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

**Pesticide Effects Determination**

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

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**Primary Authors**
**Pamela Hurley, Ph.D., Toxicologist**
**Lucy Shanaman, M. S., Chemist**

**Secondary Review**
**Brian Anderson, M.E.M., Biologist**
**James A. Hetrick, Ph.D., Senior Scientist**
**Anita Pease, M.S., Biologist**

**Branch Chief, Environmental Risk Assessment Branch 3**
**Karen Whitby, Ph.D.**

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## 1. Executive Summary

Imazapyr is a systemic, non-selective herbicide used for control of most annual and perennial broadleaf weeds and grasses, woody species, and riparian and floating and emergent aquatic weed species in terrestrial and aquatic environmental settings. Imazapyr is formulated both as an acid and as an isopropylamine salt. The salt disassociates under environmental conditions to form the acid; therefore, in this assessment, all references to the acid are applicable to either the acid or the isopropylamine salt formulations. Aqueous imazapyr formulations may be mixed with surfactants or oils for application as well as mixed with other herbicides and fertilizers. Imazapyr is also available in a water dispersible granular formulation, as an emulsifiable concentrate and in pelleted/tableted form for direct injection into plants. Typical terrestrial application methods consist of ground and aerial spray, with granular broadcast applications for forestry uses, while surface waters are treated directly with aqueous formulations. Imazapyr may also be injected directly into the plant around the stem. Imidazoline herbicides are systemic plant growth inhibitors that are normally active at very low rates. However, imazapyr appears not to be as active as most imidazoline herbicides at very low rates. Uptake of imazapyr is primarily through the foliage and roots. It is then translocated to meristematic tissue where it inhibits acetohydroxyacid synthase (AHAS, also known as acetolactate synthase or ALS), thus, disrupting protein synthesis and interfering with cell growth and DNA synthesis. AHAS is not present in mammals, birds, fish, or insects. As a result, imazapyr is intended to be specifically toxic to plants.

Imazapyr is currently registered nationwide for use in terrestrial (railroads and industrial right-of-ways, fencerows, wildlife habitats and forests) and aquatic (ponds, lakes, reservoirs, marshes, bayous, canals, streams, rivers, and water drainage systems), non-cropped areas and for corn fields. There are no other currently registered agricultural products. Although the action area is likely to encompass a large area of the United States, the scope of this assessment limits consideration of the overall action area to those portions that are applicable to the protection of the California Red Legged Frog (CRLF) and its designated critical habitat. As such, the action area includes the current range of the species and designated critical habitat, which occur within the state of California. The current labels state that imazapyr may not be used on corn crops in the state of California. In addition, the granular labels state that the granular formulations may not be used in the state of California. The initial area of concern for imazapyr is limited to all the areas within the state of California where the non-agricultural uses listed above may be applied. The initial area of concern represents the "footprint" of where imazapyr could potentially be used based on land cover information. The initial area of concern is then expanded as necessary based on the potential for direct and indirect effects above levels of concern and on consideration of the fate and transport properties of the compound. The action area is defined by the land use classes designated to represent these non-agricultural uses in a conservative fashion and accounts for the fate and transport characteristics of the pesticide, including transport in streams and rivers, spray drift, and long-range transport. For imazapyr, the action area is defined as the initial area of concern with buffers ranging from 7120 (forestry uses, ground application) to 26460 feet (forestry uses, aerial application) to account for potential drift and long-range transport away from the site of application and a total of 7,450 stream miles added downstream from the initial area of concern to account for the potential downstream movement of imazapyr residues at concentrations above levels of concern and for transport with flowing waters.

In accordance with the methodology specified in the Agency's Overview Document (U.S. EPA, 2004), screening level aquatic estimated environmental concentrations (EECs), based on the PRZM/EXAMS static water body scenario, were used to derive risk quotients (RQs) for aquatic animals and plants for all relevant imazapyr uses within the action area. It is noted that screening level EECs based on the static water body are not considered to be representative of all waters where the CRLF and designated critical habitat occur. For "may affect" determinations, screening level EECs may be further refined and characterized based on the location of the CRLF in more vulnerable waters such as shallow ponds and streams. Terrestrial EECs for terrestrial animals were derived from dietary concentrations of various avian and mammalian food items along with the dissipation rate using the model TREX 1.3.1. Terrestrial EECs for plants were estimated from the model, TerrPlant 1.2.2, which derives pesticide EECs from runoff and drift. RQs based on screening level EECs were used to distinguish "no effect" from "may affect" determinations for direct/indirect effects to the CRLF and the critical habitat impact analysis.

The assessment endpoints for the CRLF included direct toxic effects on survival, reproduction, and growth of individual CRLF's, as well as indirect effects, such as reduction of the food source and/or modification of habitat. Risk quotients (RQs) for direct acute effects to the CRLF were calculated using acute toxicity data from either registrant-submitted studies or acceptable studies available in the open literature for the surrogate species, freshwater fish for the aquatic-phase and birds for the terrestrial-phase when toxicity data on amphibians are not available. RQs for direct chronic (reproductive, growth) effects were also calculated using either registrant-submitted or acceptable open literature chronic toxicity data for freshwater fish and birds. To assess potential indirect effects to the CRLF via direct effects to potential prey (and consequently a reduction of available food items), toxicity data for freshwater fish and invertebrates as well as birds (surrogate for terrestrial-phase amphibians), terrestrial invertebrates and mammals were considered. Registrant-submitted and/or acceptable open literature aquatic and terrestrial plant toxicity studies were used to assess risk to primary producers, and in turn, potential indirect effects to the CRLF.

Federally designated critical habitat has been established for the CRLF. Adverse modifications to the primary constituent elements of designated critical habitat, as defined in 50 CFR 414.12(b), were also evaluated. PCEs evaluated as part of this assessment include the following:

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

RQs were derived as quantitative estimates of potential high-end risk. Acute and chronic RQs were compared to the Agency's Levels of Concern (LOCs) to identify instances where imazapyr use within the action area has the potential to adversely affect the CRLF or adversely modify designated critical habitat. RQs for a particular type of effect were below the LOCs, leads to a conclusion of "no effect". Where RQs exceeded LOCs, a potential to cause adverse effects or habitat modification is identified, leading to a conclusion of "may affect". If imazapyr use "may affect" the CRLF or its critical habitat, best available data and information is considered to refine the potential for exposure and effects, and distinguish actions that are not likely to adversely affect (NLAA) from those that are likely to adversely affect (LAA). Effects determinations for direct/indirect effects to the CRLF and the critical habitat impact analysis are summarized below and presented in Tables 1.1 and 1.2.

This risk assessment indicates that no direct effects are expected on either the aquatic or terrestrial phase CRLF. There are also no indirect effects expected for the CRLF through direct effects to either its terrestrial or aquatic food sources. The effects determination for direct effects on the CRLF and for indirect effects through food sources is no effect. The CRLF may be adversely affected through direct effects on habitat and/or primary productivity (i.e., ecosystem structure and function for both the aquatic plant community and riparian vegetation). Critical habitat may also be adversely modified based on direct effects to aquatic vascular plants and terrestrial plants. The risks exceed the level of concern (LOC) for non-listed non-target terrestrial plants (monocots and dicots) for all imazapyr uses. The risks to non-listed non-target aquatic vascular plants exceed the LOC for aquatic, rangeland and forestry uses (aerial application) as well as rights-of-way (assuming 50% pervious surfaces). No effects are expected for aquatic non-vascular plants. A spatial analysis of potential imazapyr usage in California was conducted using the national registered labels. The CRLF has no obligate relationships with either aquatic or terrestrial plants. Therefore, the LAA/NLAA determinations are based on direct effects to non-listed aquatic and terrestrial plants (i.e., indirect effects to habitat and/or primary productivity). To distinguish between an LAA and an NLAA determination, for each of the imazapyr uses, buffers based on expected spray drift were added from the site of potential imazapyr application to the point where the LOC for non-listed terrestrial plants would no longer be exceeded. For non-listed plants, these buffers range from 2530 (forestry uses, ground application) to 5940 feet (forestry uses, aerial application). Buffers for the other imazapyr uses are in between the two forestry use buffers. For aquatic plants, additional estimations were conducted to determine the number of miles that imazapyr residues may travel downstream to the point where the LOC for non-listed aquatic plants would no longer be exceeded. The spatial analysis shows that the potential imazapyr use sites cover a sufficiently wide area such that 94-100% (27,300 acres) of the CRLF range assessed, including core areas, critical habitat and known occurrences could be affected, even when no buffers are applied. The effects determinations for aquatic plants (indirect effects to the CRLF through direct effects on habitat and/or primary productivity) is no effect for aquatic non-vascular plants and aquatic vascular plants for residential, turf and forestry uses (ground application); may affect, LAA for aquatic vascular plants for forestry (aerial application), rangeland/hay, aquatic and rights-of-way uses; and may affect, LAA for emergent aquatic vascular plants for all uses inside a use-specific terrestrial buffer ranging from 2530 to 5940 feet with a NLAA for all uses outside the use-specific terrestrial buffer. The effects determination for terrestrial plants (monocots and dicots) is also may affect, LAA for all uses inside a use-specific terrestrial buffer ranging from 2530 to 5940 feet with a NLAA for all uses outside the use-specific terrestrial buffer. For the capsule injection application directly into the plant, the effects determination is may affect, not likely to adversely affect because the exposure is expected to be very limited and non-quantifiable. The effects determinations for the critical habitat impact are similar to that summarized for aquatic and terrestrial plants above. Habitat modification is not expected for aquatic non-vascular plants and aquatic vascular plants for residential, turf and forestry uses (ground application), for aquatic emergent vascular plants and terrestrial plants for all uses inside a use-specific terrestrial buffer and for capsule injection directly into the plant. Habitat modification is expected for aquatic vascular plants for forestry (aerial application), rangeland/hay, aquatic and rights-of-way uses and for emergent aquatic vascular plants and terrestrial plants for all uses inside a use-specific terrestrial buffer. Details of the effects determinations are listed in Tables 1.1 and 1.2.

| Table 1.1. Imazapyr Effects Determination Summary for the CRLF (Direct and Indirect Effects) | | | |
|---|---|---|---|
| | **Effects Determination and Basis** | | |
| **Assessment Endpoint** | **Effects Determination[1]** | **NLAA/LAA Discrimination** | **Basis** |
| *Aquatic Phase* | | | |
| 1. Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases (eggs, larvae, tadpoles, juveniles and adults) | Acute direct effects: no effect | N/A | No effects in surrogate species (freshwater fish) at highest concentration tested, which is significantly greater than the peak aquatic EECs |
| | Chronic direct effects: no effect | N/A | Chronic freshwater fish (surrogate species) LOC is not exceeded for any uses. |
| 2. Survival, growth, and reproduction of CRLF individuals via indirect effects to prey (freshwater invertebrates) | Acute direct effects to freshwater invertebrates: no effect | N/A | No effects in freshwater invertebrates at highest concentration tested, which is significantly greater than the peak aquatic EECs. |
| | Chronic direct effects to freshwater invertebrates: no effect | N/A | Chronic freshwater invertebrate LOC is not exceeded for any uses |
| 3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat and/or primary productivity (i.e. aquatic plant community) | Direct effects to aquatic non-vascular plants: No affect | N/A | No LOCs exceeded for non-vascular plants. |
| | Direct effects to aquatic vascular plants: No effect for residential, turf and forestry (ground) May affect, likely to adversely affect for forestry (aerial), rangeland/hay, aquatic and rights- | N/A | Aquatic plant LOCs exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses near use sites. Aquatic plant LOCs not exceeded for vascular plants for forestry (ground), residential or turf uses.[5] |

| Table 1.1. Imazapyr Effects Determination Summary for the CRLF (Direct and Indirect Effects) | | | |
|---|---|---|---|
| | Effects Determination and Basis | | |
| Assessment Endpoint | Effects Determination[1] | NLAA/LAA Discrimination | Basis |
| | of-way uses. | | |
| | Direct effects to aquatic emergent vascular plants: May affect, likely to adversely affect for all uses except capsule injection, which is may affect, .NLAA. | Forestry uses (ground application) NLAA > 2530 feet, LAA ≤ 2530 feet<br>Non-forestry terrestrial uses (ground application) NLAA > 2920 feet, LAA ≤ 2920 feet<br>Aquatic uses (ground application) NLAA > 2940 feet, LAA ≤ 2940 feet<br>Aquatic uses (helicopter application)) NLAA > 3540 feet, LAA ≤ 3540 feet<br>Non-forestry terrestrial uses (aerial application fixed wing) NLAA > 4640 feet, LAA ≤ 4640 feet<br>Forestry uses (aerial application helicopter) NLAA > 4660 feet, LAA ≤ 4660 feet<br>Forestry uses (aerial application fixed wing) NLAA > 5940 feet, LAA ≤ 5940 feet | Aquatic plant LOCs exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses near use sites. Aquatic plant LOCs not exceeded for vascular plants for forestry (ground), residential or turf uses. Emergent aquatic vascular plants in wetland areas adjacent to use sites: terrestrial plant LOC exceeded for monocots and dicots for all uses from flooding, runoff or spray drift[2-5] Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| *Terrestrial Phase* | | | |
| 4. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles | Acute direct effects: no effect | N/A | No effects in surrogate species (birds) at highest concentration/dose tested which are significantly greater than the terrestrial EECs |
| | Chronic direct effects: no effect | N/A | Chronic bird (surrogate species) LOC is not exceeded for any uses |
| 5. Survival, growth, and reproduction of CRLF individuals via indirect effects on prey (i.e., terrestrial invertebrates, small terrestrial vertebrates) | Acute direct effects to most sensitive prey: no effect | N/A | No effects in mammals at highest dose tested, which is significantly greater than the terrestrial EEC. |
| | Chronic direct effects to most sensitive prey: no effect | N/A | Chronic terrestrial animal (mammals) LOC is not exceeded for any uses. |
| 6. Survival, growth, and reproduction of CRLF individuals via | Direct effects to monocots: May affect | See details in Assessment Endpoint number 3 above. | Terrestrial plant LOC exceeded for monocots in both wetlands and uplands adjacent to use site for all uses. Risk conclusions are supported by |

| Table 1.1. Imazapyr Effects Determination Summary for the CRLF (Direct and Indirect Effects) | | | |
|---|---|---|---|
| | **Effects Determination and Basis** | | |
| **Assessment Endpoint** | **Effects Determination**[1] | **NLAA/LAA Discrimination** | **Basis** |
| indirect effects on habitat (i.e. riparian vegetatation) | Likely to adversely affect. May affect, NLAA for capsule injection use | | adverse ecological incident reports.[2-5] Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| | Direct effects to dicots: May affect Likely to adversely affect. May affect, NLAA for capsule injection use | See details in Assessment Endpoint number 3 above. | Terrestrial plant LOC exceeded for dicots in both wetlands and uplands adjacent to use site for all uses. Risk conclusions are supported by adverse ecological incident reports.[2-5] Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |

N/A = Not applicable

[1] The LAA/NLAA cut will also be influenced by other factors such as height of application, timing of application, droplet size, upwind swath displacement, the length of the boom relative to the wingspan or rotor blade diameter, wind speed, nozzle height (for ground applications), application during temperature inversion, etc. New mitigation measures are being developed; however, products with the old labels will be allowed to be distributed for up to 18 months after new labels are approved. Therefore, it is not possible to determine when all product labels will reflect the new mitigation measures. It could be assumed that most users will use their existing stocks within 2 years of purchase.

[2] The risk estimates for imazapyr-treated water flooding onto terrestrial sites are conservative because they do not address the uncertainty of dilution from rain water or water from other sources that originally precipitated the overflow.

[3] Some monocots exposed via spray drift alone following either ground or aerial application at 1.5 lbs ae/A and some of both monocots and dicots exposed via spray drift alone following ground spray at 0.91 lbs ae/A (residential uses) will not exceed the LOC for terrestrial plants. However, for the terrestrial applications, comparison of the RQs indicates that runoff, and not spray drift, is a larger contributor to potential risk for riparian vegetation.

[4] In addition to affecting seedling emergence, because imazapyr is toxic to plants when it is taken up by the roots, runoff is also expected to affect emerged plants. The RQ values for plants exposed to runoff are estimated from the seedling emergence studies because of the limitations of the vegetative vigor studies. These studies do not measure effects to emerged plants following a runoff event. Therefore, there is an uncertainty with regard to the effect of runoff to emerged plants.

[5] It is not clear for rangeland uses, whether and to what extent the critical habitat exemption applies.

| Table 1.2. Effects Determination Summary for the Critical Habitat Impact Analysis | | | |
|---|---|---|---|
| **Assessment Endpoint** | **Effects Determination[1]** | **Determination of Habitat Modification** | **Basis** |
| *Aquatic Phase PCEs* | | | |
| *Aquatic breeding and non-breeding habitat* | | | |
| Alteration of channel/pond morphology and/or water chemistry/quality; increase in sediment deposition | Direct effects to aquatic plants: no effect for non-vascular plants; No effect for aquatic vascular plants for residential, turf and forestry (ground). Modification of critical habitat for aquatic vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses. | N/A | No LOCs exceeded for non-vascular plants. Aquatic plant LOC not exceeded for vascular plants for forestry (ground), residential or turf uses. Aquatic plant LOC exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses.[5] |
| | Direct effects to aquatic emergent vascular plants: Modification of critical habitat | Forestry uses (ground application): habitat modification expected ≤ 2530 feet and not expected > 2530 feet<br>Non-forestry terrestrial uses (ground application): habitat modification expected ≤ 2920 feet and not expected > 2920 feet<br>Aquatic uses (ground application): habitat modification expected ≤ 2940 feet and not expected > 2940 feet<br>Aquatic uses (helicopter application)): habitat modification expected ≤ 3540 feet and not expected > 3540 feet<br>Non-forestry terrestrial uses (aerial application fixed wing): habitat modification expected ≤ 4640 feet and not expected> 4640 feet<br>Forestry uses (aerial application helicopter): habitat modification expected ≤ 4660 feet and not expected > 4660 feet<br>Forestry uses (aerial application fixed wing): habitat | Aquatic plant LOCs not exceeded for aquatic vascular plants for forestry (ground), residential or turf uses. Aquatic plant LOCs exceeded for aquatic vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses. Emergent aquatic vascular plants in wetland areas adjacent to use sites: terrestrial plant LOC exceeded for monocots and dicots for all uses from flooding, runoff or spray drift[2-5]. Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |

| Table 1.2. Effects Determination Summary for the Critical Habitat Impact Analysis | | | |
|---|---|---|---|
| **Assessment Endpoint** | **Effects Determination[1]** | **Determination of Habitat Modification** | **Basis** |
| | | modification expected ≤ 5940 feet and not expected > 5940 feet. | |
| | Direct effects to monocots: Modification of critical habitat. Modification of critical habitat not expected for capsule injection use. | See terrestrial buffer list above. | Terrestrial plant LOC exceeded for monocots in wetlands and uplands adjacent to use site for all uses.[2-5] Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| Alteration of channel/pond morphology and/or water chemistry/quality; increase in sediment deposition | Direct effects to dicots: modification of critical habitat Modification of critical habitat not expected for capsule injection use. | See terrestrial buffer list above. | Terrestrial plant LOC exceeded for dicots in wetlands and uplands adjacent to use site for all uses.[2-5] Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| *Terrestrial Phase PCEs* | | | |
| *Upland habitat and dispersal habitat* | | | |
| Elimination/disturbance of upland habitat and/or dispersal habitat | Direct effects to monocots: Modification of critical habitat Modification of critical habitat not expected for capsule injection use. | See terrestrial buffer list above. | Terrestrial plant LOC exceeded for monocots in wetlands and uplands adjacent to use site for all uses.[2-5] Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| | Direct effects to dicots: Modification of critical habitat Modification of critical habitat not expected for capsule | See terrestrial buffer list above. | Terrestrial plant LOC exceeded for dicots in wetlands and uplands adjacent to use site for all uses.[2-5] Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |

| Table 1.2. Effects Determination Summary for the Critical Habitat Impact Analysis | | | |
|---|---|---|---|
| **Assessment Endpoint** | **Effects Determination[1]** | **Determination of Habitat Modification** | **Basis** |
| | injection use. | | |

N/A = Not applicable

[1] The LAA/NLAA cut will also be influenced by other factors such as height of application, timing of application, droplet size, upwind swath displacement, the length of the boom relative to the wingspan or rotor blade diameter, wind speed, nozzle height (for ground applications), application during temperature inversion, etc. New mitigation measures are being developed; however, products with the old labels will be allowed to be distributed for up to 18 months after new labels are approved. Therefore, it is not possible to determine when all product labels will reflect the new mitigation measures. It could be assumed that most users will use their existing stocks within 2 years of purchase.

[2] The risk estimates for imazapyr-treated water flooding onto terrestrial sites are conservative because they do not address the uncertainty of dilution from rain water or water from other sources that originally precipitated the overflow.

[3] Some monocots exposed via spray drift alone following either ground or aerial application at 1.5 lbs ae/A and some of both monocots and dicots exposed via spray drift alone following ground spray at 0.91 lbs ae/A (residential uses) will not exceed the LOC for terrestrial plants. However, for the terrestrial applications, comparison of the RQs indicates that runoff, and not spray drift, is a larger contributor to potential risk for riparian vegetation.

[4] In addition to affecting seedling emergence, because imazapyr is toxic to plants when it is taken up by the roots, runoff is also expected to affect emerged plants. The RQ values for plants exposed to runoff are estimated from the seedling emergence studies because of the limitations of the vegetative vigor studies. These studies do not measure effects to emerged plants following a runoff event. Therefore, there is an uncertainty with regard to the effect of runoff to emerged plants.

[5] It is not clear for rangeland uses, whether and to what extent the critical habitat exemption applies.

For those uses for which an LAA determination has been made, 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 adverse 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 listed 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 imazapyr on terrestrial (railroads and industrial right-of-ways, fencerows, wildlife habitats and forests) and aquatic (ponds, lakes, reservoirs, marshes, bayous, canals, streams, rivers, and water drainage systems) non-crop sites, and to evaluate whether these actions can be expected to result in the destruction or adverse modification of the species' critical habitat. This ecological risk assessment has been prepared as part of the *Center for Biological Diversity* (*CBD) vs. EPA et al*. (Case No. 02-1580-JSW(JL)) settlement entered in the Federal District Court for the Northern District of California on October 20, 2006.

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

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 imazapyr are based on an action area. The action area is considered to be the area directly or indirectly affected by the federal action as indicated by the exceedance of Agency Levels of Concern (LOCs) used to evaluate direct or indirect effects. It is acknowledged that the action area for a national-level FIFRA regulatory decision associated with a use of imazapyr may potentially involve numerous areas throughout the United States and its Territories. However, for the purposes of this assessment, attention will be focused on relevant sections of the action area including those geographic areas associated with locations of the CRLF and its designated critical habitat within the state of California.

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

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

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 CRLF’s are aquatic and upland areas where suitable breeding and non-breeding aquatic habitat is located, interspersed with upland foraging and dispersal habitat (Section 2.6).

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

If a determination is made that use of imazapyr within the action area(s) associated with the CRLF “may affect” this species and/or its designated critical habitat, additional information is considered to refine the potential for exposure and for effects to the CRLF and other taxonomic groups upon which 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 imazapyr use sites) and further evaluation of the potential impact of imazapyr on the PCEs is also used to determine whether destruction or adverse modification to designated critical habitat may occur. Based on the refined information, the Agency uses the best available information to distinguish those actions that “may affect, but are not likely to adversely affect” from those actions that “may affect and are likely to adversely affect” the CRLF and/or the PCEs of its designated critical habitat. This information is presented as part of the Risk Characterization in Section 5 of this document.

The Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Because imazapyr is expected to directly impact living organisms within the action area (defined in Section 2.7), the critical habitat analysis for imazapyr 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 destroy or adversely modify critical habitat are those that alter the PCEs and appreciably diminish the value of the habitat. Evaluation of actions related to use of imazapyr 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

Imazapyr is a systemic, non-selective herbicide used for control of most annual and perennial broadleaf weeds and grasses, woody species, and riparian, and floating and emergent aquatic weed species in terrestrial and aquatic environmental settings. It is formulated as both an acid and as an isopropylamine salt; however, the salt disassociates under environmental conditions to form the acid. Therefore, in this assessment, all references to the acid are applicable to either the acid or the isopropylamine salt formulations. Imazapyr is currently registered for use in terrestrial (railroads and industrial right-of-ways, fencerows, wildlife habitats and forests) and aquatic (ponds, lakes, reservoirs, marshes, bayous, canals, streams, rivers, and water drainage systems) non-crop sites (**Table 2.2** (Kinard and Tompkins 05/07/07 memorandum)). Additionally, while imazapyr is also registered nationally for use on corn fields planted with Clearfield™ Corn, that use is not allowed within the state of California, and has not been considered in this assessment. Additionally, there are other nationally labeled, non-agricultural uses of imazapyr, which include all of the granular uses that are not allowed in California, and have not been included in this assessment.

| Table 2.2 Labeled Uses of Imazapyr and the Isopropylamine Salt of Imazapyr Within California | | | | | | |
|---|---|---|---|---|---|---|
| **General Use** | **Specific Use** | | **Maximum Single Application Rate (lb ae/acre)** | **Maximum Number of Applications/ Year** | **Application Methods** | **Surrogate Scenario for Aquatic Modeling** |
| Agricultural | no imazapyr uses | | NA | NA | NA | NA |
| Aquatic (non-crop) | lakes<br>rivers<br>streams<br>ponds<br>seeps<br>drainage ditches<br>canals<br>reservoirs<br>swamps<br>bogs<br>marshes | Estuaries<br>bays<br>brackish water<br>transitional areas between terrestrial sites and aquatic sites or seasonal wet areas (including estuarine and marine sites in or around surface water in wetland, riparian and terrestrial habitats) | 1.5 | 1 | Directly to Water via Ground and Aerial Spray | NA |
| Non-Cropland | trees and brush standing in water | | NA | NA | Inject capsule containing 83% a.i. into plant every 4" around the stem | NA |
| Forestry | timber production<br>non-irrigation ditch banks | | 1.5 | 1-2 times during 10-30 years | Ground and Aerial Spray | CA forestry |
| Golf Course | golf course roughs | | 1.5 | 1 | Ground Spray | CA turf |
| Pasture/ Rangeland | pasture and rangeland | | 1..5 | 1 | Ground and Aerial Spray | CA pasture/rangeland |

| Table 2.2 Labeled Uses of Imazapyr and the Isopropylamine Salt of Imazapyr Within California | | | | | | |
|---|---|---|---|---|---|---|
| **General Use** | **Specific Use** | | **Maximum Single Application Rate (lb ae/acre)** | **Maximum Number of Applications/ Year** | **Application Methods** | **Surrogate Scenario for Aquatic Modeling** |
| Residential (non-food) | bareground areas<br>storage areas<br>tank farms<br>pumping stations<br>pipelines under paved surfaces | | 0.91 | 1 | Ground Spray | CA residential / CA impervious surfaces |
| Industrial | airports<br>military installations<br>schools/universities<br>libraries<br>hospitals<br>waysides<br>service areas<br>unpaved roads | sewage disposal areas<br>industrial parks<br>plant sites<br>fencerows<br>under asphalt<br>pond liners<br>other paved areas | 1.5 | 1 | Ground Spray | CA right of way / CA impervious surfaces |
| Rights-of-Way | forest roads<br>driveways<br>highway rights-of ways<br>interchange ramps<br>railroad and utility rights-of-way | Roads<br>transmission lines<br>parking areas<br>utility rights-of-way | 1.5 | 1 | Ground and Aerial Spray | CA right of way / CA impervious surfaces |
| Non-Residential (non-food) | brick walks<br>gravel pathways<br>patios<br>along fences<br>along curbs<br>along cracks in sidewalks<br>farmyards<br>fuel storage areas | fence rows<br>non-irrigation ditchbanks<br>barrier strips (including grazed or hayed areas)<br>establishment and maintenance of wildlife openings | 1.5 | 1 | Ground and Aerial Spray | CA right of way / CA impervious surfaces |

The end result of the EPA pesticide registration process (the FIFRA regulatory action) is an approved product label. The label is a legal document that stipulates how and where a given pesticide may be used. Product labels (also known as end-use labels) describe the formulation type (e.g., liquid or granular), acceptable methods of application, approved use sites, and any restrictions on how applications may be conducted. Thus, the use or potential use of imazapyr in accordance with the approved product labels for California is "the action" being assessed. While imazapyr is formulated as both an acid and as an isopropylamine salt, the salt disassociates under environmental conditions to form the acid. Therefore, in this assessment, all references to the acid are applicable to either the acid or the isopropylamine salt formulations.

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

Laboratory studies show imazapyr is essentially stable to hydrolysis, aerobic and anaerobic soil degradation, as well as aerobic and anaerobic aquatic metabolism. Upon direct application, or indirect release into surface water, photolysis is the only identified mechanism for imazapyr degradation in the environment (half-life of 5.3 days). Imazapyr is considered to be mobile in the environment through leaching and surface run-off.[1]

### 2.2.1 Degradates

Two major photolysis transformation products (referred to as degradates in this assessment) were identified for imazapyr, pyridine hydroxy-dicarboxylic acid (maximum of 32%) and pyridine dicarboxylic acid (maximum of 23%). No data were either submitted or found in the open literature through an online search of ECOTOX on these 2 degradates. In the absence of a complete suite of toxicity data on these degradates, they are assumed to be equivalent to the parent compound. Therefore, concentrations of the imazapyr degradates are assessed with imazapyr as total toxic residues.

### 2.2.2 Total Toxic Residues

The first order, log linear photolysis half-life for the combined toxic residues of imazapyr evaluated in this endangered species assessment, and the two major photolysis transformation products is 19.9 days. Under laboratory aerobic aquatic conditions, the aerobic aquatic metabolism half-lives for the two imazapyr degradates were in the range of three to eight days in two different sediment/water systems. These two major photolysis transformation products are considered to have low to slight mobility in the environment through leaching and surface run-off[2], and would be expected to bind to soil and partition into sediment However, unlike the parent compound, these transformation

[1] EFED Standardized Soil Mobility Classification Guidance, October 21, 2005
[2] EFED Standardized Soil Mobility Classification Guidance, October 21, 2005

products are not stable to biotic degradation, and, once formed, will degrade under aerobic and anaerobic conditions. As a result, modeled aquatic concentrations are more conservative for the total toxic residues of imazapyr than would be expected from the total toxic residues of a pesticide with biotic degradation half-lives and soil sorption values similar for all modeled residues.

### 2.2.3 End Use Formulations

The Agency does not routinely include, in its risk assessments, an evaluation of mixtures of active ingredients, either those mixtures of multiple active ingredients in product formulations or those in the applicator's tank. In the case of the product formulations of active ingredients (that is, a registered product containing more than one active ingredient), each active ingredient is subject to an individual risk assessment for regulatory decision regarding the active ingredient on a particular use site. If effects data are available for a formulated product containing more than one active ingredient, they may be used qualitatively or quantitatively in accordance with the Agency's Overview Document and the Services' Evaluation Memorandum (U.S., EPA 2004; USFWS/NMFS 2004).

Imazapyr has registered products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD50 data (and available open literature for imazapyr) for multiple active ingredient products relative to the single active ingredient is provided in Appendix K. The results of this analysis show that an assessment based on the toxicity of the single active ingredient of imazapyr is appropriate.

## 2.3 Previous Assessments

An ecological risk assessment in support of the re-registration eligibility decision (RED) of imazapyr (both acid and salt formulations; PC Codes: 128821 and 128829) was finalized by EFED on September 30, 2005 (DP Barcode: D313607). The screening level risk assessment indicated risk to both listed and non-listed non-target terrestrial plants (monocots and dicots) and aquatic vascular plants from imazapyr use, based on the highest application rate of various use patterns. Seedling emergence and vegetative vigor in both monocots and dicots would be impacted by exposure to both the imazapyr acid and the isopropylamine salt. The assessment indicated minimal risk of direct acute effects to fish and aquatic invertebrates and minimal risks to aquatic non-vascular plants at maximum application rates. In addition, there were no direct chronic risks to fish and invertebrates, although there was an uncertainty for estuarine/marine fish and invertebrates, since no toxicity data were available to observe the prolonged effects of imazapyr to these taxa. Likewise, direct acute and chronic risks to mammals and birds consuming food types containing imazapyr residues are not expected from the labeled uses of the herbicide. EFED currently does not quantify risks to terrestrial non-target insects; however, available data on honey bees indicate that the direct risk to terrestrial non-target insects was likely to be low. The assessment indicted indirect risk to all taxa from direct effects on plants (i.e. effects on habitat and/or primary productivity).

EPA conducted an assessment of imazapyr (January 17, 2003) potential effects to 26 Environmentally Significant Units of pacific salmon and steelhead. That assessment was conducted in accordance with a consent decree entered by the federal government with Californians for Alternatives to Toxics (CATS). The conclusion of that assessment was that registered forest operation uses of imazapry were Not Likely to Adversely Affect the 26 species either directly or indirectly, nor adversely modify designated crticial habitat.

EPA conducted an assessment of imazapyr (January 17, 2003) potential effects to 33 federally listed plants. That assessment was conducted in accordance with a consent decree entered by the federal government with Californians for Alternatives to Toxics (CATS). The conclusion of that assessment was that registered forest operation uses of imazapyr were Not Likely to Adversely Affect the subject species. This conclusion was based in large measure on the infrequent use of imazapyr in forestry operations; the fact that most of the 33 plants subject to the assessment do not occur in coniferous forests where this herbicide is typically used in forestry operations; and some reliance on the California Department of Pesticide Regulation's endangered species program which addresses use of this pesticide.

## 2.4 Stressor Source and Distribution

### 2.4.1 Environmental Fate Assessment

Imazapyr is an anionic, organic acid that is non-volatile, degrades through photolysis in clear shallow waters, and is both persistent and mobile in soil. A summary of selected physical and chemical properties for imazapyr and imazapyr isopropylamine salt are presented in Table 2.4.1. Imazapyr is mainly present in anionic form at typical environmental pHs, and the behavior of the acid and salt forms are expected to be similar, therefore, the environmental fate of the imazapyr will be evaluated in terms of acid equivalents in this assessment. The chemical structures of imazapyr and imazapyr isopropylamine salt are shown in Figures 2.4.1.a and 2.4.1.b, respectively. The chemical structures of the two major imazapyr transformation products, CL 119060 and CL 9140, are shown in Figures 2.4.1.c and 2.4.1.d, respectively.

**Table 2.4.1. Some Physical, Chemical and Environmental Fate Properties of Imazapyr, the Isopropylamine Salt of Imazapyr, and Residues of Toxicological Concern.**

| ***Physical and Chemical Properties*** | | |
|---|---|---|
| Chemical name | *Acid:*<br>2-[4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid<br>*Salt:*<br>2-Propanamine, 2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylate | *CL 119060:*<br>Furo[3,4-*b*]pyridin-5(7*H*)-one,7-hydroxy-<br>*CL 9140:*<br>Pyridine 2,3-dicarboxylic acid |

| Table 2.4.1. Some Physical, Chemical and Environmental Fate Properties of Imazapyr, the Isopropylamine Salt of Imazapyr, and Residues of Toxicological Concern. | | |
|---|---|---|
| Empirical Formula | *Acid:* $C_{13}H_{15}N_3O_3$ *Salt:* $C_{13}H_{15}N_3O_3 \cdot C_3H_9N$ | *CL 119060:* $C_7H_4N_1O_3$ *CL 9140:* $C_7H_5N_1O_4$ |
| Chemical Abstract Service Number | *Acid:* 81334-34-1 *Salt:* 81510-83-0 | *CL 119060:* 90322-54-6 *CL 9140:* 89-00-9 |
| Molecular Weight | *Acid:* 261.28 amu *Salt:* 320.39 amu | *CL 119060:* 137.11 amu *CL 9140:* 167.12 amu |
| Aqueous Solubility at 25 °C | *Acid:* 11.1 g/L | unknown * |
| $pK_a$ | *Acid:* 3.8 | unknown * |
| Vapor Pressure at 60 °C | *Acid:* $<10^{-7}$ mm Hg | unknown * |
| Henry's Law Constant at 25 °C | *Acid:* $<7 \times 10^{-17}$ atm x m3/mol | unknown * |
| Log $P_{ow}$ at pH 7 and 20 °C | *Acid:* 0.22 | unknown * |
| ***Environmental Fate Properties*** | | |
| Hydrolysis half life (pH 7) | *Acid:* stable | unknown * |
| Aqueous photolysis half lives | *Acid:* $t_{1/2}$ = 2.5 - 5.3 days | unknown * |
| Aerobic metabolism half-lives | *Acid:* stable (in soil) | *CL 119060:* 3.9 and 5.8 days ** (in water + sediment) *CL 9140:* 2.9 and 4.3 days ** (in water + sediment) |
| Anaerobic metabolism half-lives | *Acid:* stable | unknown * |
| Soil-water distribution coefficients ($K_{oc}$) | *Acid:* 30.6 (acid in sand) 99.8 (acid in silt loam sediment) | *CL 119060:* 134 (sand) 1020 (silt loam sediment) *CL 9140:* 217 (sand) 6053 (silt loam sediment) |

* Imazapyr value (acid) have been used in absence of data for degradation products: CL 119060 and CL 9140
** Imazapyr (the parent chemical) is stable to aerobic degradation, therefore degradation product half-life values were not used in aquatic modeling

The herbicide imazapyr is a water soluble, weak acid with a $pK_a$ of about 3.8. Based on this $pK_a$, imazapyr is mainly in anionic form at typical environmental pHs (61% ionized at pH 4, 94% ionized at pH 5, greater than 99% ionized at pH 6 and higher). Commercial formulations contain either imazapyr acid or the imazapyr isopropylamine salt, both of which are generally dissolved in a water solution. Most environmental fate data available for imazapyr are based on dissociation of the isopropylamine salt in water. The behavior of these two moieties in the environment should be similar.

Imazapyr is susceptible to aqueous photolysis, the only identified route of rapid degradation for imazapyr in the open environment. Photolysis half-lives in water range between 2.5-5.3 days (MRID 00131617). Two major photolysis transformation products identified were a pyridine hydroxy-dicarboxylic acid (CL 119060) and pyridine dicarboxylic acid (CL 9140) which reached a maximum chemical equivalent of the parent compound of 32% and 23%, respectively. These two major photodegradates were each separately tested for aquatic metabolism under laboratory aerobic aquatic conditions and their aerobic aquatic metabolism half-lives were in the range of three to eight days in two different sediment/water systems.

Imazapyr was essentially stable to aerobic and anaerobic soil metabolism, and no major transformation products were identified during the course of laboratory studies. The persistence of imazapyr in soil was demonstrated by extrapolation of laboratory half-lives in three aerobic soils to approximately 1.2 years (MRID 45119701), 1.4 years (ACC. No. 251505), and 5.9 years (MRID 41023201).

Only limited data are available for these two major aquatic photolysis transformation products of imazapyr. Minor concentrations of identified and unidentified transformation products were detected in the aerobic studies (MRIDs 41023201 and 45119701). In the latter study, two transformation products reached a maximum of approximately 7% of parent radioactivity, and, based on simple kinetics, would not be expected to significantly exceed this maximum. These degradation products were estimated to have relatively short half-lives of about one month.

In the absence of a full suite of environmental fate data, for modeling purposes, these compounds are assumed to be equivalent to the parent, the acid form of imazapyr. However, data are available which indicate that the two major transformation products do degrade under aerobic aquatic conditions while the parent compound is stable, and that these compounds are much less mobile than imazapyr. Currently available aquatic modeling techniques would require conservative assumptions be made concerning maximum amount of degradates which form under environmental conditions, and/or the actual value of missing model input parameters when an approved method of combining parent/degradate data is not available. As a result, modeled aquatic EEC values for total toxic residues will be more conservative than EECs calculated for the parent only.

Laboratory bioconcentration studies with bluegill sunfish, eastern oyster, and grass shrimp indicate that parent imazapyr, even though long-lived in the environment, is not subject to bioconcentration (bioconcentration factor <1). Bioconcentration in caged fish and crayfish species was also measured as part of an otherwise unacceptable aquatic field dissipation study. The reported limit of detection for imazapyr in tissues of the caged animals (three fish and one crayfish species at each of two sites, total of seven different species) was a relatively high at 50 parts per billion (ppb). Within the 50 ppb limit, it is not unreasonable to conclude that parent imazapyr did not bioconcentrate during the aquatic field study. There was no attempt to analyze for metabolites or degradates in any of the species tested. The relatively high solubility in water and low n-octanol to water partitioning ratio of imazapyr is also consistent with little likelihood of bioconcentration.

In summary, imazapyr is an anionic, organic acid that is non-volatile and is both persistent and mobile in soil. Upon direct application, or indirect release into water, photolysis is the only identified route of imazapyr degradation in the open environment. Laboratory studies show imazapyr is essentially stable to hydrolysis, aerobic and anaerobic soil degradation as well as aerobic and anaerobic aquatic metabolism. Field study observations are consistent with imazapyr's intrinsic ability to persist in soils and move via runoff in surface water and leach to groundwater. Imazapyr did not bioconcentrate in submitted laboratory studies.

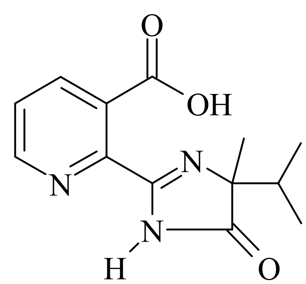


**Figure 2.4.1.a. Chemical Structure of Imazapyr**

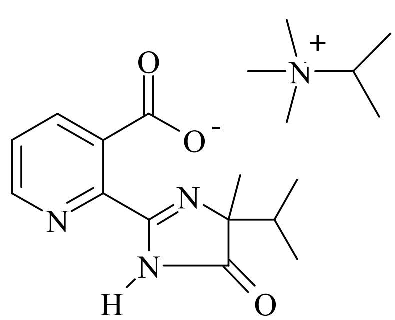


**Figure 2.4.1.b. Chemical Structure of Isopropylamine Salt of Imazapyr**

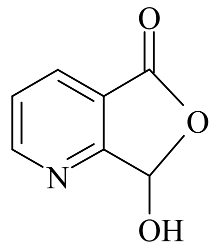



**Figure 2.4.1.c. Chemical Structure of CL 119060**

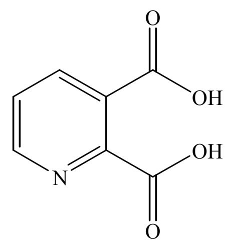



**Figure 2.4.1.d Chemical Structure of CL 9140**

### 2.4.2 Environmental Transport Assessment

*Volatility*

Based on a low vapor pressure of $<10^{-7}$ mm Hg at 60 °C, volatilization is an unlikely route of dissipation from soil. Available studies show that hydrolysis in moist soil and photodegradation on soil are unlikely to occur.

*Aquatic Transport*

Present as an anion at typical environmental pH values, imazapyr tends to be weakly sorbed to most soils, and therefore, is prone to leach and runoff. For anionic compounds, sorption would tend to diminish with increasing environmental pH. In several studies involving a total of 11 different soils and sediments, adsorption coefficients were low, as demonstrated by batch/bulk equilibrium sorption coefficients that range from 0.04 to 3.4 mL/g, with a median of 0.6 mL/g. There was no apparent correlation with soil organic matter.

In a submitted laboratory batch equilibrium study conducted with the imazapyr transformation products included in this assessment, CL 119060 and CL 9140, these transformation products were much less mobile than the parent, imazapyr. Reported $K_{oc}$ values were 6053 and 1020 in silt loam sediment for CL 119060 and CL 9140, respectively.

Field-plot studies with the formulated product, Arsenal 2AS (MRIDs 42192101 and 42192102) did not address the mode(s) of dissipation. An additional terrestrial field dissipation study (MRID 45119706) showed that imazapyr is prone to leach, and is relatively long-lived. Degradation products were not tracked in these filed dissipation studies.

Although the potential impact of discharging groundwater on CRLF populations is not explicitly delineated, it should be noted that groundwater could provide a source of pesticide to surface water bodies – especially low-order streams, headwaters, and groundwater-fed pools. This is particularly likely if the chemical is persistent and mobile. Soluble chemicals that are only subject to photolytic degradation will be very likely to persist in groundwater, and can be transportable over long distances. Much of this groundwater will eventually be discharged to the surface – often supporting stream flow in the absence of rainfall. Continuously flowing low-order streams in particular are sustained by groundwater discharge, which constitutes 100% of stream flow during baseflow (no runoff) conditions. Thus, it is important to keep in mind that pesticides in groundwater can have a major (detrimental) impact on surface water quality, and on CRLF habitat.

*Long Range Atmospheric Transport*

The physicochemical properties of imazapyr that describe its potential to enter the air from water or soil (e.g., Henry's Law constant and vapor pressure), pesticide use, modeled estimated concentrations in water and air, and available air monitoring data from the Central Valley and the Sierra Nevadas are considered in evaluating the potential for atmospheric transport of imazapyr habitat for the CRLF.

In general, deposition of drifting or volatilized pesticides is expected to be greatest close to the site of application. Computer models of spray drift (AgDRIFT or AGDISP) are used to determine if the exposures to aquatic and terrestrial organisms are below the Agency's Levels of Concern (LOCs). If the limit of exposure that is below the LOC can be determined using AgDRIFT or AGDISP, longer-range transport is not considered in defining the action area. For example, if a buffer zone <1,000 feet (the optimal range for AgDRIFT and AGDISP models) results in terrestrial and aquatic exposures that are below LOCs, no further drift analysis is required. If exposures exceeding LOCs are expected beyond the standard modeling range of AgDRIFT or AGDISP, the Gaussian extension feature of AGDISP may be used. In addition to the use of spray drift models to determine potential off-site transport of pesticides, other factors such as available air monitoring data and the physicochemical properties of the chemical are also considered.

### 2.4.3 Mechanism of Action

Imidazoline herbicides, such as imazapyr, are systemic plant growth inhibitors that are normally active at very low rates. However, imazapyr appears not to be as active as most imidazoline herbicides at very low rates. Uptake of imazapyr is primarily through the foliage and roots. It is then translocated to meristematic tissue where it inhibits acetohydroxyacid synthase (AHAS or ALS), thus, disrupting protein synthesis and interfering with cell growth and DNA synthesis. AHAS is not present in mammals, birds, fish, or insects. As a result, imazapyr is specifically toxic to plants.

### 2.4.4 Use Characterization

The only nationally labeled agricultural use of imazapyr is for use on corn fields planted with Clearfield™ Corn. However, that use is not allowed within the state of California. Granular formulations of imazapyr are also labeled for national use, but not allowed within the state of California. These uses therefore have not been considered in this assessment.

There are no labeled indoor uses for imazapyr.

Outdoor, non-agricultural uses of imazapyr include uses:

- To control aquatic weeds in or near bodies of water which may be flowing, non-flowing or transient: aquatic sites that include lakes, rivers, streams, ponds, seeps, drainage ditches, canals, reservoirs, swamps, bogs, marshes, estuaries, bays, brackish water, transitional areas between terrestrial and aquatic sites and seasonal wet areas, including estuarine and marine sites in or around surface water in wetland, riparian and terrestrial habitats.

- On industrial and public utility sites including: roads, transmission lines, bareground areas, storage areas, tank farms, pumping stations, pipelines under paved surfaces, industrial parks, plant sites, fencerows, and utility rights-of-way. Imazapyr can be used under asphalt, pond liners and other paved areas, but only in industrial sites or where the pavement has a suitable barrier along the perimeter that prevents encroachment of roots from desirable plants. Imazapyr is not recommended for use under pavement on residential properties such as driveways or parking lots, nor in recreational areas such as under bike or jogging paths, golf cart paths, tennis courts, or where landscape plantings could be anticipated.

- On forestry sites managed for timber production including forest roads and non-irrigation ditch banks

- On airports, military installations, schools/universities, libraries and hospitals, highway rights-of ways, interchange ramps, waysides, service areas, unpaved roads, railroad and utility rights-of-way, sewage disposal areas, farmyards, fuel storage areas, fence rows, non-irrigation ditch banks, and barrier strips (including grazed or hayed areas on these sites, and use for establishing and maintaining of wildlife openings).

- On pasture land and rangeland.

- On non-residential established turfgrass areas maintained under high levels of cultural management, such as: improved sections of industrial grounds, athletic fields, cemeteries, parks, golf course roughs and institutional grounds.

- On residential driveways, parking areas, brick walks, gravel pathways, patios, along fences, curbs and cracks in sidewalks.

Analysis of this labeled use information is the critical first step in evaluating the federal action. The current labels for imazapyr represent the FIFRA regulatory action. Therefore, labeled use and application rates specified on the label form the basis of this assessment. The assessment of use information is critical to the development of the action area and selection of appropriate modeling scenarios and inputs

#### 2.4.4.1 Imazapyr Use Characterization in California

An analysis of county-level usage information for imazapyr was obtained from the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[3] . California State law requires that pesticide application be reported to the state and made available to the public. These data are available by county and were averaged together over the years 2002 to 2005 to calculate average annual usage statistics by county and usage type, including pounds of active ingredient applied and base acres treated (when available). The summary of imazapyr usage for all use sites is provided below in Table 2.4.4. Uncertainties regarding the CDPR PUR data are discussed in the Uncertainties Section (Section 6.0).

Between 2002 and 2005,[4] imazapyr (salt formulation) use was reported in 51 counties in California. Reported uses were on forest trees, landscape maintenance, rights-of-way and pest control. Data for non-professional residential and turf applications, along with applications to rangeland/pastureland, and non-crop aquatic uses are not captured in CDPR PUR database, and have not been estimated here. There are no labeled agricultural uses within California. The greatest usage (average of pounds applied per commodity across all four years) was to forestry uses in Mendocino County at 3,980 lbs annually. By far, the greatest overall usage of imazapyr recorded in California is to forestry uses at an average of approximately 13,000 lbs annually, followed by rights-of-way at an average of 1325 lbs annually, landscape maintenance at 66 lbs annually, and structural and regulatory pest control with 172 lbs applied over the total four year period. All remaining imazapyr (salt) uses have not been captured by the CDPR PUR database.

[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.
[4] 2000 and 2001 CDPR PUR data not used in this assessment due to inclusion of outliers into the data set

The only reported use for imazapyr acid is for alfalfa, which is not a currently registered use. The uses considered in this risk assessment represent all currently registered uses according to a review of all current labels. No other uses are relevant to this assessment. Any reported use, such as may be seen in the CDPR PUR database, represent either historic uses that have been canceled, mis-reported uses, or mis-use. Historical uses, mis-reported uses, and misuse are not considered part of the federal action and, therefore, are not considered in this assessment.

The summary of imazapyr usage for all use sites captured in the CDPR PUR database is provided below in Table 2.4.4.

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

| Use site | Sum of average annual pounds applied | Sum of average area treated (acres) | Average application rate (lbs ai/acre) |
|---|---|---|---|
| LANDSCAPE MAINTENANCE | 175 | data not available | data not available |
| RIGHTS-OF-WAY | 5302 | data not available | data not available |
| STRUCTURAL AND REGULATORY PEST CONTROL | 172 | data not available | data not available |
| FOREST TREES, FOREST LANDS | 52,743 | 123,706.6 | 0.43 |

## 2.5 Assessed Species

The CRLF was federally listed as a threatened species by the 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, habitat requirements, and threats is provided in Sections 2.5.1 through 2.5.4, respectively. Further information on the status, distribution, and life history and specific threats to the CRLF is provided in Attachment 1.

Final critical habitat for the CRLF was designated by the 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 CRLF's 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 CRLF's (i.e., streams, creeks, tributaries, associated natural and artificial ponds, and adjacent drainages), and habitats through which CRLF's can move (i.e., riparian vegetation, uplands) (USFWS 2002).

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

*Recovery Units*

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

*Core Areas*

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

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

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

| Recovery Unit [1] (Figure 2.5.1) | Core Areas [2,7] (Figure 2.5.1) | Critical Habitat Units [3] | Currently Occupied (post-1985) [4] | Historically Occupied [4] |
|---|---|---|---|---|
| Sierra Nevada Foothills and Central Valley (1) (eastern boundary is the 1,500m elevation line) | **Cottonwood Creek (partial) (8)** | -- | ✓ | |
| | **Feather River (1)** | BUT-1A-B | ✓ | |
| | **Yuba River-S. Fork Feather River (2)** | YUB-1 | ✓ | |
| | -- | NEV-1[6] | | |
| | **Traverse Creek/Middle Fork American River/Rubicon (3)** | -- | ✓ | |
| | **Consumnes River (4)** | ELD-1 | ✓ | |

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

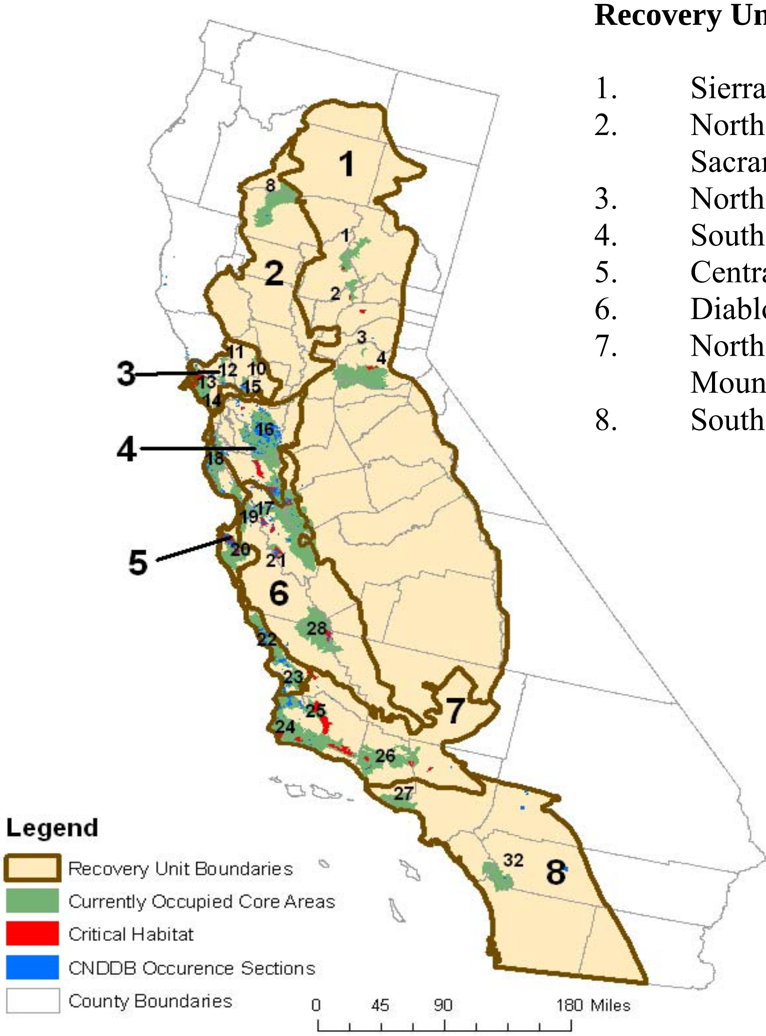
| Recovery Unit [1] (Figure 2.5.1) | Core Areas [2,7] (Figure 2.5.1) | Critical Habitat Units [3] | Currently Occupied (post-1985) [4] | Historically Occupied [4] |
|---|---|---|---|---|
| | S. Fork Calaveras River (5) | -- | | ✓ |
| | Tuolumne River (6) | -- | | ✓ |
| | Piney Creek (7) | -- | | ✓ |
| | **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** | MNT-1 | ✓ | |

| Table 2.5.1. California Red-legged Frog Recovery Units with Overlapping Core Areas and Designated Critical Habitat | | | | |
|---|---|---|---|---|
| **Recovery Unit [1] (Figure 2.5.1)** | **Core Areas [2,7] (Figure 2.5.1)** | **Critical Habitat Units [3]** | **Currently Occupied (post-1985) [4]** | **Historically Occupied [4]** |
| | **Slough (partial)(19)** | | | |
| | **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) | -- | | ✓ |

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

**Recovery Units**

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




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

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

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

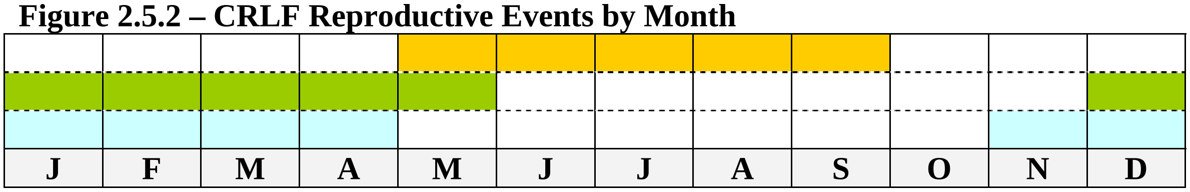
*Other Known Occurrences from the CNDBB*

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 2.5.2 depicts CRLF annual reproductive timing.

**Figure 2.5.2 – 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).

Imazapyr is registered for direct application to non-irrigation water for the control of aquatic weeds. For this assessment, concentrations were calculated resulting from thirty annual direct applications to the entire surface of the 2.0 meter deep standard EXAMS water body.

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 refuge; these cracks may provide moisture for individuals avoiding predation and solar exposure (Alvarez 2000).

### 2.6 Designated Critical Habitat

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

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

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

Occupied habitat may be included in the critical habitat only if essential features within the habitat may require special management or protection. Therefore, USFWS does not include areas where existing management is sufficient to conserve the species. Critical habitat is designated outside the geographic area presently occupied by the species only when a designation limited to its present range would be inadequate to ensure the conservation of the species. For the CRLF, all designated critical habitat units contain all four of the PCEs, and were occupied by the CRLF at the time of FR listing notice in April 2006. The FR notice designating critical habitat for the CRLF includes a special rule exempting routine ranching activities associated with livestock ranching from incidental take prohibitions. The purpose of this exemption is to promote the conservation of rangelands, which could be beneficial to the CRLF, and to reduce the rate of conversion to other land uses that are incompatible with CRLF conservation. See Section 2.6.1 below for an explanation on this special rule as it pertains to imazapyr.

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 imazapyr 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 may 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 imazapyr is expected to directly impact living organisms within the action area, critical habitat analysis for imazapyr 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.

### 2.6.1. Special Rule Exemption for Routine Ranching Activities

As part of the critical habitat designation, the Service promulgated a special rule exemption regarding routine ranching activities where there is no Federal nexus from take prohibitions under Section 9 of the ESA. (USFWS 2006, 71 FR 19285-19290). The Service's reasoning behind this exemption is that managed livestock activities, especially the creation of stock ponds, provide habitat for the CRLF. Maintenance of these areas as rangelands, rather than conversion to other uses should ranching prove to be economically infeasible is, overall, of net benefit to the species.

Several of the specific activities exempted include situations where pesticides may be used in accordance with labeled instructions. In this risk assessment, the Agency has assessed the risk associated with these practices using the standard assessment methodologies. Specific exemptions, and the reasoning behind each of the exemptions is provided below. The rule provides recommended best management practices, but does not require adherence to these practices by the landowner.

1. Stock Pond Management and Maintenance
    a. Chemical control of aquatic vegetation. These applications are allowed primarily because the Service felt "it is unlikely that vegetation control would be needed during the breeding period, as the primary time for explosive vegetation control is during the warm summer months." The Service recommends chemical control measures be used only "outside of the general breeding season (November through April) and juvenile stage (April through September) of the CRLF." Mechanical means are the preferred method of control.

    b. Pesticide applications for mosquito control. These applications are allowed because of concerns associated with human and livestock health. Alternative mosquito control methods, primarily introduction of nonnative fish species, are deemed potentially more detrimental to the CRLF than chemical or bacterial larvicides. The Service believes "it unlikely that [mosquito] control would be necessary during much of the CRLF breeding season," and that a combination of management methods, such as manipulation of water levels, and/or use of a bacterial larvicide will prevent or minimize incidental take.

2. Rodent Control. The Service notes "we believe the use of rodenticides present a low risk to CRLF conservation." In large part, this is due to the fact that "it is unknown the extent to which small mammal burrows are essential for the conservation of CRLF."

    a. Toxicant-treated grains. No data were available to evaluate the potential effects of these compounds (primarily anti-coagulants) on the CRLF. Grain is not a typical food item for the frog, but individuals may be indirectly exposed by consuming invertebrates which have ingested treated grain. There is a possibility of dermal contact, especially when the grain is placed in the burrows. Placing treated grain into the burrows is not prohibited, but should this method of rodent control be used, the Service recommends bait-station or broadcast application methods to reduce the probability of exposure.

    b. Burrow fumigants. Use of burrow fumigants is not prohibited, but the Service recommends "not using burrow fumigants within 0.7 mi (1.2 km) in any direction from a water body" suitable as CRLF habitat.

The exemption for stock pond management and maintenance may be particularly relevant to this use of imazapyr for these purposes.

### 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 imazapyr is likely to encompass considerable portions of the United States based on both the one agricultural use on Clearfield™ Corn (a use not labeled for the state of California), and on the large array of non-agricultural uses for both liquid (use allowed in California) and granular (use not allowed in California) formulations. However, the scope of this assessment limits consideration of the overall action area to those portions that may be applicable to the protection of the CRLF and its designated critical habitat within the state of California. Deriving the geographical extent of this portion of the action area is the product of consideration of the types of effects that imazapyr may be expected to have on the environment, the exposure levels to imazapyr that are associated with those effects, and the best available information concerning the use of imazapyr and its fate and transport within the state of California.

The definition of action area requires a stepwise approach that begins with an understanding of the federal action. The federal action is defined by the currently labeled uses for imazapyr. An analysis of labeled uses and review of available product labels was completed. This analysis indicates that, for imazapyr, the following uses are considered as part of the federal action evaluated in this assessment:

- Control of aquatic weeds in or near bodies of water which may be flowing, non-flowing or transient, such as aquatic sites that include lakes, rivers, streams, ponds, seeps, drainage ditches, canals, reservoirs, swamps, bogs, marshes, estuaries, bays, brackish water, transitional areas between terrestrial and aquatic sites and seasonal wet areas, including estuarine and marine sites in or around surface water in wetland, riparian and terrestrial habitats.

- Manufacturing sites including: roads, transmission lines, bareground areas, storage areas, tank farms, pumping stations, pipelines under paved surfaces, industrial parks, plant sites, fencerows, and utility rights-of-way. Imazapyr can be used under asphalt, pond liners and other paved areas, but only in industrial sites or where the pavement has a suitable barrier along the perimeter that prevents encroachment of roots from desirable plants. Imazapyr is not recommended for use under pavement on residential properties such as driveways or parking lots, nor in recreational areas such as under bike or jogging paths, golf cart paths, tennis courts, or where landscape plantings could be anticipated.

- Forestry sites managed for timber production including forest roads and non-irrigation ditch banks

- Airports, military installations, schools/universities, libraries and hospitals, highway rights-of ways, interchange ramps, waysides, service areas, unpaved roads, railroad and utility rights-of-way, sewage disposal areas, farmyards, fuel storage areas, fence rows, non-irrigation ditchbanks, and barrier strips. This includs grazed or hayed areas on these sites, and use for establishing and maintaining of wildlife openings.

- Pasture land and rangeland.

- Non-residential established turfgrass areas maintained under high levels of cultural management, such as: improved sections of industrial grounds, athletic fields, cemeteries, parks, golf course roughs and institutional grounds.

- Residential driveways, parking areas, brick walks, gravel pathways, patios, along fences, curbs and cracks in sidewalks.

- Golf course roughs.

The analysis indicates that the use on corn and granular formulations are not considered in this assessment because imazapyr is not labeled for corn use within the state of California, and is therefore not expected to result in exposure to the CRLF.

After determination of which uses will be assessed, an evaluation of the potential "footprint" of the use pattern is determined. This "footprint" represents the initial area of concern and is typically based on available land cover data. Local land cover data available for the state of California were analyzed to refine the understanding of potential imazapyr use. The overall conclusion of this analysis is that the action area contains all the current non-agricultural uses. The initial area of concern is defined as all land cover types that represent the labeled uses described above. No areas are excluded from the final action area based on usage and land cover data. A map representing all the land cover types that make up the initial area of concern is presented in Figure 2.7.a.

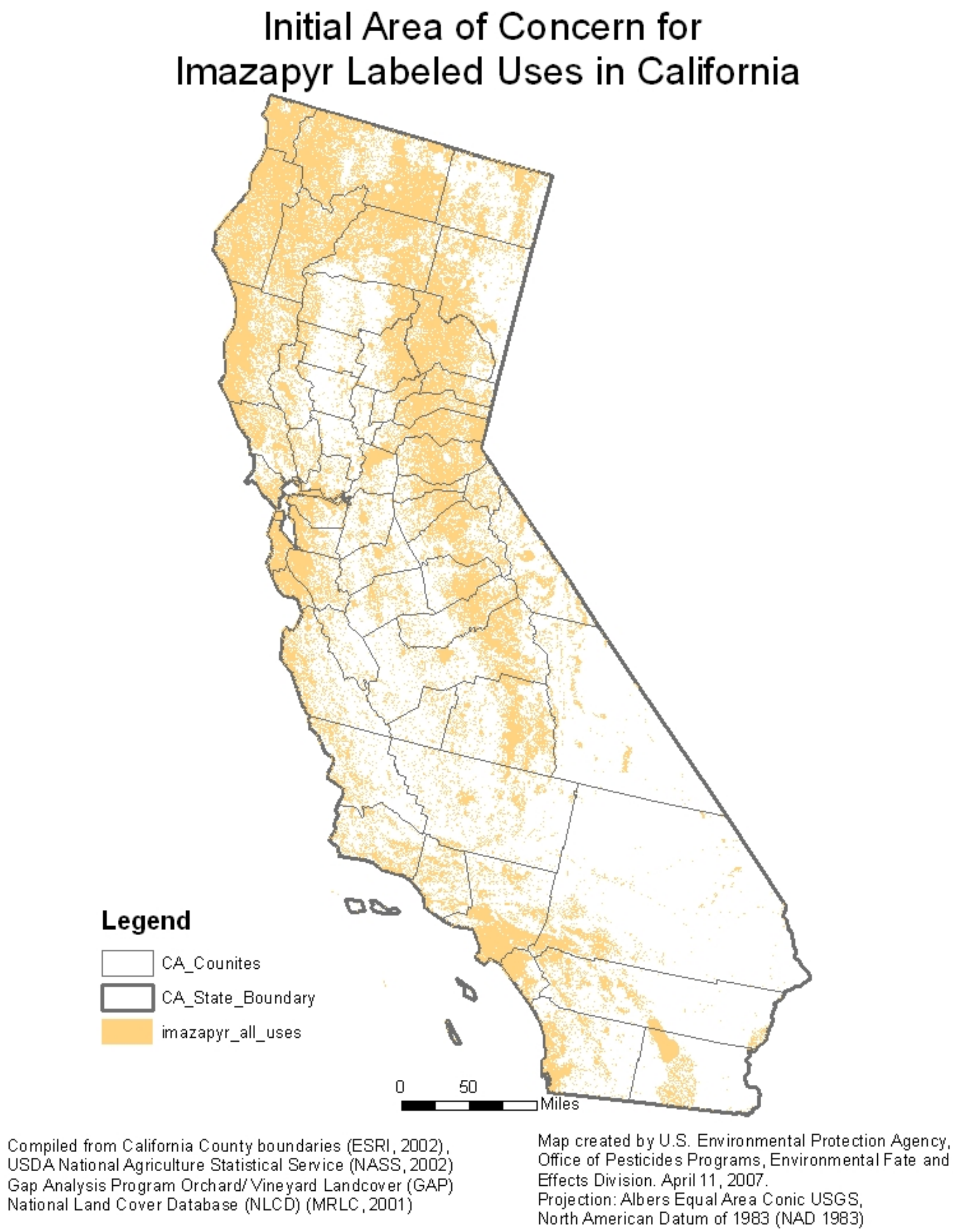



**Figure 2.7.a. Initial Area of Concern**

Once the initial area of concern is defined, the next step is to compare the extent of that area with the results of the screening level risk assessment completed as part of this assessment. The screening level risk assessment defines which taxa, if any, are predicted to be exposed at concentrations above the Agency's Levels of Concern (LOC). For imazapyr, these taxa include aquatic vascular plants and terrestrial plants, both monocots and dicots. The screening level assessment also includes an evaluation of the environmental fate properties of imazapyr to determine which routes of transport are likely to have an impact on the CRLF.

The total toxic residues of imazapyr are expected to be mobile and persistent in areas of the open environment not exposed to direct sunlight. The photolysis half-life for the total toxic residues is 20 days. While the parent compound is not susceptible to hydrolytic, aerobic or anaerobic degradation, submitted data indicate that the two major degradates degrade quickly when exposed to aerobic aquatic conditions. The parent compound, imazapyr, is expected to be mobile in the environment, while the two major degradates are shown to be less mobile in submitted laboratory studies.

**Table 2.7. Summary of Environmental Fate Data Used in the Aquatic Assessment for Total Toxic Residues of Imazapyr (Imazapyr and CL 119,060 and CL 9,140)**

| Fate Property | Value Parent Only | Value Total Toxic Residues | MRID (or source) |
|---|---|---|---|
| Molecular Weight | **261 amu** | **261 amu** | 2003 Science Chapter for Aquatic Uses of Imazapyr |
| Henry's constant at 25°C (acid) | **< 7 x $10^{-17}$ atm - $m^3$/mole** | **< 7 x $10^{-17}$ atm - $m^3$/mole *** | 2005 Science Chapter in support of RED |
| Vapor Pressure | **< $10^{-7}$ mm Hg** (torr) | **< $10^{-7}$ mm Hg** (torr) ***** | (< 1.3 x $10^{-5}$ Pa) at 60 °C (method limit); 2003 Science Chapter for New Aquatic Uses of Imazapyr |
| Solubility in Water | **11.1 x $10^3$ mg/L** | **11.1 x $10^3$ mg/L *** | 25 °C, 2003 Science Chapter for New Aquatic Uses |
| Photolysis in Water | **4.16 days** | **19.9 days** | MRID 00131617 |
| Aerobic Soil Metabolism | **Stable** | **stable** | MRID 00131619 |
| Hydrolysis | **Stable** | **stable** | MRID 00132359 |
| Aerobic Aquatic Metabolism (total sediment/water system) | **Stable** | **stable** | MRID 40003712 |
| Anaerobic Aquatic Metabolism (total sediment/water system) | **Stable** | **stable** | MRID 00131619 |
| Mobility ($K_{oc}$) | **99.8** | **99.8** | lowest non-sand (silt loam) value; MRID 45119705 |
| Application Efficiency | **0.95** (0.99) | **0.95** (0.99) | EFED Guidance for aerial (ground) application |
| Spray Drift | **0.05** (0.01) | **0.05** (0.01) | EFED Guidance for aerial (ground) application |

* Imazapyr value used in absence of data for degradation products: CL 119060 and CL 9140
** Highest value of degradation products used

Review of the environmental fate data, as well as physico-chemical properties of imazapyr indicate that direct application to water, runoff to surface water and leaching to groundwater which could, in turn, recharge surface waters are likely to be the dominant routes of exposure. Photolysis is the only route of degradation for imazapyr in the environment. Photolysis would predominantly occur in open water bodies exposed to sunlight. This is not necessarily the case for all of the environments where imazapyr will be used. Imazapyr is highly soluble in water, with an aqueous solubility value of 11.1 grams per liter. The vapor pressure ($< 10^{-7}$ mm Hg) and Henry's Law Constant ($< 7 \times 10^{-17}$ atm - $m^3$/mole) values for imazapyr are low enough to exclude atmospheric transfer as a major route of dissipation for imazapyr in the environment.

Surface water, groundwater, rainfall and atmospheric monitoring data are not available for imazapyr. While the potential for long range transport of imazapyr outside of the defined action area cannot be precluded, exposure concentrations are not expected to exceed those predicted by modeling using the residential and non-residential scenarios (Sections 3.2 - 3.4).

For the next step in defining the action area for imazapyr, the Agency's LOC exceedances are used to determine how far outside the initial area of concern effects may be expected. For imazapyr, the AGDISP model with the Gaussian Far-Field Extension provides estimates for spray drift buffers that would be needed to avoid adverse effects to non-target terrestrial plants and aquatic vascular emergent plant species. The buffers are based on expected spray drift from the site of potential imazapyr application to the point where the LOC for listed terrestrial plants would no longer be exceeded. For imazapyr, the buffers range from 7120 (forestry uses, ground application) to 26460 feet (forestry uses, aerial application). All other imazapyr uses that are applied by either aerial or ground spray in California have estimated spray drift buffers in between these two values.

For aquatic plants, the initial area of concern is further expanded by estimating the downstream distance where concentrations are expected to be above the non-listed aquatic plant LOC. Imazapyr aquatic uses provide the largest downstream distance. The determination of the downstream distance starts with finding the use with the greatest ratio of aquatic RQ to LOC. For aquatic uses with imazapyr, this ratio is 4.67 (4.67/1). The downstream dilution approach (described in Section 2.10.1.3) yields a target percent treated area (also referred to as "percent cropped area", or PCA) of 21.4% for imazapyr aquatic uses. Using this value as an input into the downstream dilution approach adds a total of 7,450 stream miles from the initial area of concern (footprint of use). The total California stream miles is 332,962 miles, the total stream miles in the initial area of concern is 222,188 miles and the total stream miles in the final action area is 229,638 miles. The stream mile maps are provided in Appendix C.

From the two methods (spray drift buffer and downstream distance), the greatest expansion of the initial area of concern is considered the action area. The initial area of concern with both the buffered area and the downstream extent yields the final action area for imazapyr use in California. The action area is presented graphically for the whole state of California in Figure 2.7.b. These data suggest that with all the imazapyr uses combined and the terrestrial buffer distance of 26460 feet on forestry uses only, the action area comprises all of the land area in the state of California, including the core and critical habitat of the CRLF.

Subsequent to defining the action area, an evaluation of usage information is conducted to determine the area where use of imazapyr may impact the CRLF. This analysis is used to characterize where predicted exposures are most likely to occur but does not preclude use in other portions of the action area. The county-level data from the CDPR PUR database suggest that the greatest overall usage of imazapyr in California is to forestry, followed by rights-of-way, landscape maintenance and structural and regulatory pest control. It is noted, however, that non-professional residential applications, applications to turf and rangeland/pastureland and non-crop aquatic uses are not captured in the CDPR PUR database. In addition, only 4 years of data are available. Therefore, these data are very limited and are only used for general descriptions of the usage patterns in California.

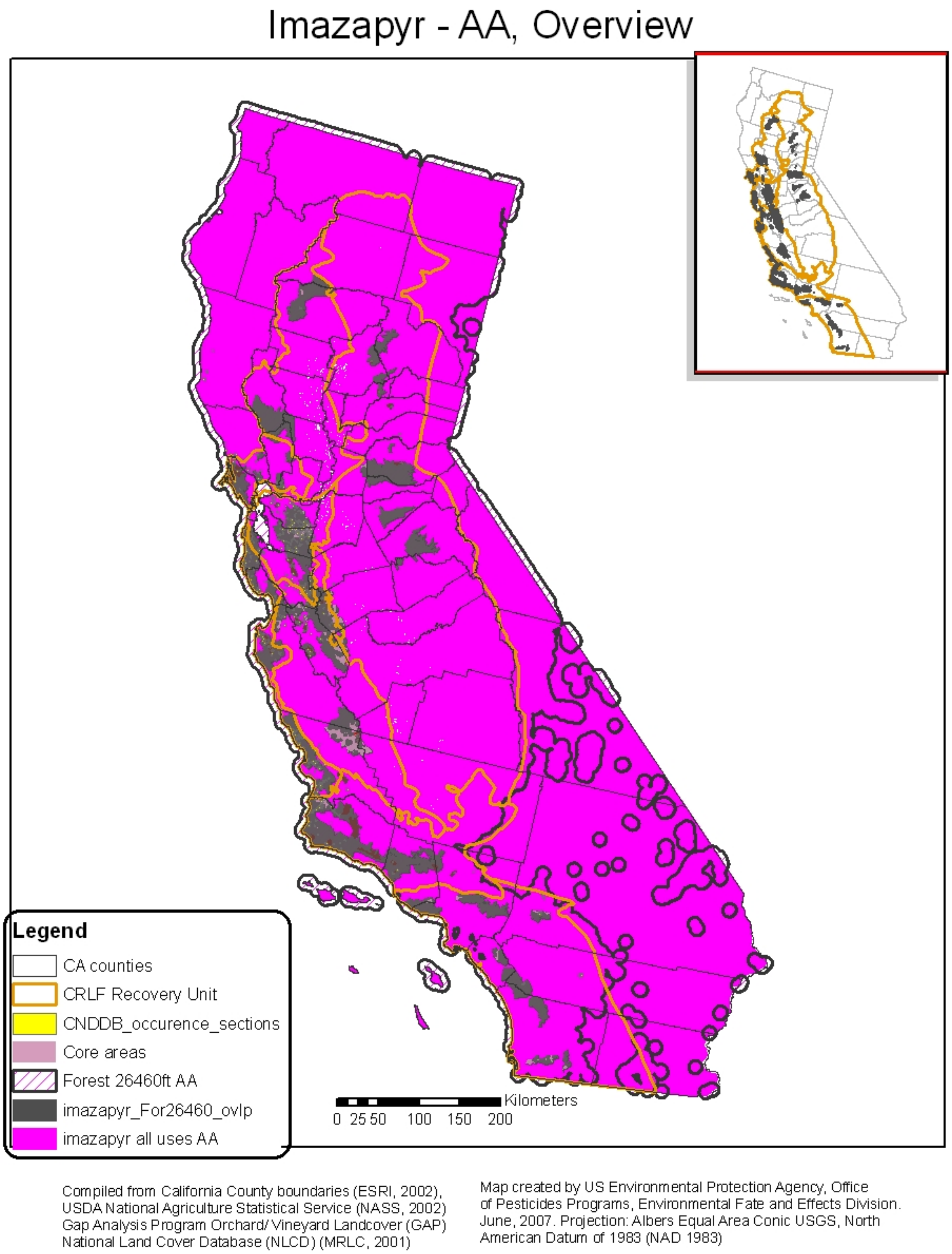



**Figure 2.7.b. Action Area Map**

## 2.8 Assessment Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected."[5] Selection of the assessment endpoints is based on valued entities (e.g., CRLF, organisms important in the life cycle of the CRLF, and the PCEs of its designated critical habitat), the ecosystems potentially at risk (e.g,. waterbodies, riparian vegetation, and upland and dispersal habitats), the migration pathways of imazapyr (e.g., runoff, spray drift, etc.), and the routes by which ecological receptors are exposed to imazapyr-related contamination (e.g., direct contact, etc).

### 2.8.1 Assessment Endpoints for the CRLF

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

A complete discussion of all the toxicity data available for this risk assessment, including resulting measures of ecological effect selected for each taxonomic group of concern, is included in Section 4 of this document. A summary of the assessment endpoints and measures of ecological effect selected to characterize potential assessed direct and indirect CRLF risks associated with exposure to imazapyr is provided in Table 2.8.1.

| **Table 2.8.1 Summary of Assessment Endpoints and Measures of Ecological Effects for Direct and Indirect Effects of Imazapyr on the California Red-legged Frog** | |
|---|---|
| **Assessment Endpoint** | **Measures of Ecological Effects[6]** |
| *Aquatic Phase (eggs, larvae, tadpoles, juveniles, and adults)*[a] | |
| 1. Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases | 1a. Most sensitive fish or amphibian acute $LC_{50}$: 96-hour $LC_{50}$ >100 mg /L (rainbow trout)<br>1b. Most sensitive fish or amphibian chronic NOAEC: 43.1 mg/L (rainbow trout)<br>1c. Most sensitive fish or amphibian early-life stage data: 43.1 mg/L (rainbow trout) |
| 2. Survival, growth, and reproduction of CRLF | 2a. Most sensitive fish, aquatic invertebrate, and |

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

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

| Table 2.8.1 Summary of Assessment Endpoints and Measures of Ecological Effects for Direct and Indirect Effects of Imazapyr on the California Red-legged Frog | |
|---|---|
| **Assessment Endpoint** | **Measures of Ecological Effects[6]** |
| individuals via effects to food supply (*i.e.,* freshwater invertebrates, non-vascular plants) | aquatic plant $EC_{50}$ or $LC_{50}$: >100 mg/L for both 96-hr $LC_{50}$ (rainbow trout) & 48-hr $EC_{50}$ (daphnia); $EC_{50}$ 11.5 mg ae/L (green algae)<br><br>2b. Most sensitive aquatic invertebrate and fish chronic NOAEC: 97.1 mg/L (daphnia), 43.1 mg/L (rainbow trout) |
| 3. Survival, growth, and reproduction of CRLF individuals via ndirect effects on habitat, cover, and/or primary productivity (*i.e.,* aquatic plant community) | 3a. Vascular plant acute $EC_{50}$: 0.018 mg ae/L (duckweed)<br>3b. Non-vascular plant acute $EC_{50}$: 11.5 mg ae/L (green algae) |
| 4. Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation, required to maintain acceptable water quality and habitat in ponds and streams comprising the species' current range. | 4a. Distribution of $EC_{25}$ values for monocots: 0.0046 – 0.054 lb ae/A<br>4b. Distribution of $EC_{25}$ values for dicots[7]: 0.0009 – 0.034 lb ae/A |
| *Terrestrial Phase (Juveniles and adults)* | |
| 5. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles | 5a. Most sensitive bird[b] or terrestrial-phase amphibian acute $LC_{50}$ or $LD_{50}$: >5,000 mg/kg diet or >2,150 mg/kg bw (bobwhite quail)<br>5b. Most sensitive bird[b] or terrestrial-phase amphibian chronic NOAEC: 1670 ppm (bobwhite quail) |
| 6. Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.,*terrestrial invertebrates, small terrestrial vertebrates, including mammals and terrestrial phase amphibians) | 6a. Most sensitive terrestrial invertebrate and vertebrate acute $EC_{50}$ or $LC_{50}$: $LD_{50}$ >5,000 mg ae/kg bw (rat); $LD_{50}$ >100 µg/bee; $LD_{50}$ >2150 mg/kg bw (bobwhite quail)<br>6b. Most sensitive terrestrial invertebrate and vertebrate chronic NOAEC: 738 mg/kg bw/day or 10000 ppm diet (male rat); 1670 ppm (bobwhite quail) |
| 7. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.,* riparian vegetation) | 7a. Distribution of $EC_{25}$ for monocots: 0.0046 – 0.054 lb ae/A<br>7b. Distribution of $EC_{25}$ for dicots[7]: 0.0009 – 0.034 lb ae/A |
| [a] Adult frogs are no longer in the "aquatic phase" of the amphibian life cycle; however, submerged adult frogs are considered "aquatic" for the purposes of this assessment because exposure pathways in the water are considerably different that exposure pathways on land.<br>[b] Birds are used as surrogates for terrestrial phase amphibians.<br>[c] Although the most sensitive toxicity value is initially used to evaluate potential indirect effects, sensitivity distribution is used (if sufficient data are available) to evaluate the potential impact to food items of the CRLF. | |

[7] The available information indicates that the California red-legged frog does not have any obligate relationships.

### 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 imazapyr that may alter the PCEs of the CRLF's critical habitat. PCEs for the CRLF were previously described in Section 2.6. Actions that may destroy or adversely modify critical habitat are those that alter the PCEs. Therefore, these actions are identified as assessment endpoints. It should be noted that evaluation of PCEs as assessment endpoints is limited to those of a biological nature (i.e., the biological resource requirements for the listed species associated with the critical habitat) and those for which imazapyr effects data are available.

Assessment endpoints and measures of ecological effect selected to characterize potential modification to designated critical habitat associated with exposure to imazapyr are provided in Table 2.8.2. Adverse modification to the critical habitat of the CRLF includes the following, as specified by USFWS (2006) and previously discussed in Section 2.6:

1. Alteration of water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs.

2. Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs.

3. Significant increase in sediment deposition within the stream channel or pond or disturbance of upland foraging and dispersal habitat.

4. Significant alteration of channel/pond morphology or geometry.

5. Elimination of upland foraging and/or aestivating habitat, as well as dispersal habitat.

6. Introduction, spread, or augmentation of non-native aquatic species in stream segments or ponds used by the CRLF.

7. Alteration or elimination of the CRLF's food sources or prey base.

Measures of such possible effects by labeled use of imazapyr on critical habitat of the CRLF are described in Table 2.8.2. Some components of these PCEs are associated with physical abiotic features (e.g., presence and/or depth of a water body, or distance between two sites), which are not expected to be measurably altered by use of pesticides. Assessment endpoints used for the analysis of designated critical habitat are based on the adverse modification standard established by USFWS (2006).

<table>
<tr><th colspan="2">Table 2.8.2 Summary of Assessment Endpoints and Measures of Ecological Effect for Primary Constituent Elements of Designated Critical Habitat</th></tr>
<tr><th>Assessment Endpoint</th><th>Measures of Ecological Effect[8]</th></tr>
<tr><td colspan="2">Aquatic Phase PCEs<br>(Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)</td></tr>
<tr><td>Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.</td><td>a. Most sensitive aquatic plant $EC_{50}$: 0.018 mg ae/L (duckweed)<br>b. Distribution of $EC_{25}$ values for terrestrial monocots: 0.0046 – 0.054 lb ae/A<br>c. Distribution of $EC_{25}$ values for terrestrial dicots: 0.0009 – 0.034 lb ae/A</td></tr>
<tr><td>Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.[9]</td><td>a. Most sensitive $EC_{50}$ values for aquatic plants: 0.018 mg ae/L (duckweed)<br>b. Distribution of $EC_{25}$ values for terrestrial monocots: 0.0046 – 0.054 lb ae/A<br>c. Distribution of $EC_{25}$ values for terrestrial dicots: 0.0009 – 0.034 lb ae/A</td></tr>
<tr><td>Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.</td><td>a. Most sensitive $EC_{50}$ or $LC_{50}$ values for fish or aquatic-phase amphibians and aquatic invertebrates: >100 mg/L for both 96-hr $LC_{50}$ (rainbow trout) & 48-hr $EC_{50}$ (daphnia)<br>b. Most sensitive NOAEC values for fish or aquatic-phase amphibians and aquatic invertebrates: 97.1 mg/L (daphnia), 43.1 mg/L (rainbow trout)</td></tr>
<tr><td>Reduction and/or modification of aquatic-based food sources for pre-metamorphs (e.g., algae)</td><td>a. Most sensitive aquatic plant $EC_{50}$: 0.018 mg ae/L (duckweed)</td></tr>
<tr><td colspan="2">Terrestrial Phase PCEs<br>(Upland Habitat and Dispersal Habitat)</td></tr>
<tr><td>Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance</td><td rowspan="4">a. Distribution of $EC_{25}$ values for terrestrial monocots: 0.0046 – 0.054 lb ae/A<br>b. Distribution of $EC_{25}$ values for terrestrial dicots: 0.0009 – 0.034 lb ae/A<br>c. Most sensitive food source acute $EC_{50}/LC_{50}$ and NOAEC values for terrestrial vertebrates (mammals) and invertebrates, birds or terrestrial-phase amphibians, and freshwater fish: 96-hr $LC_{50}$ >100 mg/L, NOAEC: 43.1 mg/L (rainbow trout); $LD_{50}$ >5,000 mg ae/kg bw, NOAEC 10000 ppm, NOAEL 738 mg/kg bw/day (rat); $LD_{50}$ >100 µg/bee; $LD_{50}$ >2150 mg/kg bw, NOAEC 1670 ppm (bobwhite quail)</td></tr>
<tr><td>Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal</td></tr>
<tr><td>Reduction and/or modification of food sources for terrestrial phase juveniles and adults</td></tr>
<tr><td>Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.</td></tr>
</table>

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

[9] 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 imazapyr to the environment. The following risk hypotheses are presumed for this listed species assessment:

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

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

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

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

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

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

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

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

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

### 2.9.2 Diagram

The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the stressor (imazapyr), release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for aquatic and terrestrial phases of the CRLF are shown in Figures 2.9.2.a and 2.9.2.b, and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in Figures 2.9.2.c and 2.9.2.d. Exposure routes shown in dashed lines are not quantitatively considered because the resulting exposures are expected to be so low as not to cause adverse effects to the CRLF.

The general conceptual model of exposure for the CRLF is expected to be dominated by direct application to water, runoff and spray drift. Imazapyr is expected to leach to groundwater which could, in turn, recharge surface waters. In addition, long-range transport beyond spray drift was evaluated, and based on the vapor pressure, is not considered a significant route of exposure.

The effects of imazapyr on the aquatic phase of the CRLF and the aquatic PCEs of its critical habitat (Figures 2.9.2 a and b) are expected to be dominated by the direct application to water (aquatic) uses. The maximum application rates are equivalent for terrestrial and aquatic uses of imazapyr. However, in spite of imazapyr being mobile and persistent to biotic degradation, estimated environmental concentrations (EECs) resulting from terrestrial uses will be attenuated by surface and subterranean transport processes to aquatic sites. While spray drift loading will also contribute to the aquatic concentrations, default assumptions estimate that only 5% of the terrestrial application will reach the standard pond water body located adjacent to the treated agricultural field. The low vapor pressure and Henry's Law constant indicate that long-range atmospheric transport will be insignificant for imazapyr. The aquatic uses for imazapyr are intended to reduce nuisance emergent aquatic plants. The labels state that imazapyr is not effective on totally submerged plants. It has to be sprayed directly on emergent foliage and stems. Therefore, although spray drift contributes to aquatic concentrations, drifting directly onto aquatic plant emergent foliage may be a more significant route than drifting into aquatic systems. Direct application to aquatic sites within the critical habitat may be of significant importance.

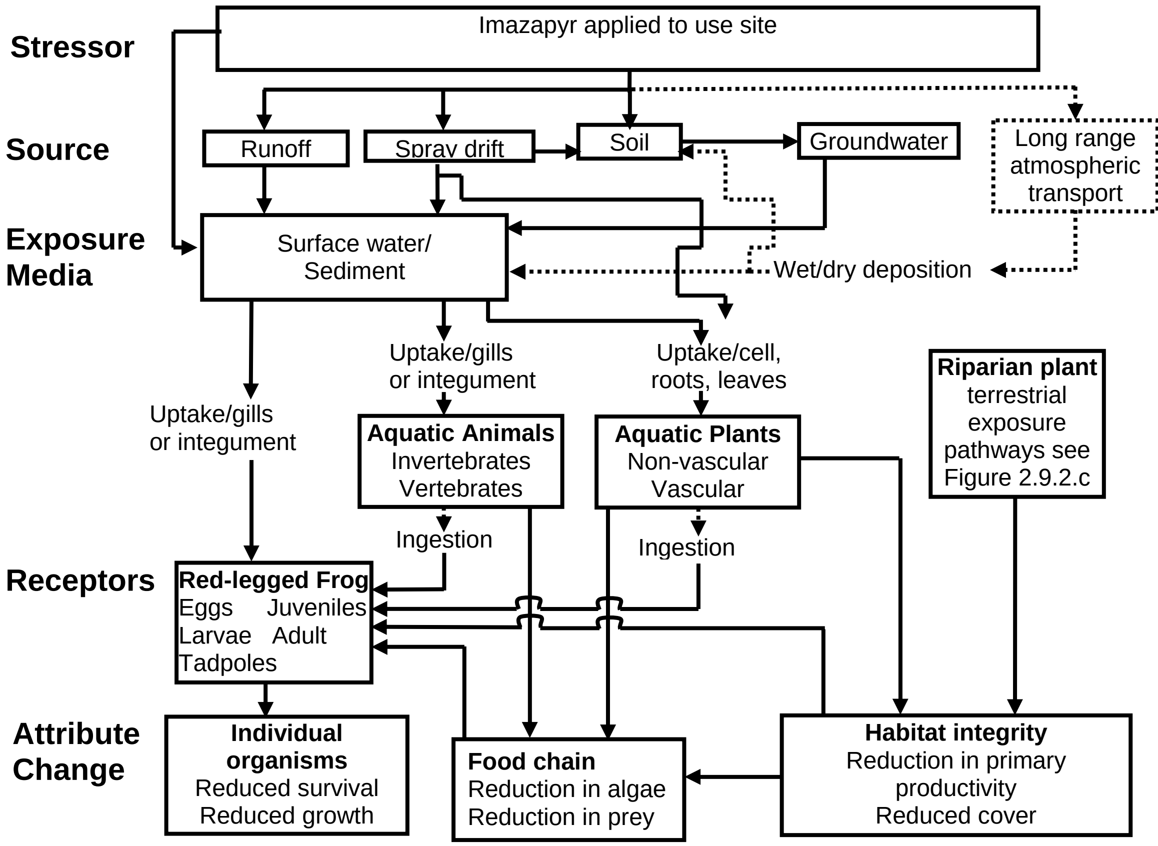



**Figure 2.9.2.a Effects on Aquatic Phase CRLF**

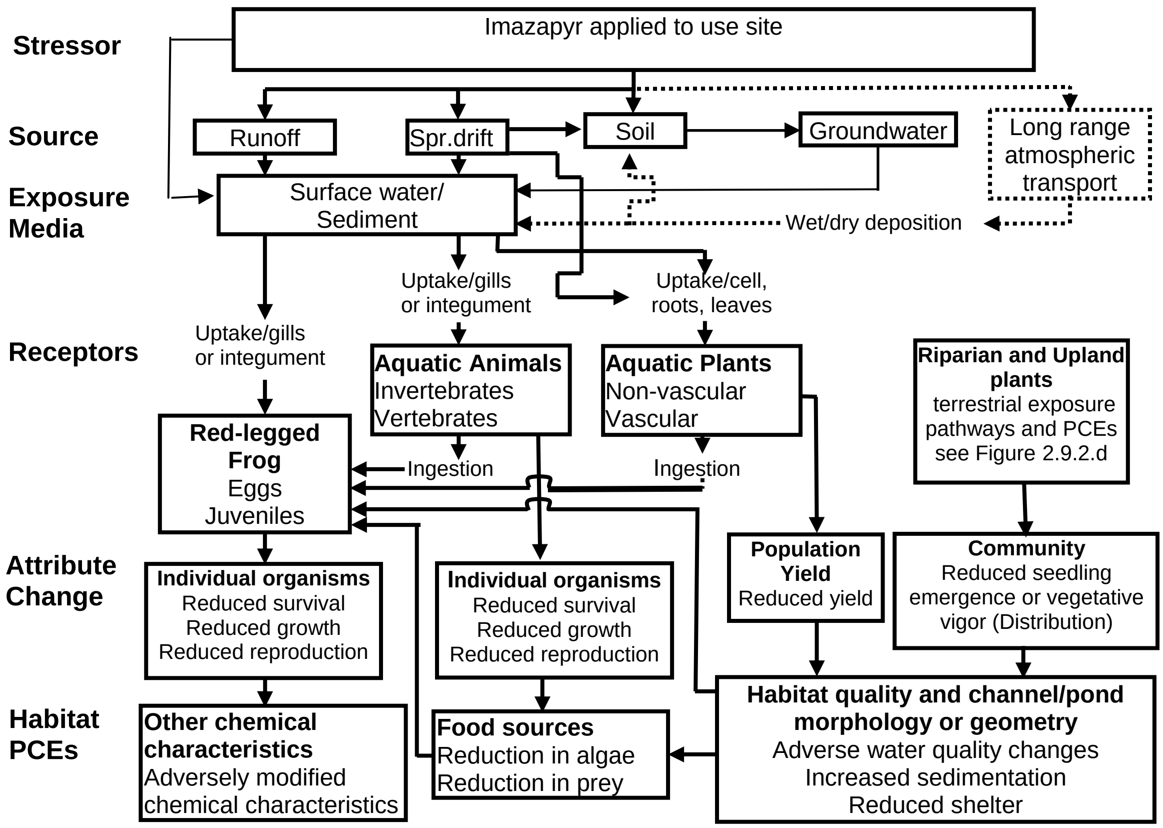



**Figure 2.9.2.b Effects on Aquatic Component of the CRLF Critical Habitat**

The effects of imazapyr on the terrestrial phase of the CRLF and the terrestrial PCEs of its critical habitat (Figures 2.9.2.c and d) is expected to be dominated by the direct application to terrestrial use sites. Spray drift loading and runoff from nearby terrestrial and aquatic use sites will also be contributing factors. Imazapyr can affect terrestrial plants through exposure to either the foliage/stems or to the roots. Potential risk to terrestrial plants from the aquatic uses is represented by direct application to surface water which in turn overflows to an adjacent terrestrial site, leaving imazapyr residues in soil and on leaves/roots/stems upon flood abatement. The low vapor pressure and Henry's Law constant indicate that long-range atmospheric transport will be insignificant for imazapyr.

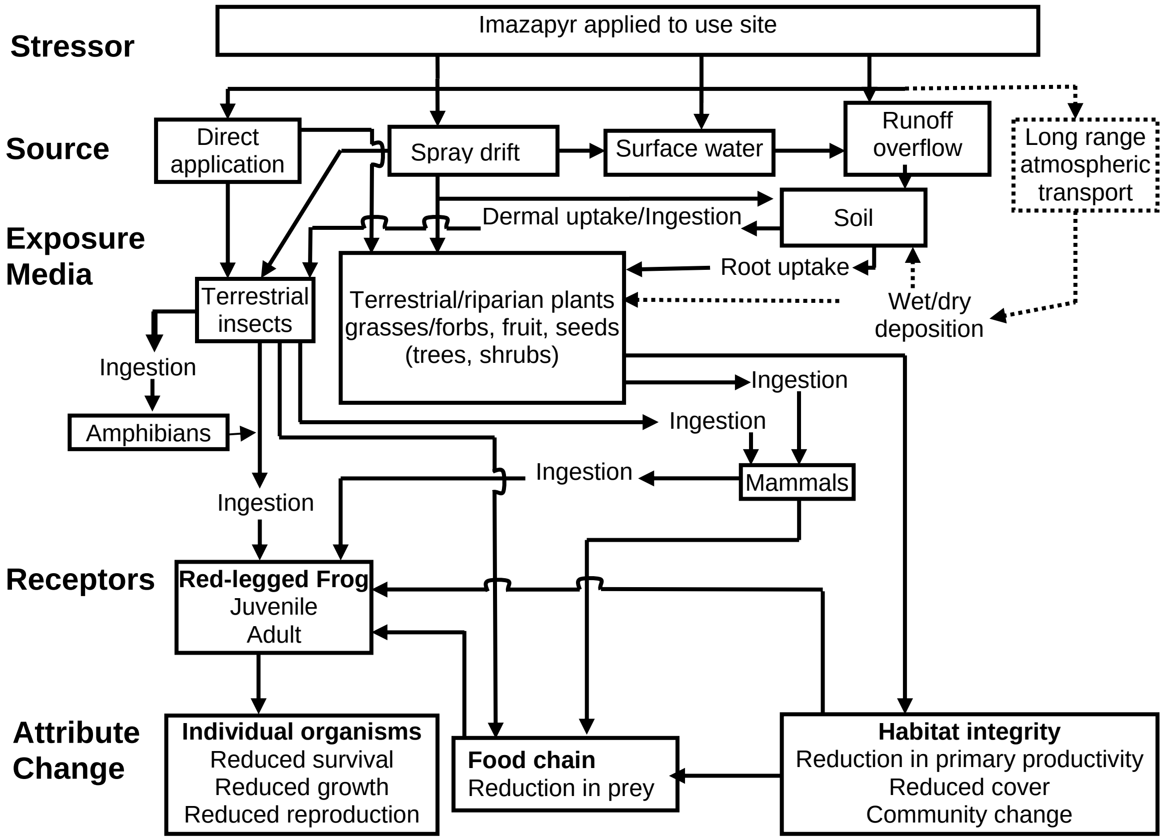



**Figure 2.9.2.c  Effects on Terrestrial Phase CRLF**

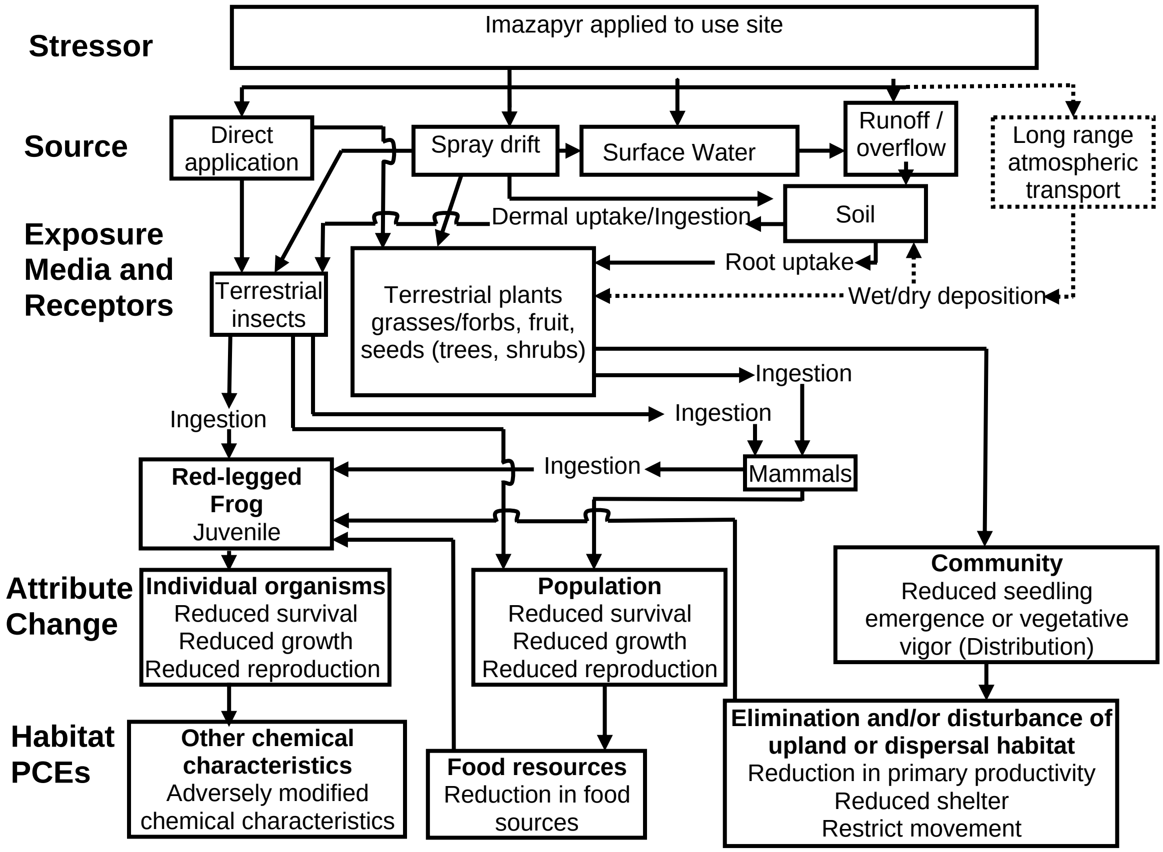



**Figure 2.9.2.d Effects on Terrestrial Component of the CRLF Critical Habitat**

## 2.10 Analysis Plan

Potential risks to the California red-legged frog and to its critical habitat have been assessed consistent with the Overview Document (EPA 2004), the Service's evaluation of EPA's risk assessment process (USFWS/NMFS 2004), and Agency guidance for ecological risk assessment (USEPA 1989). The quality of the Registrant submitted environmental and ecotoxicity data has been evaluated in a rigorous and consistent manner, according to EFED guidelines and policies. In addition, data from the outside literature (ECOTOX) has been screened and evaluated for potential use in the risk assessment. Levels of environmental exposure have been predicted using computer models, based on findings from scientifically sound environmental fate studies required under FIFRA to support registration for requested uses.

### 2.10.1 Measures to Evaluate Risk Hypotheses and Conceptual Model

#### 2.10.1.1 Measures of Exposure

Estimated environmental concentrations (EECs) for aquatic and terrestrial systems are calculated using the maximum application rates and minimum application intervals. The aquatic EECs for terrestrial uses are calculated using the EPA Tier II PRZM (Pesticide Root Zone Model) and EXAMS (Exposure Analysis Modeling System) with the most recent linkage program (PE4-PL, version 01) and the EFED Standard Pond environment, PRZM and EXAMS. PRZM is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field, and EXAMS estimates environmental fate and transport of pesticides in surface water. The aquatic EECs for the aquatic uses are calculated as application of the maximum application rate directly to the surface of the standard pond a depth of 2.0 meters, using output from 30 years of EXAMS runs. For residential and rights-of-way uses, an impervious surface scenario are developed, using percent impervious surface, percent pervious surface and percent impervious area treated for the residential scenario and percent impervious surface treated combined with percent watershed treated for the rights-of-way scenario.

Terrestrial EECs are estimated for mammals, birds and terrestrial invertebrates using the maximum single application rate of imazapyr in the model, T-REX version 1.3.1.

The TerrPlant (Ver.1.2.2) model is used to predict EECs from terrestrial uses for terrestrial plants located in dry and semi-aquatic areas adjacent to the treated field or treated water body. Terrplant is not used for the aquatic uses because the model assumes runoff into water from a terrestrial use. With aquatic uses, the pesticide is applied directly to water. Therefore, the concentrations in water are calculated directly from the application. In this case, the modeled EECs for exposure to terrestrial plants adjacent to or on the edges of the water body assume a concentration of imazapyr in a standard 2 meter pond from which 6 inches that water moves (overflows) entirely onto a hectare of dry land and dries up on the ground with imazapyr residues. For open water bodies in a tidal area, a further assumption may be made that a 2 meter depth of tide comes in on that one hectare with imazapyr residues in the soil and 6 inches of that water would overflow to flood a terrestrial site. However, since the CRLF do not inhabit higher salinity habitats, risks to plants in tidal areas are not estimated.

In addition to the TerrPlant modeling of EECs, refinement of spray drift from treated areas is assessed with the AgDrift (Ver. 2.0.1) and the AGDISP (Ver. 8.15) models. These models provide estimates of drift dispersion and deposition as the result of ground and aerial spray droplet and nozzle size, wind speed and distance from the treated field.

#### 2.10.1.2 Measures of Effect

For imazapyr, measures of effect are based on deleterious changes in a receptor as a result of exposure. The measures of effect for this risk assessment include changes in survival, reproduction, or growth as determined from standard laboratory toxicity tests. The focus on these effects for quantitative risk assessment is due to their clear relationship to higher-order ecological systems (*i.e.* populations, communities, ecosystems). Effects other than survival, reproduction, and growth are considered; however, they are not used quantitatively to estimate risks unless the relationship between these effects and higher-order processes has not been quantitatively established.

Commonly used laboratory-derived toxicity values include estimates of acute mortality (*e.g.*, $LD_{50}$, $LC_{50}$) and estimates of effects due to longer term, chronic exposures (*e.g.*, NOAEL, NOAEC) (Table 2.8.1). The latter can reflect changes seen in mortality, reproduction, or growth. As previously discussed in Section 2.8, assessment endpoints for the CRLF include not only direct toxic effects on the CRLF, but also indirect effects, such as reduction of the prey base and/or modification of its habitat. In addition, potential destruction and/or adverse modification of critical habitat are assessed by evaluating effects to the PCEs, which are components of the critical habitat areas that provide essential life cycle needs of the CRLF. Due to the lack of data on either terrestrial or aquatic amphibians following exposure to imazapyr, direct effects to the aquatic-phase of the CRLF are based on toxicity information for freshwater fish and the terrestrial-phase is based on avian toxicity data since fish are generally used as a surrogate for aquatic-phase amphibians and birds are generally used as a surrogate for terrestrial-phase amphibians (USEPA 2004, USFWS/NMFS 2004). Given that 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 and assessed for risk following exposure to imazapyr.

In addition to registrant-submitted studies, a search of the open literature using EPA's Ecotoxicology database[4] is conducted. Open literature data are assessed according to suitability for use in assessment of risk following exposure to imazapyr, either quantitatively or qualitatively. Studies from the literature that are not applicable to this risk assessment are listed in the Appendices along with reasons as to why they were not used.

Information provided in the Ecological Incident Information System (EIIS) regarding accidental exposures to commercial formulations of imazapyr is also included as supporting lines of evidence for the risk characterization.

Estimated environmental concentrations are compared to the experimentally-determined acute and chronic toxicity values for the surrogate aquatic and terrestrial species for the CRLF, its food sources and habitat. The Action Area is determined, based on the risk characterization and an evaluation of the potential "footprint" of the use pattern for imazapyr and its salt in California. This information is then be combined with the mapped CRLF habitats to determine where the imazapyr uses may impact the CRLF and its critical habitat.

Inhalation and dermal pathways are not generally considered in screening level deterministic risk assessments. The available measured data related to wildlife dermal contact with pesticides are limited and modeling techniques to account for dermal exposure are not yet available. Available data suggest that inhalation exposure at the

[4] ECOTOX at http://www.epa.gov/ecotox

time of application is not an appreciable route of exposure for terrestrial wildlife because evidence suggests that less than 1% of the applied material will be within the respirable particle size.

#### 2.10.1.3 Action Area Analysis

The Action Area for the federal action is the geographic extent of exceedance of Listed species Levels of Concern (LOC) for any taxon or effect (plant or animal, acute or chronic, direct or indirect) resulting from the maximum label-allowed use of imazapyr. For imazapyr, because the CRLF does not have an obligate relationship with any single plant species (aquatic or terrestrial) the endpoints utilized to determine the Action Area are for non-listed aquatic and terrestrial plants. To define the extent of the Action Area, the following exposure assessment tools are used: PRZM-EXAMS, Terrplant, AGDISP and ArcGIS9, a geographic information system (GIS) program. Other tools may be used as required if these are inadequate to define the maximum extent of the Action Area.

To determine the downstream extent of the Action area for effects to aquatic plants, imazapyr residues are also estimated for downstream from the treated areas by assuming dilution with stream water (derived from land area) from unaffected sources propagating downstream, until a point is reached beyond which there are no relevant LOC exceedances. In order to determine the extent of the action area downstream from the initial area of concern, all the aquatic risk quotients (RQs) are calculated, and the aquatic plant or animal endpoint with the greatest ratio of the aquatic RQ to the LOC is utilized for the analysis. Details on determination of miles downstream are provided in Appendix C.

To determine how far in land area outside the initial area of concern effects may be expected, the AGDISP model with the Gaussian Far-Field Extension is used to provide spray drift buffer estimates needed to avoid adverse effects to non-target species. This model provides estimates of drift dispersion and deposition as the result of ground and aerial spray droplet and nozzle size, wind speed and distance from the treated field.

The action area is considered to be the greatest expansion of the initial area of concern from either or both of the two methods (spray drift buffer and downstream distance) summarized above.

#### 2.10.1.4 Preliminary Identification of Data Gaps and Methods

Environmental fate data for imazapyr is mostly complete. Only two soils were tested for aerobic soil metabolism, and one soil was tested for anaerobic soil metabolism, and both aerobic and anaerobic aquatic metabolism. In this case, the stability of imazapyr in the soils tested renders the requirement for three test systems of little value. Environmental fate data gaps also arise from a supplemental field dissipation study. However, there are sufficient environmental fate chemical data from other studies to predict the needed field dissipation information.

For the CRLF, with the exception of acceptable terrestrial plant studies, the toxicity data are complete. Due to problems of overcrowding and 'fresh weight' endpoints with the seedling emergence and vegetative vigor studies with imazapyr acid, the data set for terrestrial plants is incomplete.

Toxicity data are available for either the acid, the salt or both. No toxicity information is available for degradates of imazapyr.

# 3. Exposure Assessment

## 3.1 Label Application Rates and Intervals

| Table 3.1 Imazapyr Label Application Information for the Listed Red Legged Frog[1] | | | | | |
|---|---|---|---|---|---|
| **Scenario** | **Maximum Application Rate (lbs/acre)** | **Maximum Number of Applications[2]** | **Formulation[3]** | **Method of Application** | **Interval Between Applications** |
| CAforestry | 1.5 | 1 | liquid | aerial and ground | NA |
| CAimpervious surfaces | 1.5 | 1 | liquid | aerial and ground | NA |
| CArangeland-hay | 1.5 | 1 | liquid | aerial and ground | NA |
| CAresidential | 0.91 | 1 | liquid | ground | NA |
| CAright-of-way | 1.5 | 1 | liquid | aerial and ground | NA |
| CAturf | 1.5 | 1 | liquid | ground | NA |
| non-crop aquatic[4] | 1.5 | 1 | liquid | applied directly to water | NA |

[1-]Based on 2005 RED and new label submissions subsequent to the 2005 RED.
[2-]April 1 application date used for all modeling
[3-]While granular formulations are also marketed, liquid formulations, which produce the most conservative estimates of risk, have been modeled in this assessment
[4-] There is also a capsule injection application to trees and brush standing in water (capsule containing 83% a.i.. This use is expected to have very limited non-quantifiable exposure to non-target plants.

## 3.2 Aquatic Exposure Assessment

### 3.2.1 Modeling Approach

The EECs (Environmental Effects Concentrations) were calculated using the EPA Tier II PRZM (Pesticide Root Zone Model) and EXAMS (Exposure Analysis Modeling System) with the EFED Standard Pond environment, PRZM and EXAMS. PRZM is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field, and EXAMS estimates environmental fate and transport of pesticides in surface water.

The most recent PRZM/EXAMS linkage program (PE4-PL, version 01) was used for all surface water simulations. Linked crop-specific scenarios and meteorological data were used to estimate exposure resulting from use on crops and turf. Simulations were conducted using the standard ecological pond scenario in EXAMS.

### 3.2.2 Modeling Inputs

The aqueous model predictions are based on maximum labeled application rates, estimated date of application, crop and/or use specific agronomic practices, regional weather data, soil, crop and topography characteristics, and the chemical, physical and environmental fate properties for imazapyr. Modeling scenarios contain crop and location specific characteristics in a standardized modeling format. California scenarios developed specifically for this Red legged Frog Listed Species Assessment, and a California turf scenarios developed for EPA's Organophosphate Cumulative Assessment have been used here to estimate surface water concentrations. Table 3.2.2a lists the specific locations modeled for this assessment.

**Table 3.2.2a. PRZM/EXAMS Scenarios Used to Estimate Concentrations of Imazapyr Total Toxic Residues in Surface Water**

| Tier 2 Modeling Scenario | Location Modeled |
|---|---|
| California Forestry | Trinity, Shasta, Modoc, and Humboldt Counties |
| California Impervious Surfaces | San Francisco Bay area of California |
| California Rangeland | Alameda, Contra Costa, Solano, Sonoma, and Santa Clara Counties, CA |
| California Residential | San Francisco Bay area of California |
| California Rights-of-Way | Central/Coastal California |
| California Turf | Central/Northern California |

### Selecting Input Parameters

The appropriate PRZM and EXAMS input parameters for total toxic residues (imazapyr, CL9140 and CL 119060) were selected from the environmental fate data submitted by the registrant and in accordance with US EPA-OPP EFED water model parameter selection guidelines, Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides, Version II, February 28, 2002. When data are not available for total toxic residues, values for the parent compound, imazapyr, are used for modeling purposes. The environmental fate data used to estimate the modeling input values appear in **Table 3.2.2.b**.

| Table 3.2.2.b. Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs[1] for Total Toxic Residues of Imazapyr[3] for the Listed Red Legged Frog Assessment | | |
|---|---|---|
| **Fate Property** | **Value** | **MRID (or source)** |
| Molecular Weight [2] | 261.28 | 2003 Science Chapter for Aquatic Uses of Imazapyr |
| Henry's constant at 25 °C [2] | $<10^{-17}$ atm x $m^3$/mol | 2005 Science Chapter in support of RED |
| Vapor Pressure at 60 °C [2] | $<10^{-7}$ mm Hg | (< 1.3 x $10^{-5}$ Pa; method limit); 2003 Science Chapter for New Aquatic Uses of Imazapyr |
| Solubility in Water at 25 °C [2] | 11.1 g/L | 2003 Science Chapter for New Aquatic Uses |
| Photolysis in Water | 19.9 days | MRID 00131617 (t ½ = 5.3 days for parent only) |
| Aerobic Soil Metabolism Half-lives | Stable | MRID 00131619 |
| Hydrolysis | Stable | MRID 00132359 |
| Aerobic Aquatic Metabolism (water column) | Stable | MRID 40003712 |
| Anaerobic Aquatic Metabolism (benthic) | Stable | MRID 00131619 |
| $K_{oc}$ | 99.8 | lowest non-sand (silt loam) value (parent) for total toxic residues ($K_{oc}$ = 6053 and 1020 for CL 119060 and CL 9140); MRID 45119705 |
| Application Efficiency | 0.95 (0.99) | EFED Guidance for aerial (ground) application |
| Spray Drift Fraction | 0.05 (0.01) | EFED Guidance for aerial (ground) application |

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

2- Imazapyr value used in absence of data for degradation products: CL 119060 and CL 9140

3- Imazapyr value for acid moiety and the two major degradation products are used in this assessment

### 3.2.3 Results

The EECs resulting from the standard 2.0 meter pond depth for forestry, rangeland, hay and golf course roughs are tabulated below.

| Table 3.2.3.a. Tier 2 Estimated Environmental Concentrations (EECs) for Forestry Uses of Imazapyr (total toxic residues) | | | |
|---|---|---|---|
| | **Peak (ppb)** | **21 Day (ppb)** | **60-Day (ppb)** |
| **Aerial Application** | 18.5 | 18.0 | 17.2 |
| **Ground Spray Application** | 14.1 | 13.8 | 13.1 |

| Table 3.2.3.b. Tier 2 Estimated Environmental Concentrations (EECs) for Rangeland/Hay Uses of Imazapyr (total toxic residues) | | | |
|---|---|---|---|
| | **Peak (ppb)** | **21 Day (ppb)** | **60-Day (ppb)** |
| **Aerial Application** | 33.0 | 32.1 | 30.5 |
| **Ground Spray Application** | 26.1 | 25.6 | 24.7 |

For golf course roughs, EECs were adjusted by 66%, as per EFED golf course adjustment factor[10]. Green, tees and fairways of an established, working golf course are not expected to ever become overgrown enough to require treatment with imazapyr.

| Table 3.2.3.c. Tier 2 Estimated Environmental Concentrations (EECs) for Use of Imazapyr (total toxic residues) on Golf Course Roughs (CA turf scenario) | | | |
|---|---|---|---|
| | **Peak (ppb)** | **21 Day (ppb)** | **60-Day (ppb)** |
| **Ground Spray Application** | 9.8 | 9.5 | 9.0 |

Direct application of imazapyr to water was calculated as application of the maximum application rate directly to the surface of the standard pond a depth of 2.0 meters. Direct application of imazapyr to the surface of the standard two meter ecological pond was calculated using output from thirty years of EXAMS runs. The direct application of imazapyr to water will result in EECs that increase in a pattern which can be described mathematically (Nonlinear Regression: P <0.0001 ) as an exponential rise to a maximum value (SigmaPlot 10.0):

$$y = a(1-e^{-bx})$$

EXAMS estimated EEC values for the 30 years of available weather data are tabulated below, **Table 3.2.2.d**. Acute EECs were 84.0 ppb, chronic 21 day EECs were 82.1 ppb, and chronic 60 day EECs were 79.6 ppb. Thirty yearly direct applications of 1.5 lbs./acre of imazapyr to the surface of the standard two meter ecological pond were calculated using EXAMS. Acute EECs were 971 ppb, chronic 21 day EECs were 968 ppb, and chronic 60 day EECs were 962 ppb. Because the EEC values are steadily rising for the thirty years that EXAMS simulates, the one in ten year value, which is normally reported as the value that is only expected to be exceeded every ten years has little meaning and is therefore, not reported here. Figure 3.2.2 graphically illustrates this increase. Additionally, there are no currently accepted models to account for the label mandated ½ mile setback from drinking water intakes. As a result, this factor was not accounted for in the estimated EECs.

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

**Table 3.2.2.d. Tier 2 EXAMS Estimated Environmental Concentrations (EECs) Resulting from the Yearly Application of Imazapyr (total toxic residues) to Water (Aerial or Ground Spray Application)**

| | Peak (ppb) | 21 Day (ppb) | 60-Day (ppb) |
|---|---|---|---|
| 1 application | 84 | 82 | 79 |
| 5 yearly applications | 331 | 328 | 325 |
| 10 yearly applications | 557 | 555 | 550 |
| 15 yearly applications | 718 | 715 | 710 |
| 20 yearly applications | 833 | 829 | 824 |
| 25 yearly applications | 914 | 910 | 904 |
| 30 yearly applications | 971 | 968 | 962 |

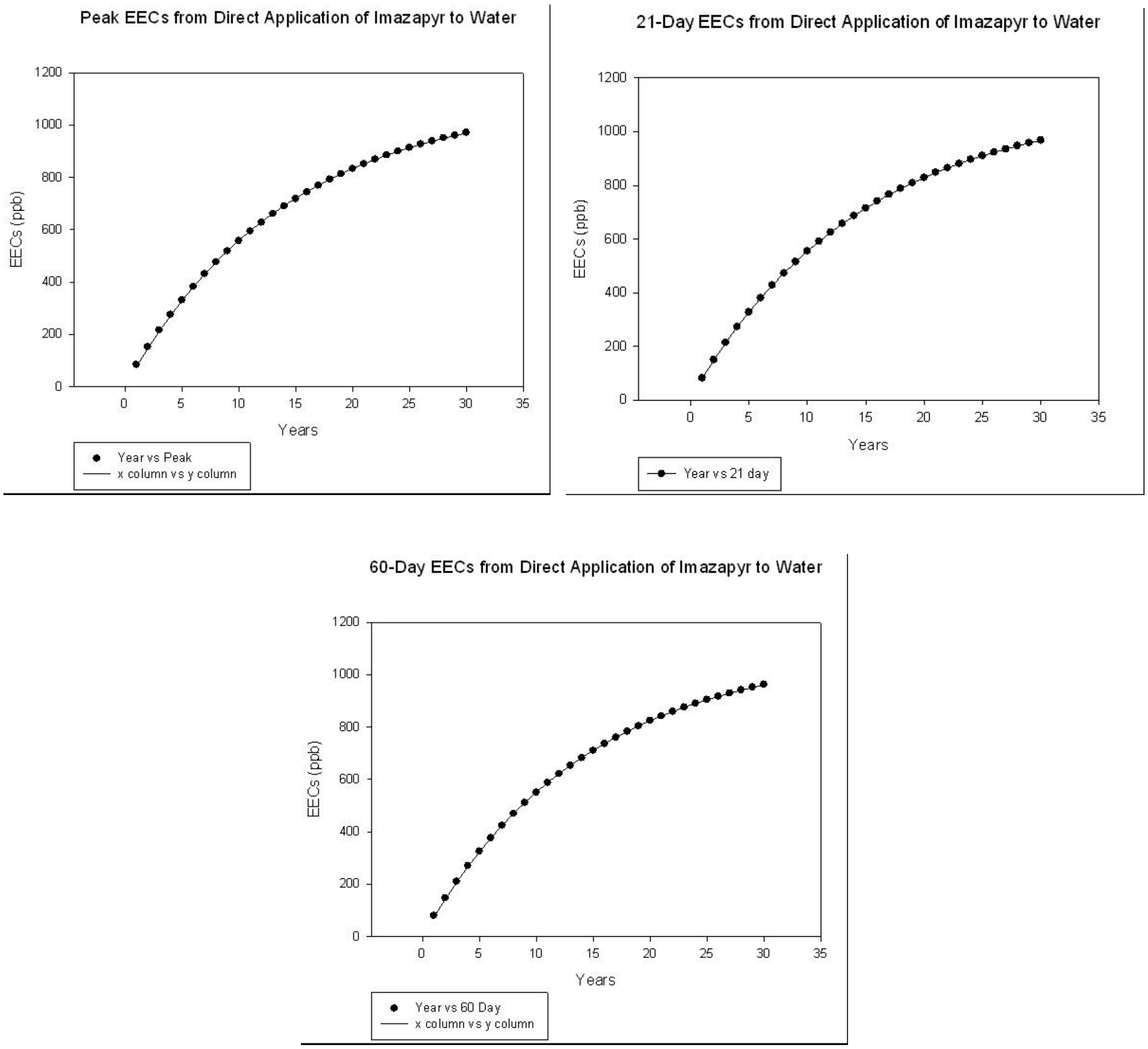



**Figure 3.2.2. Peak, 21-Day and 60-Day EECs for Direct Application of Imazapyr to Water**

The impervious surface scenario was developed to be used in conjunction with the residential and rights-of-way scenarios. A post processing step is required to merge the impervious surface output values with the output values from the residential and rights-of-way scenarios. In order to combine these values in a way that realisticely depicts environmental conditions, the percent of the watershed actually treated and the percent of that treated area existing as impervious surfaces needs to be determined.

The assumption that 12% of an average, ¼ acre residential lot consists of impervious surfaces was first made in the August 22, 2006 Atrazine Endangered Species Assessment for the Barton Springs Salamander. It was also assumed that 50% of the residential watershed consisted of impervious, paved streets. The 12% impervious surfaces assumption for the ¼ acre residential lot is retained from the Barton Springs assessment, but, unlike atrazine, imazapyr is applied to the cracks of pervious surfaces, and was modeled as being applied to different percents of the 12% impervious surfaces within the residential lot. Imazapyr is only intended to be used on pervious surfaces that are overgrown with unwanted vegetation, and not meant to be applied directly to well maintained residential turf. In this assessment, it was assumed that paved residential streets that were cracked and/or crumbling to the extent that imazapyr might be used to control vegetation growth would be repaired instead. Any overspray from use on pervious surfaces is anticipated to be negligible compared to the intended application of imazapyr to pervious surfaces. Such overspray is therefore not quantitatively estimated, but is accounted for in the uncertanties associated with applications made to sidewalks, driveways and patios located on the ¼ acre residential lot.

In the absence of data to make a definitive estimate of the extent of imazapyr use on residential sites, modeling was conducted at 50%, 25%, 10% and 1% of the impervious surfaces (12% of total lot) on the ¼ acre residential lot treated, and on 10%, 1%, and 0% of the pervious surfaces on the ¼ acre lot treated. Calculations for the ¼ acre residential lots appear in **Appendices D.2** through **D.4**. Finally, in order to account for the 50% of the residential watershed composed of untreated, paved streets, a simplifying assumption was made that an equal volumes of water would runoff of the residential streets and the ¼ acre residential lot. While this assumption may underestimate the volume of water running off of paved residential streets, the difference is eradicated in the bounding exercise tabulated in the matrices below. As a result of that assumption, the aquatic EECs were divided by two. The resulting matrices (**Tables 3.2.3.e** and **3.2.3.f.**, below) were used to characterize the effects of imazapyr under the array of differing conditions.

| Table 3.2.3.e. Tier 2 PRZM/EXAMS Estimated Environmental Concentrations (EECs) for the Standard, 2 Meter Deep Pond Resulting from the Residential Use of Imazapyr (total toxic residues in ppb) With 12% Impervious Surface | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0% pervious surface | | | 1% pervious surface | | | 10% pervious surface | | |
| | Peak | 21-Day | 60-Day | Peak | 21-Day | 60-Day | Peak | 21-Day | 60-Day |
| 1% of impervious area treated | 0.16 | 0.16 | 0.15 | 0.21 | 0.20 | 0.18 | 0.58 | 0.57 | 0.57 |
| 10% of impervious area treated | 1.6 | 1.6 | 1.5 | 1.7 | 1.6 | 1.5 | 2.1 | 2.1 | 1.9 |
| 25% of impervious area treated | 4.1 | 3.9 | 3.7 | 4.1 | 40 | 3.7 | 4.6 | 4.5 | 4.2 |
| 50% of impervious area treated | 8.1 | 7.9 | 7.4 | 8.2 | 7.9 | 7.4 | 8.7 | 8.4 | 8.0 |

The rights-of-way, industrial, and non-food, non-residential imazapyr uses have been modeled using the rights-of-way scenario. Modeling was conducted at 50%, 25%, 10% and 1% of the impervious surfaces on the actual use site treated, with the assumption that 10%, 5%, and 1% of the of the watershed actually consisted of these modeled imazapyr use sites. Calculations for the use sites modeled by the right of way scenarios appear in **Appendices D.7 and D.8**. The resulting matrices (below) were used to characterize the potential effects of imazapyr under the array of differing conditions.

| Table 3.2.3.f. Tier 2 PRZM/EXAMS Estimated Environmental Concentrations (EECs) for the Standard, 2 Meter Deep Pond Resulting from the Use of Imazapyr on Industrial, Non-Food Non-Residential Rights-of-Way (total toxic residues as ppb) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1% of impervious surfaces treated | | | 10 % of impervious surfaces treated | | | 25 % of impervious surfaces treated | | | 50 % of impervious surfaces treated | | |
| Aerial Application | Peak | 21-Day | 60-Day | Peak | 21-Day | 60-Day | Peak | 21-Day | 60-Day | Peak | 21-Day | 60-Day |
| 1% of watershed | 0.36 | 0.35 | 0.33 | 0.69 | 0.65 | 0.62 | 1.3 | 1.2 | 1.2 | 2.3 | 2.2 | 2.1 |
| 5% of watershed | 1.8 | 1.7 | 1.6 | 3.4 | 3.3 | 3.1 | 6.5 | 6.2 | 5.9 | 11.6 | 11.0 | 10.5 |
| 10% of watershed | 3.6 | 3.5 | 3.3 | 6.9 | 6.5 | 6.2 | 13.0 | 12.4 | 11.7 | 23.2 | 22.1 | 21.1 |
| Ground Spray Application | Peak | 21-Day | 60-Day | Peak | 21-Day | 60-Day | Peak | 21-Day | 60-Day | Peak | 21-Day | 60-Day |
| 1% of watershed | 0.32 | 0.32 | 0.29 | 0.65 | 0.63 | 0.59 | 1.3 | 1.2 | 1.2 | 2.3 | 2.2 | 2.1 |
| 5% of watershed | 1.6 | 1.6 | 1.5 | 3.3 | 3.1 | 2.9 | 6.4 | 6.2 | 5.8 | 11.6 | 11.2 | 10.5 |
| 10% of watershed | 3.2 | 3.2 | 2.9 | 6.5 | 6.3 | 5.9 | 12.8 | 12.3 | 11.5 | 23.2 | 22.4 | 20.9 |

Exposure from the capsule injection application to individual plants was not estimated because it is expected to produce very limited non-quantifiable amounts into water.

### 3.2.4 Existing Monitoring Data

No monitoring data for imazapyr (acid or salt), or for the major imazapyr degradation products are available, either through the USGS NAWQA Database, from the state of California or through any publicly available search engines on the internet.

## 3.3 Terrestrial Exposure Assessment

Terrestrial wildlife may be exposed to pesticides through the plant or animal material they consume as food and/or through inhalation, dermal, and drinking water pathways. In performing assessments for spray applications of pesticides, exposure to terrestrial organisms is estimated using a series of tables based on a database of actual measured pesticide residue values on plants and insects. This series of tables is called the Kenaga nomogram, as modified by Fletcher (Hoerger, F. and E.E. Kenaga, 1972; Fletcher, J.S., J.E. Nellessen, and T.G. Pfleeger, 1994). These tables relate food item residues to pesticide application rate. A computer simulation model is then used to allow degradation of residues on foliar surfaces and insects and the concentrations are predicted using a first-order residue decline method.

Terrestrial EECs were estimated using the maximum single application rate of imazapyr in the model, T-REX version 1.3.1 for mammals and birds (see risk estimation Section 5.1). Acute and chronic RQs were calculated with these upper bound EECs and appropriate toxicity data. Table 3.3 summarizes the estimated terrestrial EECs for forestry uses at the maximum allowable rate for imazapyr. Terrestrial EECs based on forestry uses are assumed to be protective of all the other uses in California because they yield the highest dietary exposure concentrations.

**Table 3.3** Upper-bound Kenaga values (T-REX v1.3.1)

| Imazapyr Use | App. Rate (lbs a.i./A) | No. Apps. | Minimum Interval (Days) | Terrestrial EEC (ppm) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Short Grass | Tall Grass | Broadleaf Plants, Small Insects | Fruits, Pods, Seeds, Large Insects |
| Forestry | 1.5 | 1 | N/A | 360 | 165 | 203 | 23 |

### Residue Studies

Since imazapyr was only applied as a single application, the foliar dissipation half-life was not needed for this assessment.

## 3.4 Terrestrial Plant Exposure Assessment

Terrestrial plants in riparian areas may be exposed to imazapyr residues carried from application sites via surface water runoff, overflow from direct application to water or spray drift. Exposures can occur directly to seedlings breaking through the soil surface, root uptake or direct deposition onto foliage to more mature plants. Riparian vegetation is important to the water and stream quality of the CRLF habitat because it serves to filter out sediment, nutrients, and contaminants before they enter the watersheds associated with the CRLF's current and designated critical habitat. Riparian vegetation has been shown to be essential in the maintenance of a stable stream (Rosgen, 1996). Destabilization of the stream can have an effect on CRLF habitat quality by increasing sedimentation within the watershed.

Effects on non-target terrestrial plants are most likely to occur as a result of spray drift, overflow from direct application to water and/or runoff from aerial and ground applications. These are important factors in characterizing the risk of imazapyr to non-target plants, which is assumed to reach off-site soil. The TerrPlant (Ver.1.2.2) model predicts EECs for terrestrial plants located in dry and semi-aquatic areas adjacent to the treated field or treated water body. The EECs are based on the application rate and solubility of the pesticide in water and drift characteristics, which, in the case of imazapyr in California, depend on either ground or aerial applications. The amount of imazapyr that runs off is a proportion of the application rate and is assumed to be 5% based on imazapyr's solubility of >100 ppm in water. Drift from ground and aerial applications are assumed to be 1% and 5%, respectively, of the application rate. An application efficiency of 100% is assumed for both aerial and ground applications. For a standard scenario on an agricultural field when applications are occurring on land, the runoff scenario for terrestrial plants inhabiting dry areas adjacent to a field is characterized as "sheet runoff" (one treated acre to an adjacent acre; a 1:1 ratio) and inhabiting semi-aquatic or wetland areas adjacent to a field is characterized as "channelized runoff" (10 treated acre to an adjacent low-lying acre; a 10:1 ratio).

Terrplant cannot be used for the aquatic uses because the model assumes runoff into water from a terrestrial use. With aquatic uses, the pesticide is applied directly to water. Therefore, the concentrations in water are calculated directly from the application. When applications are occurring on surface water such as ponds and lakes, the modeled EECs for exposure to terrestrial plants adjacent to or on the edges of the water body assumes a concentration (volume) of imazapyr in a 1 hectare pond with a water depth of 2 meters, from which 6 inches that water moves (overflows) entirely onto a hectare of dry land and dries up on the ground with imazapyr residues. The range of semi-aquatic areas apparently allowed by this broad label for aquatic uses represents much different exposure scenarios than open water bodies, including areas that might go dry at times, which could lead to the potential for imazapyr to flow entirely onto a new site and soak into the ground exposing the seedlings to the herbicide. Because the CRLF does not inhabit higher salinity habitats, risks to plants in tidal areas are not estimated.

The inputs are based on an application rate of 1.5 lb/A to a 1 hectare area with 6 inches (15.2 cm) of the water moving onto land. Flooding EEC values (lbs ae/A) were calculated as described above and in the equations below, and drift EEC values from TerrPlant were added to the runoff values.

(84 $\mu$g/L x 1 hectare) x (15.24 cm x 10000 m$^2$/hectare) x (10000 cm$^2$/m$^2$) x (1 mL/1 cm$^3$) x (1 L/1000 mL) = 1.28 x $10^8$ $\mu$g/hectare
1.28 x $10^8$ $\mu$g/hectare x 1 kg/$10^9$ $\mu$g = 0.128 kg/hectare
0.128 kg/hectare x 1 hectare/2.471 acres = 0.052 kg/A
0.052 kg/A x 2.2 lbs/kg = 0.114 lb ae/A

Details of the TerrPlant model EECs are presented in Table 3.4 for terrestrial and aquatic uses. While imazapyr is formulated both as an acid and as an isopropylamine salt, all concentrations were converted into acid equivalents for this assessment. These values are a conservative estimate because there may be dilution of the imazapyr during the flooding event and thus, overestimation of the EECs.

**Table 3.4. Estimated Environmental Concentrations of Imazapyr for Terrestrial Plants from California Uses**

| Applications Occurring on Land | | Concentration (lbs ae/acre) | | |
|---|---|---|---|---|
| **Terrestrial Use** | **Application Method** | **Total Loading to Dry areas [1]** | **Total Loading to Semi-Aquatic Areas [2]** | **Drift[3]** |
| Non-Crop<br>(1.5 lbs ae/acre) | Ground<br>Aerial | 0.09<br>0.15 | 0.765<br>0.825 | 0.015<br>0.075 |
| Non-Crop<br>(0.9 lbs ae/acre) | Ground | 0.055 | 0.464 | 0.009 |
| **Applications Occurring on Surface Water** | | **Concentration (lbs ae/acre)** | | |
| **Aquatic Use** | **Application Method** | **Shallow-Water Communities (Water overflows) [4]** | | |
| Non-Crop<br>(1.5 lbs ae/acre) | Ground<br>Aerial | 0.114<br>0.114 | | |

[1] EEC = Sheet Runoff + Drift (5% for aerial; 1% for ground)
[2] EEC = Channelized Runoff + Drift (5% for aerial; 1% for ground)
[3] EEC for ground (appl rate x 1% drift); for aerial (appl rate x 5% drift)
[4] EEC = 1.5 lb/A applied to 2 meter depth of water (1 hectare area), then 6 inches of water moves onto land

Imazapyr applied according to label directions as a liquid spray for ground or aerial applications may impact non-target plants for some distance from the application site depending on droplet size, wind speed, and other factors.

Exposure from the capsule injection application to individual plants was not estimated because it is expected to produce very limited non-quantifiable exposure to adjacent non-target plants.

In addition to the TerrPlant modeling of EECs, refinement of spray drift from treated areas was assessed with the AgDrift (Ver. 2.0.1) and the AGDISP (Ver. 8.15) models. These models provide estimates of drift dispersion and deposition as the result of ground and aerial spray droplet and nozzle size, wind speed and distance from the treated field.

## 4. Effects Assessment

This assessment evaluates the potential for imazapyr and the isopropylamine salt of imazapyr to directly or indirectly affect the CRLF and/or adversely modify designated critical habitat for the CRLF. As previously discussed in Section 2.8, assessment endpoints for the CRLF include direct toxic effects on the survival, reproduction, and growth, as well as indirect effects, such as reduction of the prey base and/or modification of its habitat. In addition, potential effects to critical habitat are 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 the terrestrial-phase is based on avian toxicity data since fish are generally used as a surrogate for aquatic-phase amphibians and birds are generally used as a surrogate for terrestrial-phase amphibians (USEPA 2004, USFWS/NMFS 2004). Given that 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. Toxicity data used to evaluate direct effects, indirect effects, and effects to critical habitat are summarized in Table 4.0.

**Table 4.0 Summary of Toxicity Data on Imazapyr and Its Isopropylamine Salt Used to Assess Direct and Indirect Effects and Adverse Modification to Critical Habitat**

| Toxicity Data | Assessment Endpoint | Comment |
|---|---|---|
| Acute and chronic studies on freshwater fish. | - Direct effects to the aquatic phase of CRLF<br>- Chemical characteristics suitable to support normal behavior, growth, and viability of CRLF | No aquatic amphibian data available. Fish data used as surrogate for amphibians. |
| Acute and chronic studies on freshwater invertebrates<br><br>Acute and chronic studies on freshwater fish[1] | - Indirect effects to aquatic phase of CRLF (reduction in prey base)<br>- Chemical characteristics suitable to support normal behavior, growth, and viability of CRLF | No aquatic amphibian data available. Fish data used as surrogate for amphibians. |

| Table 4.0 Summary of Toxicity Data on Imazapyr and Its Isopropylamine Salt Used to Assess Direct and Indirect Effects and Adverse Modification to Critical Habitat | | |
|---|---|---|
| **Toxicity Data** | **Assessment Endpoint** | **Comment** |
| Acute studies on vascular and non-vascular aquatic plants | - Indirect effects to aquatic phase CRLF via reduction in food supply, aquatic habitat, cover and/or primary productivity<br>- Habitat modification to aquatic habitat and aquatic phase PCE: Alteration to water chemistry/quality; channel/pond morphology or geometry, sediment deposition and chemical characteristics suitable to support normal behavior, growth, and viability of CRLF | |
| Acute studies on terrestrial plants | - Indirect effects to terrestrial phase CRLF via reduction in terrestrial habitat, cover and/or primary productivity<br>- Habitat modification: Alteration to water chemistry/quality; channel/pond morphology or geometry, sediment deposition and chemical characteristics suitable to support normal behavior, growth, and viability of CRLF<br>– Habitat modification to terrestrial phase PCEs: upland and dispersal habitat | |
| Acute and chronic studies on birds | - Direct effects to the terrestrial phase of CRLF<br>- Chemical characteristics suitable to support normal behavior, growth, and viability of CRLF | No terrestrial amphibian data available. Bird data used as surrogate for amphibians. |
| Acute and chronic studies on mammals<br><br>Acute studies in terrestrial invertebrates<br><br>Acute and chronic studies on birds (surrogate for terrestrial phase CRLF: no amphibian data) | - Indirect effects to terrestrial phase of CRLF (reduction in prey base and indirect effect to habitat (use of mammal burrows))<br>- Chemical characteristics suitable to support normal behavior, growth, and viability of CRLF | No terrestrial amphibian data available. Bird data used as surrogate for amphibians. |

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

Acute (short-term) and chronic (long-term) effects toxicity information is characterized, based on registrant-submitted studies and a comprehensive review of the open literature on imazapyr and its isopropylamine salt. 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), were conducted to further refine the characterization of potential ecological effects associated with exposure to imazapyr. A summary of the available freshwater and terrestrial plant ecotoxicity information, use of the probit dose response relationship and the incident information for imazapyr are provided in Sections 4.1 through 4.4, respectively.

## 4.1 Evaluation of Aquatic Ecotoxicity Studies (CRLF Aquatic Phase)

Toxicity endpoints are established based on data generated from guideline studies submitted by the registrant, and from open literature studies that meet the criteria for inclusion into the ECOTOX database maintained by EPA/Office of Research and Development (ORD) (U.S. EPA, 2004). Open literature data presented in this assessment were obtained from the 2005 imazapyr RED as well as ECOTOX information obtained on February 22, 2007. The February 2007 ECOTOX search included all open literature data for imazapyr (i.e., pre- and post-RED). 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 listed 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 is dependent on whether the information is relevant to the assessment endpoints (i.e., maintenance of CRLF survival, reproduction, and growth; alteration of PCEs in the critical habitat impact analysis) identified in the problem formulation. For example, endpoints such as biochemical modifications are likely to be qualitatively evaluated unless these endpoints are quantitatively linked with, reduction in CRLF survival, reproduction, and/or growth (e.g., the magnitude of effect on the biochemical endpoint needed to result in effects on survival, growth, or reproduction is not known). Open literature data included as part of this assessment are listed in Appendix G.

All open literature that was not considered as part of this assessment because it was either rejected by the ECOTOX screen or accepted by ECOTOX but not used (e.g., the endpoint is less sensitive and/or not appropriate for use in this assessment) are included in

Appendices H and I. These Appendices also include a rationale for rejection of those studies that did not pass the ECOTOX screen and those that were not evaluated as part of this listed species assessment.

As described in Agency's Overview Document (U.S. EPA, 2004), the most sensitive endpoint for each taxa is evaluated. For this assessment, evaluated taxa include freshwater fish, invertebrates and plants, terrestrial plants and invertebrates, birds and mammals. Table 4.1.a summarizes the most sensitive ecological toxicity endpoints for the aquatic phase of the CRLF and its designated critical habitat, based on an evaluation of both the submitted studies and the open literature, as previously discussed. Additional information is provided in Appendix B. Ecotoxicity studies on both imazapyr and its isopropylamine salt are considered in this assessment. The $EC_{50}$/NOAEC values from the toxicity tests with the isopropylamine salt of imazapyr are expressed in acid equivalents (a.e.).

**Table 4.1.a Animal and Plant Toxicity Profile of Imazapyr and Its Isopropylamine Salt For Use in Assessing Risk to the Aquatic Phase CRLF**

| Assessment Endpoint | Species | Toxicity Value Used in Risk Assessment[2] | Citation MRID # (Author & Date) | Comment |
|---|---|---|---|---|
| Direct effects on CRLF following acute exposure | Rainbow trout *(Oncorhynchus mykiss)* | 96-hour $LC_{50}$ >100 mg /L | 00131629<br>ABC Laboratories, 1983 | Acceptable; probit slope unavailable |
| Direct effects on CRLF following chronic exposure | Rainbow trout *(Oncorhynchus mykiss)* | NOAEC/LOAEC 43.1/92.4 mg/L (significantly reduced percent hatch and an observed reduction on survival) | 41315804<br>Ward, 1988 | Supplemental: survival of control embryos following thinning was below 70%. |
| Indirect effects on CRLF following acute exposure (reduction in prey base)<br><br>Indirect effects to CRLF via modification to Critical Habitat PCE Alteration of other chemical characteristics necessary for normal growth and viability of CRLF's and their food source. | Waterflea (*Daphnia magna*)<br><br>Rainbow trout[1] *(Oncorhynchus mykiss)* | 48-hour $EC_{50}$ >100 mg /L<br><br>96-hour $LC_{50}$ >100 mg /L | 00131632<br>ABC Laboratories, 1983<br><br>00131629<br>ABC Laboratories, 1983 | Acceptable: probit slope unavailable<br><br>Acceptable; probit slope unavailable |
| Indirect effects on CRLF following chronic exposure (reduction in prey base)<br><br>Indirect effects to CRLF via modification to Critical Habitat PCE Alteration of other chemical characteristics necessary for normal growth and viability of CRLF's and their food source. | Waterflea *(Daphnia magna)*<br><br>Rainbow trout[1] *(Oncorhynchus mykiss)* | 21-day NOAEC/LOAEC: 97.1/>97.1mg/L<br><br>NOAEC/LOAEC 43.1/92.4 mg/L (significantly reduced percent hatch and an observed reduction on survival) | 41315805<br>Manning, 1988<br><br>41315804<br>Ward, 1988 | Acceptable: No effects on growth or reproduction<br><br>Supplemental: survival of control embryos following thinning was below 70%. |

| **Table 4.1.a Animal and Plant Toxicity Profile of Imazapyr and Its Isopropylamine Salt For Use in Assessing Risk to the Aquatic Phase CRLF** | | | | |
|---|---|---|---|---|
| **Assessment Endpoint** | **Species** | **Toxicity Value Used in Risk Assessment[2]** | **Citation MRID # (Author & Date)** | **Comment** |
| Indirect effects on CRLF (reduction in food supply, habitat, and primary productivity)<br><br>Indirect effects to CRLF via modification to Critical Habitat PCE Reduction and/or modification of aquatic-based food sources for pre-metamorphs | Duckweed (*Lemna gibba*)<br><br>Green Algae (*Selenastrum capricornutum)* | $EC_{50}$/NOAEC 0.018/0.011 (mg ae/L)<br><br>$EC_{50}$/NOAEC 11.5/7.16 (mg ae/L) | 43889102 Hughes *et al*., 1995 | Acceptable: endpoint based on decreased frond production.<br><br>Slight change in cell shape. % a.e. = 23.3 for the salt. |
| Indirect effects to CRLF via effects to riparian vegetation required to maintain acceptable water quality and habitat in ponds and streams comprising the species' current range. | **Monocots**<br>Seedling emergence<br><br>Vegetative vigor<br><br>**Dicots**<br>Seedling emergence<br><br>Vegetative vigor | Wheat $EC_{25}$: 0.0046 lb ae/acre<br>Wheat $EC_{25}$: 0.012 lb ae/acre<br><br>Sugar beet $EC_{25}$: 0.0024 lb ae/acre<br>Cucumber $EC_{25}$: 0.0009 lb ae/acre | 40811801 Banks, 1988 | Supplemental: problems with overcrowding and fresh weight endpoints |
| Indirect effects to CRLF via modification to Critical Habitat PCE (alteration to water chemistry/quality and chemical characteristics suitable to support normal behavior, growth, and viability of CRLF; alteration of channel/pond morphology, sediment deposition and/or aquatic habitat). | Duckweed (*Lemna gibba*)<br><br>Green Algae (*Selenastrum capricornutum)*<br><br>**Monocots**<br>Seedling emergence<br><br>Vegetative vigor<br><br>**Dicots**<br>Seedling emergence<br><br>Vegetative vigor | $EC_{50}$/NOAEC 0.018/0.011 (mg ae/L)<br><br>$EC_{50}$/NOAEC 11.5/7.16 (mg ae/L)<br><br>Wheat $EC_{25}$: 0.0046 lb ae/acre<br>Wheat $EC_{25}$: 0.012 lb ae/acre<br><br>Sugar beet $EC_{25}$: 0.0024 lb ae/acre<br>Cucumber $EC_{25}$: 0.0009 lb ae/acre | 43889102 Hughes *et al*., 1995<br><br>40811801 Banks, 1988 | Acceptable: endpoint based on decreased frond production.<br><br>Slight change in cell shape. % a.e. = 23.3 for the salt.<br><br>Supplemental: problems with overcrowding and fresh weight endpoints |

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

[2] The $EC_{50}$/NOAEC values from the toxicity tests with the isopropylamine salt of imazapyr are expressed in acid equivalents (a.e.). The toxicity values with the acid are not expressed in terms of acid equivalents.

Toxicity to aquatic fish and invertebrates is categorized using the system shown in Table 4.1.b (U.S. EPA, 2004). Toxicity categories for aquatic plants have not been defined.

| Table 4.1.b. Categories of Acute Toxicity for Aquatic Organisms | |
|---|---|
| **$LC_{50}$ (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

EPA typically uses fish as a surrogate for aquatic-phase amphibians when amphibian toxicity data are not available (U.S. EPA, 2004). In the case of imazapyr, no acute or chronic toxicity data are available for aquatic-phase amphibians; thus, fish were used as a surrogate to estimate direct acute and chronic risk to the aquatic-phase CRLF.

Freshwater fish toxicity data were also used to assess potential indirect effects of imazapyr to the CRLF. Direct effects to freshwater fish resulting from exposure to imazapyr may 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).

#### 4.1.1.1 Freshwater Fish (Aquatic Phase Amphibian): Acute Exposure (Mortality) Studies

Fish toxicity studies for two freshwater species using the technical grade active ingredient (TGAI) are required to establish the acute toxicity of imazapyr acid to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Acute studies that were submitted for three freshwater fish species (rainbow trout, bluegill sunfish, channel catfish) showed that imazapyr is practically non-toxic with 96-hr $LC_{50}$ values of >100 mg/L (NOAEC = 100 ppm) for all three species. No mortalities and no clinical signs of toxicity were observed in any of the studies (MRID 00131629, MRID 00131630 and MRID 00131631).

The available fish toxicity data for one of the salt formulations indicates that this formulation may be more toxic than the acid (rainbow trout, MRID 00153778); however, analytical verification of the test material in the test solution was not conducted at any point during the definitive test so toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions. The 96-hour $LC_{50}$ is 112 mg Arsenal/L (20.8 mg ae/L) with a NOAEC of 10.4 mg ae/L and a LOAEC of 18.9 mg ae/L for sublethal effects (surfacing, loss of equilibrium, dark discoloration, fish on bottom and quiescence). This study is discussed in the risk description (Section 5.2.1) and is summarized in more detail in Appendix B. Results of the studies on the acid are summarized in Table 4.1.1.1.

| Table 4.1.1.1 Freshwater Fish Acute Toxicity for Imazapyr Acid. | | | | | |
|---|---|---|---|---|---|
| **Species** | **% ae** | **96-hour LC50 (mg/L)** | **Toxicity Category** | **MRID No. Author/Year** | **Study Classification** |
| Bluegill sunfish (Lepomis macrochirus) | 93 | >100 | Practically non-toxic | 00131630 ABC Laboratories, 1983 | Acceptable |
| Rainbow trout (Oncorhynchus mykiss) | 93 | >100 | Practically non-toxic | 00131629 ABC Laboratories, 1983 | Acceptable |
| Channel catfish (Ictalurus punctatus) | 93 | >100 | Practically non-toxic | 00131631 ABC Laboratories, 1983 | Acceptable |

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

A freshwater fish early life-stage test using the TGAI is normally required for pesticide registration if the end-use product may be transported to water from the intended use site, and the following conditions are met: (1) the presence of imazapyr in water that is not exposed to direct sunlight is likely to be continuous or recurrent and (2) fate properties indicate that imazapyr is persistent in the aquatic environment not exposed to direct sunlight. A chronic early life stage study conducted on rainbow trout showed a decrease in larval survival at a mean measured concentration of 92.4 mg/L (MRID 41315804). The NOAEC was 43.1 mg/L. The study was originally classified as invalid because survival of control embryos following thinning was below 70%. However, it was upgraded to supplemental because the Standard Evaluation Procedure (SEP) (USEPA Hazard Evaluation Division (no date)) was met and the data were still considered useful for the purpose of risk assessment. The results from this study will be used for risk assessment purposes. A chronic early life stage study conducted on the fathead minnow showed no treatment-related effects at 118 mg/L (highest concentration tested, MRID 45119711). A full life cycle study was also submitted for fathead minnow which showed no treatment-related effects at 120 mg/L. This study was classified as supplemental because the $F_1$ generation was maintained for 4 weeks instead of 8 weeks (MRID 45119712). Results of the studies on the acid are summarized in Table 4.1.1.2.

| Table 4.1.1.2 Freshwater Fish Chronic Toxicity for Imazapyr Acid | | | | | |
|---|---|---|---|---|---|
| **Species** | **% ae** | **NOAEC/LOAEC (mg ae/L)** | **Endpoints Affected** | **MRID No. Author/Year** | **Study Classification** |
| **Early Life-Stage Study under Flow-through Conditions** | | | | | |
| Rainbow Trout *(Oncorhyncus mykiss)* | 99.5 | 43.1/92.4 | Larval survival | 41315804 Ward, 1988 | Supplemental |
| Fathead Minnow (*Pimephales promelas*) | 99.6 | 118/>118 | No treatment-related effects | 45119711 Drottar *et al.*, 1998 | Acceptable |
| **Full Life cycle Study under Flow-through Conditions** | | | | | |
| Fathead Minnow *(Pimephales promelas)* | 100 | 120/>120 | No treatment-related effects | 45119712 Drottar *et al.*, 1999 | Supplemental |

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

No sublethal effects were observed in the freshwater animal studies.

### 4.1.2 Toxicity to Freshwater Invertebrates

#### 4.1.2.1 Freshwater Invertebrates: Acute Exposure Studies

Toxicity studies on freshwater invertebrates were evaluated to assess the potential for imazapyr to induce indirect effects to the aquatic phase CRLF via a reduction in prey base. A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of imazapyr to aquatic invertebrates. The preferred test species is *Daphnia magna*. Submitted data indicate that imazapyr is practically non-toxic to *Daphnia magna* with an acute 48-hour $EC_{50}$ value of >100 mg/L. There were no mortalities and no clinical signs of toxicity in this study. This value is used for evaluating acute toxic exposure to freshwater invertebrates (MRID 00131632). The available aquatic invertebrate toxicity data for one of the salt formulations indicates that this formulation may be more toxic than the acid (daphnia, MRID 00153779); however, analytical verification of the test material in the test solution was not conducted at any point during the definitive test, so toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions. The 48-hour $EC_{50}$ is 64.9 mg ae/L with a NOAEC/LOAEC of 59.3/103.8 mg ae/L. This study is discussed in the risk description (Section 5.2.2) and is summarized in more detail in Appendix B.

An open literature study is available in which the snail, *Biomphalaria tenagophila* (ECOTOX ref. number 80947) was exposed to a formulation of imazapyr containing nonylphenol. This study is summarized and discussed in Appendix K with multiple active ingredients.

| Table 4.1.2.1 Freshwater Invertebrate Acute Toxicity for Imazapyr Acid. | | | | | |
|---|---|---|---|---|---|
| **Species** | **% ae** | **48-hour $EC_{50}$ (mg/L)** | **Toxicity category** | **MRID No. Author/Year** | **Study Classification** |
| Waterflea (*Daphnia magna*) | 93 | >100 | Practically non-toxic | 00131632 ABC Laboratories, 1983 | Acceptable |

### 4.1.2.2 Freshwater Invertebrates: Chronic Exposure Studies

A freshwater aquatic invertebrate life-cycle test using the TGAI is normally required for pesticide registration if the end-use product may be transported to water from the intended use site, and the following conditions are met: (1) the presence of imazapyr in water that is not exposed to direct sunlight is likely to be continuous or recurrent and (2) fate properties indicate that imazapyr is persistent in the aquatic environment not exposed to direct sunlight. The preferred test is a 21-day life cycle on *Daphnia magna*. The data that were submitted show that imazapyr concentrations up to 97.1 mg/L did not significantly affect survival, reproductive success, or growth of first generation daphnids. The NOAEC of 97.1 mg/L will be used in assessing risk (MRID #41315805). Results of the study on the acid are summarized in Table 4.1.2.2.

| Table 4.1.2.2 Freshwater Aquatic Invertebrate Chronic Toxicity for Imazapyr Acid | | | | | |
|---|---|---|---|---|---|
| **Species/ Flow-through** | **% ae** | **21-day NOAEC (mg/L)** | **Endpoints Affected** | **MRID No. Author/Year** | **Study Classification** |
| Waterflea (*Daphnia magna)* | 99.5 | 97.1 | No effects on growth or reproduction | 41315805 Manning, 1988 | Acceptable |

### 4.1.3 Toxicity to Aquatic Plants

Aquatic plant toxicity studies were used as one of the measures of effect to evaluate whether imazapyr may affect primary production. In addition, aquatic plants are a primary food source of the larval (tadpole) life stage of the CRLF. Primary productivity is essential for indirectly supporting the growth and abundance of the CRLF. Freshwater vascular and non-vascular plant data are used to evaluate a number of the PCEs associated with the critical habitat impact analysis. Specifically, the data are used to determine whether water quality parameters, including oxygen content may be adversely modified. Laboratory studies were used to evaluate the potential of imazapyr to affect primary productivity and to determine whether imazapyr may cause direct effects to aquatic plants.

Several aquatic plant toxicity studies using the TGAI are required to establish the toxicity of imazapyr to non-target aquatic plants. The recommendation is for testing of five species: freshwater green alga *(Selenastrum capricornutum)*, duckweed *(Lemna gibba)*, marine diatom *(Skeletonema costatum)*, blue-green algae *(Anabaena flos-aquae)*, and a freshwater diatom. The 14-day $EC_{50}$ for the freshwater vascular plant (duckweed) is 0.024 mg/L (NOAEC = 0.01 mg/L), based on inhibition of population growth and reduced frond production; and the lowest 7-day $EC_{50}$ for the freshwater non-vascular plant (blue-green algae) is 12.2 mg/L (NOAEC = 9.6 mg/L), based on reduced cell counts. In the non-vascular plant studies, the study authors concluded that imazapyr acid was not expected to exert detrimental effects at the maximum application rate up to 1.5 lbs ai/acre. The toxicity of the isopropylamine salt of imazapyr to duckweed was similar to the acid, with a 14-day $EC_{50}$ of 0.018 mg ae/L (NOAEC = 0.011 mg ae/L). The isopropylamine salt of imazapyr was more toxic to the green algae than imazapyr acid and more closely resembled the toxic response of blue-green algae (see Table 4.1.3 below; MRID 40811802; MRID 43889102; and MRID 43889102) for the five required species. Since the isopropylamine salt is more toxic than imazapyr acid to both the aquatic vascular and non-vascular plants (based on duckweed and green algae), the results from the salt will be used in the risk assessment. Results of the studies are summarized in Table 4.1.3.

**Table 4.1.3 Non-target Aquatic Plant Toxicity for Imazapyr Acid and Isopropylamine Salt of Imazapyr.**

| Species [Tier II] | % ae | $EC_{50}$/NOAEC (mg/L) | Endpoints Affected | MRID No. Author, Year | Study Classification |
|---|---|---|---|---|---|
| **Isopropylamine Salt of Imazapyr*** | | | | | |
| Duckweed (*Lemna gibba*) | 23.3 | 0.018/0.011 (mg ae/L) | Frond production | 43889102 Hughes *et al*., 1995 | Acceptable |
| Green Algae (*Selenastrum capricornutum)* | 23.3 | 11.5/7.16 (mg ae/L) | Slight change in cell shape | 43889102 Hughes *et al*., 1995 | Acceptable |
| **Imazapyr Acid** | | | | | |
| Duckweed (*Lemna gibba*) | 99.5 | 0.024/0.01 | Population growth Frond production | 40811802 Hughes, 1987 | Acceptable |
| Green Algae (*Selenastrum capricornutum*) | 99.5 | 71/50.9 | Cell density | 40811802 Hughes, 1987 | Acceptable |
| Blue-green Algae (*Anabaena flos-aquae*) | 99.5 | 12.2/9.6 | Cell density | 40811802 Hughes, 1987 | Acceptable |
| Diatom (*Navicula pelliculosa*) | 99.5 | >41/41 | Cell density | 40811802 Hughes, 1987 | Acceptable |
| Diatom (*Skeletonema costatum*) | 99.5 | 92/15.9 | Cell density | 40811802 Hughes, 1987 | Acceptable |

*The $EC_{50}$/NOAEC values from the toxicity tests with the isopropylamine salt of imazapyr are expressed in acid equivalents (a.e.)

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### 4.1.4 Freshwater Field Studies

An *in situ* microcosm study, published in the open literature and accessed via ECOTOX was conducted to assess the effects of a single application of imazapyr (stirred into the water column) at the following mean concentrations: 0.19, 2.1 or 19.8 mg/L (equivalent to 1, 10 or 100 times the expected environmental concentration from a normal application rate) on the macroinvertebrate community of a logged pond cypress dome. *In situ* microcosms were set up in schedule-40 polyvinyl chloride water pipes (diameter 7.62 cm; height 45.7 cm; area 45.6 $cm^2$) driven approximately 12 cm into the substrate and leaving a mean water column depth of 32.1 cm. The microcosms were immediately dosed with the selected treatments of imazapyr and left undisturbed for two weeks. Forty eight microcosms were set up (3 blocks of 16, each block consisting of 4 replicates of 3 treatment levels and a control). In addition, 12 cypress dome cores, divided equally among the 3 blocks were sampled at the end of the study. These allowed for testing for microcosm influences on the measured parameters. Macroinvertebrates were hand picked from each sample and prepared for identification. Organisms other than chironomids were identified at the family level or to the lowest practical taxonomic level. Chironomids were identified to the genus level. Effects on aquatic plants were not examined. Changes in the macroinvertebrate composition, chironomid biomass and chironomid head-capsule deformities were assessed. A total of 2,904 individuals representing 44 taxa were collected. The following taxa were represented: *Caecidotea, Crangonyx,* Dipteran, Chironomid, *Polypedilum, Chironomus, Ablabesmyia,* and *Procladius*. There were three rain events following treatment. The half-life of imazapyr was calculated to be 3.2, 3.2 and 3.4 days for the 0.19, 2.1 and 19.8 mg/L concentrations, respectively. Imazapyr did not appear to affect any of these parameters at the concentrations tested (ECOTOX Ref. 68204). However, these results are of limited value because potential effects at the species level were not examined. Individual species could have been affected and not reported because the analysis was conducted at higher taxonomic levels. In addition, effects on aquatic plants were not examined.

## 4.2 Evaluation of Terrestrial Ecotoxicity Studies (CRLF Terrestrial Phase)

Table 4.2.a summarizes the most sensitive ecological toxicity endpoints for the terrestrial phase of the CRLF and its designated critical habitat, based on an evaluation of both the submitted studies and the open literature, as previously discussed. Additional information is provided in Appendix B. Ecotoxicity studies on both imazapyr and its isopropylamine salt are considered in this assessment. The $EC_{50}$/NOAEC values from the toxicity tests with the isopropylamine salt of imazapyr are expressed in acid equivalents (a.e.).

| Table 4.2.a Animal and Plant Toxicity Profile of Imazapyr and Its Isopropylamine Salt For Use in Assessing Risk to the Terrestrial Phase CRLF | | | | |
|---|---|---|---|---|
| **Assessment Endpoint** | **Species** | **Toxicity Value Used in Risk Assessment** | **Citation MRID # (Author & Date)** | **Comment** |
| Direct effects on CRLF following acute exposure | Northern bobwhite quail *(Colinus virginianus)* | $LD_{30}$ >2,150 mg/kg bw<br>$LC_{50}$ >5,000 mg/kg diet | Bio-Life Assoc., 1983<br>00131633<br>00131635 | Probit slopes unavailable: Acceptable<br>Acceptable |
| Direct effects on CRLF following chronic exposure | Northern bobwhite quail *(Colinus virginianus)* | NOAEC/LOAEC 1,670/>1,670 ppm | 45119714<br>Ahmed *et al.*, 1999 | Acceptable |
| Indirect effects on CRLF following acute exposure (reduction in prey base) | Rat (Sprague Dawley)<br><br>Honey Bee *(Apis mellifera)* | $LD_{50}$ >5,000 mg ae/kg bw (males/females)<br><br>>100 µg/bee | 00132030<br>American Cyanamid Co., 1983<br><br>00131637<br>Atkins, 1983 | Acceptable: probit slope unavailable<br><br>Acceptable: probit slope unavailable |
| Indirect effects on CRLF following chronic exposure (reduction in prey base) | Rat (Sprague Dawley) | NOAEL = 738 mg/kg bw/day - Males<br>NOAEL = 933.3 mg/kg bw/day - Females<br>or 10000 ppm for both. | 41039505<br>Robinson, 1987 | Acceptable reproduction study. |
| Indirect effects to CRLF via effects on habitat (reduction in riparian vegetation) | **Monocots**<br>Seedling emergence<br><br>Vegetative vigor<br><br>**Dicots**<br>Seedling emergence<br><br>Vegetative vigor | <br>Wheat $EC_{25}$: 0.0046 lb ae/acre<br>Wheat $EC_{25}$: 0.012 lb ae/acre<br><br>Sugar beet $EC_{25}$: 0.0024 lb ae/acre<br>Cucumber $EC_{25}$: 0.0009 lb ae/acre | 40811801<br>Banks, 1988 | Supplemental: problems with overcrowding and fresh weight endpoints |

**Table 4.2.a Animal and Plant Toxicity Profile of Imazapyr and Its Isopropylamine Salt For Use in Assessing Risk to the Terrestrial Phase CRLF**

| Assessment Endpoint | Species | Toxicity Value Used in Risk Assessment | Citation MRID # (Author & Date) | Comment |
|---|---|---|---|---|
| -Indirect effects to CRLF via adverse modification to Critical Habitat PCE: alteration of other chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.<br>-Indirect effects to CRLF via adverse modification to Critical Habitat PCE: reduction and/or modification of food sources for terrestrial phase juveniles and adults | Rat (Sprague Dawley) | $LD_{50}$ >5,000 mg ae/kg bw (males/females) | 00132030 American Cyanamid Co., 1983 | Acceptable: probit slope unavailable |
| | Honey Bee *(Apis mellifera)* | >100 µg/bee | 00131637 Atkins, 1983 | Acceptable: probit slope unavailable |
| | Rat (Sprague Dawley) | NOAEL = 738 mg/kg bw/day - Males<br>NOAEL = 933.3 mg/kg bw/day - Females<br>or 10000 ppm for both. | 41039505 Robinson, 1987 | Acceptable reproduction study. |
| | Northern bobwhite quail *(Colinus virginianus)* | >2,150 mg/kg bw<br>>5,000 mg/kg diet | Bio-Life Assoc., 1983<br>00131633<br>00131635 | Probit slopes unavailable:<br>Acceptable<br>Acceptable |
| | Northern bobwhite quail *(Colinus virginianus)* | NOAEC/LOAEC 1,670/>1,670 ppm | 45119714 Ahmed *et al.*, 1999 | Acceptable |
| | Rainbow trout *(Oncorhynchus mykiss)* | 96-hour $LC_{50}$ >100 mg /L | 00131629 ABC Laboratories, 1983 | Acceptable: : probit slope unavailable |
| | Rainbow trout *(Oncorhynchus mykiss)* | NOAEC/LOAEC 43.1/92.4 mg/L (significantly reduced percent hatch and an observed reduction on survival) | 41315804 Ward, 1988 | Supplemental: survival of control embryos following thinning was below 70%. |
| Indirect effects to CRLF via adverse modification to Critical Habitat PCE: elimination and/or disturbance of upland and dispersal habitat | **Monocots**<br>Seedling emergence<br><br>Vegetative vigor<br><br>**Dicots**<br>Seedling emergence<br><br>Vegetative vigor | Wheat $EC_{25}$: 0.0046 lb ae/acre<br>Wheat $EC_{25}$: 0.012 lb ae/acre<br><br>Sugar beet $EC_{25}$: 0.0024 lb ae/acre<br>Cucumber $EC_{25}$: 0.0009 lb ae/acre | 40811801 Banks, 1988 | Supplemental: problems with overcrowding and fresh weight endpoints |

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

| Table 4.2.b Categories of Acute Toxicity for Terrestrial Organisms | | |
|---|---|---|
| **Oral $LD_{50}$ (mg/kg)** | **Dietary $LC_{50}$ (ppm)** | **Toxicity Category** |
| <10 | <50 | Very highly toxic |
| 10 – 50 | 50 – 500 | Highly toxic |
| 51 – 500 | 501 – 1000 | Moderately toxic |
| 501 – 2000 | 1001 – 5000 | Slightly toxic |
| > 2000 | >5000 | Practically non-toxic |

### 4.2.1 Toxicity to Birds

EPA typically uses birds as a surrogate for terrestrial-phase amphibians when amphibian toxicity data are not available (U.S. EPA, 2004). Since there are no terrestrial-phase amphibian data available for imazapyr, acute and chronic avian toxicity data were used to assess the potential direct effects to the CRLF.

#### 4.2.1.1 Acute Exposure (Mortality) Studies

An oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the acute toxicity of imazapyr to birds. The preferred guideline test species is either mallard duck (a waterfowl) or bobwhite quail (an upland gamebird). The submitted acute data indicate that imazapyr is practically non-toxic to waterfowl and upland gamebirds with oral $LD_{50}$ values >2,150 mg a.i./kg bw. There were no mortalities or clinical signs of toxicity in either the bobwhite quail or the mallard ducks (MRID 00131633, MRID 00131634). Results of the studies are summarized in Table 4.2.1.1.a.

| Table 4.2.1.1.a Avian Acute Oral Toxicity for Imazapyr Acid. | | | | | |
|---|---|---|---|---|---|
| **Species** | **% ae** | **$LD_{50}$ (mg ae/kg-bw)** | **Toxicity Category** | **MRID No. Author, Year** | **Study Classification** |
| Northern bobwhite quail *(Colinus virginianus)* | 93 | >2,150 | Practically Non-toxic | 00131633 Bio-Life Assoc., 1983 | Acceptable |
| Mallard duck *(Anas platyrhynchos)* | 93 | >2,150 | Practically non-toxic | 00131634 Bio-Life Assoc., 1983 | Acceptable |

Two dietary studies using the TGAI are required to establish the subacute toxicity of imazapyr to birds. The preferred test species are mallard duck and bobwhite quail. The data that were submitted show that the 8-day acute dietary $LC_{50}$ for both species was >5,000 ppm; therefore, imazapyr is categorized as practically non-toxic to avian species on a subacute dietary basis. In the bobwhite quail study, there was one mortality at one of the lower concentration levels but none at the higher concentration levels. There were no clinical signs of toxicity in either study (MRID 00131635; MRID 00131636). The available subacute dietary study on bobwhite quail for the salt indicates that it is no more toxic than the acid and is summarized in Appendix B.  Results of the studies are summarized in Table 4.2.1.1.b.

**Table 4.2.1.1.b  Avian Subacute Dietary Studies for Imazapyr Acid.**

| Species | % ae | 8-Day $LC_{50}$ (mg ae/kg-diet) | Toxicity Category | MRID No. Author, Year | Study Classification |
|---|---|---|---|---|---|
| Northern bobwhite quail *(Colinus virginianus)* | 93 | >5,000 | Practically non-toxic | 00131635 Bio-Life Assoc., 1983 | Acceptable |
| Mallard duck *(Anas platyrhynchos)* | 93 | >5,000 | Practically non-toxic | 00131636 Bio-Life Assoc., 1983 | Acceptable |

### 4.2.1.2 Chronic Exposure (Growth/Reproduction) Studies

Avian reproduction studies using the TGAI were required because birds may be subject to repeated or continuous exposure to imazapyr, especially preceding or during the breeding season.  The preferred test species are mallard duck and bobwhite quail.  The submitted data indicate no evidence of adverse reproductive effects to bobwhite quail at concentrations up to 1,670 ppm (MRID 45119714) and 2000 ppm (MRID 43831401), and to mallard ducks at concentrations up to 1890 ppm (MRID 43831402).  Results of the studies are summarized in Table 4.2.1.2.

**Table 4.2.1.2. Avian Reproduction for Imazapyr Acid**

| Species | % ae | NOAEC/LOAEC (mg ae/kg-diet) | LOAEC Endpoints | MRID No. Author, Year | Study Classification |
|---|---|---|---|---|---|
| Northern bobwhite quail *(Colinus virginianus)* | 100 | 1,670/>1,670 | No treatment-related toxicity | 45119714 Ahmed *et al.*, 1999 | Acceptable |
| Northern bobwhite quail *(Colinus virginianus)* | Technical - % not stated | 2000/>2000 | No treatment-related toxicity | 438314011987 | Acceptable |
| Mallard duck *(Anas platyrhynchos)* | Technical - % not stated | 1890/>1890 (2000 nominal) | No treatment-related toxicity | 438314021987 | Acceptable |

### 4.2.1.3 Sublethal Effects and Additional Open Literature Information

No treatment-related sublethal effects were observed following either acute or chronic exposure.

### 4.2.2 Toxicity to Mammals

#### 4.2.2.1 Acute Exposure (Mortality) Studies

*Technical*

Toxicity studies on mammals were evaluated to assess the potential for imazapyr to induce indirect effects to the terrestrial phase CRLF via a reduction in prey base. Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. These toxicity values are reported below.

The results indicate that imazapyr acid is categorized as practically non-toxic to small mammals on an acute oral basis ($LD_{50}$ value >5,000 mg/kg bw, both sexes (MRID 00132030)). Results of the study are summarized in Table 4.2.2.1a. The available acute oral studies with rats for the salt indicate that it is no more toxic than the acid and are summarized in Appendix B.

**Table 4.2.2.1 Mammalian Acute Toxicity for Imazapyr Acid.**

| Species | % ae | Toxicity | Affected Endpoints | MRID No. Author, Year | Study Classification |
|---|---|---|---|---|---|
| Rat (Sprague-Dawley) | 93 | $LD_{50}$ >5,000 mg ae/kg bw (males/females) | Mortality | 00132030 American Cyanamid Co., 1983 | Acceptable |

*Formulated Products Containing One or More Active Ingredients*

Acute oral toxicity data (i.e., $LD_{50}$ values) from mammalian studies for formulated products that contain imazapyr and one or more additional active ingredients are summarized in Appendix K.

#### 4.2.2.2 Chronic Exposure (Growth/Reproduction) Studies

In a 2-generation reproduction study with rats exposed to imazapyr acid, no treatment-related effects were observed. Consequently, the NOAEL for parental systemic, reproductive, and offspring was 738 mg/kg bw/day for males and 933.3 mg/kg bw/day for males. The NOAEC is 10000 ppm (MRID 41039505). The NOAEC/NOAEL from this study will be used in assessment of risk.

In developmental toxicity studies, administration of imazapyr acid by gavage resulted in no treatment-related effects in developmental parameters at doses up to and including 1000 and 400 mg/kg bw/day in the rat and rabbit, respectively. In the rat study, the only maternal toxicity observed at 300 mg/kg bw/day was salivation during gestation days 8 - 15. This effect is not likely to affect reproduction, growth or survival. Therefore, it is not be used quantitatively in assessment of risk. The salivation is likely due to the route of administration (gavage) with a potentially irritating substance (an acid). In the rabbit study, no maternal toxicity was observed at 400 mg/kg bw/day, the highest dose tested. Mortality was observed in the does at 250 mg/kg/day and above in the pilot study (MRID 00131614). Microscopic examination of the does that died showed gastric ulcers and lesions in the gastrointestinal tract. These effects are not considered to be effects that would occur following chronic exposure. They are considered to be acute effects and are more likely a result of the route of administration (gavage with imazapyr acid, a probable irritating substance (MRID 00131611; MRID 00131613)). Results of the studies are summarized in Table 4.2.2.2.

**Table 4.2.2.2 Mammalian Developmental/Reproductive Toxicity for Imazapyr Acid.**

| Species | % Purity | Test Type | Toxicity | Affected Endpoints | MRID No. Study author Classification |
|---|---|---|---|---|---|
| Rat (Sprague Dawley) | 93 | Developmental | NOAEL/LOAEL = 300/1000 mg/kg bw/day<br>NOAEL = 1000 mg/kg bw/day | Maternal tox[1]<br>Developmental | 00131611 Salamon & Mayhew, 1983 Acceptable |
| Rabbit (New Zealand White) | 93 | Developmental | NOAEL = 400 mg/kg bw/day<br>NOAEL = 400 mg/kg bw/day | No effects | 00131613 Mayhew & Salamon, 1983 Acceptable |
| Rat (Sprague Dawley) | 99.5 | Reproduction | NOAEL = 738 mg/kg bw/day - Males<br>NOAEL = 933.3 mg/kg bw/day - Females or 10000 ppm for both. | No effects | 41039505 Robinson, 1987 Acceptable |

[1] Maternal toxicity - Gravid dams exhibited salivation during gestation days 8 - 15 (likely related to gavage route of administration).
Developmental toxicity - No treatment-related effects in developmental parameters; no treatment-related malformations.

#### 4.2.2.3 Sublethal Effects and Additional Open Literature Information

No treatment-related sublethal effects were observed following acute exposure. Salivation was the only sublethal effect observed following subacute exposure in a developmental study in the rat. This effect is likely due to the route of administration (gavage) and is not likely to occur in wild mammalian populations.

### 4.2.3 Toxicity to Terrestrial Invertebrates

Toxicity studies on terrestrial invertebrates were evaluated to assess the potential for imazapyr to induce indirect effects to the terrestrial phase CRLF via a reduction in prey base. A honey bee acute contact study using the TGAI is required for imazapyr because its foliar application treatment use will result in honey bee exposure. The acute contact

$LD_{50}$, using the honey bee, *Apis mellifera*, is an acute contact, single-dose laboratory study designed to estimate the quantity of toxicant required to cause 50% mortality in a test population of bees. The acute contact $LD_{50}$ for imazapyr is > 100 µg/bee and it is, therefore, classified as practically non-toxic to bees on a contact exposure basis (MRID 00131637). Results of the study are summarized in Table 4..2.3.

**Table 4.2.3 Non-target Insects - Acute Contact (Imazapyr Acid).**

| Species | % ae | $LD_{50}$ (µg ae/bee) | Toxicity Category | MRID No. Author/Year | Study Classification |
|---|---|---|---|---|---|
| Honey Bee *(Apis mellifera)* | Tech | >100 | Practically non-toxic | 00131637 Atkins, 1983 | Acceptable |

### 4.2.4 Toxicity to Terrestrial Plants

Terrestrial plant toxicity data are used to evaluate the potential for imazapyr to affect riparian zone vegetation within the action area for the CRLF. These data are also used to evaluate potential for habitat modification to terrestrial PCEs, including upland and dispersal habitat. Riparian zone effects may result in increased sedimentation, which may impact the aquatic phase CRLF by reducing feeding and respiratory efficiency from clogged gills, disrupting metabolic processes, reducing growth rates and increasing substrata instability (Ellis, 1936; Stansbery, 1971; Markings and Bills, 1979; Kat, 1982; Vannote and Minshall, 1982; Aldridge et al., 1987; and Waters, 1995). In addition, many of the aquatic PCEs associated with designated critical habitat for the CRLF (i.e., geomorphically stable banks, water temperature, quality and substrate composition) and terrestrial PCEs (upland and dispersal habitats) rely on the presence of riparian vegetation.

Plant toxicity data from both registrant-submitted studies and studies in the scientific literature were reviewed for this assessment. Registrant-submitted studies are conducted under conditions and with species defined in EPA toxicity test guidelines. Sublethal 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 in the context of this assessment, 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 imazapyr, is largely unknown. Homogenous test plant seed lots also lack the genetic variation that occurs in natural populations; therefore, the range of effects seen from these tests is likely to be smaller than would be expected from wild populations.

Tier II terrestrial plant toxicity studies were conducted to establish the toxicity of imazapyr and the isopropylamine salt of imazapyr to non-target terrestrial plants. The recommendations for seedling emergence and vegetative vigor studies are for testing of (1) six species of at least four dicotyledonous families, one species of which is soybean (*Glycine max*), and the second of which is a root crop, and (2) four species of at least two monocotyledonous families, one of which is corn (*Zea mays*). Due to problems of overcrowding and 'fresh weight' endpoints with the seedling emergence and vegetative vigor studies with imazapyr acid, only results classified as supplemental will be used to assess risk of imazapyr acid (seedling emergence for 3 monocots and 2 dicots; vegetative vigor for 3 monocots and 4 dicots). Tier II vegetative vigor studies were performed with the isopropylamine salt of imazapyr for one monocot (onion) and two dicots (soybean and sugar beet). These data will be used to assess risk to the isopropylamine salt of imazapyr (MRID 40811801).

Results of Tier II toxicity studies with monocots and dicots indicate that seedling emergence and vegetative vigor are impacted by exposure to imazapyr acid and to the isopropylamine salt of imazapyr. Seedling emergence, based on weight, was adversely impacted in monocots (wheat) at an $EC_{25}$ of 0.0046 lb ae/are and in dicots (sugar beet) with an $EC_{25}$ of 0.0024 lb ae/acre. In the wheat, stunting, interveinal chlorosis, and cessation of growth occurred at doses >0.0078 lb ae/acre. After 28 days, imazapyr acid resulted in >60% crop injury in sugar beets at all doses >0.031 lb ae/acre. Vegetative vigor in monocots, based on weight, was adversely impacted by both imazapyr acid and the isopropylamine salt of imazapyr at an $EC_{25}$ of 0.012 lb ae/acre in wheat and 0.012 lb ae/acre in onion, respectively. In vegetative vigor studies with dicots, imazapyr acid was more toxic than the isopropylamine salt of imazapyr with an acid $EC_{25}$ of 0.0009 lb ae/acre (cucumber) versus salt $EC_{25}$ of 0.002 lb ae/acre (sugar beet), respectively. The observed effects to monocots and dicots including stunting, chlorosis, and plant death were observed for isopropylamine salt (MRID 40003711). Results of the study are summarized in Table 4.2.4.

| Table 4.2.4 Tier II Terrestrial Non-target Plant Toxicity.[C*] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Species | Seedling Emergence | | Endpoint Affected | Vegetative Vigor | | Endpoint Affected | MRID No. Author/Year | Study Classification |
| | $EC_{25}$ (lb ae/acre) | NOAEC/[$EC_{05}$][**] | | $EC_{25}$ (lb ae/acre) | NOAEC/[$EC_{05}$] | | | |
| **Monocots** | **Isopropylamine Salt of Imazapyr[*]** | | | | | | | |
| Onion | --[A] | -- | -- | 0.012 | [0.005] | Dry weight | 43889101 Feutz & Canez, 1995 | Acceptable |
| **Dicots** | | | | | | | | |
| Soybean | -- | -- | -- | 0.034 | 0.008 | Shoot length | | |
| Sugar beet | -- | -- | -- | 0.002 | 0.001 | Dry weight | | |
| Species | **Imazapyr Acid [B]** | | | | | | | |
| | Seedling Emergence | | Endpoint Affected | Vegetative Vigor | | Endpoint Affected | MRID No. Author/Year | Study Classification |
| | $EC_{25}$ (lb ae/acre) | NOAEC/[$EC_{05}$] | | $EC_{25}$ (lb ae/acre) | NOAEC[/$EC_{05}$] | | | |
| **Monocots** | | | | | | | | |
| Corn | -- | -- | -- | >0.0156 | 0.0078 | Weight | 40811801 Banks, 1988 | Supplemental |
| Oat | 0.054 | 0.0156 | Height | 0.013 | 0.0039 | Height | | Supplemental |
| Onion | 0.034 | [0.01] | Weight | -- | -- | -- | | Supplemental |
| Wheat | **0.0046** | **[0.00099]** | Weight | **0.012** | **0.0039** | Weight | | Supplemental |
| **Dicots** | | | | | | | | |
| Sugar beet | **0.0024** | **[0.00017]** | Weight | 0.00097 | [0.00039] | Weight | | Supplemental |
| Sunflower | -- | -- | -- | 0.0054 | 0.0039 | Weight | | Supplemental |
| Cucumber | -- | -- | | **0.0009** | **[0.000064]** | Height | | Supplemental |

| Table 4.2.4 Tier II Terrestrial Non-target Plant Toxicity.[C*] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Species | Seedling Emergence | | Endpoint Affected | Vegetative Vigor | | Endpoint Affected | MRID No. Author/Year | Study Classification |
| | $EC_{25}$ (lb ae/acre) | NOAEC/[$EC_{05}$]** | | $EC_{25}$ (lb ae/acre) | NOAEC/[$EC_{05}$] | | | |
| Tomato | 0.008 | 0.0003 | Weight | >0.0156 | 0.00097 | Weight | | Supplemental |

*The $EC_{50}$/NOAEC values from the toxicity tests with the isopropylamine salt of imazapyr are expressed in acid equivalents (a.e.).
**If the NOAEC value is above the $EC_{25}$, equal to the $EC_{25}$, or below the lowest concentration, an $EC_{05}$ value is used instead.
[A] –- = no data [B] No data for pea and soybeans tested with acid, and the study was invalid. [C] Bold values are used in risk assessment.

## 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 the CRLF and aquatic and terrestrial animals that may indirectly affect the CRLF (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 imazapyr 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. The upper and lower bounds of the effects probability are based on available information on the 95% confidence interval of the slope. Studies with good probit fit characteristics (i.e., statistically appropriate for the data set) are associated with a high degree of confidence. Conversely, a low degree of confidence is associated with data from studies that do not statistically support a probit dose response relationship. In addition, confidence in the data set may be reduced by high variance in the slope (i.e., large 95% confidence intervals), despite good probit fit characteristics. In the event that dose response information is not available to estimate a slope, a default slope assumption of 4.5 (95% C.I.: 2 to 9) (Urban and Cook, 1986) is used.

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

FIFRA 6(a)(2) incident data add lines of evidence to the risk predictions from the screening level assessment helping to indicate whether the predictions are substantiated with actual effects in the field. Twelve incidents resulting from imazapyr and its isopropylamine salt use have been recorded in the Ecological Incident Information System (EIIS) as of February 22, 2007. All of the reported incidents occurred between the dates of 04/20/1995 - 03/01/2004. Incidents reported include possible impacts to terrestrial and aquatic plants, fish and birds. The majority of reported incidents are damage to terrestrial plants, especially food crops as a result of exposure following application of formulations containing imazapyr and other pesticide active ingredients. Due to the fact that multiple active ingredients were involved in all of the incidences involving either aquatic or terrestrial animals, effects from exposure to imazapyr could not be definitively determined. Therefore, these incidences are not discussed in the risk description.

### 4.4.1 Incidents Involving Aquatic Organisms

One incident was reported in which a mixed herbicidal spray, containing a mixture of the isopropylamine salt of imazapyr, diuron and metsulfuron methyl was sprayed onto a fence row and either drifted or ran-off into a pond 60 feet away resulting in a fish and algae kill (species unknown). The certainty index is rated possible and the legality is undetermined. It cannot be definitively determined whether or not the fish and algae kill was due to exposure to imazapyr.

A second incident was reported which involved a goldfish kill. There was suspected runoff or drift into the pond following an aerial application of an imazapyr formulation to a nearby 145 acres. The cause of the kill was undetermined.

### 4.4.2 Incidents Involving Terrestrial Organisms

#### 4.4.2.1 Terrestrial Animals

The same fencerow incident as listed in the aquatic organism section drifted onto adjacent birdnest boxes and a bird kill of nestling and mature birds located from 2-85 feet from the application site occured. Thirty-two bluebirds, 5 Carolina chickadees and 35 unknown birds were affected. Again, this was a mixture of herbicides. The certainty index is rated possible and the legality is undetermined. It cannot be definitively determined whether or not the bird kill was due to exposure to imazapyr.

#### 4.4.2.2 Terrestrial Plants

An incident was reported which involved the spraying of a mixture of glyphosate, the isopropylamine salt of imazapyr and metsulfuron methyl to a right-of-way at a distance of approximately 150 yards from watermelon and cantaloupe crops, and 1/4 of a mile from tomato crops. There was damage to the crops. It cannot be definitively determined whether or not the damage to the crops was due to imazapyr alone since glyphosate and metsulfuron methyl, also herbicides, were used.

In a second incident, there was damage to 3 oak trees, some grape vines and 1.5 acres of beans as a result of spray drift from an application of a formulation containing the isopropylamine salt of imazapyr approximately 150 - 200 feet away. It is probable that this incident was due to exposure to imazapyr.

Nine incidents of damages to plants were reported following application of imazapyr formulations. Several dead or dying cherry and pear trees were reported following root uptake of residual imazapyr applied to an irrigation canal. Low yield in a 120 acre corn crop occurred following application of two herbicidal formulations, one of which contained imazapyr. The certainty index classified these as possibly related to imazapyr exposure. Damage was sustained by winter wheat from carryover of imazapyr which had been applied to peas the previous Spring. Three oaks were injured following a runoff event from an adjacent plant site. The certainty index classified these as probably related to the presence of imazapyr. There was a possible connection to imazapyr to the loss of loblolly pine seedlings in one area. Other pesticides may have been involved as well: glyphosate and hexazinone. Finally, willow and spruce were killed following application of imazapyr to a driveway surface. No other information was provided. The certainty index classified this event as probably related to exposure to imazapyr.

# 5. Risk Characterization

Risk characterization is the integration of the exposure and effects characterizations to determine the potential ecological risk from varying imazapyr use scenarios within the action area and likelihood of direct and indirect effects on the CRLF and their designated critical habitat. The risk characterization provides an estimation (Section 5.1) and a description (Section 5.2) of the likelihood of adverse effects; articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the likelihood of adverse effects to the CRLF and/or their designated critical habitat (i.e., “no effect,” “likely to adversely affect,” or “may affect, but not likely to adversely affect”).

As stated in Section 2.2, for the purpose of this assessment, the toxicity of the imazapyr degradates are assumed to be equivalent to the parent, imazapyr. Therefore, the aquatic EECs were calculated for total toxic residues.

## 5.1 Risk Estimation

### 5.1.1 Direct Effects

Direct effects to the CRLF associated with acute and chronic exposure to imazapyr are based on the most sensitive toxicity data available for CRLF and/or other surrogate amphibians, fish and birds.

#### 5.1.1.1 Direct Acute Risks

*Aquatic Phase*

No acute toxicity data on aquatic phase amphibians are available, either submitted or in the open literature (ECOTOX). Therefore, freshwater fish are used as a surrogate for the aquatic phase CRLF. All of the acute $LC_{50}$s for freshwater fish are greater than the highest concentration tested in each study. Therefore, no acute risk quotients for fish are calculated. Direct acute risk to aquatic phase CRLF using the rainbow trout as a surrogate freshwater fish is discussed further in the Risk Description.

*Terrestrial Phase*

No acute toxicity data on terrestrial phase amphibians are available, either submitted or in the open literature. Therefore, birds are used as a surrogate for the terrestrial phase CRLF. All of the acute $LD/LC_{50}$s for birds are greater than the highest dose/concentration tested in each study. Therefore, no acute risk quotients for birds are calculated. Direct acute risk to terrestrial phase CRLF using the bobwhite quail as a surrogate bird species is discussed further in the Risk Description.

#### 5.1.1.2 Direct Chronic Risks

*Aquatic Phase*

No chronic toxicity data on aquatic phase amphibians are available, either submitted or in the open literature. Therefore, freshwater fish are used as a surrogate for the aquatic phase CRLF. The chronic toxicity study with rainbow trout, with a NOAEC of 43.1 mg/L (43100 ppb) is used as a surrogate study for the aquatic phase CRLF. The LOAEC is 92.4 mg/L, based on a decrease in larval survival. For estimation of the chronic RQ, the highest modeled aquatic EEC with a 2 meter depth standard pond scenario (60-day for chronic exposure to fish) was selected as an upper bound estimate. This EEC was estimated for the aquatic uses. The highest modeled EEC (60-day) is 79 ppb. The chronic RQ is estimated to be 79 ppb (EEC) ÷ 43100 ppb (NOAEC) = $1.8 \times 10^{-3}$, which is orders of magnitude less than the chronic LOC of 1 for fish.

*Terrestrial Phase*

No chronic toxicity data on terrestrial phase amphibians are available, either submitted or in the open literature. Therefore, birds are used as a surrogate for the terrestrial phase CRLF. The chronic toxicity study with bobwhite quail, with a NOAEC of 1,670 ppm is used as a surrogate study for the terrestrial phase CRLF. There were neither reproductive nor other toxicological effects in this study, up to and including the highest concentration tested.

Table 5.1.1 presents the avian chronic RQs as a surrogate for the terrestrial phase CRLF. There are no exceedances of the avian chronic LOC of 1 for birds consuming upper bound or mean predicted residues on food items based on a NOAEC of 1670 ppm from the bobwhite quail reproduction study and a maximum application rate of 1.5 lbs. ae/acre.

| Table 5.1.1 Summary of Direct Chronic RQs for the Terrestrial Phase CRLF Using Avian Endpoints as a Surrogate[a,b,c] | | |
|---|---|---|
| **Food type** | **Application of 1.5 lbs ae/acre** | |
| | **Avian Chronic RQ** | |
| | **predicted upper bound residues** | **predicted mean residues** |
| short grass | 0.22 | 0.08 |
| tall grass | 0.10 | 0.03 |
| broadleaf forage, small insects | 0.12 | 0.04 |
| Fruits, pods, large insects | 0.01 | 0.01 |

[a] Chronic toxicity NOAEC =1,670 mg ae/kg-bwt.
[b] RQs in this table were calculated for the maximum labeled application rate for non-crop use of 1.5 lbs ae/acre.
[c] Avian chronic LOC = 1

### 5.1.2 Indirect Effects

#### 5.1.2.1 Evaluation of Potential Indirect Effects via Reduction in Food Items (Freshwater Invertebrates and Fish for the Aquatic Phase; Terrestrial Invertebrates and Mammals for the Terrestrial Phase)

*Acute Risks, Aquatic Phase*

Acute risks to the prey base for the aquatic phase CRLF are considered for freshwater invertebrates and fish (note: submerged adult CRLFs are considered "aquatic" for the purposes of this assessment). All of the acute $LC_{50}$/$EC_{50}$s for freshwater fish and invertebrates are greater than the highest concentration tested in each study. Therefore, no acute risk quotients for fish and aquatic invertebrates are calculated. Acute risk to the prey items, freshwater fish and invertebrates is discussed further in the Risk Description.

*Acute Risks, Terrestrial Phase*

Acute risks to the prey base for the terrestrial phase CRLF are considered for terrestrial invertebrates and mammals. The acute $LC_{50}$ for mammals (rat) is greater than the highest dose tested in the study. Therefore, no acute risk quotients for mammals are calculated. The acute contact $LD_{50}$ for imazapyr on honey bees is also greater than the highest dose tested in the study. Acute risk to the prey items, mammals and terrestrial invertebrates is discussed further in the Risk Description.

*Chronic Risks, Aquatic Phase*

Chronic risks to the prey base for the aquatic phase CRLF are considered for freshwater invertebrates and fish. The rainbow trout and the water flea are used as surrogate prey species. As stated in the direct effects section (Section 5.1.1), the highest RQ for freshwater fish from chronic exposure to imazapyr is less than the chronic LOC for fish. For freshwater invertebrates, the chronic toxicity study with daphnia, with a 21-day NOAEC of 97.1 mg/L (97100 ppb) is used as a surrogate study for freshwater invertebrate prey species. There is no LOAEC because no effects were observed, up to and including the highest concentration tested. For estimation of the chronic RQ, the highest modeled aquatic EEC with a 2 meter depth standard pond scenario (21-day for chronic exposure to aquatic invertebrates) was selected as an upper bound estimate. This EEC was estimated for the the aquatic uses. The highest modeled EEC (21-day) is 82 ppb. The chronic RQ is estimated to be 82 ppb (EEC) ÷ 97100 ppb (NOAEC) = $8.4 \times 10^{-4}$, which is orders of magnitude less than the chronic LOC of 1 for aquatic invertebrates.

*Chronic Risks*, *Terrestrial Phase*

Chronic risks to the prey base for the terrestrial phase CRLF are considered for terrestrial invertebrates and mammals. No chronic toxicity data are available for terrestrial invertebrates. The chronic toxicity study with the rat, with a NOAEL of 738 mg/kg bw/day and a NOAEC of 10,000 ppm from the reproduction study is used as a surrogate for mammalian prey species. There is no LOAEL/LOAEC because no effects were observed, up to and including the highest concentration tested.

The highest estimated chronic dose- and dietary-based RQs for mammals are detailed in Tables 5.1.2.1.a and 5.1.2.1.b, respectively.

Assuming upper bound and mean residue levels at the maximum single application rate (1.5 lbs ae/acre), neither the dose-based risk quotients (Table 5.1.2.1.a) nor the dietary-based risk quotients (Table 5.1.2.1.b) exceed the chronic LOC for all weight classes (15 g, 35 g, and 1000g) of mammals consuming short grass, tall grass, broadleaf forage/small insects and seeds.

| Table 5.1.2.1.a Summary of Indirect Effect (Prey Base Mammals) Dose-Based Chronic RQs for the Terrestrial Phase CRLF [a,b] | | | |
|---|---|---|---|
| **Food type** | **Weight class (g)** | **RQs for 1.5 lbs ae/acre** | |
| | | **Predicted upper bound residues** | **Predicted mean residues** |
| short grass | 15 | 0.21 | 0.07 |
| | 35 | 0.18 | 0.06 |
| | 1000 | 0.10 | 0.03 |
| tall grass | 15 | 0.10 | 0.03 |
| | 35 | 0.08 | 0.03 |
| | 1000 | 0.04 | 0.01 |
| broadleaf forage, small insects | 15 | 0.12 | 0.04 |
| | 35 | 0.10 | 0.03 |
| | 1000 | 0.05 | 0.02 |
| fruit, large insects | 15 | 0.01 | 0.01 |
| | 35 | 0.01 | 0.01 |
| | 1000 | 0.01 | <0.01 |
| seeds, pods | 15 | <0.01 | <0.01 |
| | 35 | <0.01 | <0.01 |
| | 1000 | <0.01 | <0.01 |

[a] Chronic reproductive toxicity NOAEL = 738 mg ae/kg/day
[b] Mammalian chronic LOC = 1.

| Table 5.1.2.1.b. Summary of Indirect Effect (Prey Base Mammals) Dietary-Based Chronic RQs for the Terrestrial Phase CRLF [a,b] | | |
|---|---|---|
| **Food type** | **RQs for 1.5 lbs ae/acre** | |
| | **Predicted upper bound residues** | **Predicted mean residues** |
| short grass | 0.04 | 0.01 |
| tall grass | 0.02 | 0.01 |
| broadleaf forage, small insects | 0.02 | 0.01 |
| fruit, large insects<br>seeds, pods | <0.01 | <0.01 |

[a] Chronic reproductive toxicity NOAEC = 10000 ppm.
[b] Mammalian chronic LOC = 1.

### 5.1.2.2 Evaluation of Potential Indirect Effects via Reduction in Food Items, Habitat and/or Primary Productivity (Freshwater Aquatic Plants)

Risks to aquatic plants, which would indicate indirect risks to the CRLF are estimated using the most sensitive non-vascular and vascular plant endpoints. Since there are no obligate relationships between the CRLF and any aquatic plant species, the most sensitive 14-day $EC_{50}$'s were considered for RQ calculations. The most sensitive vascular plant $EC_{50}$ is 18 ppb ae (duckweed) for the isopropylamine salt of imazapyr, with effects on population growth and frond production. The most sensitive non-vascular aquatic plant $EC_{50}$ is 11500 ppb ae (green algae) for the isopropylamine salt of imazapyr with a slight change in cell shape as the endpoint.

RQs were estimated using the modeled peak EECs for the various uses of imazapyr in California and the most sensitive $EC_{50}$'s for vascular and non-vascular plants. None of the RQs for non-vascular plants exceed the LOC of 1 for aquatic plants. The RQs for aquatic vascular plants do not exceed the aquatic plant LOC at the maximum rates for residential, turf or ground applications for forestry uses. The aquatic plant LOC is exceeded for aquatic vascular plants with forestry (aerial), rangeland (aerial and ground) and aquatic uses. For rights-of-way uses, the aquatic vascular plant RQs exceed the aquatic plant LOC for both ground and aerial spray, assuming 50% impervious surface coverage and 10% treatment of the watershed. For all other assumed percentages of watershed treated, the aquatic vascular plant LOC is not exceeded (see Table 5.1.2.2). Additional discussion on risks to aquatic plants is provided in the Risk Description in Section 5.2.2.2.

In summary, the preliminary effects determination is "may effect", based on indirect effects to habitat and/or primary productivity for the aquatic phase CRLF.

**Table 5.1.2.2 Tier 2 Peak EECs and RQs for Aquatic Vascular and Non-Vascular Plants with Forestry, Rangeland/Hay, Turf, Aquatic, Residential and Rights-of-Way Uses**

| Indirect Effect to CRLF | Use | Peak EEC (ppb) | Vascular plant RQ $EC_{50}$: 18 ppb ae | Non-vascular plant RQ $EC_{50}$: 11500 ppb ae |
|---|---|---|---|---|
| Reduced Food Supply, Habitat and/or Primary Productivity via Direct Toxicity to Aquatic Plants | Forestry (aerial) | 18.5 | **1.03** | <1 |
| | Forestry (ground) | 14.1 | 0.78 | <1 |
| | Rangeland/Hay (aerial) | 33.0 | **1.83** | <1 |
| | Rangeland/Hay (ground) | 26.1 | **1.45** | <1 |
| | Turf (ground) | 9.8 | 0.54 | <1 |
| | Direct Application to Water (aerial and ground) | 84 | **4.67** | <1 |
| | Residential Uses[3] | 8.7 | 0.48 | <1 |

| Table 5.1.2.2 Tier 2 Peak EECs and RQs for Aquatic Vascular and Non-Vascular Plants with Forestry, Rangeland/Hay, Turf, Aquatic, Residential and Rights-of-Way Uses | | | | |
|---|---|---|---|---|
| **Indirect Effect to CRLF** | **Use** | **Peak EEC (ppb)** | **Vascular plant RQ $EC_{50}$: 18 ppb ae** | **Non-vascular plant RQ $EC_{50}$: 11500 ppb ae** |
| | Rights-of-Way[4] | | | |
| | Aerial | | | |
| | 1% of watershed treated | 2.3 | 0.13 | <1 |
| | 5% of watershed treated | 11.6 | 0.64 | <1 |
| | 10% of watershed treated | 23.2 | **1.29** | <1 |
| | Ground | | | |
| | 1% of watershed treated | 2.3 | 0.13 | <1 |
| | 5% of watershed treated | 11.6 | 0.64 | <1 |
| | 10% of watershed treated | 23.2 | **1.29** | <1 |

[1] LOC for aquatic plants = 1
[2] **Bold** = exceeds LOC for aquatic plant
[3] Ground application with 12% impervious surface, 10% pervious surface and 50% of impervious surface treated
[4] Assumed 50% impervious surfaces

#### 5.1.2.3 Evaluation of Potential Indirect Effects via Reduction in Terrestrial Plant Community (Riparian Habitat)

##### 5.1.2.3.1 Terrestrial Uses of Imazapyr

Potential indirect effects to the CRLF resulting from direct effects on riparian vegetation were assessed using RQs from terrestrial plant seedling emergence and vegetative vigor $EC_{25}$ data as a screen. Risks are estimated using the most sensitive monocot and dicot plant endpoints (the most sensitive seedling emergence endpoints for runoff and the most sensitive endpoint from either seedling emergence or vegetative vigor studies for spray drift). Since there are no obligate relationships between the CRLF and any terrestrial plant species, the most sensitive $EC_{25}$'s were considered for RQ calculations. The most sensitive toxicity thresholds were 0.0046 (monocot) and 0.0024 (dicot) lb ae/acre (effects on weight) for the seedling emergence studies and 0.012 (monocot) and 0.0009 (dicot) lb ae/acre (stunting, chlorosis and plant death) for the vegetative vigor studies with the isopropylamine salt of imazapyr. RQs were estimated using the Terrplant (Version 1.2.2) model for the various uses of imazapyr in California.

Table 5.1.2.3.a presents RQs for terrestrial plants for imazapyr uses with both ground and aerial spray applications. The terrestrial plant LOC of 1 was exceeded for all non-listed monocots and dicots located adjacent to treated areas, in semi-aquatic areas, and as a result of runoff and/or spray drift for the maximum application rates of 0.9 and 1.5 lbs ae/acre. RQs were higher for aerial applications when compared to ground applications. This would be expected given the percentages of drift assumptions of 5% and 1% for aerial and ground sprays, respectively. Risk estimates to terrestrial plants from the capsule injection application were not conducted because exposure to adjacent plants is expected to be very limited and non-quantifiable.

If the CRLF habitat is inside the treated area and the terrestrial plants in the habitat are treated, then it is assumed that the terrestrial plants are exposed directly to either 1.5 or 0.91 pounds per acre. Using the most sensitive toxicity thresholds of 0.0046 (monocot) and 0.0009 lbs/A (dicot), the RQs would be estimated by directly dividing the application rates by the toxicity thresholds. The estimated RQs for application directly on CRLF habitat plants are 326/198 for monocots (1.5/0.91 lbs/A, respectively) and 1667/1011 for dicots (1.5/0.91 lbs/A, respectively).

#### 5.1.2.3.2 Aquatic Uses of Imazapyr

For aquatic use patterns (direct application to surface water), RQs were estimated from treated water overflowing to flood a terrestrial site. The aquatic EECs for exposure to riparian plants adjacent to or on the edges of the water body were modeled, assuming a concentration (volume) of imazapyr in a 1 hectare pond with a water depth of 2 meters, from which 6 inches of that water moves (overflows) entirely onto a hectare of dry land and dries up on the ground with imazapyr residues. The inputs are based on an application rate of 1.5 lb/A to a 1 hectare area with 6 inches (15.2 cm) of the water moving onto land. Table 5.1.2.3.b presents the RQs for this scenario.

The terrestrial plant LOC is exceeded for aquatic uses for both monocots and dicots (Table 5.1.2.3.b).

Currently, the Agency does not perform chronic risk assessments for terrestrial plants. Bold values in the following tables are LOC exceedances.

| Table 5.1.2.3.a Non-Listed Terrestrial Plant Risk Quotient Summary for Terrestrial Spray Uses [a, b, c] | | | |
|---|---|---|---|
| **Application Type/Surrogate Species** | **Adjacent to treated sites (1:1 ratio)** | **Semi-aquatic areas (10:1 ratio)** | **Drift** |
| **Terrestrial non-crop uses high application rate (1.5 lbs ae/acre)** | | | |
| Ground spray application | | | |
| Monocot | **20** | **166** | **3** |
| Dicot | **38** | **319** | **17** |
| Aerial spray application | | | |
| Monocot | **33** | **179** | **16** |
| Dicot | **63** | **344** | **83** |
| **Terrestrial residential low application rate (0.91 lbs ae/acre)** | | | |
| Ground spray application | | | |
| Monocot | **12** | **101** | **2** |
| Dicot | **23** | **193** | **10** |

[a] RQs for ground and aerial spray applications in this table were calculated for the terrestrial non-crop low and high application rates of 1.5 and 0.91 lbs ae/A, respectively.
[b] Non-endangered toxicity thresholds $EC_{25}$s are 0.0046, 0.0024, 0.012, and 0.0009 lb ae/acre for seedling emergence monocot, seedling emergence dicot, vegetative vigor monocot, and vegetative vigor dicot, respectively.
[c] **Bold** indicates an exceedance of the Acute Risk LOC for plants.

| Table 5.1.2.3.b Terrestrial Plant Risk Quotient Summary for Aquatic Spray Uses [a, b, c] | |
|---|---|
| **Scenario** | **Water overflows to flood a terrestrial site[d]** |
| **Aquatic non-crop high application rate (1.5 lbs ae/acre)** | |
| Ground spray application | |
| Monocot | **28** |
| Dicot | **54** |
| Aerial spray application | |
| Monocot | **41** |
| Dicot | **79** |

[a] RQs for ground and aerial spray applications in this table were calculated for the aquatic non-crop high application rate of 1.5 lb ae/A.
[b] Non-endangered toxicity thresholds ($EC_{25}$) were 0.0046 and 0.0024, lb ae/acre for seedling emergence monocot and seedling emergence dicot, respectively.
[c]**Bold** indicates an exceedance of the terrestrial plant LOC.
[d] 1.5 lb/A applied to 2 meter depth of water (1 hectare area), then 6 inches of water moves onto land

In summary, for both the terrestrial and aquatic uses of imazapyr, the preliminary effects determination is “may effect” based on indirect effects via reduction of terrestrial vegetation (i.e., riparian habitat) required to maintain acceptable water quality and aquatic and terrestrial habitat.

### 5.1.3 Adverse Modification to Designated Critical Habitat

Critical habitat was designated for the CRLF by the USFWS on April 13, 2006 (USFWS 2006; 71 FR 19244-19346). Designated critical habitat receives special protection under Section 7 of the ESA by prohibiting against the destruction or adverse modification of critical habitat with regard to Federal actions, such as use of pesticides registered under FIFRA. 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 (i.e., areas on which the PCEs are found, as defined in 50 CFR 414.12(b)). 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 imazapyr use that may alter the PCEs of the CRLF's critical habitat form the basis of the critical habitat impact analysis. As previously discussed in Section 2.8 of the problem formulation, PCEs that are identified as assessment endpoints are limited to those that are of a biological nature and those PCEs for which imazapyr effects data are available. For the purposes of this critical habitat impact analysis, PCEs selected as assessment endpoints for the CRLF are grouped according to the measures of ecological effect that are used to determine whether the assessment endpoint (i.e. PCE) may be adversely modified. As such, groupings of PCEs and the measures of ecological effect used in this critical habitat impact analysis are identified in **Table 5.1.3**.

**Table 5.1.3 PCE Groupings for Critical Habitat Impact Analysis**

| PCE | Measure of Ecological Effect |
|---|---|
| - Characteristics necessary for normal behavior, growth, and viability of all CRLF life stages related to:<br>(1) Aquatic habitat for shelter, foraging, predator avoidance and aquatic dispersal for juvenile and adult CRLF's<br>(2) Water chemistry/quality including temperature, oxygen content and turbidity for normal growth of both CRLF and their prey<br>(3) Substrates with low amount of sedimentation necessary for viability of CRLF<br>(4) Alteration in channel/pond morphology | - Acute vascular and non-vascular aquatic plant data and/or<br>- Terrestrial plant seedling emergence and vegetative vigor data |
| Reduction/modification of aquatic-based food sources for pre-metamorphs | Acute vascular and non-vascular aquatic plant data |
| Alteration in both terrestrial (dispersal and upland) and aquatic habitat (riparian vegetation) | Terrestrial plant seedling emergence and vegetative vigor data |

| Table 5.1.3 PCE Groupings for Critical Habitat Impact Analysis | |
|---|---|
| **PCE** | **Measure of Ecological Effect** |
| Alteration of other chemical characteristics necessary for normal behavior, growth, and viability of aquatic CRLF's and their food source (includes juveniles and submerged adult frogs) | Most sensitive acute and chronic data on freshwater fish and/or invertebrates |
| (1) Alteration of chemical characteristics necessary for normal behavior, growth, and viability of terrestrial CRLF's and their food source<br>(2) Reduction and/or modification of food sources for terrestrial phase juveniles and adults | Most sensitive<br>- Acute data on honey bees and/or<br>- Acute and chronic data on mammals<br>- Acute and chronic data on birds |

Risk estimates of potential adverse modification to the PCEs identified in Table 5.1.3 are provided in Sections 5.1.3.1 through 5.1.3.4.

#### 5.1.3.1 Adverse Modification to Designated Critical Habitat via Direct Effects to Aquatic Plants and/or Riparian Vegetation

Adverse modification of designated critical habitat via actions that may directly impact aquatic and terrestrial plants are associated with those characteristics necessary for normal behavior, growth, and viability of all CRLF life stages. These characteristics are listed in Table 5.10. In some cases, direct effects on aquatic and terrestrial plants are assessed together because they each affect many of the same aspects of the habitat.

Indirect effects to the CRLF resulting from direct effects on aquatic and terrestrial plants were assessed in Sections 5.1.2.2 and 5.1.2.3. These evaluations are also applicable to the critical habitat impact analysis because the same aquatic and terrestrial EECs and aquatic and terrestrial plant toxicity study endpoints are used for both types of analyses (see Tables 5.1.2.2.a through 5.1.2.3b). Both aquatic vascular and terrestrial plant RQs are exceeded for many of the imazapyr uses in California and therefore, may adversely modify the critical habitat.

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

Chemical characteristics necessary for normal behavior, growth, and viability of all life stages of the CRLF are assessed by utilizing existing RQs for direct and indirect effects. If LOCs are exceeded for either direct and/or indirect effects, the chemical environment is presumed to be such that normal behavior, growth, and viability of the CRLF's critical habitat may be adversely modified. No LOCs were exceeded for either direct effects on the CRLF or for any of the prey items for the CRLF (see Sections 5.1.1 and 5.1.2).

### 5.2 Risk Description

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

If the RQs presented in the Risk Estimation (Section 5.1) show no direct or indirect effects for individual CRLFs, and no adverse modification to PCEs of the CRLF's designated critical habitat (RQs < LOC), a "no effect" determination is made, based on screening level modeled EECs of imazapyr's use within the action area. If, however, direct or indirect effects to the individual CRLFs are anticipated and/or effects may adversely modify the PCEs of the CRLF's designated critical habitat (RQs > LOC, the Agency concludes a preliminary "may affect" determination for the FIFRA regulatory action regarding imazapyr. A summary of the results of the risk estimation (i.e., "no effect" or "may affect" finding) presented in Sections 5.1.1 through 5.1.3 is provided in **Table 5.2.1** for direct and indirect effects to the CRLF as well as adverse modification to PCEs of the CRLF's designated critical habitat.

**Table 5.2.1. Preliminary Effects Determination Summary for the CRLF and Critical Habitat Impact Analysis Based on Risk Estimation**

| Direct and Indirect Effects to CRLF[a] | | |
|---|---|---|
| **Assessment Endpoint** | **Preliminary Effects Determination** | **Basis for Preliminary Determination[a]** |
| 1. Survival, growth, and reproduction of assessed CRLF individuals via direct effects | Acute direct effects: No effect for either aquatic or terrestrial phase. | No effects in surrogate species at highest concentrations/doses tested which are significantly greater than the peak aquatic and terrestrial EECs (Sections 5.1.1 and 5.2.1.1). |
| | Chronic direct effects: No effect for either aquatic or terrestrial phase. | Chronic aquatic/terrestrial animal LOCs are not exceeded for any uses (Section 5.1.1, Table 5.1.1) |
| 2. Indirect effects to assessed CRLF individuals via reduction in food items | Acute indirect effects: No effect for freshwater invertebrates and fish (aquatic phase); terrestrial invertebrates and mammals (terrestrial phase) | No effects in freshwater fish and invertebrates, honey bees and mammals at highest concentrations/doses tested which are significantly greater than the peak aquatic and terrestrial EECs (Sections 5.1.1, 5.1.2, 5.2.1.1 and 5.2.1.2). |
| | Chronic indirect effects: No effect for freshwater invertebrates and fish (aquatic phase); mammals (terrestrial phase) | Chronic aquatic/terrestrial animal LOCs are not exceeded for any uses (Sections 5.1.1, 5.1.2, Tables 5.1.2.1.a and 5.1.2.1.b) |
| 3. Indirect effects to assessed CRLF individuals via reduction of food (aquatic plants), habitat and/or primary productivity | Indirect effects: No effect for aquatic plant food supply for aquatic phase CRLF.<br>No effect for habitat and/or primary productivity for forestry (ground), residential or turf uses.<br>May affect habitat and/or primary productivity for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses. | Aquatic plant LOCs exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way use scenarios (Table 5.1.2.2).<br>Aquatic plant LOCs not exceeded for vascular plants for forestry (ground), residential or turf uses.<br>No LOCs are exceeded for non-vascular plants (Table 5.1.2.2). |

| **Table 5.2.1. Preliminary Effects Determination Summary for the CRLF and Critical Habitat Impact Analysis Based on Risk Estimation** | | |
|---|---|---|
| **Direct and Indirect Effects to CRLF[a]** | | |
| **Assessment Endpoint** | **Preliminary Effects Determination** | **Basis for Preliminary Determination[a]** |
| 4. Indirect effects to assessed CRLF individuals via reduction of terrestrial vegetation (i.e., riparian habitat) required to maintain acceptable water quality and habitat | May affect | Terrestrial plant LOC exceeded for monocots and dicots for all uses (Table 5.1.2.3, Section 5.1.2.3). |
| **Adverse Modification to Designated Critical Habitat via PCE Analysis** | | |
| 5. Aquatic habitat for shelter, foraging, predator avoidance and aquatic dispersal for juveniles and adults. | No effect for habitat and/or primary productivity for forestry (ground), residential or turf uses.<br>May affect habitat and/or primary productivity for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses. | Aquatic plant LOCs exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way use scenarios (Table 5.1.2.2).<br>Aquatic plant LOCs not exceeded for vascular plants for forestry (ground), residential or turf uses.<br>No LOCs are exceeded for non-vascular plants (Section 5.1.2.2). |
| 6. Water chemistry/quality including temperature, oxygen content and turbidity for normal growth of both CRLF and their prey. | May affect habitat and/or primary productivity | Aquatic plant LOCs exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way use scenarios (Table 5.1.2.2.).<br>Terrestrial plant LOC exceeded for monocots and dicots for all uses (Tables 5.1.2.3.a and b). |
| 7. Substrates with low sedimentation | May affect | |
| 8. Reduction/modification of aquatic-based food sources for pre-metamorphs | No affect | No LOCs are exceeded for non-vascular plants (Section 5.1.2.2). |
| 9. Alteration in channel/pond morphology | May affect | Terrestrial plant LOC exceeded for monocots and dicots for all uses (Tables 5.1.2.3.a and b). |
| 10. Alteration in both terrestrial (dispersal and upland) and aquatic habitat (riparian vegetation) | May affect | Terrestrial plant LOC exceeded for monocots and dicots for all uses (Tables 5.1.2.3.a and b) |
| 11. Other chemical characteristics necessary for normal behavior, growth, and viability of all life stages of CRLF | Acute direct effects: No effect for either aquatic or terrestrial phase | No effects in freshwater fish and invertebrates, honey bees and mammals at highest concentration/dose tested which are significantly greater than the peak aquatic and terrestrial EECs (Sections 5.1.1, 5.2.1.1 and 5.2.1.2). |
| | Chronic direct effects: No effect for either aquatic or terrestrial phase | Chronic aquatic/terrestrial animal LOCs are not exceeded for any uses (Sections 5.1.1 and 5.1.2, Table Table 5.1.1) |
| | Indirect food source- No effect for either aquatic or terrestrial phase | No effects in freshwater fish and invertebrates, honey bees and mammals at highest concentration/dose tested which are significantly greater than the peak aquatic and terrestrial EECs (Sections 5.1.1, 5.1.2, 5.2.1.1 and 5.2.1.2). |
| | Indirect food source – No effect for either aquatic or terrestrial phase | Chronic aquatic/terrestrial animal LOCs are not exceeded for any uses (Section 5.1.1, Table 5.1.1) |
| [a]All screening level EECs for the preliminary effects determination are based on modeled scenarios for surface water (Table 3.6) and terrestrial plants (Table 3.16); toxicity values are based on the most sensitive endpoint summarized in Table 4.3. | | |

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

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

- Significance of Effect: Insignificant effects are those that cannot be meaningfully measured, detected, or evaluated in the context of a level of effect where "take" occurs for even a single individual. "Take" in this context means to harass or harm, defined as the following:

    - Harm includes significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.

    - Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.

- Likelihood of the Effect Occurring: Discountable effects are those that are extremely unlikely to occur. For example, use of dose-response information to estimate the likelihood of effects can inform the evaluation of some discountable effects.

- Adverse Nature of Effect: Effects that are wholly beneficial without any adverse effects are not considered adverse.

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

In the conceptual model, direct application, spray drift and surface runoff/leaching to adjacent bodies of water were predicted as the most likely sources of exposure of imazapyr and the isopropylamine salt of imazapyr to nontarget aquatic organisms. Risks to aquatic organisms (i.e. fish, invertebrates, and plants) were assessed based on modeled estimated environmental concentrations (EECs) and available toxicity data. Aquatic EECs for the ecological exposure to imazapyr were estimated using PRZM/EXAMS employing the standard field pond scenario.

The risk hypothesis states that the labeled uses of imazapyr have the potential to cause direct adverse effects to both terrestrial and aquatic phase CRLF, indirect adverse effects to its food supply and habitat, and adverse modification to designated critical habitat. The assessment does not support the hypothesis regarding direct adverse effects to terrestrial and aquatic CRLFs and indirect adverse effects to its animal food supply. The hypothesis is supported for direct adverse effects to both terrestrial (monocots and dicots) and aquatic vascular plants, and thus, through indirect effects, adverse effects to the aquatic phase CRLF food supply, the aquatic and terrestrial phase CRLF habitat, and adverse modification to the critical habitat.

### 5.2.1 Direct Effects to the CRLF

*Acute Risks, Aquatic Phase*

As stated previously, freshwater fish are used as a surrogate for the aquatic phase CRLF. All of the acute $LC_{50}$s for freshwater fish are greater than 100 mg/L (100,000 ppb). The highest peak aquatic EEC for imazapyr is 84 ppb for aquatic uses. This EEC was estimated from the aquatic uses (direct application to water) following one application. 100,000 ppb is 1190 times higher than the aquatic EEC. Even when modeled with 1 annual application for 30 years, the EEC will not reach a level where the acute LOC for fish will be exceeded (see Figure 3.2.2 for graphical representation of the aquatic EEC).

A supplemental study has been conducted on rainbow trout with a 22.6% acid equivalent formulation of the imazapyr salt (MRID 00153778). In this study, it appears that this formulation may be more toxic than the acid. Nevertheless, it is noted that the toxicity endpoints are based on nominal concentrations; therefore, there are uncertainties in the endpoint values. The 96-hour $LC_{50}$ is 112 mg Arsenal/L (20.8 mg ae/L or 20800 ppb). This value is 248 times higher than the aquatic EEC. Again, even with this more conservative acute toxicity endpoint, the EEC will not reach a level where the acute LOC for fish will be exceeded.

For freshwater fish (surrogate for the CRLF), the chance of an individual mortality is estimated using the default slope of 4.5 with default lower and upper bounds of 2 and 9 and the acute aquatic endangered species LOC of 0.05. The estimated chance of individual mortality of freshwater fish following imazapyr application is 1 in 4.18E+08. Using the default upper and lower values for the default mean slope estimate (2 - 9), the upper and lower estimates of the effects probability associated with the listed species LOC of 0.05 are 1 in 2.16E+02 and 1 in 1.75E+31, respectively.

Therefore, the effects determination is “no effect” following acute exposure to the aquatic phase CRLF.

*Acute Risks, Terrestrial Phase*

Acute risk quotients were not estimated for birds, the surrogate for CRLF, because there was neither mortality nor any other signs of toxicity in either the acute oral studies or the acute dietary studies. For terrestrial uses with spray applications of 1.5 lb ae/acre, the highest dose-based EEC concentration for birds is 410 mg/kg bw for short grass consumed by a 20 g bird. The adjusted $LD_{50}$ for 20 g birds is > 1549 mg/kg bw. The 8-day dietary $LC_{50}$ for bobwhite quail is > 5000 ppm. The highest dietary-based EEC concentration for birds is 360 ppm for short grass. The acute endangered LOC for birds is 0.1. Therefore, the acute $LD_{50}$ and $LC_{50}$ would have to be greater than 10 times the highest corresponding EEC to be protective of endangered species. The acute oral $LD_{50}$ is more than 4 times the highest EEC on a dose basis and the acute $LC_{50}$ more than 14 times the highest EEC on a dietary basis. Birds are currently used as surrogates for reptiles and terrestrial-phase amphibians. However, reptiles and amphibians are poikilotherms (body temperature varies with environmental temperature) while birds are homeotherms (temperature is regulated, constant, and largely independent of environmental temperatures). Therefore, reptiles and amphibians tend to have much lower metabolic rates and lower caloric requirements than birds or mammals. As a consequence, birds are likely to consume more food than amphibians or reptiles on a daily dietary intake basis, assuming similar caloric content of the food items. This can be seen when comparing the estimated caloric requirements for free living iguanid lizards to passerines (song birds) (U.S. EPA, 1993):

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

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

With relatively comparable slopes to the allometric functions, one can see that, given a comparable body weight, the free living metabolic rate of birds can be 40 times higher than reptiles, though the requirement differences narrow with high body weights. Consequently, use of avian food intake allometric equation is likely to result in an over-estimation of exposure and risk for reptiles and terrestrial-phase amphibians.

For terrestrial animals, the chance of an individual mortality is estimated using the default slope of 4.5 with default lower and upper bounds of 2 and 9 and the endangered species acute LOC of 0.1. The corresponding estimated chance of individual mortality of terrestrial species following imazapyr application is 1 in 2.94E+05. Using the default upper and lower values for the default mean slope estimate (2 - 9), the upper and lower estimates of the effects probability associated with the listed species LOC of 0.1 are 1 in 4.40E+01 and 1 in 8.86E+18, respectively.

Because of the lack of any indications of toxicity in the available acute studies in birds and/or any other terrestrial species at the highest doses/concentrations tested, the differences between the EECs and the $LD_{50}$/$LC_{50}$'s were more than 4 to 14-fold, and because use of avian food intake allometric equation is likely to result in an over-estimation of exposure and risk for reptiles and terrestrial-phase amphibians, no direct effect following acute exposure is expected for the terrestrial phase CRLF. Therefore, the effects determination is “no effect” following acute exposure to the terrestrial phase

CRLF.

*Chronic Risks, Aquatic Phase*

When freshwater fish are used as a surrogate for the aquatic phase CRLF, the chronic RQ, using the highest modeled aquatic EEC is estimated to be 1.8 x $10^{-3}$. This EEC was estimated from the aquatic uses (direct application to water) following one application. This value is over 555 times less than the chronic LOC of 1 for fish. Even when modeled with 1 annual application for 30 years, the EEC will not reach a level where the chronic LOC for fish will be exceeded (see Figure 3.2.2 for graphical representation of the aquatic EEC). Therefore, no direct effect following chronic exposure is expected for the aquatic phase CRLF and the effects determination is “no effect” following chronic exposure to the aquatic phase CRLF.

*Chronic Risk, Terrestrial Phase*

No reproductive or other toxicological effects in the chronic study were observed with bobwhite quail, the surrogate for the terrestrial phase CRLF. Chronic RQs based on the predicted residues on food at the maximum application rate of 1.5 lbs. ae/acre and the toxicity endpoint from the avian reproduction study did not exceed the chronic LOC of 1 for birds. The highest RQ was 0.22 for short grass. Therefore, no direct effect following chronic exposure is expected for the terrestrial phase CRLF and the effects determination is “no effect” following chronic exposure to the terrestrial phase CRLF.

### 5.2.2 Indirect Effects to the CRLF

#### 5.2.2.1 Indirect Effects via Reduction in Food Items (Freshwater Invertebrates and Fish for the Aquatic Phase; Terrestrial Invertebrates and Mammals for the Terrestrial Phase)

As stated in Section 2.5.3, it is assumed that the diet of the CRLF aquatic-phase larvae (tadpoles) is similar to that of other frog species, consuming diatoms, algae, and detritus (USFWS 2002). Juvenile and adult CRLFs may feed on aquatic and terrestrial invertebrates, amphibians, fish and small mammals. The aquatic plant food items are addressed in the next section (5.2.1.3).

*Aquatic Invertebrates*

For aquatic invertebrates, all of the acute $LC_{50}$s from the submitted studies for freshwater invertebrates are greater than 100 mg/L (100,000 ppb). As stated previously, the highest peak aquatic EEC for imazapyr is 84 ppb. Again, this EEC was estimated from the aquatic uses (direct application to water) following one application. 100,000 ppb is 1190 times higher than the aquatic EEC. As with fish, even when modeled with 1 annual application for 30 years, the EEC will not reach a level where the acute LOC for aquatic invertebrates will be exceeded (see Figure 3.2.2 for graphical representation of the aquatic EEC).

A supplemental study has been conducted on daphnia with a 22.6% acid equivalent formulation of the imazapyr salt (MRID 00153779). In this study, it appears that this formulation may be more toxic than the acid. Nevertheless, it is noted that the toxicity endpoints are based on nominal concentrations; therefore, there are uncertainties in the endpoint values. The 48-hour $EC_{50}$ is 64.9 mg ae/L or 64900 ppb. This value is 773 times higher than the aquatic EEC. Again, even with this more conservative acute toxicity endpoint, the EEC will not reach a level where the acute LOC for aquatic invertebrates.

For freshwater invertebrates, the chance of an individual mortality is estimated using the default slope of 4.5 with default lower and upper bounds of 2 and 9 and the acute aquatic endangered species LOC of 0.05. The estimated chance of individual mortality of freshwater invertebrates following imazapyr application is 1 in 4.18E+08. Using the default upper and lower values for the default mean slope estimate (2 - 9), the upper and lower estimates of the effects probability associated with the listed species LOC of 0.05 are 1 in 2.16E+02 and 1 in 1.75E+31, respectively.

There is an open literature study in which an *in situ* microcosm study found no effects following a single application of imazapyr up to a concentration of 19.8 mg/L on the macroinvertebrate community of a logged pond cypress dome. Comparing this NOAEC (19800 ppb) with the peak EEC in surface water indicates a 236-fold difference. Although the data from this study are limited because examinations were conducted at the family/genus level and effects on individual species were not examined, it provides further weight of evidence that direct acute risk to freshwater invertebrates, including benthic organisms, is not expected. The highest chronic RQ for freshwater invertebrates is estimated to be $8.4 \times 10^{-4}$. This value is 1190 times less than the chronic LOC of 1 for aquatic invertebrates. As before, even when modeled with 1 annual application for 30 years, the EEC will not reach a level where the chronic LOC for aquatic invertebrates will be exceeded. Therefore, direct risk to freshwater invertebrates from chronic exposure to imazapyr is not expected.

*Mammals*

For mammals, the acute $LD_{50}$ for rats is >5000 mg ae/kg bw. For terrestrial uses with spray applications of 1.5 lb ae/acre, the highest dose-based EEC concentration for mammals is 343 mg/kg bw for short grass consumed by a 15 g mammal. The adjusted $LD_{50}$ for 15 g mammals is > 10989 mg/kg bw. This is more than 32 times the highest estimated EEC, which would be protective of endangered species when using the acute endangered species LOC of 0.1 for mammals as a point of reference. The chance of an individual mortality is the same as that for birds: 1 in 2.94E+05 with upper and lower estimates of 1 in 4.40E+01 and 1 in 8.86E+18.

No reproductive or other toxicological effects were observed in the chronic study with the rat. The predicted residues on food at the maximum application rate of 1.5 lbs. ae/acre coupled with the toxicity endpoint from the rat reproduction study provided no exceedances of the chronic LOC of 1 for mammals. The highest dose-based RQ was 0.21 for short grass and the highest dietary-based RQ was 0.04 for short grass (Tables 5.1.2.1.a and b). Therefore, indirect risk to the terrestrial phase CRLF via direct acute and chronic risk to mammals as dietary food items is not expected.

*Terrestrial Invertebrates*

Acute risk to terrestrial invertebrates may be estimated using the exposure value for seeds, pods and insects from the T-REX model 1.3.1 for the maximum application rate of imazapyr. The exposure value for large insects for the application rate of 1.5 lbs a.i./A is 22.5 ppm or 22.5 µg a.i./g of insect and the exposure value for small insects is 202.5 ppm or 202.5 µg a.i./g. The residue for one bee may be estimated using the adult honey bee weight of 0.128 g. 22.5 µg ae/g bee x 0.128 g bee = 2.88 µg a.i./bee. The acute contact $LD_{50}$ for imazapyr is > 100 µg/bee, which is 34 times greater than the estimated exposure per honey bee. As an upper bound estimate, the residue for one bee (small insects) may be 202.5 µg ae/g bee x 0.128 g bee = 25.9 µg a.i./bee. The acute contact $LD_{50}$ value of 100 µg/bee is 4 times greater than the estimate exposure per honey bee. Therefore, indirect risk to the CRLF via direct acute risk to terrestrial invertebrates as dietary food items is not expected.

The acute and chronic risks to fish (aquatic amphibians) and birds (terrestrial amphibians) were discussed in the direct effects section (5.2.1.1). No acute or chronic direct risks are expected for either fish or bird.

Based on direct risk estimates for expected food items (except aquatic plants) for both the aquatic and terrestrial phase CRLF, no indirect effects to the CRLF through reduction in food supply are expected. Therefore, the effects determination for indirect effects via reduction in food items (freshwater invertebrates and fish for the aquatic phase; terrestrial invertebrates and mammals for the terrestrial phase CRLF) is "no effect".

#### 5.2.2.2 Evaluation of Potential Indirect Effects via Reduction in Food Items, Habitat and/or Primary Productivity (Freshwater Aquatic Plants)

*Aquatic Non-vascular Plants*

None of the RQs for non-vascular aquatic plants exceed the LOC of 1 for aquatic plants for any of the uses of imazapyr in California, even when the aquatic application is modeled with 1 annual application for 30 years. It is assumed that like other frog species, the aquatic phase CRLF feed exclusively in water, consuming diatoms, algae, and detritus (USFWS 2002). These are generally non-vascular plants. Because direct risk to non-vascular plants from imazapyr uses is not expected, indirect risk to the aquatic phase CRLF from reduction in food supply (aquatic non-vascular plants) is not expected. Therefore, the effects determination for indirect effects via reduction in food items (aquatic non-vascular plants) for the aquatic phase CRLF is “no effect”.

*Aquatic Vascular Plants*

For aquatic vascular plants, the RQs do not exceed the aquatic plant LOC with the turf use, the forestry use with ground application and the residential use at the maximum application rates. However, the aquatic vascular plant RQs exceed the aquatic plant LOC for rangeland, rights-of-way, aquatic and forestry (aerial application) uses (see Table 5.1.2.2). As indicated in the previous sections, the aquatic uses were modeled using a single application. Since the RQ for aquatic vascular plants exceeds the aquatic plant LOC following a single application, it is expected to exceed following either multiple applications or single applications repeated once each year over any number of years.

Both the residential and rights-of-way uses have a variety of uses and use sites with a wide variety of impervious/pervious surface areas and areas that can be potentially treated. Therefore, for further characterization, residential and rights-of-way aquatic EECs were modeled for a matrix of % impervious surface and % impervious area treated for residential uses and % impervious surfaces treated and % watershed treated for the rights-of-way uses. Residential uses were modeled with an assumption of a 12% impervious surface, a range of 0% to 10% pervious surface and a range of 1% to 50% of the impervious area treated. Rights-of-way uses were modeled with a range of 1% to 50% impervious surfaces treated with 1 – 10% of the watershed treated.

As stated above, for residential uses, none of the aquatic vascular plant RQs exceeded the aquatic plant LOC. For rights-of-way uses, the aquatic vascular plant RQs exceed the aquatic plant LOC, for only the assumed 50% impervious surface and 10% of the watershed treated. None of the other aquatic vascular plant RQs exceed the aquatic plant LOC with any of the other impervious surface scenarios.

As described in the Problem Formulation section (Section 2.5.2), egg masses of the CRLF 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). They frequently breed in artificial impoundments such as stock 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).

The labels for aquatic uses state that imazapyr is not effective on totally submerged plants. Imazapyr is effective when applied to the emerged foliage of aquatic plants. This statement is supported by studies conducted on smooth cordgrass (*Spartina alterniflora*), a vascular plant (ECOTOX reference # 76872). Imazapyr was effective in killing these plants when they were on dry land but not effective when the plants were totally submerged. The labels further state that, when imazapyr is applied to the emergent part of the plant, it can then be “translocated throughout the plant, where it accumulates in rapidly-growing meristematic tissue….[It] is translocated into and kills underground or submerged storage organs to prevent regrowth." The labels also state that "injury or loss of non-target plants may result if [imazapyr] is applied onto or near desirable plants, or to areas where their roots extend, or in areas where treated soil may be washed or moved into contact with their root zone."

The design of the aquatic plant toxicity studies received by the Agency for herbicide registrations only considers direct application to the test water. The studies do not examine potential effects from a direct spray application or spray drift onto emergent aquatic vegetation. Based on the label information provided above, coupled with the study on smooth cordgrass, it would be relevant to evaluate risk to non-target aquatic emergent vegetation using both terrestrial plant exposure estimates and the standard estimated aquatic EECs from PRZM-EXAMS. The emergent vegetation that the CRLF may use for deposition of egg masses (bulrushes and cattails), although technically classified as aquatic vegetation, can act more like terrestrial plants when growing in semi-aquatic areas (http://www.explorebiodiversity.com/problem_plants/plants-by-habitat.htm and http://el.erdc.usace.army.mil/aqua/apis/plants/html/typha_sp.html). Therefore, when assessing risk to emergent aquatic vegetation using terrestrial exposure estimations, a better surrogate for the toxicological endpoints would be to use the most sensitive terrestrial plant toxicity endpoint.

For emergent aquatic plants, this assessment will evaluates risk from direct spray application to CRLF habitat within the treated area, spray drift from both aquatic and terrestrial uses, and flooding from an aquatic application into semi-aquatic areas.

***Risk to Emergent Aquatic Vegetation***

***Risk from Direct Application Within Habitat Area***

When imazapyr is used to control undesirable emergent and floating aquatic vegetation within the habitat area, the risk from direct spray onto non-target emergent plants would be estimated in a similar fashion as for direct spray onto terrestrial plants. It is assumed that the emergent aquatic plants are exposed directly to either 1.5 lbs/A or 0.91 lbs/A (residential uses). Using the most sensitive toxicity thresholds from the vegetative vigor studies (a seedling emergence endpoint would not apply to emergent aquatic vegetation for spray drift): 0.012 (monocot) and 0.0009 lbs/A (dicot) for terrestrial plants, the RQs would range from 125 for monocots to 1667 for dicots. For exposure to imazapyr in contaminated soil during the dry times after application to a semi-aquatic habitat area, the more sensitive seedling emergence endpoint for monocots (0.0046 lbs/A) would apply and the RQ for monocots would be increased to 326/198 for application rates of 1.5/0.91 lbs/A, respectively.

***Risk from Spray Drift Adjacent to Habitat Area***

Section 5.2.2.3 describes the risk to the terrestrial plant community. Risks to emergent plants following spray drift may be assessed using the same parameters (see Section 5.2.2.3.1). Using the most sensitive $EC_{25}$ values for both dicots and monocots, the RQs range from 2 – 83 with the application rates of 1.5 lbs ae/A and 0.91 lbs ae/A. Using some of the less sensitive $EC_{25}$ values, some monocots exposed via spray drift alone following either ground or aerial spray at 1.5 lbs ae/A and some of both monocots and dicots exposed via spray drift alone following ground spray at 0.91 lbs ae/A (residential uses) will not exceed the LOC for terrestrial plants. Therefore, it is possible that not all emergent aquatic plants will be affected following spray drift alone. Spray drift buffers are estimated in Section 5.2.2.4.

For each of the imazapyr uses, buffers based on expected spray drift may be added from the site of potential imazapyr application to the point where the LOC would no longer be exceeded for either listed plants (for defining the action area) or non-listed plants (for distinguishing between LAA and NLAA determinations). For listed plants, the buffers range from 7120 (forestry uses, ground application) to 26460 feet (forestery uses, aerial application). For non-listed plants, the buffers range from 2530 (forestry uses, ground application) to 5940 feet (forestry uses, aerial application). Buffers for the other imazapyr uses are in between the two forestry use buffers.

***Risk from Flooding of a Treated Aquatic Area***

Risks to emergent aquatic vegetation in semi-aquatic areas following flooding of an aquatic treated area is estimated using the same calculations as were used in the risk estimation section for terrestrial plants following flooding of an aquatic treated area to a semi-aquatic site (Table 5.1.2.3.b). The RQs will range from 28 – 79 for ground and aerial applications.

In summary, based on exceedance of the aquatic and terrestrial (for emergent aquatic plants) plant LOCs, the following general conclusions can be made with respect to potential harm to aquatic habitat:

- Imazapyr may enter aquatic areas via direct application, runoff, flooding and/or spray drift where it may be taken up by the plant and translocated to the root system of sensitive plants.

- Comparison of aquatic plant $EC_{50}$'s to estimated aquatic EECs suggests that aquatic non-vascular plants are not affected by imazapyr applications; therefore, reduction in aquatic plant food supply for CRLF tadpoles is not expected to be affected.

- Comparison of aquatic plant $EC_{50}$'s to estimated aquatic EECs suggests that aquatic vascular plants will not be affected by the turf uses, forestry (ground application) and residential uses but may be affected by forestry (aerial application), rangeland, aquatic and rights-of-way uses (where the area contains 50% impervious surfaces), resulting in degradation of the existing aquatic habitat, particularly for emergent aquatic plants.

- Comparison of seedling emergence and vegetative vigor $EC_{25}$ values to estimated EECs from exposure through imazapyr treated water overflowing to flood a terrestrial site and from spray drift estimations from Terrplant suggests that existing aquatic emergent vegetation typically used by the CRLF for reproduction may be affected. Since the aquatic uses of imazapyr are formulated to affect emergent aquatic plants, it is anticipated that the emergent vegetation upon which the CRLF attaches its egg masses may be affected by imazapyr uses. It is noted here that the Recovery Plan (USFWS 2002) states that CRLFs breed from November through late April. The CDPR PUR database reports imazapyr usage in forestry, rights-of-way, some landscape maintenance and a few pest control applications (www.cdpr.ca.gov/docs/pur/purmain.htm). The reported application times for these uses vary. Based on the available limited data, it appears that there is some direct overlap with the breeding season with rights-of-way applications and some landscape maintenance, both of which may be used all year around. The forestry uses and pest control applications tend to be applied at opposite times from the breeding season; however, the incidence data has shown damage to crops from carryover of an application the previous spring. In addition, imazapyr has been shown to be stable in aquatic environments and it can still kill plants when present in the soil. Therefore, it is expected that emergent vegetation may still be affected by imazapyr, even it it was applied in the previous season.

#### 5.2.2.3 Indirect Effects via Alteration in Terrestrial Plant Community (Riparian Habitat)

##### 5.2.2.3.1 Terrestrial Uses of Imazapyr

The estimated risks to terrestrial plants indicate that for all labeled non-crop terrestrial uses in California, the terrestrial plant LOC of 1 was exceeded for all monocots and dicots at all application rates by ground and aerial spray.

In Terrplant v1.2.2, the terrestrial plant RQs for monocots and dicots inhabiting dry and semi-aquatic areas are derived by dividing the total EEC by the most sensitive seedling emergence value. The EEC values from Terrplant are in Table 3.4. The seedling emergence $EC_{25}$ values for dicots range from 0.0024 – 0.008 lbs ae/A, and for monocots range from 0.0046 – 0.0054 lbs ae/A. The RQs with the terrestrial uses of imazapyr for monocots and dicots inhabiting dry and semi-aquatic areas (runoff and spray drift), utilizing the most sensitive seedling emergence $EC_{25}$ values range from 12 to 344. Even with the least sensitive $EC_{25}$ (0.008), the LOC for terrestrial plants would still be exceeded with any of the crops tested. These risk estimates are based on terrestrial plant toxicity data for a limited set of agricultural plants. Therefore, there are uncertainties associated with potential toxicity to the wide variety of non-agricultural plants inhabitating the CRLF habitat. Even if imazapyr only kills the most sensitive terrestrial plants, the habitat may still be sufficiently modified to the point such that it is no longer viable CRLF habitat.

In addition to affecting seedling emergence, because imazapyr is toxic to plants when it is taken up by the roots, runoff is also expected to affect emerged plants. The RQ values for plants exposed to runoff are estimated from the seedling emergence studies because of the limitations of the vegetative vigor studies. These studies do not measure effects to emerged plants following a runoff event. Therefore, there is an uncertainty with regard to the effect of runoff to emerged plants.

For RQs derived for spray drift only, TerrPlant compares estimated spray drift deposition, without a runoff exposure component, to the more sensitive measure of effect, either seedling emergence or vegetative vigor from both the monocot and dicot values. For spray drift only, the RQs range from 2 – 83 with the application rates of 1.5 lbs ae/A and 0.91 lbs ae/A. These values were derived from the most sensitive $EC_{25}$ value of 0.0009 lb ae/A (dicots). The $EC_{25}$ values range from 0.0009 to >0.0156 lbs ae/A (>17.3 X 0.0009) for dicots and from 0.0046 - > 0.0156 lbs ae/A (> 3.4 X 0.0046) for monocots for both the vegetative vigor and seedling emergence studies. Based on these ranges, some monocots exposed via spray drift alone following either ground or aerial application at 1.5 lbs ae/A and some of both monocots and dicots exposed via spray drift alone following ground spray at 0.91 lbs ae/A (residential uses) will not exceed the LOC for terrestrial plants. However, for the terrestrial applications, comparison of the RQs indicates that runoff, and not spray drift, is a larger contributor to potential risk for riparian vegetation.

#### *5.2.2.3.2 Aquatic Uses of Imazapyr*

The risk from spray drift and flooding of terrestrial plants inhabiting semi-aquatic areas was estimated in the risk estimation section. With the most sensitive seedling emergence toxicity thresholds of 0.0046 (monocot) and 0.0024 lbs/A (dicot) for terrestrial plants, the RQs range from 28-41 for monocots and 54 – 79 for dicots. Comparing the least sensitive seedling emergence $EC_{25}$ values to the estimated EECs, all of the monocots and dicots exposed via spray drift alone following either ground or aerial spray at 1.5 lbs ae/A (aquatic uses) will still exceed the LOC for terrestrial plants. The risk estimates for imazapyr-treated water flooding onto terrestrial sites are conservative because they do not address the uncertainty of dilution from rain water or water from other sources that originally precipitated the overflow.

***Summary for Terrestrial and Aquatic Uses of Imazapyr***

In summary, based on exceedance of the terrestrial plant LOCs for all terrestrial plant species following runoff, flooding and spray drift for both terrestrial and aquatic uses, the following general conclusions can be made with respect to potential harm to riparian habitat:

- Imazapyr may enter riparian areas via runoff, flooding of treated aquatic areas and/or spray drift where it may be taken up by the plant and translocated to the root system of sensitive plants.

- Comparison of seedling emergence $EC_{25}$ values to EECs estimated using Terrplant suggests that existing vegetation may be affected or inhibition of new growth may occur. 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. Inhibition of new growth may also slow the recovery of degraded riparian areas that function poorly due to sparse vegetation because imazapyr deposition onto bare soil would be expected to inhibit the growth of new vegetation. As stated previously, imazapyr is persistent. The incidence reports support the fact that its presence in soil can affect emergence of plants later in the year. The reports also support terrestrial plants being affected by root uptake from an aquatic application (see paragraph below).

- Because LOCs were exceeded for all species tested in the seedling emergence and vegetative vigor studies, it is likely that many species of herbaceous plants may be potentially affected by exposure to imazapyr via runoff and spraydrift.

- Some monocots exposed to the maximum non-residential application rate and some of both monocots and dicots exposed to the maximum residential application rate may not be affected by exposure to imazapyr via spray drift alone; however, runoff appears to be the larger contributor to potential risk for riparian vegetation.

The incidence data supports the risk conclusions for terrestrial plants for the imazapyr labeled uses. Damaged or dying trees (oak, cherry, pear, loblolly pine seedlings, willow and spruce) were reported, most of which were rated as probably related to exposure to imazapyr (a couple incidences were rated as possibly related to exposure to imazapyr). Damage to crops (beans, corn, wheat, grape vines) was also reported. These effects were observed following a variety of use applications, all of which are possible for imazapyr according to its registered uses and all of which are addressed in this risk assessment: a nearby spray application, root uptake of residual imazapyr from the soil following an aquatic application, damage to a crop from carryover of an application the previous spring, runoff event from a treated adjacent site and a nearby application to a driveway surface.

#### 5.2.2.4 Spray Drift Buffers for Non-Target Plants

The AgDrift model was used to calculate spray drift buffers that would be needed to avoid adverse effects to non-target terrestrial and aquatic vascular emergent plant species. For the action area, the NOAEC of 0.000064 lb/acre (vegetative vigor study with imazapyr acid on cucumber) was used as a reference toxicity endpoint (terrestrial plant value used for endangered species) for estimation of the spray drift buffer distances. Because the CRLF does not have an obligate relationship with any particular plant species, the cucumber $EC_{25}$ of 0.0009 lb/acre was used as a toxicity endpoint (terrestrial plant value used for non-listed species) for estimation of the spray drift buffer distances that will be used to discriminate between the LAA and the NLAA determination. All of the buffer values for all use rates were beyond the range of the model. Therefore, AGDISP (v. 8.15) was used to estimate spray drift buffers. Again, the buffer values were out of range for the AGDISP model. Therefore, the Gaussian Far-Field Extension was utilized to get an estimate of the size of the buffer needed for the effects on terrestrial plants to be below the Level of Concern for plants. The following tables provide the estimated buffers for the uses with the highest potential exposures for plants. For the action area, the buffer distances required to dissipate spray drift to levels that are protective of listed plants range from 7120 (forestry, ground application) to 26460 feet (forestry, aerial application). These buffers are based on the listed species terrestrial plant toxicity endpoint. For discrimination between the LAA and NLAA determinations, the buffer distances range from 2530 to 5940 feet. Table 5.2.2.4.a provides the buffer distances for the various uses of imazapyr and Table 5.2.2.4.b shows the differences in buffer distances for forestry uses with varying droplet sizes.

**Table 5.2.2.4.a Imazapyr AGDISP Buffers for Listed and Non-Listed Terrestrial Plant Species**

| Use Site and % Acid Equivalents | Application | Release Height (feet) | Volume Product Applied (Gal/lb/A) | Buffer Distance | |
|---|---|---|---|---|---|
| | | | | For LAA Determination | For Action Area |
| | | | | Non-Listed Plants (ft) | Listed Plants (ft) |
| Aquatic 22.6% | Ground | 4 | 0.75/1.5 | 2920 | **9800** |
| Aquatic 22.6% | Aerial Helicopter | 10 | 0.75/1.5 | 3470 | **15110** |
| Aquatic 23.4% | Ground | 4 | 0.75/1.5 | 2940 | **9960** |
| Aquatic 23.4% | Helicopter | 10 | 0.75/1.5 | 3540 | **15420** |
| Forestry 43.3% | Ground | 4 | 0.375/1.5 | 2530 | **7120** |
| Forestry 43.3% | Aerial Fixed Wing | 10 | 0.375/1.5 | 5940 | **26460** |
| Forestry 43.3% | Aerial Helicopter | 10 | 0.375/1.5 | 4660 | **21160** |
| Other Terrestrial 22.6% | Ground | 4 | 0.75/1.5 | 2920 | **9800** |
| Other Terrestrial 22.6% | Aerial Fixed Wing | 10 | 0.75/1.5 | 4640 | **19420** |

**[Bold] buffer distance used for Action Area.**
**Wind speed = 10 mph**
**Spray volume rate (volume of finished spray applied) = 5 gallons water/A**
**Specific gravity = 1.06**
**Initial average deposition ($EC_{25}$/application rate or NOAEC/application rate for Action Area: 0.0006 lb/A for non-listed plants and 0.0000426 lb/A for listed plants)**
**Droplet size very fine to fine**

| Table 5.2.2.4b. Imazapyr AGDISP Buffers for Forestry Uses with Listed and Non-Listed Terrestrial Plant Species Using Various Droplet Sizes | | | | | |
|---|---|---|---|---|---|
| **Droplet Size** | **Application** | **Release Height (feet)** | **Volume Product Applied (Gal/lb/A)** | **Buffer Distance** | |
| | | | | **For LAA Determination** | **For Action Area** |
| | | | | **Non-Listed Plants (ft)** | **Listed Plants (ft)** |
| Very fine to fine | Ground | 4 | 0.375/1.5 | 2530 | **7120** |
| Medium | Ground | 4 | 0.375/1.5 | 1750 | **2590** |
| Medium to Coarse | Ground | 4 | 0.375/1.5 | 1680 | **2200** |
| Coarse | Ground | 4 | 0.375/1.5 | 1670 | **2130** |
| Very fine to fine | Aerial Helicopter | 10 | 0.375/1.5 | 4660 | **21160** |
| Medium | Aerial Helicopter | 10 | 0.375/1.5 | 2210 | **8400** |
| Medium to Coarse | Aerial Helicopter | 10 | 0.375/1.5 | 2440 | **6870** |
| Coarse | Aerial Helicopter | 10 | 0.375/1.5 | 1690 | **5970** |
| Very fine to fine | Aerial Fixed Wing | 10 | 0.375/1.5 | 5940 | **26460** |
| Medium | Aerial Fixed Wing | 10 | 0.375/1.5 | 2770 | **10170** |
| Medium to Coarse | Aerial Fixed Wing | 10 | 0.375/1.5 | 2240 | **7590** |
| Coarse | Aerial Fixed Wing | 10 | 0.375/1.5 | 2050 | **6650** |

**[Bold] buffer distance used for Action Area**
**Wind speed = 10 mph**
**Spray volume rate (volume of finished spray applied) = 5 gallons water/A**
**Specific gravity = 1.06**
**Initial average deposition ($EC_{25}$/application rate for Action Area: 0.0006 lb/A for non-listed plants and 0.0000426 lb/A for listed plants)**
**Forestry uses: 43.3% acid equivalent formulation**

The current label use information memorandum (Kinard and Tompkins 05/07/07) provides mitigation measures to reduce environmental exposure of imazapyr. It is not known when these measures will be implemented because the reregistration process will not be completed for 2 years and the registrants will be allowed to distribute products with old labels for up to 18 months after the new labels are approved. In addition, existing stocks can be used until they are exhausted. It is assumed that most users will use their existing stocks within 2 years of purchase. The mitigation measures identified in the June 12, 2006 RED are as follows:

- For aerial applications, applicators are required to use a Coarse or coarser droplet size (ASABE S572) or, if specifically using a spinning atomizer nozzle, applicators are required to use a volume mean diameter (VMD) of 385 microns or greater for release heights below 10 feet; Applicators are required to use a Very Coarse or coarser droplet size or, if specifically using a spinning atomizer nozzle, applicators are required to use a VMD of 475 microns or greater for release heights above 10 feet; applicators must consider the effects of nozzle orientation and flight speed when determining droplet size;

- For aerial applications, applicators are required to use upwind swath displacement;

- For aerial applications, the boom length must not exceed 60% of the wingspan or 90% of the rotor blade diameter, to reduce spray drift;

- For aerial applications, applications with wind speeds less than 3 mph and with wind speeds greater than 10 mph are prohibited;

- For groundboom applications, applicators are required to use a nozzle height below 4 feet above the ground or plant canopy and coarse or coarser droplet size (ASABE S572) or, if specifically using a spinning atomizer nozzle, applicators are required to use a VMD of 385 microns or greater;

- For groundboom applications, applications with wind speeds greater than 10 mph are prohibited;

- Applications into temperature inversions are prohibited.

Based on the estimations in Table 5.2.2.4b, utilization of a coarse droplet size could potentially reduce the buffer distance 1.5 to 4-fold. Other mitigation measures would also be expected to reduce environmental exposure.

Because RQs for terrestrial plants are above the Agency's LOCs, imazapyr use is considered to have the potential to directly impact plants in riparian areas, potentially resulting in degradation of stream water quality and alteration of the CRLF's habitat. Therefore, an analysis of the potential for habitat degradation to affect the CRLF is necessary.

Riparian plants beneficially affect water and stream quality in a number of ways (discussed below) in both adjacent river reaches and areas downstream of the riparian zone. Imazapyr use in the action area, which is inclusive of the CRLF range, may potentially affect these species by impacting riparian vegetation and subsequently causing a degradation in water quality and alteration of available habitat. In order to characterize the potential indirect effects caused by imazapyr-related impacts to riparian vegetation, a general discussion of riparian habitat and its relevance to the CRLF and a description of the types of riparian zones that may be potentially impacted by imazapyr use in the action area for the CRLF are discussed below.

#### *5.2.2.5 Importance of Riparian Habitat to the CRLF*

Riparian vegetation provides a number of important functions in the stream/river ecosystem for the CRLF, including the following:

- serves as an energy source;
- provides organic matter to the watershed;
- provides shading, which ensures thermal stability of the stream

- serves as a buffer, filtering out sediment, nutrients, and contaminants before they reach the stream; acts as a stabilizing factor for water chemistry/quality.
- provides shelter, foraging, predator avoidance, aestivating habitat and terrestrial dispersal habitat for juveniles and adults
- provides habitat support for food source of CRLFs
- stabilizes the channel/pond morphology or geometry

The specific optimal characteristics of a riparian zone for the CRLF are expected to vary with developmental stage, the use of the reach adjacent to the riparian zone, and the hydrology of the watershed. Criteria developed by Fleming et al. (2001) have been used to assess the health of riparian zones and their ability to support habitat for aquatic communities. These criteria, which include the width of vegetated area (i.e. distance from cropped area to water), structural diversity of vegetation, and canopy shading, are summarized in Table 5.2.2.5.

**Table 5.2.2.5. Criteria for Assessing the Health of Riparian Areas to Support Aquatic Habitats** (adapted from Fleming et al. 2001)

| | **Quality** | | | |
|---|---|---|---|---|
| **Criteria** | **Excellent** | **Good** | **Fair** | **Poor** |
| Buffer width | >18m | 12 - 18m | 6 - 12m | <6m |
| Vegetation diversity | >20 species | 15 - 20 species | 5 - 14 species | <5 species |
| Structural diversity | 3 height classes grass/shrub/tree | 2 height classes | 1 height class | sparse vegetation |
| Canopy shading | mixed sun/shade | sparse shade | 90% sun | no shade |

To maintain at least "good" water quality for aquatic habitats in general, riparian areas should contain at least a 12 m (~40 feet) wide vegetated area, 15 plant species, vegetation of at least two height classes, and provide at least sparse shade (>10% shade). In general, higher quality riparian zones (wider vegetated areas with greater plant diversity) are expected to have a lower probability of being significantly affected by imazapyr than poor quality riparian areas (narrower areas with less vegetation and little diversity).
The following attributes of riparian vegetation habitat quality were evaluated for this assessment: sedimentation; thermal stability; stabilization of channel/pond morphology; water chemistry/quality; habitat for shelter, foraging, predator avoidance, aestivation, and dispersal and support for food source of CRLFs. Each of these attributes and their relative importance with respect to the CRLF is discussed briefly below.

***Stabilization of channel/pond morphology***

Riparian vegetation typically consists of three distinct types of plants, including a groundcover of grasses and forbs, an understory of shrubs and young trees, and an overstory of mature trees. These plants serve as structural components for streams, with the root systems helping to maintain stream stability, and the large woody debris from the mature trees providing instream cover. Riparian vegetation has been shown to be essential to maintenance of a stable stream (Rosgen, 1996). Destabilization of the stream can have a severe impact on aquatic habitat quality. In fact, geomorphically stable stream and river channels and banks are identified as PCEs for designated critical habitat of the CRLF. Any action that would significantly alter channel morphology or geometry to a degree that would appreciably reduce the value of the critical habitat for both the long-term survival and recovery of the species is considered as part of the critical habitat impact analysis. Channelization of creeks reduces or eliminates breeding sites and increases suitability for predators such as non-native fish, bullfrogs, and raccoons, all of that thrive in disturbed conditions.

Following a disturbance in the watershed bank, the stream may widen, releasing sediment from the stream banks and scouring the stream bed. Changes in depth and or the width/depth ratio via physical modification to the stability of stream and river banks may also affect light penetration and the flow regime of the CRLF's habitat. Destabilization of the stream can have severe effects on aquatic habitat quality by increasing sedimentation within the watershed. The effects of sedimentation are summarized below.

***Sedimentation***

Sedimentation refers to the deposition of particles of inorganic and organic matter from the water column. Increased sedimentation is caused primarily by disturbances to river bottoms and streambeds and by soil erosion. Riparian vegetation is important in moderating the amount of sediment loading from upland sources. The roots and stems of riparian vegetation can intercept eroding upland soil (USDA NRCS, 2000), and riparian plant foliage can reduce erosion from within the riparian zone by covering the soil and reducing the impact energy of raindrops onto soil (Bennett, 1939). The CRLF recovery plan states that high levels of sediment introduced into streams can alter primary productivity and fill interstitial spaces in streambed materials with fine particulates, which impede water flow, reduce dissolved oxygen levels, and restrict waste removal.

***Water chemistry/quality and thermal stability***

Water quality parameters, including temperature may be impacted by direct effects to forested riparian areas. Riparian habitat includes mature woody trees which provide stream shading, thus stabilizing the thermal environment within the stream. The CRLF recovery plan states that early embryos of northern red-legged frogs are tolerant of temperatures only between 9 and 21 degrees Celsius. Observations in the field indicate that the areas with the greatest number of CRLF tadpoles had mean water temperatures between 15.0 and 24.9 degrees Celsius and that no CRLF's were present when temperatures exceed 22 degrees Celsius, particularly when there are no cooler sections in the pool. In addition, increased temperatures encourages reproduction of bullfrog and nonnative warm water fishes.

***Habitat for shelter, foraging, predator avoidance, aestivation, and dispersal***

The CRLF recovery plan states that during periods of wet weather, some individuals may make overland excursions through upland habitats. Evidence indicates that CRLF movements, via upland habitats, of about 1.6 – 3 kilometers, are possible over the course of a wet season without apparent regard to topography, vegetation type, or riparian corridors. The manner in which CRLFs use upland habitats is not well understood. CRLFs spend considerable time resting and feeding in riparian vegetation when it is present. It is believed that the moisture and cover of the riparian plant community provide good foraging habitat and may facilitate dispersal in addition to providing pools and backwater aquatic areas for breeding. CRLFs can be encountered living within streams at distances exceeding 3 kilometers from the breeding site, and have been found up to 30 meters from water in adjacent dense riparian vegetation, for up to 77 days (USFWS 2002).

***Habitat support for food source of CRLFs***

The CRLF recovery plan states that loss of streamside vegetation reduces habitat for insects and small mammals, which are important dietary components for aquatic and riparian associated species, including the CRLF. If the habitat changes, non-native animals may increase, which may in turn, prey on the CRLF. In addition to non-native animals, if the native riparian species are altered, non-native plants may invade and threaten the integrity of aquatic systems by out-competing and replacing native plants and thus decreasing plant diversity. These species not only change the structure and function of a riparian corridor, but also can result in losses of surface water due to their increased transpiration rates. Some non-native plant species may secrete toxic chemicals into the water, which may decrease the suitability of the area for the CRLFs. The relationship between the presence of non-native plants and habitat suitability for CRLF, however, is currently unknown (USFWS. 2002).

#### *5.2.2.6 Effect of Imazapyr on Health and Function of Riparian Areas*

As previously summarized in Table 5.2.2.5, the parameters used to assess riparian quality include buffer width, vegetation diversity, vegetation cover, structural diversity, and canopy shading. Buffer width, vegetation cover, and/or canopy shading may be reduced if imazapyr exposure impacts plants in the riparian zone or prevents new growth from emerging. Plant species diversity and structural diversity may also be affected if only sensitive plants are impacted (Jobin et al., 1997; Kleijn and Snoeijing, 1997), leaving non-sensitive plants in place. Imazapyr may also affect the long term health of high quality riparian habitats by affecting plant communities. Thus, if imazapyr exposure impacted these riparian parameters, water quality within the action area for the CRLF could be affected.

According to the labels and weed control handbooks (example: http://tncweeds.ucdavis.edu/products/handbook/17.Imazapyr.pdf), all plants, including woody plants are expected to be affected by imazapyr applications. Effects on shading, streambank stabilization, and structural diversity (height classes) of woody forested vegetation are expected. The riparian health criteria described in Fleming et al. (2001; Table 5.16) and the characteristics associated with effective vegetative buffer strips suggest that healthy riparian zones would be less sensitive to the impacts of imazapyr runoff than poor riparian zones. Wider buffers have more potential to reduce imazapyr residues over a larger area, resulting in lower loading levels. According to Fleming et al. (2001), buffer distances of >18 m (approximately 60 feet) are characterized as "excellent" in supporting aquatic habitats. In addition, trees and woody plants in a healthy riparian area may act to filter spray drift (Koch et al., 2003) and push spray drift plumes over the riparian zone (Davis et al., 1994), thus reducing exposure to herbaceous plants. Therefore, high quality riparian zones are expected to be less sensitive to imazapyr than riparian zones that are narrow, low in species diversity, and comprised of young herbaceous plants or unvegetated areas. Bare ground riparian areas could also be adversely affected by prevention of new growth of grass, which can be an important component of riparian vegetation for maintaining water quality. Since all types of vegetation, including woody plants are expected to be sensitive to imazapyr, it is likely that imazapyr will affect both forested and grassy riparian vegetation adjacent to use sites.

As a note, one uncertainty associated with overstory vegetation and protection from pesticide deposition on the ground relates to the spray-drift filtering effect of tree canopies. These may only be temporary. Chemicals that are intercepted by tree canopies and other overstory vegetation can be re-delivered to the surface during the first rainfall following pesticide application (Carlisle et al., 1967). This is especially true for chemicals that are persistent and soluble. Rainfall that contacts leaves and upper branches that have intercepted and collected spray drift is delivered to the surface via throughfall (rain hitting the tree canopy before reaching the ground) and stemflow (rain flowing along the branches, stems, and trunk of a tree, to the ground). Rain from these sources typically contains higher pesticide concentrations than rain that falls directly onto the ground (http://www.ars.usda.gov/research/programs/programs.htm?np_code=203&docid=1380). The effects of stemflow and throughfall on resident flora and fauna have also been documented. There is often a pronounced difference in soil chemistry (pH, nutrients, etc.) between areas of soil affected by stemflow and those outside the influence of canopy washoff (Gersper and Holowaychuk, 1971), with a concomitant impact on local invertebrates (Carpenter, 1982). Rainfall in riparian zones is also likely to enter the associated water body (stream, pond) rapidly in response to storms (as saturated overland flow), carrying additional pesticide load into the surface water. Thus, the interception of spray drift by tree canopies and the removal of the chemical from the local ecosystem may be overestimated, depending on persistence of the chemical and the time between application and rainfall. The chemical washed off the canopy may end up in the same water body as runoff water from the upland application area, at approximately the same time. Thus, the protective effect of a healthy woody riparian zone with tree canopies and other overstory vegetation on runoff into water bodies may be somewhat less than anticipated.

It is difficult to estimate the magnitude of potential impacts of imazapyr use on riparian habitat and the magnitude of potential effects on stream water quality, channel/pond morphology, sediment loading, thermal stability and habitat as they relate to survival, growth, and reproduction of the CRLF. The level of exposure and any resulting magnitude of effect on riparian vegetation are expected to be highly variable and dependent on many factors. The extent of runoff and/or drift into CRLF aquatic/terrestrial areas is affected by the distance the imazapyr use site is offset from the habitat, the method of application, local geography, weather conditions, and quality of the riparian buffer itself. The sensitivity of the riparian vegetation is dependent on the susceptibility of the plant species present to imazapyr and composition of the riparian zone (e.g. vegetation density, species richness, height of vegetation, width of riparian area).

Terrestrial plant RQs are above LOCs for all uses; therefore, riparian vegetation may be affected by use of imazapyr. As previously discussed, the potential for imazapyr to affect the CRLF via impacts on riparian vegetation depends primarily on the extent of potentially sensitive riparian zones and their impact on water quality in the streams and rivers where the CRLF are known to occur. Because woody plants are expected to be sensitive to imazapyr at anticipated exposure concentrations, riparian areas where the predominant vegetation is woody plants (e.g., trees and woody shrubs) may be impacted by imazapyr use. Therefore, imazapyr may adversely affect populations of CRLF in watersheds with predominantly forested riparian areas. Imazapyr is also likely to affect herbaceous and grassy riparian zones, resulting in increased sedimentation which could impact the CRLF in ways previously described.

Therefore, for CRLF habitats that are in close proximity to potential imazapyr use sites, the effects determination is “may affect and likely to adversely affect” because imazapyr may affect riparian zones with either herbaceous and grassy riparian zones or predominantly forested riparian zones.

Given the finding of “may affect and likely to adversely affect”, the Agency has completed a summary of the environmental baseline and cumulative effects for the CRLF included in this assessment in Attachment 2. The environmental baseline is defined as the effects of past and ongoing human induced and natural factors leading to the status of the species, its habitat, and ecosystem, within the action area. The baseline information provides a snapshot of the CRLF’s status at this time. A summary of all USFWS biological opinions that are relevant to the CRLF that have been made available to EPA included in this assessment is also provided as part of the baseline status. Cumulative effects include the effects of future state, tribal, local, private, or other non-federal entity activities on endangered and threatened species and their critical habitat that are reasonably expected to occur in the action area.

### 5.2.3 Adverse Modification to Designated Critical Habitat

#### 5.2.3.1 Direct Effects to Aquatic Plants

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

As stated in Sections 5.1.2.2 and 5.2.2.2, direct risk to non-vascular plants from imazapyr uses is not expected. Therefore, indirect effects on CRLF individuals via reduction in aquatic-based food sources for pre-metamorphs are not expected. The effects determination for the critical habitat impact analysis PCE associated with reduction and/or modification of aquatic-based food sources for pre-metamorphs (e.g. algae) is "no effect". This finding is based on lack of exceedances of the aquatic plant LOC for all nonvascular plants for all imazapyr uses.

Sections 5.1.2.2 and 5.2.2.2 indicate that direct risk to aquatic vascular plants from imazapyr uses on rangeland, rights-of-way with 50% or more impervious surfaces and 10% or more of the watershed treated, aquatic and forestry (aerial) uses is possible, especially for vascular plants with emerged foliage such as cattails and bulrushes where the CRLFs lay their eggs. Direct risk to emerged aquatic plants via spray drift alone from all imazapyr uses is also possible. Most of the PCEs listed above (alteration of channel/pond morphology or geometry, maintenance of water quality parameters, alteration in sediment deposition within stream channel or pond, alteration in habitat which provides shelter, foraging, predator avoidance and aquatic dispersal territories for juveniles and adults and alteration of other chemical characteristics necessary for maintenance of CRLF food source) are associated with a healthy aquatic vascular plant community. Therefore, based on the screening level analysis of indirect effects to the aquatic habitat via direct effects to aquatic plants (Sections 5.1.2.2 and 5.2.2.2), imazapyr may adversely modify designated critical habitat of the CRLF. The effects determination for all of these PCEs is "likely to adversely affect". This finding is based on exceedances of the aquatic plant LOC for vascular plants for rangeland, some rights-of-way, aquatic and some forestry uses and exceedances of the terrestrial plant LOC for all imazapyr uses following spray drift onto emergent aquatic vegetation.

#### 5.2.3.2 Adverse Modification to Designated Critical Habitat via Effects to Riparian Vegetation

Reduction in riparian vegetation could impact the following PCEs: (1) presence/maintenance of geomorphically stable stream and river channels; (2) maintenance of water quality parameters including temperature and turbidity; (3) presence/maintenance of silt-free substrates necessary for viability of the CRLF; (4) presence/maintenance of riparian habitat for shelter, foraging, predator avoidance, aestivation and terrestrial dispersal and (5) habitat support for the food source of CRLF's.

The potential for imazapyr to affect riparian vegetation was evaluated as an indirect effect to the CRLF and is presented in Sections 5.1.2.3 and 5.2.2.3. Conclusions from the analysis presented in Section 5.2.2.3 are also applicable to the evaluation of riparian vegetation as it relates to adverse modification of designated critical habitat and include the following:

- Riparian areas comprised of predominantly grassy and herbaceous vegetation in close proximity to imazapyr use may be affected such that their ability to maintain water quality could be reduced.

- Riparian areas comprised predominantly of forested land in close proximity to imazapyr use may be affected such that their ability to maintain thermal stability of the stream may be reduced.

- Riparian areas in close proximity to imazapyr use may be affected such that their ability to stabilize channel/pond morphology and sedimentation may be reduced.

- Riparian areas in close proximity to imazapyr use may be affected such that their ability to provide habitat for shelter, foraging, dispersal, predator avoidance, aestivation and support for the CRLF food source may be reduced.

Therefore, based on the screening level analysis of indirect effects to the riparian habitat via direct effects to terrestrial plants (Sections 5.1.2.3 and 5.2.2.3), imazapyr may adversely modify designated critical habitat of the CRLF. The effects determination for all of the PCEs listed above is "likely to adversely affect". This finding is based on exceedance of the terrestrial plant LOC of 1 for all monocots and dicots, in all modeled locations at all application rates by either ground or aerial spray.

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

The critical habitat impact analysis associated with chemical characteristics necessary for normal behavior, growth, and viability of all life stages of the CRLF is based on the direct effects to CRLF (Sections 5.1.1 and 5.2.1) and indirect effects to CRLF via reduction in food items (Sections 5.1.2.1, 5.1.2.2, 5.2.1, 5.2.2 and 5.2.2.2). Other indirect effects to the CRLF (via alteration to water quality and thermal stability, silt-free substrates and alteration in habitat) are assessed via other specified PCEs for their designated critical habitat. If LOCs are exceeded for direct effects and for indirect effects based on a reduction in food items, then the chemical environment is presumed to be such that normal behavior, growth, and viability of the CRLF's critical habitat may be adversely modified. Potential direct and indirect effects were previously evaluated. Results of those analyses are summarized below.

*Direct Effects to the Aquatic and Terrestrial Phase CRLF*

Section 5.2.1 summarizes the direct effects determination for both the aquatic and terrestrial phase CRLF. The effects determination is "no effect" following acute and chronic exposure to both the aquatic and terrestrial phase CRLF.

*Indirect Effects to the CRLF via Reduction in Food Items (Freshwater Invertebrates, Fish and Aquatic Plants (Algae) for the Aquatic Phase; Terrestrial Invertebrates and Mammals for the Terrestrial Phase)*

The effects determination for indirect effects via reduction in food items (freshwater invertebrates and fish for the aquatic phase and terrestrial invertebrates and mammals for the terrestrial phase CRLF) is "no effect". This finding is based on the lack of exceedances of the acute and/or chronic LOCs for direct effects on the food items of either the aquatic or terrestrial phase CRLF (Sections 5.2.2.1 and 5.2.2.2).

In summary, the effects determination for chemical characteristics necessary for normal behavior, growth, and viability of all CRLF life stages is "no effect". This finding is based on the lack of exceedances of the acute and chronic LOCs for direct effects on either the aquatic or terrestrial phase CRLF and for direct effects on their food items (Sections 5.2.1 and 5.2.2).

# 6. Assumptions, Limitations and Uncertainties

## 6.1 Uncertainties Related to Exposure For All Taxa

### 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 insecticide resistance, timing of applications, cultural practices, and market forces.

## 6.2 Exposure Assessment Uncertainties

Overall, the uncertainties inherent in the exposure assessment tend to result in both an over-estimation and under-estimation of exposures. Factors influencing the over-estimation of exposure in the screening level modeling include the assumption of no flow in the modeled water body. Furthermore, the impact of setbacks on runoff estimates has not been quantified, although well-vegetated setbacks are likely to result in significant reduction in runoff loading of imazapyr.

This risk assessment focuses on characterizing potential ecological risks resulting from a maximum use scenario, which is determined from labeled statements of maximum imazapyr 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 herbicide resistance, timing of applications, cultural practices, and market forces.

### 6.2.1 Modeling Assumptions

Generally, the uncertainties addressed in this assessment cannot be quantitatively characterized. However, given the available data and the tendency to rely on conservative modeling assumptions, it is expected that the modeling results in an over-prediction in exposure, particularly in the screening-level assessment.

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

### 6.2.2 Impact of Vegetative Setbacks on Runoff

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

### 6.2.3 PRZM Modeling Inputs and Predicted Aquatic Concentrations

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

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

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

The Agency acknowledges that there are some unique aquatic habitats that are not accurately captured by this modeling scenario and modeling results may, therefore, under- or over-estimate exposure, depending on a number of variables. For example, aquatic-phase CRLFs may inhabit water bodies of different size and depth and/or are located adjacent to larger or smaller drainage areas than the EXAMS pond. The Agency does not currently have sufficient information regarding the hydrology of these aquatic habitats to develop a specific alternate scenario for the CRLF. As previously discussed in Section 2.5.4 and Attachment 1, CRLFs prefer habitat with perennial (present year-round) or near-perennial water and do not frequently inhabit vernal (temporary) pools because conditions in these habitats are generally not suitable (Hayes and Jennings 1988). Therefore, the EXAMS pond is assumed to be representative of exposure to aquatic-phase CRLFs. In addition, the Services agree that the existing EXAMS pond represents the best currently available approach for estimating aquatic exposure to pesticides (USFWS/NMFS 2004).

### 6.2.4 Modeling Total Toxic Residues

In the absence of data concerning the toxicity of the two major imazapyr transformation products, the assumption that these two degradates were of equal toxicity to the parent compound was made. When the parent compound degraded under aqueous photolysis, the sum of residues for the parent compound and for the major degradate were taken at each sampling interval and plotted verses time, and regressed in order to obtain a total toxic residue half-life. When the parent compound does not degrade, the modeling input value for a stable compound was chosen, in spite of data indicating that the degradates are not stable under aerobic conditions. This value provides more conservative EECs than attempting to model each toxic moiety separately.

## 6.3 Terrestrial Assessment

### 6.3.1 Location of Wildlife Species

For the screening level terrestrial risk assessment, a generic bird or mammal was assumed to occupy either the treated field or adjacent areas receiving imazapyr at the treatment rate on the field. Actual habitat requirements of 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.

### 6.3.2 Routes of Exposure

For terrestrial animals, this screening level terrestrial assessment for spray applications of imazapyr only considered dietary exposure. Other routes of exposure that were not considered in the assessment are incidental soil ingestion exposure, inhalation exposure, dermal exposure, and drinking water exposure.

### 6.3.3 Residue Levels Selection

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. Depending upon a specific wildlife species' foraging habits, whole aboveground plant samples may either underestimate or overestimate actual exposure.

### 6.3.4 Dietary Intake

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.

Finally, the screening procedure does not account for situations where the feeding rate may be above or below requirements to meet free living metabolic requirements. Gorging behavior is a possibility under some specific wildlife scenarios (e.g., bird migration) where the food intake rate may be greatly increased. Kirkwood (1983) has suggested that an upper-bound limit to this behavior might be the typical intake rate multiplied by a factor of 5. In contrast, there may be potential for avoidance (animals respond to the presence of noxious chemicals in food by reducing consumption of treated dietary elements). This response is seen in nature where herbivores avoid plant secondary compounds.

Risk quotients calculated using the dose-based toxicity values are generally higher than RQs calculated using the dietary-based toxicity values. The dose-based approach considers the uptake and absorption kinetics of a gavage toxicity study to approximate exposure associated with uptake from a dietary matrix. Toxic response is a function of duration and intensity of exposure. For many compounds a gavage dose represents a very short-term high intensity exposure. Although the dose-based estimates may not reflect reality in that animals do not receive a gavage while feeding, it is possible that a short-duration, high-intensity exposure could occur associated with feeding on a agricultural field since many birds may gorge themselves when food items are available. On the other hand, the dietary-based approach assumes that animals in the field are consuming food at a rate similar to that of confined laboratory animals despite the fact that energy content in food items differs between the field and the laboratory as does the energy requirements of wild and captive animals. Also, the design of dietary-based studies precludes the estimation of food consumption on a per-bird basis since birds are group housed and tend to spill feed further confounding any estimates of food consumption.

## 6.4 Effects Assessment Uncertainties

### 6.4.1 Age Class and sensativity of Effects Threshold

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 pesticidal active ingredients, such as imazapyr, 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.

### 6.4.2 Use of Freshwater Fish and Bird Toxicity Data for the CRLF

Freshwater fish and birds were used as surrogate species for the aquatic and terrestrial phases of the CRLF, respectively. Submitted studies indicate that imazapyr is not toxic to either aquatic or terrestrial animals. The mode of action for imazapyr supports the submitted data. Nevertheless, since there are no data on the effects of imazapyr on either the CRLF or other amphibians, there is an uncertainty associated with the potential effects on both the aquatic and terrestrial phase CRLF. However, 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.

### 6.4.3 Sublethal Effects

For an acute risk assessment, 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 assessment is exercised on a case-by-case basis and only after careful consideration of the nature of the sublethal effect measured and the extent and quality of available data to support establishing a plausible relationship between the measure of effect (sublethal endpoint) and the assessment endpoints.

No sublethal effects were observed in any of the studies that were more sensitive than the endpoints used to calculate risk quotients for direct and indirect effects to the CRLF. No treatment-related sublethal effects were observed in the freshwater animal studies. For birds, no treatment-related sublethal effects were observed following either acute or chronic exposure. For mammals, the only observed sublethal effect was salivation in a gavage developmental study in the rat. The effect is likely due to the route of administration and is not likely to occur in wild mammalian populations.

## 6.5 Assumptions Associated with the Acute LOCs

The risk characterization section of this listed species assessment includes an evaluation of the potential for individual effects. 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 for the effects study corresponding to the taxonomic group for which the LOCs are exceeded.

For imazapyr, no mortality was observed in acute toxicity studies for freshwater fish (rainbow trout, bluegill sunfish, channel catfish), freshwater invertebrates (daphnia), birds (bobwhite quail, mallard ducks), honey bees, or mammals (Sprague-Dawley rats). Consequently, a default slope assumption of 4.5 with default upper and lower slope bounds of 2 and 9 were used as per original Agency assumptions of a typical slope cited in Urban and Cook (1986). The use of a default slope assumption provides an uncertainty in the probability of individual effects; however, as stated previously, the mode of action for imazapyr supports a conclusion that it will have no direct effects to either aquatic or terrestrial animals.

## 6.6 Uncertainty in the Potential Effect to Riparian Vegetation vs. Increased Sedimentation

Effects to riparian vegetation were evaluated using submitted guideline seedling emergence and vegetative vigor studies. LOCs were exceeded for seedling emergence and vegetative vigor endpoints with the vegetative vigor endpoint being considerably more sensitive. Based on LOC exceedances and the lack of readily available information to allow for characterization of riparian areas of the CRLF, it was concluded that imazapyr use is likely to adversely affect the CRLF via potential impacts on grassy/herbaceous and forested riparian vegetation resulting in increased sedimentation. However, soil retention/sediment loading is dependent on a number of factors including land management and tillage practices. Use of herbicides (including imazapyr) may be incorporated into a soil conservation plan. Therefore, although this assessment concludes that imazapyr is likely to adversely affect the CRLF and its designated critical habitat by potentially impacting riparian areas, it is possible that adverse impacts on sediment loading may be ameliorated in areas where soil retention strategies are used.

## 6.7 Usage Uncertainties

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

## 6.8 Action Area

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

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

## 7. Risk Conclusions:  Summary of Direct and Indirect Effects to the CRLF and Adverse Modification to Designated Critical Habitat for the CRLF

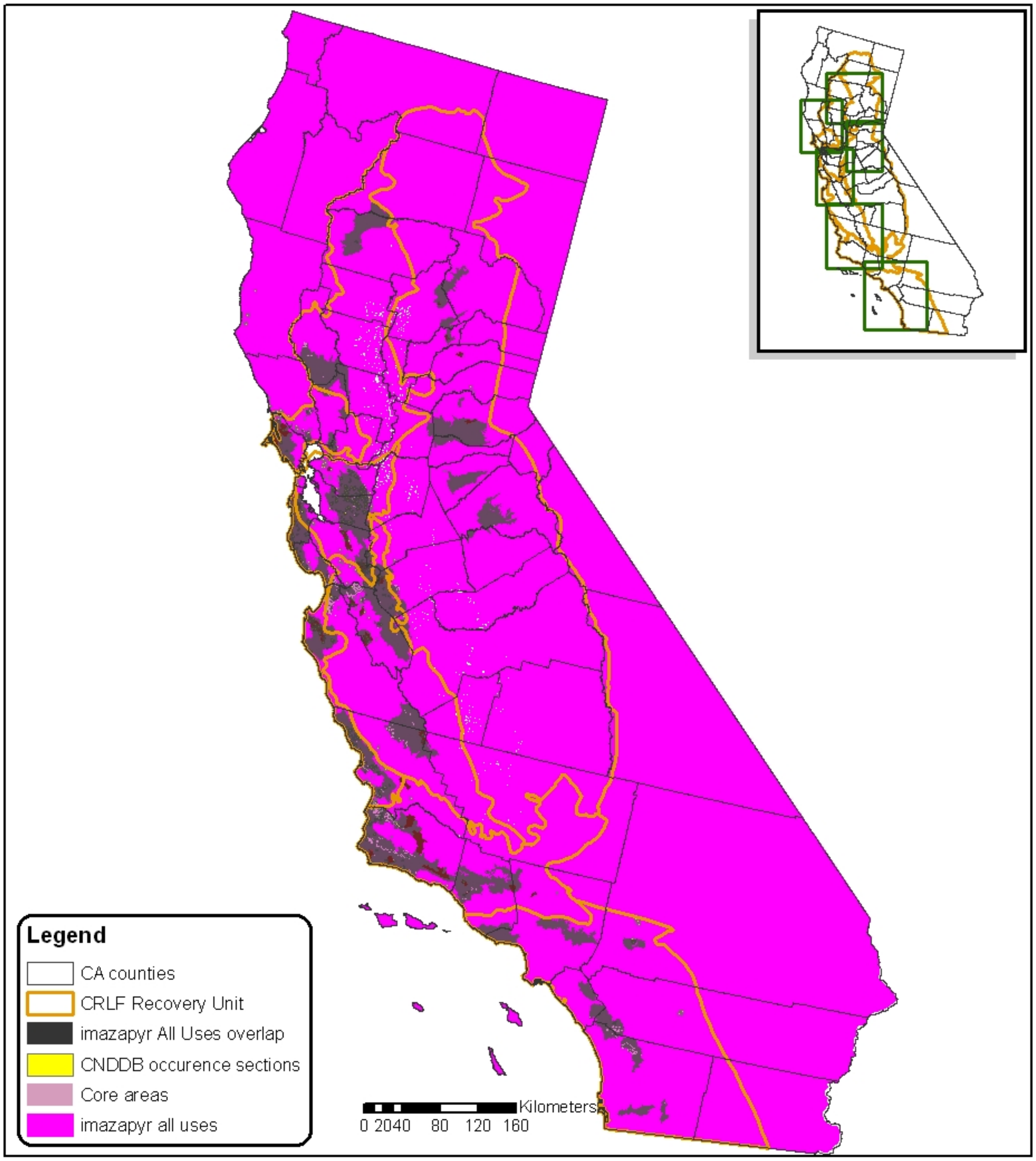
In fulfilling its obligations under Section 7(a)(2) of the Endangered Species Act, the information presented in this listed species risk assessment represents the best available data to assess the potential risks of imazapyr to the CRLF and its designated critical habitat.  A summary of the risk conclusions and effects determination for the CRLF and designated critical habitat for the CRLF, given the uncertainties discussed in Section 6, is presented in Tables 7.1 and 7.2.

The CRLF has no obligate relationships with either aquatic or terrestrial plants.  Therefore, the LAA/NLAA discrimination is based on direct effects to non-listed aquatic and terrestrial plants (i.e., indirect effects to habitat and/or primary productivity).  To distinguish between an LAA and an NLAA determination, for each of the imazapyr uses that are applied either as a ground or aerial spray, buffers based on expected spray drift are added from the site of potential imazapyr application to the point where the LOC for non-listed terrestrial plants would no longer be exceeded.  For non-listed plants, these buffers range from 2530 to 5940 feet (see Table 7.1).  For aquatic plants, a total of 7,450 downstream miles may also be used for this determination.

After completing the analysis of the effects of imazapyr on the Federally listed threatened California red-legged frog *(Rana aurora draytonii),* in accordance with methods delineated in the Overview Document (USEPA 2004), it is concluded that the use of imazapyr and its isopropylamine salt (PC Code #'s 128821 and 128829) is may affect, and is likely to adversely affect the CRLF, based on indirect effects (habitat modification to aquatic and terrestrial plants). It is also concluded that these same effects will constitute adverse modification to critical habitat. These effects are anticipated to occur only for those occupied core habitat areas, CNDDB occurrence sections, and designated critical habitat for the CRLF that are located within distances ranging from 2530 to 5940 feet, depending upon the specific use from legal use sites (see Table 7.1). Rationale and specifics for each component assessed are provided Tables 7.1 and 7.2.

Using ARGIS9, the NLCD classification data and CLRF habitat information supplied by the U.S. FWS, habitat areas where indirect effects and designated critical habitat areas where adverse modifications are anticipated to occur have been identified (Figure 7.1). Even without buffers on any of the imazapyr uses, indirect effects (modification of the terrestrial and aquatic vascular plant community) could potentially occur in approximately 94-100% (27,300 acres) of the CRLF range assessed, including core areas, critical habitat and known occurrences. Figure 7.1 shows the overlap of all imazapyr uses with no buffers with the CRLF core and critical habitat as well as the known occurrences. Firgure 7.2 shows that even with only the imazapyr forestry uses with a 5940 foot buffer, plus urban uses (no buffer) significantly overlap with the core areas, critical habitat and known occurrences by 68 – 99%. Detailed maps are provided in Appendix C.

## Imazapyr - Initial Area of Concern with Habitat Overlap




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

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

**Figure 7.1**

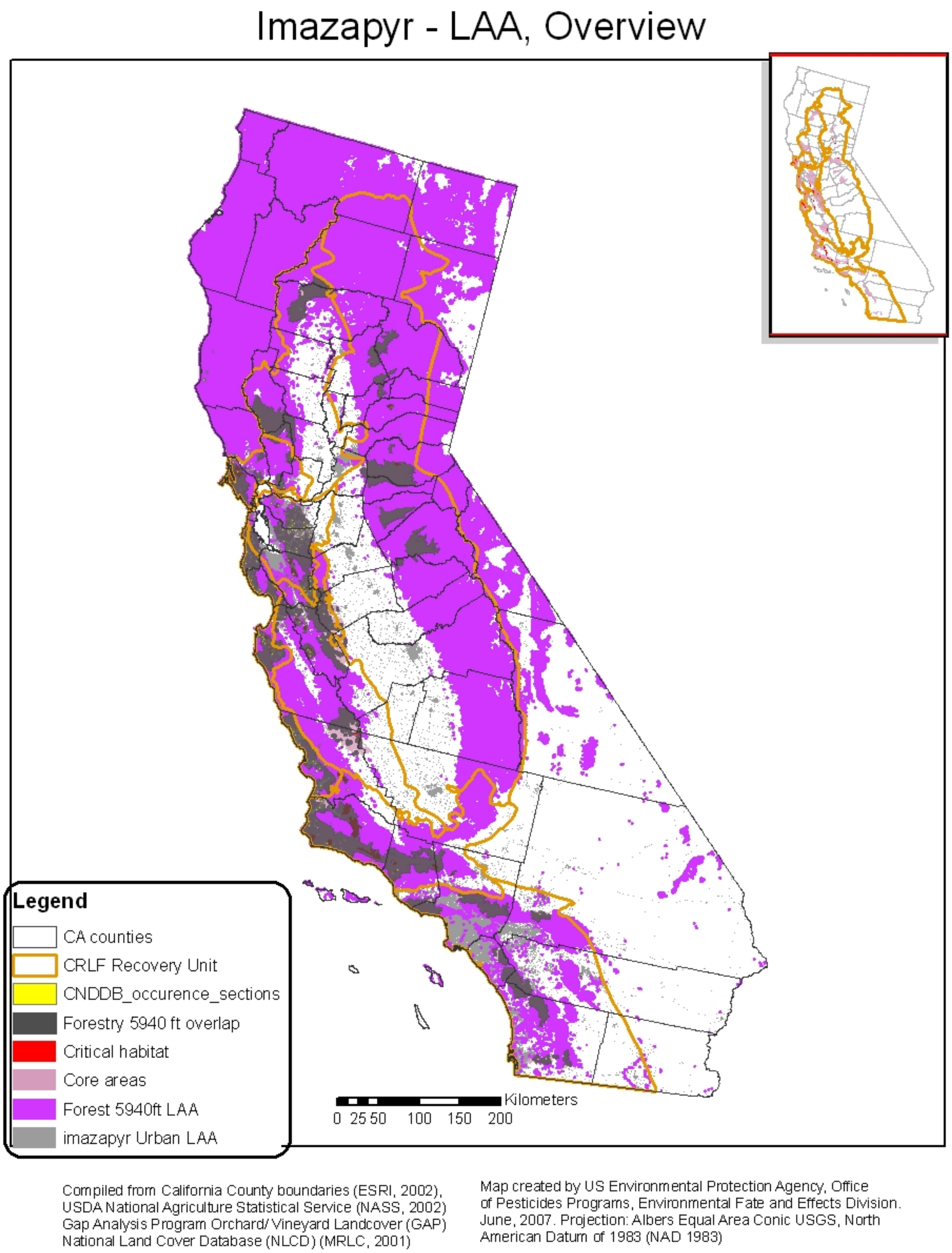



**Figure 7.2 Buffered Forestry Uses and Unbuffered Urban Uses with Habitat Overlap**

| Table 7.1. Imazapyr Effects Determination Summary for the CRLF (Direct and Indirect Effects) | | | |
|---|---|---|---|
| | Effects Determination and Basis | | |
| **Assessment Endpoint** | **Effects Determination**[1] | **NLAA/LAA Discrimination** | **Basis** |
| *Aquatic Phase* | | | |
| 1. Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases (eggs, larvae, tadpoles, juveniles and adults) | Acute direct effects: no effect | N/A | No effects in surrogate species (freshwater fish) at highest concentration tested, which is significantly greater than the peak aquatic EECs |
| | Chronic direct effects: no effect | N/A | Chronic freshwater fish (surrogate species) LOC is not exceeded for any uses. |
| 2. Survival, growth, and reproduction of CRLF individuals via indirect effects to prey (freshwater invertebrates) | Acute direct effects to freshwater invertebrates: no effect | N/A | No effects in freshwater invertebrates at highest concentration tested, which is significantly greater than the peak aquatic EECs. |
| | Chronic direct effects to freshwater invertebrates: no effect | N/A | Chronic freshwater invertebrate LOC is not exceeded for any uses |
| 3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat and/or primary productivity (i.e. aquatic plant community) | Direct effects to aquatic non-vascular plants: No affect | N/A | No LOCs exceeded for non-vascular plants. |
| | Direct effects to aquatic vascular plants: No effect for residential, turf and forestry (ground) May affect, likely to adversely affect for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses. | N/A | Aquatic plant LOCs exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses near use sites. Aquatic plant LOCs not exceeded for vascular plants for forestry (ground), residential or turf uses.[5] |

| Table 7.1. Imazapyr Effects Determination Summary for the CRLF (Direct and Indirect Effects) | | | |
|---|---|---|---|
| | **Effects Determination and Basis** | | |
| **Assessment Endpoint** | **Effects Determination[1]** | **NLAA/LAA Discrimination** | **Basis** |
| | Direct effects to aquatic emergent vascular plants: May affect, likely to adversely affect for all uses except capsule injection, which is may affect, .NLAA.. | Forestry uses (ground application) NLAA > 2530 feet, LAA ≤ 2530 feet<br>Non-forestry terrestrial uses (ground application) NLAA > 2920 feet, LAA ≤ 2920 feet<br>Aquatic uses (ground application) NLAA > 2940 feet, LAA ≤ 2940 feet<br>Aquatic uses (helicopter application)) NLAA > 3540 feet, LAA ≤ 3540 feet<br>Non-forestry terrestrial uses (aerial application fixed wing) NLAA > 4640 feet, LAA ≤ 4640 feet<br>Forestry uses (aerial application helicopter) NLAA > 4660 feet, LAA ≤ 4660 feet<br>Forestry uses (aerial application fixed wing) NLAA > 5940 feet, LAA ≤ 5940 feet | Aquatic plant LOCs exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses near use sites. Aquatic plant LOCs not exceeded for vascular plants for forestry (ground), residential or turf uses. Emergent aquatic vascular plants in wetland areas adjacent to use sites: terrestrial plant LOC exceeded for monocots and dicots for all uses from flooding, runoff or spray drift[2-5] Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| *Terrestrial Phase* | | | |
| 4. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles | Acute direct effects: no effect | N/A | No effects in surrogate species (birds) at highest concentration/dose tested which are significantly greater than the terrestrial EECs |
| | Chronic direct effects: no effect | N/A | Chronic bird (surrogate species) LOC is not exceeded for any uses |
| 5. Survival, growth, and reproduction of CRLF individuals via indirect effects on prey (i.e., terrestrial invertebrates, small terrestrial vertebrates) | Acute direct effects to most sensitive prey: no effect | N/A | No effects in mammals at highest dose tested, which is significantly greater than the terrestrial EEC. |
| | Chronic direct effects to most sensitive prey: no effect | N/A | Chronic terrestrial animal (mammals) LOC is not exceeded for any uses. |
| 6. Survival, growth, and reproduction of CRLF individuals via indirect effects on | Direct effects to monocots: May affect<br>Likely to adversely | See details in Assessment Endpoint number 3 above. | Terrestrial plant LOC exceeded for monocots in both wetlands and uplands adjacent to use site for all uses. Risk conclusions are supported by adverse ecological incident reports.[2-5] Capsule |

| Table 7.1. Imazapyr Effects Determination Summary for the CRLF (Direct and Indirect Effects) | | | |
|---|---|---|---|
| | Effects Determination and Basis | | |
| **Assessment Endpoint** | **Effects Determination**[1] | **NLAA/LAA Discrimination** | **Basis** |
| habitat (i.e. riparian vegetatation) | affect. May affect, NLAA for capsule injection use | | injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| | Direct effects to dicots: May affect Likely to adversely affect. May affect, NLAA for capsule injection use | See details in Assessment Endpoint number 3 above. | Terrestrial plant LOC exceeded for dicots in both wetlands and uplands adjacent to use site for all uses. Risk conclusions are supported by adverse ecological incident reports.[2-5] Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |

N/A = Not applicable

[1] The LAA/NLAA cut will also be influenced by other factors such as height of application, timing of application, droplet size, upwind swath displacement, the length of the boom relative to the wingspan or rotor blade diameter, wind speed, nozzle height (for ground applications), application during temperature inversion, etc. New mitigation measures are being developed; however, products with the old labels will be allowed to be distributed for up to 18 months after new labels are approved. Therefore, it is not possible to determine when all product labels will reflect the new mitigation measures. It could be assumed that most users will use their existing stocks within 2 years of purchase.

[2] The risk estimates for imazapyr-treated water flooding onto terrestrial sites are conservative because they do not address the uncertainty of dilution from rain water or water from other sources that originally precipitated the overflow.

[3] Some monocots exposed via spray drift alone following either ground or aerial application at 1.5 lbs ae/A and some of both monocots and dicots exposed via spray drift alone following ground spray at 0.91 lbs ae/A (residential uses) will not exceed the LOC for terrestrial plants. However, for the terrestrial applications, comparison of the RQs indicates that runoff, and not spray drift, is a larger contributor to potential risk for riparian vegetation.

[4] In addition to affecting seedling emergence, because imazapyr is toxic to plants when it is taken up by the roots, runoff is also expected to affect emerged plants. The RQ values for plants exposed to runoff are estimated from the seedling emergence studies because of the limitations of the vegetative vigor studies. These studies do not measure effects to emerged plants following a runoff event. Therefore, there is an uncertainty with regard to the effect of runoff to emerged plants.

[5] It is not clear for rangeland uses, whether and to what extent the critical habitat exemption applies.

| Table 7.2. Effects Determination Summary for the Critical Habitat Impact Analysis | | | |
|---|---|---|---|
| **Assessment Endpoint** | **Effects Determination[1]** | **Determination of Habitat Modification** | **Basis** |
| *Aquatic Phase PCEs* | | | |
| *Aquatic breeding and non-breeding habitat* | | | |
| Alteration of channel/pond morphology and/or water chemistry/quality; increase in sediment deposition | Direct effects to aquatic plants: no effect for non-vascular plants;<br>No effect for aquatic vascular plants for residential, turf and forestry (ground).<br>Modification of critical habitat for aquatic vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses. | N/A | No LOCs exceeded for non-vascular plants. Aquatic plant LOC not exceeded for vascular plants for forestry (ground), residential or turf uses. Aquatic plant LOC exceeded for vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses.[5] |
| | Direct effects to aquatic emergent vascular plants: Modification of critical habitat | Forestry uses (ground application): habitat modification expected ≤ 2530 feet and not expected > 2530 feet<br>Non-forestry terrestrial uses (ground application): habitat modification expected ≤ 2920 feet and not expected > 2920 feet<br>Aquatic uses (ground application): habitat modification expected ≤ 2940 feet and not expected > 2940 feet<br>Aquatic uses (helicopter application)): habitat modification expected ≤ 3540 feet and not expected > 3540 feet<br>Non-forestry terrestrial uses (aerial application fixed wing): habitat modification expected ≤ 4640 feet and not expected> 4640 feet<br>Forestry uses (aerial application helicopter): habitat modification expected ≤ 4660 feet and not expected > 4660 feet<br>Forestry uses (aerial application fixed wing): habitat modification expected ≤ 5940 feet and not expected > | Aquatic plant LOCs not exceeded for aquatic vascular plants for forestry (ground), residential or turf uses. Aquatic plant LOCs exceeded for aquatic vascular plants for forestry (aerial), rangeland/hay, aquatic and rights-of-way uses. Emergent aquatic vascular plants in wetland areas adjacent to use sites: terrestrial plant LOC exceeded for monocots and dicots for all uses from flooding, runoff or spray drift[2-5]. Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |

| Table 7.2. Effects Determination Summary for the Critical Habitat Impact Analysis | | | |
|---|---|---|---|
| **Assessment Endpoint** | **Effects Determination**[1] | **Determination of Habitat Modification** | **Basis** |
| | | 5940 feet. | |
| | Direct effects to monocots: Modification of critical habitat. Modification of critical habitat not expected for capsule injection use. | See terrestrial buffer list above. | Terrestrial plant LOC exceeded for monocots in wetlands and uplands adjacent to use site for all uses.[2-5] Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| Alteration of channel/pond morphology and/or water chemistry/quality; increase in sediment deposition | Direct effects to dicots: modification of critical habitat Modification of critical habitat not expected for capsule injection use. | See terrestrial buffer list above. | Terrestrial plant LOC exceeded for dicots in wetlands and uplands adjacent to use site for all uses.[2-5] Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| *Terrestrial Phase PCEs* | | | |
| *Upland habitat and dispersal habitat* | | | |
| Elimination/disturbance of upland habitat and/or dispersal habitat | Direct effects to monocots: Modification of critical habitat Modification of critical habitat not expected for capsule injection use. | See terrestrial buffer list above. | Terrestrial plant LOC exceeded for monocots in wetlands and uplands adjacent to use site for all uses.[2-5] Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |
| | Direct effects to dicots: Modification of critical habitat Modification of critical habitat not expected for capsule injection use. | See terrestrial buffer list above. | Terrestrial plant LOC exceeded for dicots in wetlands and uplands adjacent to use site for all uses.[2-5] Risk conclusions are supported by adverse ecological incident reports. Capsule injection use expected to have very limited nonquantifiable exposure to non-target plants. |

N/A = Not applicable

[1] The LAA/NLAA cut will also be influenced by other factors such as height of application, timing of application, droplet size, upwind swath displacement, the length of the boom relative to the wingspan or rotor blade diameter, wind speed, nozzle height (for ground applications), application during temperature

inversion, etc. New mitigation measures are being developed; however, products with the old labels will be allowed to be distributed for up to 18 months after new labels are approved. Therefore, it is not possible to determine when all product labels will reflect the new mitigation measures. It could be assumed that most users will use their existing stocks within 2 years of purchase.

[2] The risk estimates for imazapyr-treated water flooding onto terrestrial sites are conservative because they do not address the uncertainty of dilution from rain water or water from other sources that originally precipitated the overflow.

[3] Some monocots exposed via spray drift alone following either ground or aerial application at 1.5 lbs ae/A and some of both monocots and dicots exposed via spray drift alone following ground spray at 0.91 lbs ae/A (residential uses) will not exceed the LOC for terrestrial plants. However, for the terrestrial applications, comparison of the RQs indicates that runoff, and not spray drift, is a larger contributor to potential risk for riparian vegetation.

[4] In addition to affecting seedling emergence, because imazapyr is toxic to plants when it is taken up by the roots, runoff is also expected to affect emerged plants. The RQ values for plants exposed to runoff are estimated from the seedling emergence studies because of the limitations of the vegetative vigor studies. These studies do not measure effects to emerged plants following a runoff event. Therefore, there is an uncertainty with regard to the effect of runoff to emerged plants.

[5] It is not clear for rangeland uses, whether and to what extent the critical habitat exemption applies.

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 adverse modification to critical habitat.

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