by T-REX for small and large insects are divided by the calculated toxicity value for terrestrial invertebrates, which is > 86µg a.i./g of bee.

As the toxicity endpoint for honey bee is non-definitive (*i.e.*, the $LD_{50}$ value is greater than the highest test concentration), the reported RQ values represent an upper bound. The resulting non-definitive RQ values for large insect and small insect exposures bound the potential range of exposures for terrestrial insects to oryzalin (**Table 5.8**).

**Table 5.8 Summary of RQs Used to Estimate Indirect Effects to the Terrestrial-phase CRLF via Direct Effects on Terrestrial Invertebrates as Dietary Food Items**

| Use | Small Insect RQ[1] | Large Insect RQ[1] |
|---|---|---|
| **Food Uses** | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards | **<9.4** | **<1.0** |
| **Non-Food Uses** | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | **<6.3** | **<0.7** |
| Ornamental Bulbs | | |
| Christmas Tree Plantations | **<6.3** | **<0.7** |
| Warm Season Turf | **<3.1** | **<0.3** |
| Rights-of-ways | **<12.8** | **<1.4** |

[1]LOC exceedances (RQ > 0.05) are bolded. Because a definitive endpoint was not established for terrestrial invertebrates (*i.e.*, the value is greater than the highest test concentration), the RQ represents an upper bound value.

**Table 5.8** suggests that the acute RQ values, which range from < 0.7 to <12.8, may exceed the LOC (RQ ≥ 0.05) for both large and small terrestrial insects for all modeled scenarios. These exceedances refer to on-site residue exposures for terrestrial insects and would be expected to decline with distance from the site of application. The preliminary effects determination for indirect effects to terrestrial-phase CRLFs via reduction in terrestrial invertebrates as dietary food items is "may affect".

#### 5.1.2.2.2 Mammals

Risks associated with the ingestion of small mammals by large terrestrial-phase CRLFs are derived for dietary-based and dose-based exposures modeled in T-REX for a small mammal (15g) consuming short grass. Acute and chronic effects are estimated using the most sensitive mammalian toxicity data. EECs are divided by the toxicity value to estimate acute and chronic dose-based RQs as well as chronic dietary-based RQs.

Definitive acute dose-based RQ values could not be derived because the mammalian LD50 value is >10,000 mg/kg-bw. Therefore, the acute dose-based RQ values are representative of upper bound values (**Table 5.9**). The upper bound acute dose-based RQs did not exceed LOCs for any of the use categories modeled using T-REX.

Chronic dose-based and dietary-based RQ values exceed the chronic risk LOC (RQ ≥ 1.0) for mammals considered as potential prey species for CRLF for all modeled uses of oryzalin (**Table 5.9**). Therefore, the preliminary effects determination for indirect effects to terrestrial-phase CRLFs via reduction in small mammals (exposed to broadcast spray applications of oryzalin) as dietary food items is "may affect".

**Table 5.9 Summary of Acute and Chronic RQs Used to Estimate Indirect Effects to the Terrestrial-phase CRLF via Direct Effects on Small Mammals as Dietary Food Items (Broadcast Spray Application)**

| Use (Application Rate) | Chronic RQ[1] | | Acute RQ[1] |
|---|---|---|---|
| | Dose-based Chronic RQ[1] | Dietary-based Chronic RQ[2] | Dose-based Acute RQ[3] |
| **Food Uses** | | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards | **45.2** | **5.2** | <0.06 |
| **Non-Food Uses** | | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | **30.1** | **3.5** | <0.04 |
| Ornamental Bulbs | **11.3** | **1.3** | <0.02 |
| Christmas Tree Plantations | **30.1** | **3.5** | <0.04 |
| Warm Season Turf | **15.1** | **1.7** | <0.02 |
| Rights-of-ways | **46.1** | **5.3** | <0.06 |

[1]LOC exceedances (acute RQ ≥ 0.1 and chronic RQ ≥ 1) are bolded; [2]Based on dose-based EEC and oryzalin rat NOAEL of 13.82 mg/kg-bw; [3]Based on dietary-based EEC and oryzalin rat NOAEC of 276.4 mg/kg-diet; [4]Based on dose-based EEC and oryzalin rat acute oral $LD_{50}$ of >10,000 mg/kg-bw.

#### 5.1.2.2.2a Mammals (Granular Applications)

Indirect effects to terrestrial-phase CRLFs via ingestion of small mammals that may consume oryzalin granules are based on $LD_{50}/ft^2$ values. However, a definitive $LD_{50}/ft^2$ value could not be derived because the mammalian $LD_{50}$ value was reported as >10,000 mg/kg-bw (*i.e.*, 50% mortality was not observed in the highest treatment levels of oryzalin). Comparison of granular EECs with the adjusted mammalian $LD_{50}$ value for the smallest weight class of 15g (representative of a small mammal that an adult terrestrial-phase CRLF could consume) was performed (**Table 5.10**).

Because the predicted EECs are well below the adjusted $LD_{50}$ values for mammals, there is a low likelihood of acute mortality to mammals consuming granules at application rates $\leq$ 4.0 lb ai/A. Therefore, the preliminary effects determination for indirect effects to terrestrial-phase CRLFs via an acute reduction in small mammals (exposed to granular applications of oryzalin) as dietary food items is "no effect".

**Table 5.10 Comparison of Granular EECs to Adjusted $LD_{50}$ Value Used to Estimate Indirect Effects to the Terrestrial-phase CRLF via Direct Effects on Small Mammals as Dietary Food Items (Granular Non-Food Uses)**

| Use | Application Rate (lb ai/A) | EEC ($mg/ft^2$) | Adjusted $LD_{50}$ Value (mg/kg-bw)[1] |
|---|---|---|---|
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 4 | 41.7 | >4,472 |
| Ornamental Bulbs | 1.5 | 15.6 | |
| Christmas Tree Plantations | 4.01 | 41.8 | |
| Warm Season Turf | 1.5 | 15.6 | |
| Rights-of-ways | 4.01 | 41.8 | |
| Residential areas | 2 | 20.8 | |

[1]Adjusted Mammalian $LD_{50} = LD_{50} (TW/AW)^{(0.25)}$

#### 5.1.2.2.3 Frogs

An additional prey item of the adult terrestrial-phase CRLF is other species of frogs. In order to assess risks to these organisms, dietary-based and dose-based exposures modeled in T-REX for a small bird (20g) consuming small invertebrates are used. As previously discussed in Section 5.1.2.1, direct acute (dose-based) (RQs = 0.6 – 2.6) and chronic (RQs = 1.5 – 6.3) effects to frogs are likely, based on the available avian acute and chronic toxicity data. Therefore, the preliminary effects determination for indirect effects to terrestrial-phase CRLFs via reduction in other species of frogs as dietary food items is "may affect".

### 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 direct effects on riparian and upland vegetation are assessed using RQs from terrestrial plant seedling emergence and vegetative vigor $EC_{25}$ data as a screen. Based on the results of the submitted terrestrial plant toxicity tests, it appears that both monocot and dicot plants are more sensitive to applications of oryzalin at the seedling emergence stage than at the vegetative stage. Seedling emergence of corn, soybean, and radish and vegetative vigor of onion, cabbage, cucumber, radish, and soybean were not affected following exposure to oryzalin. The results of these tests indicate that a variety of terrestrial plants that may inhabit riparian and upland zones may be sensitive to oryzalin exposure.

**Table 5.11 RQs* for Monocots Inhabiting Dry and Semi-Aquatic Areas Exposed to Oryzalin via Runoff and Drift**

| Use Category | Type of Application | Application Rate (lb ai/A) | Drift Value (%) | Dry area RQ | Semi-aquatic area RQ | Spray drift RQ |
|---|---|---|---|---|---|---|
| **Food Uses** | | | | | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards – | Ground Broadcast | 6 | 1 | **4.2** | **23.2** | **2.11** |
| **Non-Food Uses** | | | | | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | Ground Broadcast | 4 | 1 | **2.8** | **15.4** | **1.4** |
| | Granular | 4 | 0 | **1.4** | **14.0** | <0.1 |
| Ornamental Bulbs | Ground Broadcast | 1.5 | 1 | **1.1** | **5.8** | 0.5 |
| | Granular | 1.5 | 0 | 0.5 | **5.3** | <0.1 |
| Christmas Tree Plantations | Ground Broadcast | 4 | 1 | **2.8** | **15.4** | **1.4** |
| | Granular | 4 | 0 | **1.4** | **14.1** | <0.1 |
| Warm Season Turf | Ground Broadcast | 2 | 1 | **1.4** | **7.7** | 0.7 |
| | Granular | 1.5 | 0 | 0.5 | **5.3** | <0.1 |
| Rights-of-ways | Ground Broadcast | 6.1 | 1 | **4.3** | **23.6** | **2.2** |
| | Granular | 4 | 0 | **1.4** | **14.1** | <0.1 |
| Residential areas | Granular | 2 | 0 | 0.7 | **7.0** | <0.1 |

[1]LOC exceedances (RQ ≥ 1) are bolded

The LOC (RQ $\geq$ 1.0) is exceeded for exposures resulting from single applications of all liquid and granular uses of oryzalin for both monocot and dicot plants inhabiting semi-aquatic areas (**Tables 5.11 and 5.12**). Dry area RQs did not exceed LOC for monocots from granular applications of oryzalin in ornamental bulbs, warm season turf, and residential areas only where as LOC is exceeded for several granular uses and non-granular uses for dicots. Spray drift RQs, on the other hand, exceeded for oryzalin non-granular uses in bearing trees, non-bearing trees, ornamentals (excluding bulbs), Christmas tree plantations, and rights-of-ways for monocots and bearing trees and rights-of-ways for dicots. Example output from TerrPlant v.1.2.2 is provided in **Appendix F.** The preliminary effects determination for indirect effects to terrestrial- and aquatic-phase CRLFs via reduction in the terrestrial plant community is "may affect".

**Table 5.12 RQs[1] for Dicots Inhabiting Dry and Semi-Aquatic Areas Exposed to Oryzalin via Runoff and Drift**

| Use Category | Type of Application | Application Rate (lbs ai/A) | Drift Value (%) | Dry Area RQ | Semi-Aquatic Area RQ | Spray Drift RQ |
|---|---|---|---|---|---|---|
| **Food Uses** | | | | | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards – | Ground Broadcast | 6 | 1 | **2.4** | **13.0** | **1.2** |
| **Non-Food Uses** | | | | | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | Ground Broadcast | 4 | 1 | **1.6** | **8.7** | 0.8 |
| | Granular | 4 | 0 | 0.8 | **7.9** | <0.1 |
| Ornamental Bulbs | Ground Broadcast | 1.5 | 1 | 0.6 | **3.3** | 0.3 |
| | Granular | 1.5 | 0 | 0.3 | **3.0** | <0.1 |
| Christmas Tree Plantations | Ground Broadcast | 4 | 1 | **1.6** | **8.7** | 0.8 |
| | Granular | 4 | 0 | 0.8 | **7.9** | <0.1 |
| Warm Season Turf | Ground Broadcast | 2 | 1 | 0.8 | **4.4** | 0.4 |
| | Granular | 1.5 | 0 | 0.3 | **3.0** | <0.1 |
| Rights-of-ways | Ground Broadcast | 6.1 | 1 | **2.4** | **13.3** | **1.2** |
| | Granular | 4 | 0 | 0.8 | **7.9** | <0.1 |
| Residential areas | Granular | 2 | 0 | 0.4 | **4.0** | <0.1 |

[1]LOC exceedances (RQ $\geq$ 1) are bolded

### 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).

The preliminary effects determination for aquatic-phase PCEs of designated habitat related to potential effects on aquatic and/or terrestrial plants is "habitat modification", based on the risk estimation provided in Sections 5.1.1.2, 5.1.1.3, and 5.1.2.3.

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 oryzalin 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. Based on these results, the preliminary effects determination for alteration of characteristics necessary for normal growth and viability of the CRLF is "habitat modification" (see Section 5.1.1.1). Aquatic invertebrate and non-vascular aquatic plant food items of the CRLF may be affected; therefore the preliminary effects determination for potential impacts to these food items is "habitat modification" (see Section 5.1.1.2).

#### 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 n 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

The preliminary effects determination for terrestrial-phase PCEs of designated habitat related to potential effects on terrestrial plants is “habitat modification”, based on the risk estimation provided in Section 5.1.2.3.

The third terrestrial-phase PCE is “reduction and/or modification of food sources for terrestrial phase juveniles and adults.” To assess the impact of oryzalin on this PCE, acute and chronic toxicity endpoints for birds, mammals, and terrestrial invertebrates are used as measures of effects. RQs for these endpoints, calculated in Section 5.1.2.2. exceed the LOCs for all oryzalin non-granular broadcast spray uses. Granular uses of oryzalin, however, are not expected to cause direct effects to frog prey items of the terrestrial-phase CRLF. The preliminary effects determination for this PCE via impacts of non-granular uses of oryzalin to terrestrial-phase CRLF food items is “habitat modification”.

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. Both direct acute effects (via mortality) and chronic reproductive effects are possible with all the spray and granular applications of oryzalin for the terrestrial-phase CRLF (see Section 5.2.1.2). Therefore the preliminary effects determination for this PCE is “habitat modificaiton” due to direct acute effects to terrestrial-phase CRLFs and “habitat modification” based on chronic exposures to liquid spray applications of oryzalin.

### 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, and no modification to PCEs of the CRLF's designated critical habitat, a "no effect" determination is made, based on oryzalin'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 oryzalin. A summary of the results of the risk estimation (*i.e.*, "no effect" or "may affect" finding) is provided in **Table 5.13** for direct and indirect effects to the CRLF and in **Table 5.14** for the PCEs of designated critical habitat for the CRLF.

**Table 5.13 Preliminary Effects Determination Summary for Oryzalin - Direct and Indirect Effects to CRLF**

| Assessment Endpoint | Preliminary Effects Determination | Basis For Preliminary Determination |
|---|---|---|
| ***Aquatic Phase (eggs, larvae, tadpoles, juveniles, and adults)*** | | |
| Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases | Fish: May affect | Using the bluegill sunfish (a freshwater fish) as a surrogate, no chronic LOCs are exceeded for any use (Table 5.1). However, acute LOCs are exceeded for 1 non-food use (rights-of-ways) only for both liquid and granular uses. |
| Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants) | Freshwater invertebrates and aquatic non-vascular plants: May affect<br><br>Fish and frogs: May affect | Except for citrus, pome and stone fruits, table grapes, Christmas tree plantations, ornamental bulbs, residential areas, and warm season turf grass, endangered/non-endangered aquatic non-vascular plant RQs exceeded LOCs for all other modeled scenarios (Tables 5.2 and 5.3). Acute invertebrate RQs exceeded LOCS for nonbearing fruits, nuts, and vineyards (granular), rights-of-ways (liquid and granular) and ornamentals (excluding bulbs) (granular). Chronic aquatic invertebrate RQs did not exceed Agency's LOC for any of the modeled scenarios for either liquid or granular formulations.<br><br>Dose-based acute LOCs are exceeded for rights-of-ways only based on the most sensitive toxicity data for freshwater fish (Table 5.1). No chronic LOC exceedances were noted for freshwater fish with any of the modeled scenarios. |
| Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community) | Aquatic plants: May affect | LOCs are exceeded for non-vascular aquatic plants (all scenarios except citrus, pome and stone fruits, table grapes, ornamental bulbs, warm season turf grass, residential areas, and Christmas tree plantations) and vascular plants (all scenarios |

| | | |
|---|---|---|
| | | except citrus, warm season turf, and residential areas) (Table 5.2). |
| 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. | Aquatic and terrestrial plants: May affect | Most uses are likely to adversely affect CRLF via effects to riparian vegetation. Both upland and aquatic plants are expected to be significantly impacted by oryzalin use (Tables 5.2, 5.4, 5.10, and 5.11) |
| ***Terrestrial Phase (Juveniles and adults)*** | | |
| Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles | Acute avian: May affect<br><br>Chronic avian: May affect | Based on the available avian acute toxicity data, which is used as a surrogate for terrestrial-phase amphibians, predicted EECs for liquid formulation of oryzalin are above the reported dose-based acute avian toxicity value for all modeled scenarios (Table 5.6). Therefore, direct adverse effects are expected on terrestrial phase adults and juveniles. Endangered species acute avian risk is also expected for granular applications of oryzalin for all scenarios except ornamental bulbs, warm season turf, and residential areas.<br><br>Dietary-based chronic RQs exceeded the LOC for all modeled broadcast spray applications (food uses) of oryzalin (Tables 5.5). |
| Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial mammals and terrestrial phase amphibians) | Acute terrestrial invertebrates: May affect<br><br>Chronic birds and mammals: May affect | All uses are likely to adversely affect CRLF via effects on terrestrial invertebrates that are prey items of the frog's diet.<br><br>Dietary-based chronic RQs for mammals and birds exceed the LOCs for all modeled non-granular uses of oryzalin (Tables 5.5 and 5.8). However, acute RQs for mammals did not exceed LOCs for either formulation (Table 5.8). |
| Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian vegetation) | Terrestrial plants: May affect | LOCs are exceeded for both monocots and dicots for all modeled uses of oryzalin (Tables 5.10 and 5.11). |

| **Table 5.14 Preliminary Effects Determination Summary for Oryzalin – PCEs of Designated Critical Habitat for the CRLF** | | |
|---|---|---|
| **Assessment Endpoint** | **Preliminary Effects Determination** | **Basis For Preliminary Determination** |
| ***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. | Habitat modification | LOCs are exceeded for both monocots and dicots for all modeled uses of oryzalin (Tables 5.10 and 5.11). |
| 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. | Habitat modification | LOCs are exceeded for both monocots and dicots for all modeled uses of oryzalin (Tables 5.10 and 5.11). |
| Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source. | Growth and viability of CRLF: Habitat modification<br><br>Food source: Habitat modification | Acute LOCs exceeded for freshwater fish for rights-of-ways only.<br><br>Acute freshwater invertebrate and aquatic non-vascular plant RQs exceed LOCs for both formulations for most uses (Tables 5.2 and 5.3). |
| Reduction and/or modification of aquatic-based food sources for pre-metamorphs (e.g., algae) | Habitat modification | Acute LOCs are exceeded for non-vascular aquatic plants for most uses. |
| ***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 | Habitat modification | LOCs are exceeded for both monocots and dicots for all modeled uses of oryzalin (Tables 5.10 and 5.11). |
| 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 | Habitat Modification | LOCs are exceeded for both monocots and dicots for all modeled uses of oryzalin (Tables 5.10 and 5.11). |
| Reduction and/or modification of food sources for terrestrial phase juveniles and adults | Habitat modification | Based on likely effects to small mammals, amphibians, and terrestrial invertebrates reduction in food sources is expected (Tables 5.5, 5.7, and 5.8). |
| Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source. | Habitat modification | Chronic RQs for mammals and birds exceed the LOCs for all modeled granular and non-granular uses of oryzalin (Tables 5.5 and 5.8). Therefore, chronic effects are possible for small insectivorous mammals that are food items of the CRLF. Acute RQs for small terrestrial invertebrates exceed the LOC for all modeled uses of oryzalin (Table 5.7). |

Following a preliminary "may affect" or "habitat modification" determination, additional information is considered to refine the potential for exposure at the predicted levels based on the life history characteristics (*i.e.*, habitat range, feeding preferences, etc.) of the CRLF. 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 5.2.3**.

### 5.2.1 Direct Effects

#### 5.2.1.1 Aquatic-Phase CRLF

The aquatic-phase considers life stages of the frog that are obligatory aquatic organisms, including eggs and larvae. It also considers submerged terrestrial-phase juveniles and adults, which spend a portion of their time in water bodies that may receive runoff and spray drift-containing oryzalin. Based on the highest modeled EECs for oryzalin use on rights-of-ways (6.1 lb ai/A) and the most sensitive freshwater fish (bluegill sunfish for acute toxicity and fathead minnow for chronic toxicity) (both used as surrogates for aquatic-phase amphibians), acute RQs are above the Agency's risk LOCs for oryzalin uses on rights-of-ways only (for both liquid and granular formulations) (**Table 5.1**). However, chronic toxicity did not exceed the risk LOC for any of the modeled scenarios.

Model-estimated peak environmental concentrations resulting from different oryzalin uses ranged from 3.5 to 149.5 µg/L. Comparison of the highest modeled surface water EEC (peak = 149.5 µg/L) with available NAWQA surface water monitoring data from California (1.51 µg/L) indicates that the peak modeled EEC is approximately 99 times higher than the maximum concentration of oryzalin detected in Arcade Creek near Norwood, Sacramento. Therefore, use of modeled EECs is assumed to provide a conservative measure of oryzalin exposures for aquatic-phase CRLFs.

While the acute RQ for mortality effects for the aquatic-phase CRLF exceeded the listed species LOC for only one non-food use (rights-of-ways), the probability of individual effects was low enough that the likelihood of measuring such an effect was considered improbable. The bluegill sunfish study reported a slope of 9.3. Calculated RQs ranged between 0.05 (liquid spray) and 0.052 (granular) for applications on rights-of-ways. The corresponding estimated chance of an individual acute mortality to the aquatic-phase CRLF is 1 in 1.88E+33 and 1 in 2.77E+32. Given the low probability of an individual mortality occurrence based on acute exposure and in view of chronic RQs that are well below LOCs, oryzalin is not likely to cause direct adverse effects to aquatic-phase CRLFs.

The CDPR (California Department of Pesticide Registration)'s pesticide use reporting data for the period 2002 to 2005 indicates that oryzalin use in rights-of-ways accounted for only 11% of the total use in California. Since most of the oryzalin used in California is applied in tree nuts (43%) and grapes (25%), it is unlikely that direct and indirect effects would result to the aquatic phase CRLF based on acute LOC exceedances for rights-of-ways.

Only one freshwater aquatic incident involving fish (bluegill sunfish and largemouth bass) kills were reported for oryzalin. The incident, which happened in 2001 in Georgia, was classified as misuse as it resulted possibly from either spray drift or run off following a rain event. More details on the incident can be found in **Appendix I**.

In summary, the Agency concludes a "not likely to adversely effect (NLAA)" determination for direct effects to the aquatic-phase CRLF, via mortality, growth, or fecundity, based on all available lines of evidence.

#### 5.2.1.2 Terrestrial-Phase CRLF

Acute mortality is expected for the terrestrial-phase CRLF (based on avian toxicity data) via exposure to spray and granular applications of oryzalin. The acute avian dose-based EEC values are above the dose-based $LD_{50}$ values for most uses for the non-granular formulations of oryzalin suggesting concerns for risk. Endangered species LOCs are exceeded for juvenile frogs with most uses for granular formulations of oryzalin. Therefore, direct effects to the terrestrial-phase CRLF via ingestion of terrestrial invertebrate food items are expected.

Before concluding LAA or NLAA for acute direct effects to the terrestrial-phase CRLF, a refinement of the risks posed to the terrestrial-phase CRLF from ingestion of residues on small insects was performed. As the avian acute RQs exceeded the listed species acute LOC (0.1) when calculated with T-REX, the likelihood of the risk should be considered in light of the results of the T-HERPS model. This refinement was performed because the avian acute dose-based RQ values in **Table 5.5**, used as screening surrogates for terrestrial-phase amphibians, likely overestimated risks to amphibians. Overestimation is due to the higher energy requirements of birds over amphibians of the same body weight, which results in a higher daily food intake rate value and a resultant higher dose-based exposure for birds than would occur for an amphibian of the same body weight. The T-HERPS model refines the RQ values based on dietary intake rate of an amphibian, rather than a dietary intake rate of an avian. Results of the analysis performed with T-HERPS are presented in **Table 5.15**. An example T-HERPS output is presented in **Appendix F**.

**Table 5.15 Terrestrial-Phase Amphibian RQ[1] Values Based on T-HERPS for Direct Effects to the CRLF from Ingestion of Oryzalin Residues on or in Prey Items (Based on Broadcast Spray Applications)**

| Use Category | Dose-based EEC | Dose-based Acute RQ | Dietary-based EEC | Dietary-based Acute RQ[2] | Dietary-based Chronic RQ[3] |
|---|---|---|---|---|---|
| **Food Uses** | | | | | |
| Bearing and Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards | 31.5 | 0.06 | 810 | <0.16 | **6.1** |
| **Non-Food Uses** | | | | | |
| Nonbearing Avocado, Fig, Olive, Berries, Citrus Fruits, Pome Fruits, Stone Fruits, Tree Nuts and Vineyards and Ornamentals (Excluding Bulbs) | 20.98 | 0.04 | 540 | <0.11 | **4.1** |
| Ornamental Bulbs | 7.87 | 0.02 | 203 | <0.04 | **1.5** |
| Christmas Tree Plantations | 20.98 | 0.04 | 540 | <0.11 | **4.1** |
| Warm Season Turf | 10.49 | <0.01 | 270 | <0.05 | **2.1** |
| Rights-of-ways | 32.1 | 0.01 | 826 | <0.17 | **6.3** |
| Residential areas | 10.49 | 0.02 | 270 | <0.05 | **2.1** |

[1]Based on the daily food ingestion rate for a small sized amphibian of 1.4 g for which the exposure concentrations and RQs represent conservative estimates.
[2]Dietary-based acute RQs did not exceed the avian acute endangered species LOC of 0.1 as the avian $LC_{50}$ of >5000 mg/kg-diet is greater than the predicted dietary-based EECs.
[3]LOC exceedances (chronic RQ $\geq$ 1) are bolded.

Dose-based acute risk quotients for all the modeled use scenarios (based on broadcast spray applications) dropped below acute endangered species LOCs (0.1) using T-HERPS. Dose-based acute risk quotients for terrestrial phase amphibians from ingestion of residues on or in prey items ranged between <0.01 and 0.08. However, dietary-based chronic RQs exceeded listed species LOCs for all uses modeled using T-HERPS (dietary-based RQs calculated by T-HERPS and T-REX are the same).

Dietary-based chronic RQs exceed the Agency's LOCs for all of the non-granular uses of oryzalin. With chronic dietary-based RQ values ranging from approximately 1.5 to 6.3, terrestrial-phase CRLFs foraging on small insects may result in reduction in offspring survival via reproductive effects. Chronic risks to the terrestrial-phase CRLF were evaluated using a bobwhite quail NOAEC value of 132 mg/kg-diet, which is based on reduction in female body weight. No reproductive effects were noted at this NOAEC level. Based on the bobwhite quail NOAEC value of 132 mg/kg-diet, chronic LOCs are exceeded for terrestrial-phase CRLFs that consume small insects for all modeled scenarios and application rates (1.5 to 6.1 lb ai/A per application or 2.25 to 12.2 lb ai/A/year). An application rate of 0.9 lb ai/A would be required to achieve chronic RQ values for terrestrial-phase CRLFs that are less than chronic LOCs. This value is approximately 85% less than the maximum spray (liquid formulation) application rate for oryzalin of 6.1 lb ai/A.

T-REX is not a bioaccumulation model. Because CRLF ingests small mammals another refinement included in the T-HERPS model was a conservative bioaccumulation model for residues in small herbivorous and insectivorous mammals. The bioaccumulation model assumes that the animal ingests 100% of its daily intake instantaneously and that there is no metabolism or elimination of the pesticide residues before being consumed. Additionally, the diet of the herbivorous small mammal is modeled as short grass, which has the highest chemical residues after a pesticide exposure of any of the plant residues modeled. This scenario is highly improbable and also not relevant for oryzalin because of its short half-life period and low bioaccumulation potential. Therefore, oryzalin is not likely to be bioavailable for a secondary poisoning type exposure once consumed by the small mammal. Therefore this refinement was not conducted for oryzalin.

No ecological incidents involving birds were reported for oryzalin.

In summary, the Agency concludes a "likely to adversely affect" or "LAA" effects determination based on chronic direct effects to the terrestrial-phase CRLF via current liquid spray (non-granular) uses of oryzalin.

### 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 unicellular aquatic plants (i.e., algae and diatoms) and detritus. Risk quotients for non-vascular plants were calculated based on the $EC_{50}$ value of 42 μg/L for freshwater green algae (*Selenastrum capricornutum*). Risk quotients exceeded acute aquatic plant risk LOCs for all the modeled scenarios except citrus fruits, pome and stone fruits, Christmas tree plantations, ornamental bulbs, and warm season turf grass for liquid formulations and Christmas tree plantations, ornamental bulbs, warm season turf grass, and residential areas for granular formulations (**Table 5.2**).

Toxicity values for freshwater non-vascular plants (other than marine diatom of 41 ppb) are 42, 72, and 24,000 ppb for green algae, freshwater diatom, and bluegreen algae, respectively. Thus, all the freshwater non-vascular plant endpoints are above the peak measured concentrations of oryzalin in California watersheds ($\leq$ 1.5 μg/L). The range of toxic endpoints for the above aquatic non-vascular plants suggests that the endpoint values for green algae and freshwater diatoms fall within the range of peak modeled oryzalin concentrations for the use patterns mentioned above (3.5 to 149.5 μg/L) and therefore are at risk from oryzalin applications. Bluegreen algae, on the other hand, do not appear to be adversely affected by oryzalin uses.

Based on the above, oryzalin may affect sensitive aquatic non-vascular plants such as green algae and diatoms (freshwater and marine) but is not likely to affect others such as bluegreen algae. Even though the CRLF consumes a wide range of other types of non-vascular plants, it is possible that several species other than those tested would be adversely impacted due to herbicidal nature of oryzalin. Though the measured peak concentration of oryzalin in California watersheds (1.5 ppb) is lower than the above toxicity endpoints, it is expected that oryzalin concentrations in the environment may exceed the 1.5 ppb levels at times, such as the periods that soon follow the application. Thus, it is likely that oryzalin could indirectly affect the CRLF via reduction in aquatic non-vascular plants as food items.

The effects determination for indirect effects of oryzalin to CRLF tadpoles via reductions in non-vascular plants is “likely to adversely affect” or “LAA” for oryzalin uses in avocado, berries, olives, tree nuts, vineyards, non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals excluding bulbs for liquid formulation and non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals excluding bulbs for granular formulations. Oryzalin uses in citrus fruits, pome and stone fruits, Christmas tree plantations, ornamental bulbs, warm season turf grass, and residential areas are not expected to indirectly impact CRLF tadpoles (via a reduction in non-vascular plants as food) because all RQs for these uses are below LOCs. According to the 2002-2005 CA PUR data described in Section 2.4.3 and summarized in **Table 2.5**, the highest oryzalin usage in California is reported for tree nuts, grapes, rights-of-ways, stone fruits, landscape maintenance, pome fruits, citrus fruits, and outdoor container ornamentals. Based on this statistic, the overall effects determination for indirect effects of oryzalin to CRLF tadpoles via reductions in non-vascular plants is “likely to adversely affect” or “LAA”.

#### 5.2.2.2 Aquatic Invertebrates

Acute RQs exceeded the LOCs for listed species (RQ $\geq$ 0.05) due to broadcast spray applications of oryzalin on rights-of-ways and granular applications in nonbearing fruits, ornamentals (excluding bulbs), and rights-of-ways (**Table 5.3**). Regardless the type of formulation, acute RQs exceeded the listed species LOC for rights-of-ways due to highest oryzalin application rates for this use. Although acute RQs exceeded the acute listed species LOC of 0.05 for the above uses, they are less than the non-listed acute LOC of

0.5. Chronic RQs for aquatic invertebrates, on the other hand, are less than the chronic LOC (RQ $\geq$ 1.0) for aquatic invertebrates for all modeled oryzalin uses.

Predicted chance of individual effect using probit dose-response curve slope from the daphnid study (slope = 9.5) and median lethal estimate ($LC_{50}$ = 1500 ppb) to a freshwater invertebrate at an RQ level of 0.1 (highest calculated RQ) is 1 in 9.53E+20. At the lower RQ range of 0.05, the corresponding estimated chance of an individual acute mortality/immobilization to a freshwater invertebrate is 1 in 1.03E+47.

The potential for oryzalin to elicit indirect effects to the CRLF via effects on freshwater invertebrate food items is dependent on several factors including: (1) the potential magnitude of effect on freshwater invertebrate individuals and populations; and (2) the number of prey species potentially affected relative to the expected number of species needed to maintain the dietary needs of the CRLF. Together, these data provide a basis to evaluate whether the number of individuals within a prey species is likely to be reduced such that it may indirectly affect the CRLF.

Oryzalin may affect sensitive aquatic invertebrates, such as the water flea; however, the low probability of an individual effect to the water flea is not likely to indirectly affect the CRLF, given the wide range of other types of freshwater invertebrates that the species consumes. Based on the non-selective nature of feeding behavior in the CRLF, the low magnitude of anticipated acute individual effects to preferred aquatic invertebrate prey species, and the measured low concentrations of oryzalin in California watersheds (~1.5 ppb), oryzalin is not likely to indirectly affect the CRLF via reduction in freshwater invertebrate food items. Therefore, the effects determination for indirect effects to the CRLF via direct acute effects on freshwater invertebrates as prey is “not likely to adversely affect” or “NLAA”.

#### 5.2.2.3 Fish and Aquatic-phase Frogs

The Agency concluded a “NLAA” determination for direct effects to the aquatic-phase CRLF, via mortality, growth, or fecundity. Therefore, indirect effects to the CRLF via a reduction in freshwater fish and other aquatic-phase frog species as prey items are not expected.

#### 5.2.2.4 Terrestrial Invertebrates

When the terrestrial-phase CRLF reaches juvenile and adult stages, its diet is mainly composed of terrestrial invertebrates. As previously discussed in Section 5.1.2.2.1b, indirect effects to the CRLF via reduction in terrestrial invertebrates prey items that are exposed to the broadcast spray applications of oryzalin are expected. RQ values representing acute exposures to terrestrial invertebrates (**Table 5.8**) indicate that all non-granular uses of oryzalin may potentially result in adverse effects to small invertebrates. However, the acute RQ values are non-definitive (*i.e.*, “less than” values). The extent to which the acute RQs, ranging from <0.3 to <12.8, may fall below the terrestrial invertebrate LOC of 0.05 is uncertain. Therefore, the effects determination for indirect effects to the CRLF via a reduction in terrestrial invertebrates is “may affect, but not likely to adversely affect” or “NLAA”. This finding is based on discountable effects (*i.e.*, acute effects at the expected levels of exposure are not likely to occur via a reduction in terrestrial invertebrates as food items).

#### 5.2.2.5 Mammals

Life history data for terrestrial-phase CRLFs indicate that large adult frogs consume terrestrial vertebrates, including mice. As previously discussed, definitive acute RQ values could not be derived because the mammalian $LD_{50}$ value is >10,000 mg/kg-bw. Dose-based acute risk quotients ranged from <0.02 to <0.06 and risk do not appear to exist based on all modeled oryzalin uses (**Table 5.9**). Granular formulations of oryzalin are also not expected to cause acute mortality to mammals because predicted EECs (15.6 to 41.8 mg/sq ft) are well below the adjusted $LD_{50}$ values for mammals (>4,472 mg/kg-bw) (**Table 5.10**). On the other hand, chronic RQs (1.3 to 69.5) representing oryzalin exposures to rats (small mammals) indicate risks resulting from all broadcast spray (non-granular) uses.

Based on the available toxicity data, chronic exposure of laboratory rats to oryzalin resulted in consistent reductions in adult body weight and hematology parameters and increased microscopic findings in the thyroid in females at 42.89 mg/kg/day and decreased survival, decreased weight gain and hematology parameters, increased thyroid weight, incidence of skin lesions, and microscopic findings in males at 112.5 mg/kg/day. The corresponding NOAEC was 13.8 and 36.9 mg/kg-diet for males and females, respectively, suggesting that females were most sensitive to oryzalin than males.

Overall, indirect effects are possible for large CRLF adults through decreases in mammalian prey via chronic exposure to non-granular uses of oryzalin. Therefore, the effects determination for indirect effects to terrestrial-phase CRLFs via reduction in small mammals as prey is “likely to adversely affect” or “LAA” for all modeled uses. The maximum application rate of non-granular uses of oryzalin would have to be reduced to 1.1 lb ai/A to eliminate potential chronic risks to mammals and associated indirect dietary effects to terrestrial-phase CRLFs.

#### 5.2.2.6 Terrestrial-phase Amphibians

Terrestrial-phase adult CRLFs also consume frogs. RQ values representing direct exposures of oryzalin to terrestrial-phase CRLFs are used to represent exposures of oryzalin to frogs in terrestrial habitats. Based on estimated exposures resulting from non-granular uses of oryzalin, both acute (dose-based) and chronic risks to frogs are possible. Therefore, the effects determination for indirect effects to large CRLF adults that feed on other species of frogs as prey, via acute and chronic exposure to oryzalin, is “likely to adversely affect” or “LAA.”

### 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, rather than energy, to the system, as attachment sites for many aquatic invertebrates, and refugia for juvenile organisms, such as fish and frogs. Emergent plants help reduce sediment loading and provide stability to near shore areas and lower stream banks. 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 are assessed using RQs from freshwater aquatic vascular and non-vascular plant data. Based on RQs for non-vascular plants (previously described in Section 5.2.2.1 and summarized in **Table 5.2**), LOCs are exceeded for RQs for liquid applications of oryzalin to avocado, berries, olives, tree nuts, non-bearing fruits, nuts, and vineyards, ornamentals excluding bulbs, and rights-of-ways. Similar to liquid formulations, non-vascular plant RQs did not exceed LOCs for Christmas tree plantations, ornamental bulbs, and warm season turf grass for granular applications. Vascular plant RQs are less than the LOC of 1 for citrus fruits (liquid formulation), warm season turf grass (both liquid and granular formulations) and residential uses (granular formulation) only (**Table 5.4**). Therefore, indirect effects to the CRLF via direct effects to vascular plants as habitat are expected.

As previously discussed in Section 5.2.2.1, the range of toxic endpoints for three out of the four non-vascular plants and the vascular plant included in this assessment fell with the range of peak modeled oryzalin concentrations (3.5 to 149.5 μg/L). Even though the CRLF depends on a wide range of non-vascular and vascular plants, it is expected that oryzalin, being a herbicide, would elicit adverse impacts on other vascular and no-vascular plants resulting in indirect effects to CRLFs via direct habitat-related impacts to non-vascular and vascular plants. Therefore, the effects determination for indirect effects of oryzalin to CRLFs via impacts to habitat and/or primary production through direct effects to non-vascular plants is “likely to adversely affect” or “LAA”.

#### 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. 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.

Loss, destruction, and alteration of habitat were identified as a threat to the CRLF in the USFWS Recovery Plan (USFWS, 2002). Herbicides can adversely impact habitat in a number of ways. In the most extreme case, herbicides in spray drift and runoff from the site of application have the potential to kill (or reduce growth and/or biomass in) all or a substantial amount of the vegetation, thus removing or impacting structures which define the habitat, and reducing the functions (*e.g.*, cover, food supply for prey base) provided by the vegetation.

Oryzalin is a systemic herbicide that is absorbed mainly through the roots of developing plants. It has little or no foliar activity and is not translocated within the plant. Thus the primary effect of oryzalin is on root development of emerging plants. Roots of affected plants are relatively few in number, short, thick, and club shaped. The inhibited root growth causes tops of plants to be stunted and demonstrate a dark green color. Based on the available toxicity data for terrestrial plants, it appears that emerged monocot and dicot seedlings are more sensitive to oryzalin in the seedling emergence test than in the vegetative vigor test. This is demonstrated by the difference in both monocot and dicot plant response to the two guideline studies. The monocot (ryegrass) $EC_{25}$ values for the seedling emergence and vegetative vigor tests are 0.029 lb ai/A and 0.174 lb ai/A, respectively, representing almost a six-fold difference in sensitivity. The dicot (tomato) $EC_{25}$ values for the seedling emergence and vegetative vigor tests are 0.0506 lb ai/A and 0.0828 lb ai/A, respectively.

Riparian vegetation typically consists of three tiers of vegetation, which include a groundcover of grasses and forbs, an understory of shrubs and young trees, and an overstory of mature trees. Frogs spend a considerable amount of time resting and feeding in riparian vegetation; the moisture and cover of the riparian plant community provides good foraging habitat, and may facilitate dispersal in addition to providing pools and backwater aquatic areas for breeding (USFWS, 2002). According to Hayes and Jennings (1988), the CRLF tends to occupy water bodies with dense riparian vegetation including willows (*Salix* sp.). Upland habitat includes grassland and woodlands, as well as scrub/shrub habitat. No guideline data are available on the toxicity of oryzalin to woody plants. However, as oryzalin is labeled for use around numerous woody species including citrus, tree nuts, and grapes, as well as uses associated with tree plantations and nurseries, toxicity to woody plants (except for species such as Douglas fir as specified in the label) is not expected. Furthermore, the label for oryzalin recommends its use on numerous shrubs and trees including *Salix* species (willows) to which CRLF exhibits preference.

As shown in **Tables 5.11 and 5.12**, RQs exceed LOCs for monocots and dicots inhabiting dry and semi-aquatic areas exposed to liquid formulations of oryzalin via runoff and drift. Spray drift RQs did not exceed LOCs for granular formulations. In general, it appears that monocots are more sensitive than dicots to oryzalin in dry and semi-aquatic areas.

In summary, based on exceedance of the terrestrial plant LOCs for all oryzalin use patterns following runoff and spray drift to semi-aquatic and dry areas, the following general conclusions can be made with respect to potential harm to riparian habitat:

- Oryzalin may enter riparian areas via runoff and/or spray drift where it may be taken up by the roots of sensitive emerging seedlings.

- Based on Oryzalin's mode of action and a comparison of seedling emergence $EC_{25}$ values to EECs estimated using TerrPlant, emerging or developing seedlings may be affected. Furthermore, based on the residual nature of oryzalin, it is expected to impact germinating seedlings and emerging plants for several months after application. Inhibition of new growth could result in degradation of high quality riparian habitat over time because as older growth dies from natural or anthropogenic causes, plant biomass may be prevented from being replenished in the riparian area.

- Because 7 out of 10 species tested in the seedling emergence studies and five out of 10 species tested in the vegetative vigor studies were affected, it is likely that many species of herbaceous plants may be potentially affected by exposure to oryzalin via runoff and spray drift.

A review of the oryzalin incidents for terrestrial plants revealed 5 incidents. Phototoxicity or plant death reported in almost all of these incidents was due to the use of other herbicides that have the potential to cause injury either in mixture or use before/after the oryzalin applications. Although the reported number of oryzalin incidents for terrestrial plants is low, an absence of reports does not necessarily provide evidence of an absence of incidents. The only plant incidents that are reported are those that are alleged to occur on more than 45 percent of the acreage exposed to the pesticide. Therefore, an incident could impact 40% of an exposed crop and not be reported by a registrant.

In summary, terrestrial plant RQs are above LOCs; therefore, upland and riparian vegetation may be affected. However, woody plants are generally not sensitive to environmentally relevant oryzalin concentrations; therefore, effects on shading, bank stabilization, structural diversity (height classes) of vegetation, and woodlands are not expected. Given that both upland and riparian areas are comprised of a mixture of both non-sensitive woody (trees and shrubs) and sensitive grassy herbaceous vegetation, CRLFs may be indirectly affected by adverse effects to herbaceous vegetation which provides habitat and cover for the CRLF and its prey. Therefore, the effects determination for this assessment endpoint is "likely to adversely affect" or "LAA" for all assessed oryzalin use patterns.

The distance required to dissipate spray drift to below the LOC was determined using AgDrift based on the $EC_{25}$ levels for terrestrial plants. Input parameters for AgDrift included a high boom, screens no finer than 50 mesh (365 µm) for nozzles specified in the labels, and the spray droplet size distribution of "ASAE medium to coarse ($D_{V0.5}$= 340.87 µm). Theoretically, dissipation to the no effect level should be modeled in order to provide potential buffer distances that are protective of endangered terrestrial plant species. This distance beyond the site of application is considered as the action area for oryzalin. However, because no obligate relationship exists between the CRLF and terrestrial plants, the portion of the action area that is relevant to the CRLF is defined by the dissipation distance to the $EC_{25}$ level (*i.e.*, the potential buffer distance required to protect non-endangered terrestrial plant species).

Since the seedling emergence endpoint ($EC_{25}$ for ryegrass and tomato = 0.0285 and 0.0506 lb ai/A, respectively) is more sensitive than the vegetative vigor endpoint ($EC_{25}$ for ryegrass and tomato = 0.174 and 0.0828 lb ai/A, respectively) and as oryzalin is a preemergence herbicide that inhibits roots of emerging/developing plants with no activity against existing vegetation, spray drift distances are derived using the seedling emergence endpoint for both monocots and dicots. For comparison purposes, spray drift dissipation distances were also calculated using the vegetative vigor endpoint for monocots and dicots.

Spray drift dissipation distances for typical oryzalin use rates are presented in **Table 5.16**. Based on the endpoints derived for seedling emergence, adverse effects to terrestrial plants might reasonably be expected to occur up to 164 feet for monocots and up to 79 feet for dicots from the use site for ground applications of oryzalin. Vegetative vigor-based dissipation distances were only 12 and 54% of those calculated based on seedling emergence endpoints for monocots and dicots, respectively. The dissipation distance is expected to increase based on a decrease in droplet size as fine drops will result in more drift. In some cases, topography (such as an intervening ridge) or weather conditions (such as prevailing winds towards or away from the frog habitat) could affect the estimates presented in **Table 5.16**.

**Table 5.16 Spray Drift Dissipation Distances for Oryzalin**

| Oryzalin Application Rate (lb ai/A) | Dissipation Distance (ft) | | | |
|---|---|---|---|---|
| | Seedling Emergence | | Vegetative Vigor | |
| | Monocot | Dicot | Monocot | Dicot |
| 6 | 164 | 79 | 20 | 43 |
| 4 | 98 | 49 | 13 | 26 |
| 2 | 43 | 20 | 7 | 13 |
| 1.5 | 30 | 16 | 7 | 10 |

In addition to the spray drift dissipation distance, the distance which represents the maximum continuous downstream dilution from the edge of the initial area of concern where direct/indirect effects and/or critical habitat modification may occur from oryzalin applications was also calculated. The downstream dilution analysis is based on the greatest ratio of aquatic RQ to LOC, which was calculated to be 9.7 for oryzalin. This value was estimated using the NOAEC value for the most sensitive aquatic plant species, duckweed in this case, of 15.4 ppb and maximum peak EEC from oryzalin applications to rights-of-ways of 149 ppb. Downstream dilution analysis for oryzalin suggests that 51 kilometers is the furthest distance that could be added downstream (**Appendix D**).

### 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).

The effects determinations for indirect effects to the CRLF via direct effects to aquatic and terrestrial plants are used to determine whether modification to critical habitat may occur. Based on the results of the effects determinations for aquatic plants (see Sections 5.2.2.1 and 5.2.3.1), critical habitat of the CRLF may be modified via oryzalin-related impacts to non-vascular aquatic plants as food items for tadpoles and habitat for aquatic-phase CRLFs. Critical habitat may be modified by an increase in sediment deposition and associated turbidity (via impacts to herbaceous riparian vegetation), potential reduction in oxygen (via impacts to the aquatic plant community and primary productivity), and reduction in herbaceous riparian vegetation that provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult aquatic-phase CRLFs. Oryzalin uses may result in modification to critical habitat via direct effects to non-vascular plants for both liquid and granular applications.

Based on the results of the effects determination for terrestrial plants (see Section 5.2.3.2), oryzalin-related effects on shading (*i.e.*, temperature), bank stabilization, and structural diversity (height classes) of vegetation are not expected because woody plants (other than plants such as Douglas fir) are generally not sensitive to environmentally-relevant concentrations of oryzalin. However, modification to critical habitat may occur via oryzalin-related impacts to sensitive herbaceous vegetation, which provide habitat and cover for the CRLF and its prey, based on all assessed uses of oryzalin.

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 was 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. As discussed in Section 5.2.1.1, direct effects to the aquatic-phase CRLF, via mortality are expected. Therefore, oryzalin is likely to adversely affect critical habitat by altering chemical characteristics necessary for normal growth and viability of aquatic-phase CRLFs and their non-plant food sources.

#### 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 drip line surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance.

- Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.

As discussed above, modification to critical habitat may occur via oryzalin-related impacts to sensitive herbaceous vegetation, which provides habitat, cover, and a means of dispersal for the terrestrial-phase CRLF and its prey, based on all assessed uses of oryzalin. Modification to critical habitat is not expected to occur in woodland areas because most woody plants are not sensitive to environmentally relevant concentrations of oryzalin.

The third terrestrial-phase PCE is "reduction and/or modification of food sources for terrestrial phase juveniles and adults." To assess the impact of oryzalin on this PCE, acute and chronic toxicity endpoints for terrestrial invertebrates, mammals, and terrestrial-phase frogs are used as measures of effects. Based on the characterization of indirect effects to terrestrial-phase CRLFs via reduction in the prey base (see Section 5.2.2.4 for terrestrial invertebrates, Section 5.2.2.5 for mammals, and 5.2.2.6 for frogs), critical habitat may be modified via a reduction in mammals and terrestrial-phase amphibians as food items.

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. As discussed in Section 5.2.1.2, direct acute effects, via mortality, are expected for the terrestrial-phase CRLF. Furthermore, chronic reproductive effects are also possible for all non-granular uses of oryzalin. Therefore, oryzalin may adversely critical habitat by altering chemical characteristics necessary for normal growth and viability of terrestrial-phase CRLFs and their mammalian and amphibian food sources.

# 6. Uncertainties

## 6.1 Exposure Assessment Uncertainties

### 6.1.1 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.

### 6.1.2 Aquatic Exposure Modeling of Oryzalin

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).

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

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 oryzalin 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 oryzalin use areas. The maximum concentration of oryzalin reported by

NAWQA (2000-2005) for California surface waters with agricultural watersheds is 1.51 µg/L. This is roughly 198 times lower than the highest peak EEC estimated for rights-of-ways (3.5 – 149.5 ppb) using PRZM/EXAMS. Therefore, use of the PRZM/EXAMS EECs is assumed to represent a conservative measure of exposure.

### 6.1.3 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 homeowner-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.

### 6.1.4 Terrestrial Exposure Modeling of Oryzalin

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.

### 6.1.5 Spray Drift Modeling

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 oryzalin from multiple applications, each application of oryzalin would have to occur under identical atmospheric conditions (e.g., same wind speed and same wind direction) and (if it is an animal) the animal being exposed would have to be located in the same location (which receives the maximum amount of spray drift) after each application. 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 model spray drift from aerial and ground applications in a flat area with little to no ground cover and a steady, constant wind speed and direction). Therefore, in most cases, the drift estimates from AgDRIFT may overestimate exposure, especially as the distance increases from the site of application, since the model does not account for potential obstructions (*e.g*., large hills, berms, buildings, trees, *etc*.). Furthermore, conservative assumptions are made regarding the droplet size distributions being modeled (‘ASAE Medium to Course “ for agricultural and non-agriculture uses), and ‘the application method (*i.e*., ground), release heights and wind speeds. Alterations in any of these inputs would decrease the area of potential effect.

## 6.2 Effects Assessment Uncertainties

### 6.2.1 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.

### 6.2.2 Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on oryzalin 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.

### 6.2.3 Sublethal Effects

When assessing acute risk, the screening risk assessment relies on the acute mortality endpoint as well as a suite of sublethal responses to the pesticide, as determined by the testing of species response to chronic exposure conditions and subsequent chronic risk assessment. Consideration of additional sublethal data in the effects determination t is exercised on a case-by-case basis and only after careful consideration of the nature of the sublethal effect measured and the extent and quality of available data to support establishing a plausible relationship between the measure of effect (sublethal endpoint) and the assessment endpoints. However, the full suite of sublethal effects from valid open literature studies is considered for the purposes of defining the action area.

No studies were identified in the submitted studies or open literature that documented sublethal effects (other than the assessment endpoints such as growth, survival, and reproduction) associated with exposure to oryzalin. To the extent to which sublethal effects are not considered in this assessment, the potential direct and indirect effects of oryzalin on CRLF may be underestimated.

### 6.2.4 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.

## 7. Risk Conclusions

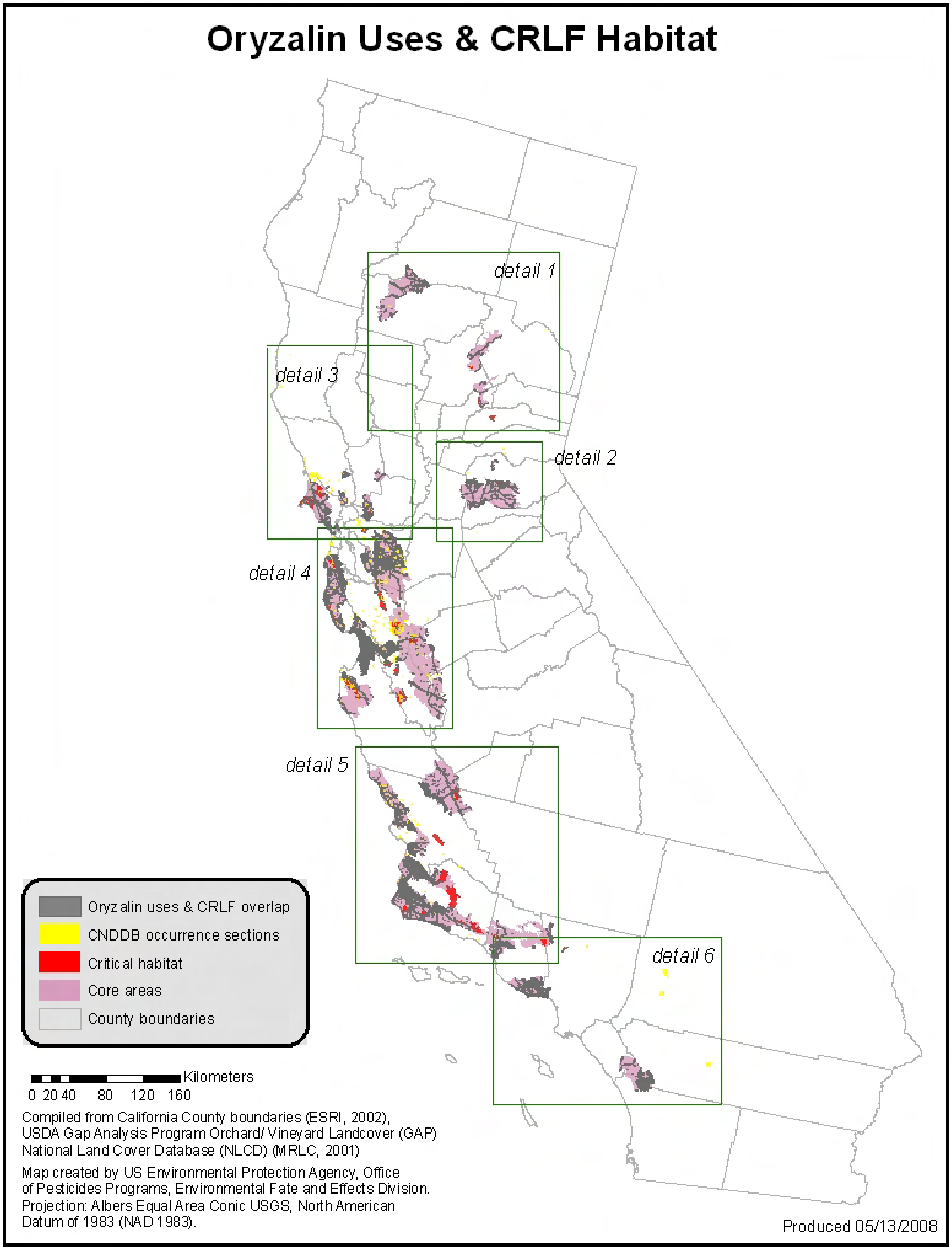
In fulfilling its obligations under Section 7(a)(2) of the Endangered Species Act, the information presented in this endangered species risk assessment represents the best data currently available to assess the potential risks of oryzalin to the CRLF and its designated critical habitat.

Based on the results of the Agency's endangered species risk assessment for oryzalin, a Likely to Adversely Affect (LAA) and modification to critical habitat determination was concluded for the CRLF. The spatial extent of the effects determination is based on the initial area of concern for application of oryzalin on cultivated crops, orchards/vineyards, turf, rights of way, and developed, open space, low, medium, and high densities, and expanded to include the total area where there is potential for direct or indirect effects to occur via off-site transport mechanisms. The extent of potential off-site transport is determined by deriving the spray drift area and the run-off area based on downstream dilution. The identified direct and indirect effects are anticipated to occur only for those currently occupied core areas, CNDDB occurrence sections, and areas of designated critical habitat for the CRLF that are located 164 feet from legal use sites where oryzalin is applied to the use sites listed above. Downstream extent analysis (which is based on the greatest ratio of aquatic RQ to LOC of 9.7 that was estimated using the NOAEC value for the vascular aquatic plant duckweed (the most sensitive species) of 15.4 ppb and a maximum peak EEC for applications to rights-of-ways of 149 ppb) shows that 51 kilometers is the furthest distance that could be added downstream. This distance represents the maximum continuous downstream dilution from the edge of the initial area of concern where direct/indirect effects and/or critical habitat modification may occur.

Using ARCGIS9, the National Land-Cover Dataset (NLCD, 2001), and the CRLF habitat information provided by the USFWS, the Agency has identified the areas where indirect effects to the CRLF and modification to designated critical habitat are anticipated to occur (Figure 7.1). Additional details on the GIS maps can be obtained from Appendix D.

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

**Figure 7.1**


Oryzalin Uses & CRLF Habitat
detail 1
detail 2
detail 3
detail 4
detail 5
detail 6
Oryzalin uses & CRLF overlap
CNDDB occurrence sections
Critical habitat
Core areas
County boundaries
Kilometers
0 20 40 80 120 160
Compiled from California County boundaries (ESRI, 2002),
USDA Gap Analysis Program Orchard/ Vineyard Landcover (GAP)
National Land Cover Database (NLCD) (MRLC, 2001)
Map created by US Environmental Protection Agency, Office
of Pesticides Programs, Environmental Fate and Effects Division.
Projection: Albers Equal Area Conic USGS, North American
Datum of 1983 (NAD 1983).
Produced 05/13/2008

| Table 7.1 Effects Determination Summary for Direct and Indirect Effects of Oryzalin on the CRLF | | |
|---|---|---|
| **Assessment Endpoint** | **Effects Determination**[1] | **Basis for Determination** |
| ***Aquatic-Phase CRLF (Eggs, Larvae, and Adults)*** | | |
| Direct Effects:<br>Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases | NLAA | Using freshwater fish as a surrogate, no chronic LOCs are exceeded; acute LOCS are exceeded for 1 use only (rights-of-ways) for which the probability of individual mortality is very low (1 in 1.9E+33 to 3.05E+26). |
| Indirect Effects:<br>Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants, fish, and frogs) | Freshwater invertebrates: NLAA | Oryzalin may affect sensitive aquatic invertebrates, such as the water flea; however, the low probability (1 in 1.03E+47 to 9.53E+20) of an individual effect to the water flea is not likely to indirectly affect the CRLF, given the wide range of other types of freshwater invertebrates and food items that the species consumes during its aquatic phase. Based on the non-selective nature of feeding behavior in the aquatic-phase CRLF, the low magnitude of anticipated acute individual effects to preferred aquatic invertebrate prey species, and low measured concentrations of oryzalin in California watersheds, oryzalin is not likely to indirectly affect the CRLF via reduction in freshwater invertebrate food items. |
| | Non-vascular aquatic plants: LAA | Oryzalin (in liquid form) uses in avocado, berries, olives, tree nuts, vineyards, non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals (excluding bulbs) and granular uses in non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals (excluding bulbs) exceeded LOCs. Indirect effects to tadpoles that feed on algae, therefore, are possible. |
| | Fish and frogs: NLAA | Using freshwater fish as a surrogate, no chronic LOCs are exceeded; acute LOCS exceeded for only 1 scenario (rights-of-ways) for which the probability of individual mortality is very low. |
| Indirect Effects:<br>Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community) | Non-vascular aquatic plants: LAA | LOCs are exceeded for non-vascular aquatic plants for broadcast spray applications of oryzalin in avocado, berries, olives, tree nuts, vineyards, non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals (excluding bulbs) and granular applications in non-bearing fruits, nuts and vineyards, rights-of-ways, and ornamentals (excluding bulbs). |
| | Vascular aquatic plants: LAA | RQs for vascular plants are higher than LOCs for almost all oryzalin use patterns except citrus fruits, warm season turf grass, and residential areas. |
| Indirect Effects:<br>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. | Direct effects to forested riparian vegetation: NLAA<br><br>Direct effects to grassy/herbaceous | Riparian vegetation may be affected because terrestrial plant RQs are above LOCs. However, woody plants (other than species such as Douglas fir) are generally not sensitive to oryzalin; therefore, effects of riparian areas in the action area are not expected.<br><br>Aquatic-phase CRLFs may be indirectly affected by adverse effects to sensitive herbaceous vegetation (based |

| | | |
|---|---|---|
| | riparian vegetation:<br>LAA (ground applications): <164 ft (monocots); <79 ft (dicots)<br>NLAA (ground applications): >164 ft (monocots); >79 ft (dicots) | on all oryzalin liquid spray and granular uses), which provides habitat and cover for the CRLF and attachment sites for its egg masses. |
| ***Terrestrial-Phase CRLF (Juveniles and adults)*** | | |
| Direct Effects:<br>Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles | Acute: NLAA | The acute avian effects data was used as a surrogate for the terrestrial-phase CRLF. Dose-based acute avian RQs, refined based on amphibian dietary intake using the T-HERPS model, did not exceed LOCs for any of the modeled uses. |
| | Chronic: LAA | Chronic reproductive effects are possible based on non-granular uses of oryzalin. |
| Indirect Effects:<br>Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial vertebrates, including mammals and terrestrial phase amphibians) | Terrestrial invertebrates: NLAA | Oryzalin is non-toxic to terrestrial invertebrates at environmentally relevant concentrations. At the expected levels of oryzalin exposure, the effects on vertebrates are small and thus a reduction in terrestrial invertebrates as food items is unlikely. |
| | Mammals: LAA | Chronic RQs for non-granular formulations exceed LOCs. |
| | Frogs: LAA | Chronic risks for terrestrial-phase frogs exposed to broadcast spray applications of oryzalin may occur. |
| Indirect Effects:<br>Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian vegetation) | Direct effects to forested riparian vegetation: NLAA<br><br>Direct effects to grassy/herbaceous riparian vegetation:<br>LAA (ground applications): <164 ft (monocots); <79 ft (dicots)<br>NLAA (ground applications): >164 ft (monocots); >79 ft (dicots) | Riparian vegetation may be affected because terrestrial plant RQs are above LOCs. However, woody plants (other than species such as Douglas fir) are generally not sensitive to oryzalin; therefore, effects of riparian areas in the action area are not expected.<br><br>Aquatic-phase CRLFs may be indirectly affected by adverse effects to sensitive herbaceous vegetation (based on all oryzalin liquid spray and granular uses), which provides habitat and cover for the CRLF and attachment sites for its egg masses. |
| [1]NE = no effect; NLAA = may affect, but not likely to adversely affect; LAA = likely to adversely affect | | |

| Table 7.2 Effects Determination Summary for the Critical Habitat Impact Analysis | | |
|---|---|---|
| **Assessment Endpoint** | **Effects Determination[1]** | **Basis for Determination** |
| ***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. | Habitat modification | Both liquid and granular formulations of oryzalin may affect sensitive riparian seedlings. As a result, critical habitat may be modified by an increase in sediment deposition and reduction in herbaceous riparian vegetation that provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult aquatic-phase 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.[6] | Habitat modification | Both liquid and granular formulations of oryzalin may affect sensitive seedlings. As a result, critical habitat may be modified via turbidity and reduction in oxygen content necessary for normal growth and viability of juvenile and adult aquatic-phase CRLFs. |
| Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source. | Effects on growth and viability of CRLF<br><br>Habitat modification based on alteration of food source | Direct effects to the aquatic-phase CRLF, via mortality are expected.<br><br>Critical habitat of the CRLF may be modified via oryzalin-related impacts (both formulations) to non-vascular aquatic plants as food items for tadpoles. |
| Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae) | Habitat modification | Based on the results of the effects determinations for aquatic plants, critical habitat of the CRLF may be modified via oryzalin-related impacts to non-vascular aquatic plants as food items for tadpoles. |
| ***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 | Habitat modification | Modification to critical habitat may occur via impacts of oryzalin on sensitive seedlings which provide habitat and cover for the terrestrial-phase CRLF and its prey. |
| 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 | Habitat modification | |
| Reduction and/or modification of food sources for terrestrial phase juveniles and adults | Habitat modification | Based on the characterization of indirect effects to terrestrial-phase CRLFs via reduction in the prey base, critical habitat may be modified via a reduction in mammals and terrestrial-phase amphibians as food items. |
| Alteration of chemical characteristics necessary for normal | Habitat | Direct acute effects, via mortality, are not expected for |

[6] 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.

| | | |
|---|---|---|
| growth and viability of juvenile and adult CRLFs and their food source. | modification | the terrestrial-phase CRLF; however, chronic reproductive effects are possible for all non-granular uses of oryzalin. Therefore, oryzalin may adversely affect critical habitat by altering chemical characteristics necessary for normal growth and viability of terrestrial-phase CRLFs and their mammalian and amphibian food sources. |
| 1 NE = No effect; HM = Habitat modification | | |

Based on the above, the Agency makes a "Likely to Adversely Affect" determination for the CRLF from the use of oryzalin. Oryzalin is not likely to adversely affect the aquatic-phase CRLF by direct toxic effects or by indirect effects resulting from effects to aquatic invertebrates, fish, and other aquatic-phase frogs as food items. In addition, direct acute effects and indirect effects via reduction of terrestrial invertebrates as prey are not expected for terrestrial-phase CRLFs. However, an "LAA" determination was concluded for the aquatic-phase CRLF, based on indirect effects related to a reduction in algae as food items for the tadpole, and on aquatic non-vascular plants and sensitive herbaceous terrestrial plants that comprise its habitat. For the terrestrial-phase CRLF, an "LAA" determination was concluded for chronic direct effects and indirect effects related to a reduction in mammals and terrestrial-phase frogs as food items, and herbaceous terrestrial plants as habitat. Given these direct and indirect effects to the CRLF, modification of critical habitat is also expected for both aquatic and terrestrial primary constituent elements (PCEs). A summary of the risk conclusions and effects determinations for the CRLF and its critical habitat is presented **in Tables 1.1 and 1.2**. Further information on the results of the effects determination is included as part of the Risk Description in Section 5.2.

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.

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