Risks of Mancozeb and Maneb Uses to the Federally Listed California Red Legged Frog
(*Rana aurora draytonii*)

Pesticide Effects Determination

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1 Executive Summary

The purpose of this assessment is to make an "effects determination" by evaluating the potential direct and indirect effects of the fungicides, mancozeb and maneb, on the survival, growth, and reproduction of the California red legged frog (*Rana aurora draytonii*). In addition, this assessment evaluates the potential for mancozeb and maneb uses to result in the modification of designated critical habitat for the California red legged frog (CRLF). 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).

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

Mancozeb and maneb are members of the ethylene-bis-dithio-carbamate group of fungicides (EBDCs). The two EBDCs are non-systematic preventive fungicides with wide use patterns throughout the United States. The use patterns of the two chemicals include: row, field and vegetable crops, orchards and vines, nursery and greenhouse, turf, and forestry. Use patterns are either for mancozeb alone, maneb alone, or can be interchanged between mancozeb and maneb. In addition, mancozeb and maneb can be used as seed or dip treatment for seed and seed pieces. The total number of federally registered products that can be used in California is 55 for mancozeb and 25 for maneb.

This assessment is unique as it covers two chemicals (mancozeb and maneb) with similar complex polymer chemistry. The decision to combine the two EBDCs in one assessment was based on the fact that both degrades into similar chemical species (though at varied rates), can be used interchangeably on one third of the use patterns, and most importantly produce a common degradate ethylenethiourea (ETU); a carcinogen. ETU is of human health concern and therefore it played an import role in regulatory decisions concerning use of the EBDCs (e.g., maximum seasonal or yearly labeled uses for mancozeb were set as maximum for EBDCs not mancozeb).

Parent mancozeb and parent maneb are applied under moist conditions (rain and/or irrigation-fed growing plants). Under such conditions, the two chemicals reaching the soil system are expected to be short lived due to their hydrolytic instability (hydrolysis half-life in hours). Therefore environmental exposure will result from chemical species produced by hydrolysis of mancozeb and maneb, which is the EBDC complex[1]. Given these factors, a process was implemented to arrive at

[1] The term EBDC complex is used to refer to a complex of multi chemicals that results from hydrolysis of either mancozeb or maneb. This EBDC complex forms from mancozeb and maneb and based on fate studies and media of formation, the suite of chemicals includes the following two categories: (1) chemicals associated with the short-term acute exposure potential which includes variable/low molecular weight polymeric chains and short-lived transient chemicals; and (2) chemicals associated with the long-term chronic exposure potential which includes ETU and ETU

the EBDCs acute and chronic exposure that can be closely related to submitted measures of acute and chronic effects (acute and chronic toxicity data). The process is presented in details elsewhere in this document (refer to section 2.10). The process is based on estimations of acute and chronic exposure to the chemicals present "in the EBDC complex" at the short-term for the potential acute exposure and for chemicals present "in the EBDC complex" at the long-term for the potential chronic exposure. The environmental fate properties of the two chemicals indicate that spray drift and run-off represent potential transport mechanisms of parents and resultant EBDC complex into the aquatic and terrestrial habitats of the CRLF. In this assessment, transport of parent mancozeb and maneb from initial application sties through spray drift and runoff are considered in deriving quantitative estimates of exposure to the CRLF, its prey and its habitats.

Since CRLFs exist within aquatic and terrestrial habitats, exposure of the CRLF, its prey and its habitats to mancozeb and maneb are assessed separately for the two habitats. Tier-II aquatic exposure models are used to estimate high-end exposures of the EBDC complex in aquatic habitats resulting from runoff and spray drift from different uses. Peak model-estimated environmental concentrations of the EBDC complex resulting from the different mancozeb and maneb major uses range from 0.7 to 132 ppb depending on whether mancozeb or maneb is used. To estimate mancozeb and maneb exposures to the terrestrial-phase CRLF, and its potential prey resulting from uses involving mancozeb and maneb applications, the T-REX model is used. AgDRIFT and AgDISP are also used to estimate potential deposition of the two EBDCs on terrestrial habitats from spray drift. The TerrPlant model is used to estimate exposures to terrestrial-phase habitat, including plants inhabiting semi-aquatic and dry areas, resulting from foliar application.

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

Risk quotients (RQs) are derived as quantitative estimates of potential high-end risk. Acute and chronic RQs are compared to the Agency's levels of concern (LOCs) to identify instances where mancozeb and maneb use within the action area has the potential to adversely affect the CRLF and its designated critical habitat via direct toxicity or indirectly based on direct effects to its food supply (i.e., freshwater invertebrates, algae, fish, frogs, terrestrial invertebrates, and mammals) or habitat (i.e., aquatic plants and terrestrial upland and riparian vegetation). When RQs for a particular type of effect are below LOCs, the pesticide is determined to have "no effect" on the subject species. Where RQs exceed LOCs, a potential to cause adverse effects is identified, leading to a conclusion

degradates. In the presence of soil or sediment particles part of the chemical species partitions into the solid phase and are referred to as bound species.

of "may affect." If a determination is made that a use pattern, within the action area, "may affect" the CRLF and its designated critical habitat, additional information is considered to refine the potential for exposure and effects, and the best available information is used to distinguish those actions that "may affect, but are not likely to adversely affect" (NLAA) from those actions that are "likely to adversely affect" (LAA) the CRLF and its critical habitat.

Based on the conclusions of this assessment a "likely to adversely affect" determination is made for some of the mancozeb and maneb use patterns within the action area for; 1) direct effects to aquatic and terrestrial phase CRLF; 2) indirect effects to aquatic-phase CRLF via direct effects to food supply (i.e., freshwater invertebrates, non-vascular plants), and indirect effects on habitat (i.e., aquatic and terrestrial plants); 3) indirect effects to terrestrial-phase CRLF via direct effects on prey (i.e., terrestrial invertebrates, small terrestrial vertebrates, including mammals and terrestrial phase amphibians), indirect effects on habitat (i.e., riparian vegetation), 4) aquatic breeding habitat and aquatic non-breeding habitat modification, and 5) upland and dispersal habitat modification. A "no effect" determination to the CRLF is made for all mancozeb and maneb seed and dip treatment uses. Since some of the mancozeb and maneb use patterns result in a "LAA" determination; the overall CRLF effects determination for mancozeb and maneb use is "LAA".

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

- Enhanced information on the density and distribution of CRLF life stages within specific recovery units and/or designated critical habitat within the action area. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the species.
- Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase frogs. While existing information provides a preliminary picture of the types of food sources utilized by the frog, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.
- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced

understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual frogs and potential adverse modification to critical habitat.

2 Problem Formulation

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

2.1 Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the federally threatened CRLF *(Rana aurora draytonii*) arising from FIFRA regulatory actions regarding use of mancozeb and maneb on a variety of row, field, and vegetable crops, orchards and vines, ornamentals, turf, forestry, seed, and dip treatments. In addition, this assessment evaluates whether these actions can be expected to result in modification of the species' critical habitat. Key biological information for the CRLF is included in Section 2.5, and designated critical habitat information for the species is provided in Section 2.6 of this assessment. This ecological risk assessment has been prepared as part of the *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 02-1580-JSW (JL)) settlement entered in the Federal District Court for the Northern District of California on October 20, 2006.

In this endangered species assessment, direct and indirect effects to the CRLF and potential modification to its critical habitat are evaluated in accordance with the methods (both base line and species-specific refinements, when appropriate) described in the Agency's Overview Document (U.S. EPA 2004). In addition, in accordance with two interim policies, terrestrial invertebrate LOCs will be used and terrestrial amphibian modeling will used as a refinement. Use of such information is consistent with the guidance provided in the Overview Document (U.S. EPA 2004), which specifies that "the assessment process may, on a case-by-case basis, incorporate additional methods, models, and lines of evidence that EPA finds technically appropriate for risk management objectives" (Section V, page 31 of U.S. EPA 2004).

In accordance with the Overview Document, provisions of the ESA, and the Services' *Endangered Species Consultation Handbook*, the assessment of effects associated with registrations of mancozeb and maneb is 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 exceedances 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 mancozeb or maneb 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 mancozeb and maneb at the use sites described in this document to affect CRLF individuals and/or result in 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 listed species. The PCEs for CRLFs are aquatic and upland areas where suitable breeding and non-breeding aquatic habitat is located, interspersed with upland foraging and dispersal habitat (Section 2.6).

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

If a determination is made that use of mancozeb or maneb within the action area(s) associated with the CRLF "may affect" this species or its designated critical habitat, additional information is considered to refine the potential for exposure and for effects to the CRLF and other taxonomic groups upon which these species depend (e.g., aquatic and terrestrial vertebrates and invertebrates, aquatic plants, riparian vegetation, etc.). Additional information, including spatial analysis (to determine the geographical proximity of CRLF habitat and mancozeb and maneb use sites) and further evaluation of the potential impact of mancozeb and maneb on the PCEs is also used to determine whether modification to designated critical habitat may occur. Based on the refined information, the Agency uses the best available information to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that "may affect and are likely to adversely affect" the CRLF 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 mancozeb and maneb are expected to directly impact living organisms within the action area (defined in Section 2.7), critical habitat analysis for mancozeb and maneb is limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes (i.e., the biological resource requirements for the listed species associated with the critical habitat or important physical aspects of the habitat that may be reasonably influenced through biological processes). Activities that may modify critical habitat are those that alter the PCEs and appreciably diminish the value of the habitat. Evaluation of actions related to use of mancozeb and maneb 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

Mancozeb and maneb are non-systematic preventive fungicides with wide use patterns including a variety of row crops, orchards and vines, ornamentals, turf, and forestry in addition to seed or dip treatment for seed and seed pieces. The total number of federally registered products applicable to uses in CA is 55 for mancozeb and 25 for maneb. The California Department of Pesticide Regulation (CDPR) registers pesticides for use within California as well. Of the 55 and 25 registered products for mancozeb and maneb respectively, California has registered only thirty-nine mancozeb and eight maneb products[2]. However, that this assessment is based on the federal action and therefore, considers the current federally registered labels. Instructions on these labels indicate that mancozeb and maneb can be used interchangeably in about one third of the use patterns.

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 mancozeb and maneb in accordance with the approved product labels for California is "the action" being assessed.

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

Mancozeb ((1,2-Ethanediylbis (carbamodithioato))(2-)) manganese and zinc mixture, and maneb, (1,2-Ethanediylbis (carbamodithioato)(2-)-manganese, are members of the ethylene-*bis*-dithiocarbamate group of fungicides (EBDCs). Parent mancozeb and parent maneb are both expected to be hydrolytically unstable in the natural environment as both are applied under moist conditions (rain and/or irrigation-fed growing plants). Therefore, this risk assessment is based on estimates of exposure to the mancozeb and maneb hydrolytic residue; referred to hereinafter as the EBDC complex. As it will be discussed later, the EBDC complex consists of multi-chemical species including the major degradate ethylenethiourea (ETU). In the risk assessment process, acute exposure concentrations will be estimated for chemical species present in the EBDC complex at the short-term, which are believed to be the same chemical species causing the measured acute toxicity. Likewise, chronic exposure concentrations will be estimated for ETU, the main constituent of the aged EBDC complex, which is the same chemical from which the chronic toxicity is obtained. Use of this procedure in the risk assessment process was necessary due to the unique hydrolytic instability of mancozeb and maneb and the formation of the EBDC complex. Details of the short and long-term exposure estimation procedures and justification for relating them to measured acute and chronic effects are presented elsewhere in this document (2.10 Analysis Plan).

[2] http://www.cdpr.ca.gov/cgi-bin/label/labq.pl?p_chem=211&activeonly=on

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).

Mancozeb has twenty registered products that contain multiple active ingredients while maneb has two. Analysis of the available open literature data and acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **Appendix A**. The result of this analysis show that an assessment based on the toxicity of the single active ingredient of maneb and of mancozeb (considering as well the EBDC complex and ETU degradates) is appropriate.

The results of available toxicity data for mixtures of maneb and mancozeb with other pesticides are presented in Sections 4.1.3, 4.2.4, Appendices A and D. The registrant has submitted several aquatic and terrestrial plant studies conducted with mancozeb co-formulated products. The results of the terrestrial plant studies conducted with mancozeb co-formulated products were used in this assessment. No data is available on mancozeb as single active ingredient of Typical Enduse Product (TEP).

Maneb and mancozeb have been linked to sub-lethal effects, of the thyroid (for example, thyroid weight increases and microscopic changes in thyroid and lethargy). These potential sublethal effects are discussed qualitatively in this assessment since it is not possible to quantitatively link effects such as these to the selected assessment endpoints for the CRLF (*i.e.*, survival, growth, and reproduction of individuals and maintenance of critical habitat PCEs). Further detail on sub-lethal effects of mancozeb and maneb is provided in Sections 4.1.1.4 and 4.2.1.3, for fish and birds, respectively.

2.3 Previous Assessment

Mancozeb was first registered in the USA in 1948 while maneb was registered in 1962. Both chemicals were registered as a broad-spectrum fungicide for use in agriculture, professional turf management and horticulture. Degradation of these two EBDCs results in the formation of the common metabolite ethylenethiourea (ETU). Between 1986 and 1995 the registration standards for mancozeb and maneb were issued (1986-1987)/updated in 1992) and Special Reviews for EBDCs, including mancozeb and maneb, were conducted requiring risk reduction measures, submission of additional data, and cancellation of EBDC use on 11 food/feed crops. During this period, EPA issued two data call-ins (DCIs) requiring data to complete re-registration (1986-1987) and to evaluate worker exposure (October, 1995). In 2005, the Environmental Fate and Effects Division (EFED) completed the environmental fate and ecological risk assessments, in support of the re-registration eligibility decisions (REDs) on mancozeb, maneb, and their major common degradate ETU (U.S. EPA, 2005a, b and c). Following this, OPP issued the REDs in three separate documents on mancozeb, maneb, and ETU in 2005[3]. In these REDs, EPA determined that most uses of mancozeb and maneb are eligible for re-registration provided specific risk mitigation measures are adopted. These risk mitigation measures include: reduction of the application rates, limitation of the number of applications per year and cancellation of some use patterns.

In the ecological risk assessment completed to support the RED for mancozeb, endangered species chronic risk levels of concern (LOCs) were exceeded for birds, terrestrial-phase amphibians, reptiles and mammals for all mancozeb uses. Also, acute and chronic risks to endangered species LOCs were exceeded for freshwater fish, aquatic-phase amphibians and freshwater invertebrates for all modeled uses of mancozeb. At that time, potential risk to terrestrial invertebrates was not assessed. Due to lack of data, risks to terrestrial plants or vascular aquatic plants were not assessed. Based on data for nonvascular plants, mancozeb's uses exceeded the endangered species acute risk LOC for nonvascular aquatic plants.

In the ecological risk assessment completed to support the RED for maneb, endangered species chronic risk LOCs were exceeded for birds, terrestrial-phase amphibians, reptiles and mammals for all maneb uses. Also, the acute risk to endangered species LOC was exceeded for freshwater fish, aquatic-phase amphibians and freshwater invertebrates for all maneb modeled uses. At that time risk to terrestrial invertebrate was not assessed quantitatively. However, based on the lack of acute maneb toxicity to honeybees, EFED expected a low acute risk to non-target terrestrial insects. Due to lack of data, EFED did not assess chronic risks to freshwater invertebrates, terrestrial plants or fully assess risks to aquatic plants. Based on data for one surrogate species, maneb's modeled use patterns exceeded acute risk LOCs for nonvascular aquatic plants.

In the ecological risk assessment completed to support the RED for ETU, the chronic risk LOC was exceeded for mammals across all uses of the parent compounds. Due to lack of data, potential acute and chronic risks to birds, terrestrial-phase amphibians and reptiles, chronic risks to freshwater fish, aquatic-phase amphibians and aquatic invertebrates, or potential acute risks to aquatic vascular plants were not assessed.

2.4 Stressor Source and Distribution

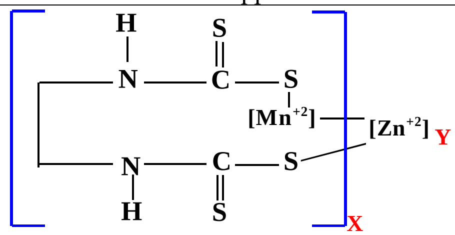
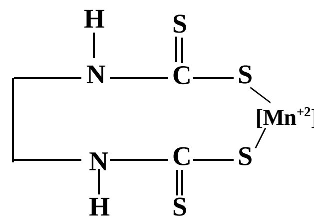
In this assessment the stressor is considered to be the EBDC complex resulting from the rapid hydrolysis of mancozeb and maneb in aquatic systems. For the terrestrial system, the stressor is parent mancozeb and maneb and their major degradate ETU.

2.4.1 Environmental Fate and Transport Assessment

Mancozeb and maneb are polymers or highly coordinated salt complexes, in which each EBDC ligand is present in coordination with zinc (Zn^{+2}) and manganese (Mn^{+2}) ions in mancozeb or with manganese (Mn^{+2}) ions alone in maneb. Table 2-1 specifies the identity of the two chemicals along with a summary of laboratory measured physiochemical and abiotic fate properties (U.S. EPA, 2005 a, and b).

[3] http://www.epa.gov/pesticides/reregistration/status.htm

Table 2-1 Chemical identity and laboratory measured physiochemical and abiotic fate properties for mancozeb and maneb.

Parameters	*Mancozeb*	*Maneb*
CAS name	((1,2-ethanediylbis (carbamodithioato)) (2-) Mn mixture with ((1,2-ethandiylbis (carbamodithioate)) (2-)) zinc	[[1,2-Ethanediylbis [carbamodithioato]] - (2-)] manganese
CAS registry number	8018-01-7	12427-38-2
PC code	014504	014505
Molecular weight	271	265
Vapor pressure (torr)	1.003x10 -7	7.577 x10 -8
Water solubility*	6-20 ppm	150 ppm
Chemical structure	 Mancozeb X:Y= 10:1	 Maneb
Hydrolysis	t ½ at pH 7= 0.7 day (17 hours)	t ½ at pH 7= <0.1 day (3 hours)
Aqueous & soil photolysis	Stable	

* Note that when mancozeb or maneb is dissolved in water up to 20 ppm of the polymeric mancozeb or 150 ppm of the polymeric maneb completely hydrolyzes into the EBDC complex.

Based on laboratory fate studies, the complete polymeric chains of parent mancozeb or maneb (the active ingredient "a.i." in mancozeb or maneb) are expected to be non-persistent in most natural environments (hydrolysis t ½= <1 day). Hydrolytic decomposition appears to be a complex process as it involves breakdown of the polymers into fresh EBDC complex consisting of variable/low molecular weight polymeric chains (i.e. polymer fragments), monomeric species, transient species, and EBDC ligand in association with metal ions other than Mn^{+2} or Zn^{+2}. Aging of the complex results in enrichment with ETU and ETU degradates. The rate of hydrolytic degradation appears to increase with particle size reduction of the applied parent, availability of moisture, oxygen, and high acidic and neutral conditions. The product of hydrolytic decomposition of mancozeb or maneb is a multi-chemical species complex hereinafter referred to as the "mancozeb or maneb complex" or the "EBDC complex".

In an agricultural setting, foliar application of mancozeb or maneb is expected to cause it to reach plant/soil surfaces directly and air/water bodies by drift. In the air, either chemical will eventually be deposited onto soil/plant/water surfaces with minimal change. On plant surfaces, it is affected by physical wash-off and abiotic hydrolytic decomposition into the EBDC complex given water availability and time. In contrast to each of the parents, the EBDC complex is a suite of multi-chemicals. Based on fate studies and media of formation, the suite includes the following two categories:

(a) Chemicals associated with the short-term acute exposure potential which includes variable/low molecular weight polymeric chains and short-lived transient chemicals; and
(b) Chemicals associated with the long-term chronic exposure potential which includes ETU and ETU degradates, and bound species.

For the EBDC complex at the short-term, laboratory fate parameters were obtained using radioactivity as a surrogate for concentration. Based on this radio-labeled fate data, it appears that the fate of the complex is controlled by further hydrolytic decomposition, soil/sediment adsorption and to a lesser extent biotic mineralization into CO_2. Table 2-2 summarizes the fate parameters for the EBDC complex of mancozeb and maneb calculated from parent studies (U.S. EPA, 2005c).

Table 2-2 Laboratory measured fate properties for the mancozeb and maneb complexes including their major degradate, ETU.

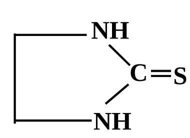
Fate Parameter	*Short-Term constituents of the Mancozeb Complex**	*Short-Term constituents of the Maneb Complex**	*ETU*
Hydrolysis t ½ at pH 7 (days)	4		Stable
Aqueous (direct) photolysis t ½ (days)	Stable		
Photolysis on soil t ½ (days)	Stable		
Aerobic soil metabolism t ½ (days)	21-29	8-12	1-3
Aerobic aquatic metabolism t ½ (days)	38-41	No study	No study

* Data are based on radiolabel associated the constituents of the EBDC complex minus ETU and ETU degradates.

For the aged EBDC complex (at the long-term), fate and transport data are available for only one of its major constituents, ETU (Table 2-2, above). ETU data were obtained from studies in which ETU was the experimental material. In contrast to ETU, bound residues forming in soil/sediment systems were poorly characterized and there is uncertainty whether these residues are actually ethylene diamine (EDA). However, in the absence of a complete characterization of the bound residues, the screening-level assessments (U.S. EPA 2005a and b) included bound residues as part of the total residue complex. Inclusion of bound residues in estimated half-lives resulted in conservative half-life estimates for the total EBDC complex in soil and water/sediment systems. In this refined assessment, exposure to bound species will be covered by ETU because bound species are suspected to be precursor to ETU.

Fate properties of ETU were presented earlier in Table 2-2 and important physiochemical properties are summarized in Table 2-3 (U.S. EPA 2005c).

Table 2-3 Chemical identity and laboratory measured physiochemical properties of ETU.

Parameters	***ETU***	***Structure***
CAS name	2-Imidazolidinethione	
CAS Registry Number	96-45-7	
Molecular Weight	102	
Vapor Pressure	9.728x10 -1	
Water Solubility	20,000 ppm	**ETU**

The constituents of the EBDC complex depend on the characteristics of the system and aging. For example, bound residue is expected to form late and persist only in systems containing soil or sediment particles. Furthermore, the important ETU metabolite was shown to vary in concentration and persistence from one system to another (Table 2-4).

Table 2-4 Maximum ETU produced in fate studies for parent EBDCs.

Type of Study	Parent EBDCs Used as a Test Substance (Number of Studies)	Maximum ETU Formed	
		As % Parent Equivalent	As % ETU*
Aqueous Hydrolysis	Maneb (1); Metiram (1)	93.0%	35.8%
Aerobic/Anaerobic Aquatic	Metiram (2); Maneb (1)	61.4%	23.6%
Aerobic Soil	Metiram (4); Mancozeb (3); Maneb (3)	24.8%	09.6%

* % ETU= % Parent Equivalent multiplied by Molar ratio of Parent to ETU of 38.5%; for example, the maximum for hydrolysis studies= 93% x 0.385 = 35.8%.

Potential transport mechanisms include pesticide surface water runoff, spray drift, and secondary drift of volatilized or soil bound residues leading to deposition onto nearby or more distant ecosystems. A number of studies have documented atmospheric transport and re-deposition of pesticides from the Central Valley to the Sierra Nevada Mountains (Fellers et al., 2004, Sparling et al., 2001, LeNoir et al., 1999, and McConnell et al., 1998). Prevailing winds blow across the Central Valley eastward to the Sierra Nevada Mountains, transporting airborne industrial and agricultural pollutants into the Sierra Nevada ecosystems (Fellers *et al.,* 2004, LeNoir *et al.,* 1999, and McConnell *et al.,* 1998). Several sections of critical habitat for the CLRF are located east of the Central Valley. The magnitude of transport via secondary drift depends on the maneb and mancozeb's ability to be mobilized into air and its eventual removal through wet and dry deposition of gases/particles and photochemical reactions in the atmosphere. Therefore, physicochemical properties of these chemicals that describe its potential to enter the air from water or soil (*e.g.,* Henry's Law constant and vapor pressure), pesticide use data, modeled estimated concentrations in water and air, and available air monitoring data from the Central Valley and the Sierra Nevada's are considered in evaluating the potential for atmospheric transport of mancozeb and maneb to locations where it could impact the CRLF.

For mancozeb and maneb parents, the principal route of transport from application sites is expected to be spray drift. Secondary drift (atmospheric transport) of volatilized parents leading to deposition onto nearby or more distant ecosystems is not expected. This is attributed to the reported low vapor pressures and Henry's law constants (1×10^{-7} torr and 5.5×10^{-9} atm. m^3 $mole^{-1}$ for mancozeb, and 8×10^{-8} and 9.97×10^{-11} atm. m^3 $mole^{-1}$ for maneb).

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 result in risk quotients that are below the Agency's acute and chronic risk LOCs. If the maximum estimate environmental concentration (EEC) determined using spray drift models (AgDrift and AgDISP) results in a risk quotient that is below the LOC, then 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 acute and chronic risk LOCs, no further drift analysis is required. If exposures exceeding acute or chronic risk LOCs and buffers necessary to bring exposure below the LOC are greater than 1,000 feet, the Gaussian extension feature of AgDISP may be used.

AgDRIFT (version 2.01) utilizes empirical data to estimate off-site deposition of aerial and ground applied pesticides. Similarly, AgDISP (version 8.15) predicts the motion of spray material released from aircraft, including the mean position of the material and the position variance about the mean as a result of turbulent fluctuations.

In contrast to the movement of parent mancozeb and maneb by spray drift, run-off/erosion is the principal route of transport for constituents of the EBDC complex from application sites to nearby terrestrial and/or aquatic systems. This is due to rapid hydrolysis of parents and relative high affinity of significant portions of the EBDC complex to soil particles.

Based on laboratory studies, the whole freshly formed EBDC complex, resulting from either mancozeb or maneb, can be characterized by low mobility (FAO, 1998). Calculated K_{oc} values were in the range of 860-1,642 L kg^{-1} for the mancozeb complex and in the range of 400-1,692 L kg^{-1} for the maneb complex. Aged EBDC complex of mancozeb and maneb is dominated by the ETU degradate which is highly soluble (water solubility= 20,000 ppm) and very mobile (Average K_{oc}= 288 L kg^{-1}). In surface water, sources of ETU are formation from parent mancozeb or maneb deposited by drift, transportation by runoff in dissolved form, and the possible continuous, slow formation from bound species transported on soil particles by runoff or erosion. Quantities of ETU that reach or form in natural surface water are expected to be stable to hydrolysis and direct photolysis, however, it was reported that it can be removed rather quickly from these waters by indirect photolysis (half-lives of 1-4 days). Additionally, the relatively short half-life of ETU in the soil system (t ½ = 1-3 days) reduces the possibility of leaching of this degradate to ground water.

2.4.2 Mechanism of Action

Mancozeb and maneb are broad-spectrum fungicides belonging to a chemical class of polymeric dithiocarbamates and a group classified as ethylene-bis-dithiocarbamate (EBDC) fungicides. They are non-systemic, contact fungicides with preventive activity. The EBDCs (mancozeb, maneb, and metiram) can be metabolized to ETU which is of toxicological concern due to ETU's carcinogenicity, teratogenicity, and anti-thyroid properties. OPP has determined that there is sufficient evidence to group the EBDCs based on a common mechanism for the induction of thyroid effects.

2.4.3 Use Characterization

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for mancozeb and maneb represent the FIFRA regulatory action; therefore, labeled uses, application parameters (e.g., rates and methods), and restrictions specified on the labels 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

There are 55 and 25 agricultural labeled use patterns for mancozeb and maneb, respectively that are relevant to California. In the REDs for mancozeb and maneb, EPA determined that most uses are eligible for re-registration provided adoption of specific risk mitigation measures. Table 2-5 lists measures that are expected to reduce environmental exposure from uses considered in this assessment noting that implementation of these measures might take place sometime in 2009. It is however noted that some of the mitigation measures had already been implemented for all labels in the case of papaya use pattern and some of the labels in the case of turf. Accordingly, in this assessment, the new rate for papaya was used and no changes were considered in the case of turf. This is because some of the available turf labels didn't include cancellation of residential and athletic fields turf use pattern and reduction of rate to other turf uses including sod farms.

Table 2-5 Risk mitigation measures included in the mancozeb and maneb REDs[4].

Use Pattern	*RED Risk Mitigation Measure*
Mancozeb Use Patterns	
Turf: residential and athletic fields	Use cancellation
Turf: others including sod farms	Reduce single rate from 19.1 to 17.4 lb a.i./A with a maximum of 4 applications or 69.6 lb a.i./year at a minimum of 10 to 14-day intervals (increased from 5 to 7-day intervals).
Papaya [1]	Reduce single rate to 2 lb a.i./A (from 4 lb a.i./A) with a maximum of 14 applications or 28 lb a.i./year at a minimum of 14-day intervals [1]
Sweet Corn	Homeowner use cancellation
Pachysandra (Ornamental plant)	Use cancellation
Pineapple	Seed piece treatment use cancellation
Cotton	Foliar use cancellation
Maneb Use Patterns	
Sweet corn, grapes, apples, and kadota figs	Use cancellation
Rice and peanuts	Seed treatment use cancellation
Almonds	Reduce the maximum rate to 19.2 lb a.i./A/year (from 25.6 lb a.i./A/year) with no change in the single rate of 6.4 lb a.i./A (three applications)
Turf: sod farm	Reduce single rate to 8.7 lb a,i./A with a maximum of 4 applications or 34.8 lb a.i./A/year (from 69.6 lb a.i./year)
Oats seed treatment	Reduce this single application rate to 0.21/cwt (0.21lb a.i./A)

[1] It appears that labels for this use pattern has affected this change in the single rate, therefore the new rate was used in this risk assessment.

Application parameters relevant to the labeled use patterns included in Table 2-6 and Table 2-7 for mancozeb, and Table 2-8 and Table 2-9 for maneb. These use patterns represent labeled uses up to 2007 and do not include mitigation measures stated in Table 2-5 above that have not been adopted on product labels.

[4] http://www.epa.gov/pesticides/reregistration/status.htm

Table 2-6 Mancozeb use patterns in California (*MSR*= maximum single rate (lb a.i./acre), *MNA*= maximum number of applications, *MTR*= maximum total rate (lb a.i./acre/crop cycle or year), and *MAI*= minimum re-application intervals in days).

Crop Use Pattern	*MSR*	*MNA*	*MTR* [1]	*MAI*
Apples, Crab apple, Pear & Quince	4.8	4	19.2	7
Asparagus	1.6	4	6.4	10
Bananas	2.4	10	24	14
Cereal Grains [2]	1.6	3	4.8	7
Corn (field & seed)	1.2	10	12	4
Corn (sweet/pop)	1.2	5	6	4
Cotton	1.6	4	6.4	10
Cucurbits [3]	2.4	8	19.2	7
Fennel	1.6	8	12.8	7
Forestry (Douglas Fir)	3.2	3	9.6	14
Garlic & Onion: dried	2.4	10	24	7
Grapes	2.0	3	6.0	7
Ornamentals (pachysandra)	17.4	5	87.1	10
Ornamentals (others) [4]	1.4	5	6.8	7
Papayas	2	14	28	14
Plantains	2.4	10	24	14
Potatoes	1.6	7	11.2	3
Shallot	2.4	10	24	7
Sugar Beet	1.6	7	11.2	7
Tomatoes	1.6	4	6.4	7
Turf [5]	19.1	4	76.4	5
X-mass tree plantations	3.2	3	9.6	14

[1] MTR= maximum total rate in lb a.i./acre/year is only for apples, crab apple, pear & quince otherwise this rate is in lb a.i./acre/crop cycle.

[2] Grains include: barley, oats, rye, triticale, and wheat.

[3] Cucurbits: cucumber, cantaloupe, honeydew, casaba melon, crenshaw melon, watermelon, musk melon and edible gourds

[4] Ornamentals (others) include: shade trees, ground cover plants, herbaceous plants, non-flowering plants & woody shrubs and vines.

[5] Turf includes: commercial/industrial/recreational area lawns, golf course turf, ornamental sod farm turf, and ornamental lawns & turf (residential).

Table 2-7 Additional mancozeb use patterns in California: Dip and pre-plant seed treatments (Maximum application rate; all are single rates)

I. Dip or Seedling Treatment (as specified below): Rates in lbs/Acre			
Use Pattern			***Rate (lb a.i./Acre)***
Asparagus: pre-plant crowns dip in burlap bag or dip tank			3.0
Capri fig: dip treatment in a dip tank			3.2
Potatoes: pre-plant seed/seed pieces dip tank @ 0.08 cwt [1]			2.72 (seedling rate of 3,400 lbs/Acre)[5]
Pineapple: pre-plant dip treatment			25.6
II. Pre-plant Seed Treatment (Mist, Slurry and Planter/Drill boxes)			
Use Pattern	***Application Rate (cwt [1])***	***Seeding Rate (lb/Acre)[6]***	***Application Rate (lb a.i./Acre)***
Barely	0.2100	100	0.2100
Corn	0.2719	18.3	0.0498
Cotton	0.3156	10	0.0316
Flax	0.3602	50	0.1801
Oats	0.3150	100	0.3150
Rice	0.2094	150	0.3141
Rye	0.1801	90	0.1621
Safflower	0.1063	25	0.0266
Sorghum	0.2271	12	0.0273
Tomatoes	0.3984	0.5	0.0020
Triticale	0.1650	90	0.1485
Wheat	0.1625	89	0.1446

[1] cwt= hundredweight (i.e., lbs/100 lbs of seeds).

[5] Potatoes: http://gardenguide.montana.edu/additional%20info%20pages/Vegetable%20Charts.htm
http://www.hort.purdue.edu/newcrop/duke_energy/Avena_sativa.html#Cultivation

[6] Barley: http://www.ag.ndsu.edu/procrop/bar/baseed04.htm
Corn, cotton, rice and wheat: http://www.hort.purdue.edu/newcrop/duke_energy/
Flax, rye, safflower sorghum: http://www.hort.purdue.edu/newcrop/afcm/flax.html
Oats: http://extension.oregonstate.edu/catalog/html/em/em8692/
Tomatoes: http://aggie-horticulture.tamu.edu/extension/vegetable/cropguides/tomato.html
Triticali: http://southeastfarmpress.com/news/90204Triticale-cover/
Other Reference: http://www.reimerseeds.com/Search.aspx?Keyword=Triticali

Table 2-8 Maneb use patterns in California (*MSR*= maximum single rate (lb a.i./acre), *MNA*= maximum number of applications, *MTR*= maximum total rate (lb a.i./acre/crop cycle or year), and *MAI*= minimum re-application intervals in days).

Crop Use Pattern	*MSR*	*MNA*	*MTR* [1]	*MAI*
Almonds	6.4	4	25.6	7
Apples	4.8	4	19.2	7
Bananas	2.4	10	24	14
Beans (dried)	1.6	6	9.6	5
Brassica [2]	1.6	6	9.6	7
Brussels sprouts	1.6	6	9.6	7
Corn (sweet/pop)	1.2	5	6	3
Chinese Cabbage "loose head"	1.2	6	7.2	7
Cucurbits [3]	1.6	8	12.8	7
Eggplant	1.6	7	11.2	7
Figs	One application of 2.4 lb a.i/acre/season			
Garlic & Onion: dried	2.4	10	24	7
Grapes	2	3	6	7
Kale	1.6	2	3.2	7
Lettuce (leaf & head) and Endive (Escarole)	1.6	6	9.6	7
Onion: green	2.4	7	16.8	7
Ornamentals (pachysandra)	13.9	4	55.7	10
Ornamentals (others) [4]	1.2	3	3.6	7
Papayas	2	14	28	14
Pepper	1.6	6	9.6	7
Potatoes	1.6	7	11.2	5
Sugar Beet	1.6	7	11.2	7
Tomatoes	1.6	4	6.4	7
Turf [5]	17.4	4	69.7	7

[1] MTR= maximum total rate in lb a.i./acre/year is for apples only otherwise this rate is in lb a.i./acre/crop cycle.
[2] Brassica: broccoli, Brussels sprouts, cabbage, Chinese cabbage (tight head), cauliflower, and kohlrabi.
[3] Cucurbits: cucumber, cantaloupe, honeydew, casaba melon, crenshaw melon, watermelon, winter squash, and pumpkin.
[4] Ornamentals (others) include: shade trees, ground cover plants, herbaceous plants, non-flowering plants & woody shrubs and vines.
[5] Turf includes: commercial/industrial/recreational area lawns, golf course turf, ornamental sod farm turf, and ornamental lawns & turf (residential).

Table 2-9 Additional maneb use patterns in California: dip and pre-plant seed treatments (maximum application rate; all are single rates).

I. Dip Treatment (as specified below): Rates in lbs/Acre			
Use Pattern			*Rate (lb a.i./Acre)*
Potatoes: pre-plant seed/seed pieces dip tank @ 0.08 cwt [1]			**2.72** (seedling rate of 3,400 lbs/Acre)[7]
II. Pre-plant Seed Treatment (Mist, Slurry and Planter/Drill boxes)			
Use Pattern	***Application Rate (cwt [1])***	***Seeding Rate (lb/Acre)[8]***	***Application Rate (lb a.i./Acre)***
Barely	0.2094	100	0.2094
Corn	0.2688	18.3	0.0492
Cotton	0.3	10	0.0300
Flax	0.3531	50	0.1766
Oats	0.3125	100	0.3125
Rice	0.20	150	0.3000
Rye	0.1781	90	0.1603
Safflower	0.1	25	0.0250
Sorghum	0.225	12	0.0270
Tomatoes	0.4	0.5	0.0020
Wheat	0.1625	89	0.1446

[1] cwt= hundredweight (i.e., lbs/100 lbs of seeds).

Mancozeb and maneb labeled use data can be summarized into three types of applications: 1) foliar, 2) dip and 3) seed treatments. Equipment that can be used include: aerial equipment, ground-boom, chemigation, high- and low-pressure handheld equipment, and backpack sprayers. Important information for foliar applications can be summarized as follows:

(a) Use patterns for mancozeb and maneb may be categorized for into five categories:

1) Row, field and vegetable crops;
2) Orchards and vines;
3) Nursery and greenhouse;
4) Turf; and
5) Forestry.

[7] Potatoes: http://gardenguide.montana.edu/additional%20info%20pages/Vegetable%20Charts.htm
http://www.hort.purdue.edu/newcrop/duke_energy/Avena_sativa.html#Cultivation

[8] Barley: http://www.ag.ndsu.edu/procrop/bar/baseed04.htm
Corn, cotton, rice and wheat: http://www.hort.purdue.edu/newcrop/duke_energy/
Flax, rye, safflower sorghum: http://www.hort.purdue.edu/newcrop/afcm/flax.html
Oats: http://extension.oregonstate.edu/catalog/html/em/em8692/
Tomatoes: http://aggie-horticulture.tamu.edu/extension/vegetable/cropguides/tomato.html

(b) Use patterns either are for mancozeb alone, maneb alone, or interchanged between mancozeb and maneb. Mancozeb alone uses include crops belonging to categories 1, 2, and 3; maneb alone uses include crops belonging to categories 1, 2, and 6; while mancozeb and maneb uses include crops belonging to all categories except 6. Later in section 2.7, a separation between labeled uses for mancozeb, maneb, and mancozeb & maneb are included.
(c) The maximum single application rates are: pome fruits/forestry (4.8/3.2 lb a.i./A) for mancozeb; almonds/apples (6.4/4.8 lb a.i./A) for maneb; and turf/pachysandra for mancozeb & maneb (mancozeb rates=19.1/13.9 lb a.i./A and maneb rates= 17.4/13.9 lb a.i./A). Single rates for mancozeb and maneb use on all other crops are in the range of 1.2 to 3.2 lb a.i./A.
(d) The ranges of seasonal application rates are cereal grains/onions & garlic (4.8 to 24.0 lb a.i./A/season) for mancozeb; figs/almonds (2.4 to 25.6 lb a.i./A/season) for maneb; and grapes & corn/turf for mancozeb & maneb (mancozeb rates=6.0 to 76.4 lb a.i./A/season and maneb rates= 6.0 to 69.7 lb a.i./A/season)
(e) Number of applications range from one to 15 (mostly 3 to 10) with application intervals ranging from 7 to 14 days (mostly 3 to10 days).
(f) With the exception of residential landscaping (ornamentals & turf), all types of ground and aerial applications are permitted. Turf and ornamentals, in residential areas, are treated by ground spray.
(g) Several crops can be grown more than one time per year in CA (i.e., they have multiple crop cycles). Labels specified seasonal application rates on the labels except of mancozeb use on pome fruits (yearly rates were specified). Therefore, for uses that have more than one crop cycle per year, the maximum allowable yearly application rate will be higher than the maximum seasonal application rate. Multiple cropping is discussed later in the assessment (refer to section 3.2.2 modeling inputs).

For seed and seed pieces treatments, the application methods for treatment include commercial stationary equipment, on-farm stationary equipment and tractor drawn planter boxes. Important information can be summarized as follows:

(a) Mancozeb and maneb are used as a seed treatment for only 8 crops that can also be treated later with foliar sprays. These crops lie within the field crops and vegetables category. The list of crops is: four cereal grains "except triticale" with application rates ranging from 0.15-0.32 lb a.i. /A for either mancozeb or maneb; cotton and corn with application rates ranging from 0.03-0.05 lb a.i./A for either mancozeb or maneb (maneb is not foliar applied to cotton); and tomatoes with an application rate of 0.002 lb a.i./A for either mancozeb or maneb. Triticale seeds can only be treated with mancozeb with a rate of 0.15 lb a.i./A.

(b) Mancozeb and maneb can also be used to treat seeds alone for an additional four crops, namely: flax, safflower, sorghum, and rice with application rates ranging from 0.03-0.31 lb a.i. /A.

(c) Seeds and dip treatments are one-time treatments and multiple cropping is not reported for any of the crops for which the seeds are treated.

(d) Mancozeb and maneb are used as a pre-plant for potato seed or seed piece as a dip treatment with the same application rate of 2.72 lb a.i./seed or seed pieces needed for one acre.

Additionally, dip treatment is used on asparagus, Capri fig and pineapple, which are treated with mancozeb only with rates ranging from 3.2 to 25.6 lb a.i/A. Due to the fact that the dip solution is used only to treat plant parts, quantities of pesticide active expected to reach seeded soils are minimal.

Of all federally labeled uses of mancozeb and maneb, peanuts and cranberry and tobacco use patterns were excluded from our assessment. This is because, peanuts and cranberry are grown in very limited acreage in California and tobacco is not grown in Califonria.

EPA's Biological and Economic Analysis Division (BEAD) provides an analysis of both national- and county-level usage information (Kaul and Jones, 2006) using state-level usage data obtained from USDA-NASS[9], Doane (www.doane.com, the full set is not provided due to its proprietary nature), and the CDPR, Pesticide Use Reporting (PUR) database[10]. CDPR PUR is considered a more comprehensive source of usage data than USDA-NASS or EPA proprietary databases, and thus the usage data reported for mancozeb and maneb by county in this CA-specific assessment were generated using CDPR PUR data. Four years (2002-2005) of usage data were included in this analysis. Data from CDPR PUR were obtained for every pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system. BEAD summarized these data to the county level by site, pesticide, and unit treated. Calculating county-level usage involved summarizing across all applications made within a section and then across all sections within a county for each use site and for each pesticide. The county level usage data that were calculated include: average annual pounds applied, average annual area treated, and average and maximum application rate across all five years. The units of area treated are also provided where available. A summary of these data is presented inTable 2-10 and Table 2-11 for mancozeb and maneb, respectively.

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

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

Table 2-10 California usage data for mancozeb

Use Pattern	*Average Annual Applied Across 2002-2005*				*Application Rate Across All observations*	
	Lbs. Used		*Area Treated*			
	Lbs	*%*	*Acres*	*%*	*Average*	*Maximum*
ONION, DRY	62,707	12.97%	36,716	14.27%	1.8	4.4
TURF/SOD	61,721	12.77%	5,772	2.24%	8.2	33.8
TOMATO, PROCESSING	58,638	12.13%	47,729	18.55%	1.3	3.4
POTATO	58,597	12.12%	48,123	18.71%	1.1	4.1
GRAPE	57,209	11.84%	40,120	15.60%	1.4	4.8
LANDSCAPE MAINTENANCE	51,628	10.68%	ND*	ND	ND	ND
GRAPE, WINE	48,835	10.10%	34,080	13.25%	1.4	8.3
PEAR	30,767	6.37%	10,597	4.12%	2.9	7
N-OUTDR TRANSPLANTS	26,228	5.43%	21,931	8.52%	1.2	7.5
APPLE	18,517	3.83%	7,568	2.94%	2.6	8.9
WHEAT (FORAGE - FODDER)	3,276	0.68%	2,007	0.78%	1.7	3.1
FENNEL	1,380	0.29%	929	0.36%	1.3	1.5
SUGARBEET	1,379	0.29%	956	0.37%	1.5	1.5
GARLIC	396	0.08%	192	0.07%	2.1	2.3
ONION, GREEN	382	0.08%	253	0.10%	1.5	1.7
STRAWBERRY	105	0.02%	35	0.01%	2	2.3
ASPARAGUS	99	0.02%	87	0.03%	1.1	1.5
WATERMELON	90	0.02%	49	0.02%	1.7	2.4
CUCUMBER	32	0.01%	14	0.01%	2.3	3.4
CHRISTMAS TREE	25	0.01%	10	0.00%	2.8	3.1
OTHERS**	1,291	0.26%	90	0.05%	ND-1.3	ND-2.3
TOTALS	483,302	100%	257,258	100%		

* ND= Not determined; ** Others= research commodity, right of way, soil fumigation/pre-plant, structural pest control and vertebrates control. These are not registered uses of mancozeb and there report may be attributed to misreporting, misuse, or data entry error.

In addition, Figure 2-1 summarizes the distribution of the crop use patterns for mancozeb while those for the counties are included in **Appendix B**.

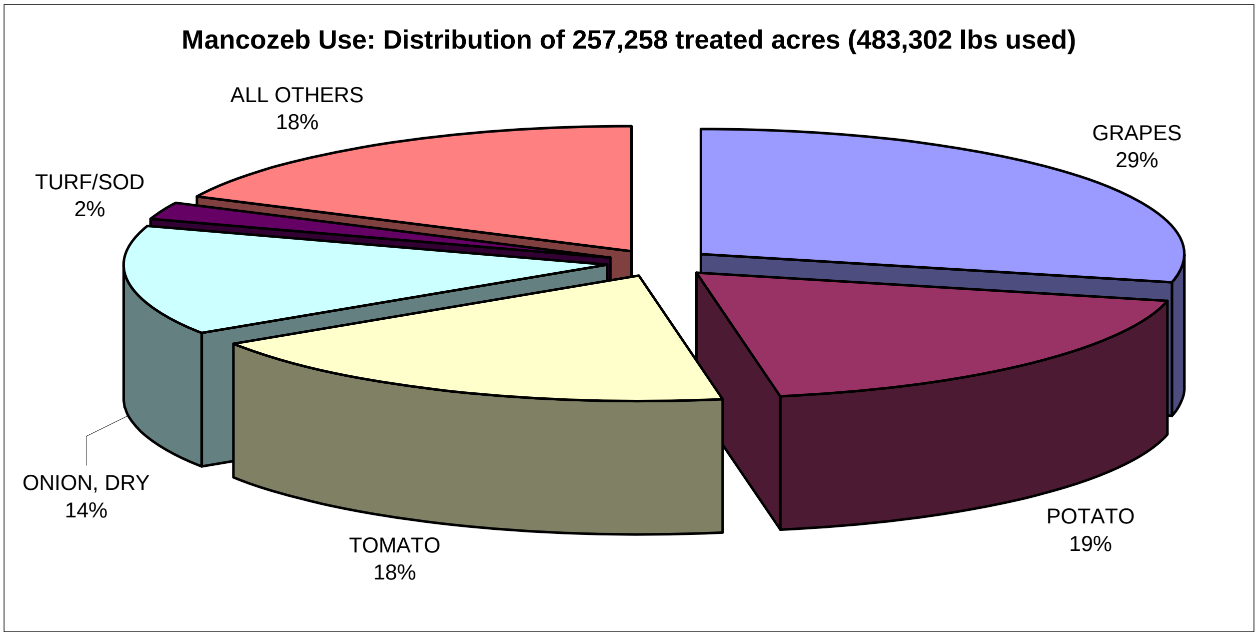


Figure 2-1 Important crop use patterns for mancozeb

Table 2-11 California usage data for maneb

Use Pattern	*Average Annual Applied Across 2002-2005*				*Application Rate Across All observations*	
	Lbs. Used		*Area Treated*			
	Lbs	*%*	*Acres*	*%*	*Average*	*Maximum*
LETTUCE, LEAF	513,598	52.13%	373,234	58.82%	1.3	5.5
WALNUT	248,608	25.23%	145,595	22.95%	1.7	5.7
ALMOND	108,733	11.04%	35,472	5.59%	3.2	9.5
ONION, DRY	31,110	3.16%	19,172	3.02%	1.7	3.2
TOMATO, PROCESSING	28,303	2.87%	25,434	4.01%	1.1	3.3
POTATO	10,006	1.02%	8,790	1.39%	1.2	4.8
TURF/SOD	7,721	0.78%	555	0.09%	17.4	82.4
BROCCOLI	6,549	0.66%	4,881	0.77%	1.3	4.5
N-OUTDR TRANSPLANTS	6,281	0.64%	3,170	0.50%	1.3	5.3
CABBAGE	4,902	0.50%	3,833	0.60%	1.3	3.6
ONION, GREEN	4,429	0.45%	2,815	0.44%	1.7	5.5
CHINESE CABBAGE (NAPPA)	4,398	0.45%	3,493	0.55%	1.2	1.9
GRAPE	2,022	0.21%	1,516	0.24%	1.7	4.3
CAULIFLOWER	1,779	0.18%	1,245	0.20%	1.4	5
PEPPER, FRUITING	1,650	0.17%	1,377	0.22%	1.1	2.4
GRAPE, WINE	1,265	0.13%	610	0.10%	2.1	6.3
BOK CHOY	1,224	0.12%	1,148	0.18%	1.1	2.2
BRUSSELS SPROUT	994.7	0.10%	776.8	0.12%	1.4	1.6
SPINACH*	521	0.05%	337	0.05%	1.2	4.9
ENDIVE (ESCAROLE)	381	0.04%	275	0.04%	1.4	3.8
SUGARBEET	209.6	0.02%	180.5	0.03%	1.2	1.2
SQUASH, SUMMER	153.7	0.02%	103.2	0.02%	1.2	1.4
CELERY	108	0.01%	54	0.01%	2.1	5.1
APPLE	101	0.01%	42	0.01%	None	100.8
BEAN, UNSPECIFIED	70.1	0.01%	47.8	0.01%	1.4	1.5
CORN, HUMAN CONSUMPTION	66.3	0.01%	53.8	0.01%	1.2	1.5
GARLIC	50	0.01%	233	0.04%	0.5	2
KOHLRABI	30	0.00%	28	0.00%	1.3	3
WATERMELON	17	0.00%	12	0.00%	1.5	1.6
CUCUMBER	16	0.00%	11	0.00%	1.3	1.6
PUMPKIN	12	0.00%	9	0.00%	None	12.2
COLLARD*	2.5	0.00%	2.3	0.00%	1.1	1.2
	985,311	100.00%	634,505	100.00%		

* Spinach and collards are not registered uses for maneb and there report may be attributed to misreporting, misuse, or data entry error.

In addition, Figure 2-2 summarizes the distribution of the crop use patterns for mancozeb while those for the counties are included in **Appendix B**.

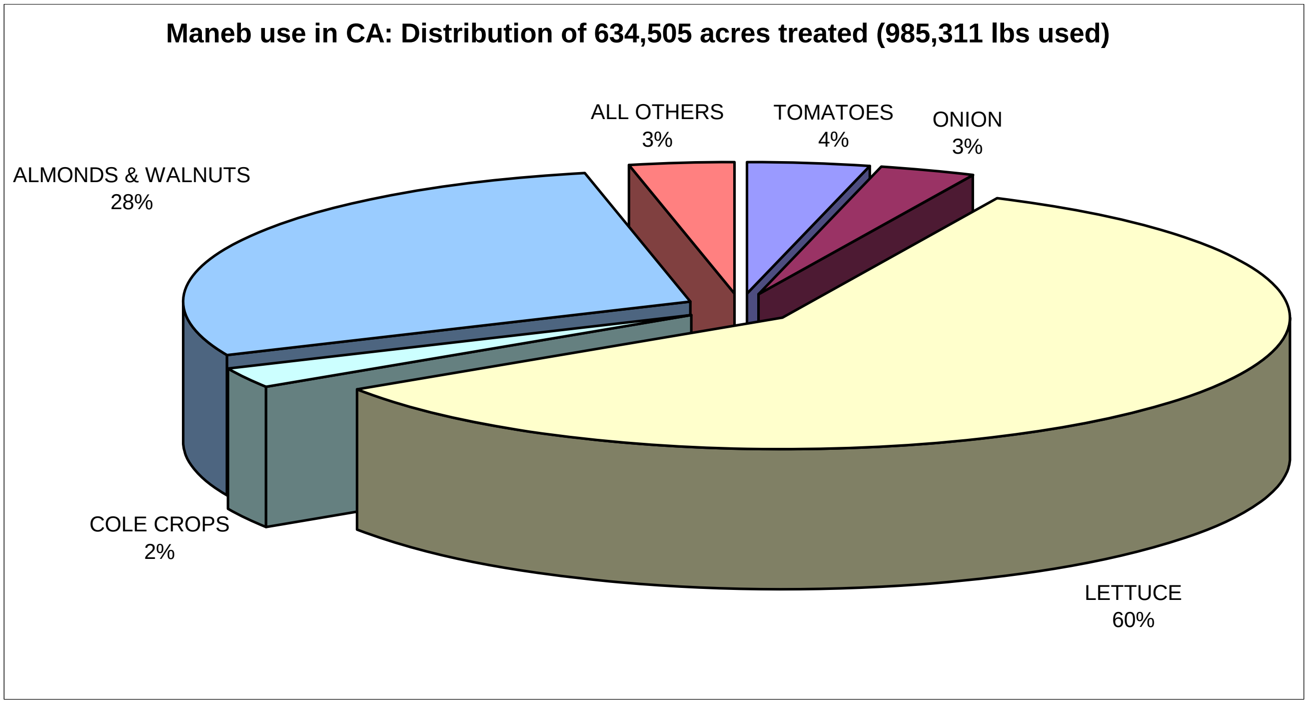


Figure 2-2 Important crop use patterns for maneb

Analysis of the 2002-2005 CDPR PUR usage data is important in determining the intensity and extent of mancozeb and maneb usage in California. For intensity of use, reported mancozeb and maneb application rates, across all use reported, show average rates that are generally consistent with or less than the maximum allowable label rates. However, it appears that there are some problems in the reported maximum rates, as it appears to be generally higher than labeled maximum rates. Data on the average four-year annual amounts of applied mancozeb (a total of 483,302 lbs) suggest that nearly 99% of this amount is distributed between the top ten uses as follows: grapes (22%); onions (13%), turf/sod (13%); tomatoes (12%); potatoes (12%); landscaping (11%); pears (6%); nursery plants (5%); apples (4%); and wheat (1%). In terms of extent of use, the same crops also represent 99% of total acreage treated (257,258 Acres) but with different order of % treated as follows: grapes (29%); potatoes (19%); tomatoes (19%); onions (14%); nursery plants (9%); pears (4%); apples (3%); turf/sod (2%) and wheat (1%); with no acreage reported for landscaping.

In contrast, the average annual amounts of maneb (985,311 lbs) for the same four years was much higher than mancozeb with nearly 99% of this amount distributed between the top ten uses as follows: lettuce (52%); walnuts (25%), almonds (11%); onion (4%); tomatoes (3%); cole crops (2%); and potatoes, turf/sod/nursery and dried beans (4% total, 1% each). The same crops also represent 99% of total acreage treated (634,506 Acres) with the % treated as follows: lettuce (59%); walnuts (23%), almonds (6%); onion (3%); tomatoes (4%); cole crops (2%); and potatoes, turf/sod/nursery and dried beans (4% total, 1% each).

In general, data revealed that ⅓ of the total amounts of the two EBDCs used was mancozeb and that this quantity of mancozeb was used to treat nearly ⅓ (29%) of the total area treated. Almost 98% of the total quantity of the two EBDCs was used to treat 15 use patterns, which represents nearly 98% of the total treated acreage. Table 2.12 summarizes the distribution of the total quantity of mancozeb/maneb between various use patterns as well as the distribution of the total acreage treated in the state of California.

Table 2-12 Combined usage data for mancozeb and maneb showing the % share for each

Use Pattern	*Mancozeb Share: % **		*Maneb Share: % **	
	Pounds	***Acres***	***Pounds***	***Acres***
Lettuce	No reported usage		35%	42%
Walnuts and Almonds			24%	20%
Cole Crops			1%	2%
Grapes, including Wine	7%	8%	No reported usage	
Tomato, Processing	4%	5%	2%	3%
Onion, Dry	4%	4%	2%	2%
Potatoes	4%	5%	1%	1%
Turf: Sod	4%	1%	1%	0%
Residential Landscaping	4%	ND	No reported usage	
Pear and Apples	3%	2%		
Nursery: Outdoor plants & Wheat	2%	2%		
Totals	**32%**	**28%**	**66%**	**70%**
Pounds Applied (32%+66%= 98%)	**32%**	**-**	**66%**	**-**
Acres Treated (28%+70%= 98%)	**-**	**28%**	**-**	**70%**

* % of the total pounds of a.i used of mancozeb or maneb from the total pound used for both **<u>or</u>** % of the total acres treated by mancozeb or maneb from the total acres treated by both EBDCs.

Figure 2-3 is included to display the spatial distribution of total use of mancozeb and maneb and the relative use between the two chemicals in all the counties of California. In this Figure, large blue circles represent total use of maneb + mancozeb while the inner red circles represent mancozeb use only. For reference, recovery units and all catchments associated with CRLF are included.

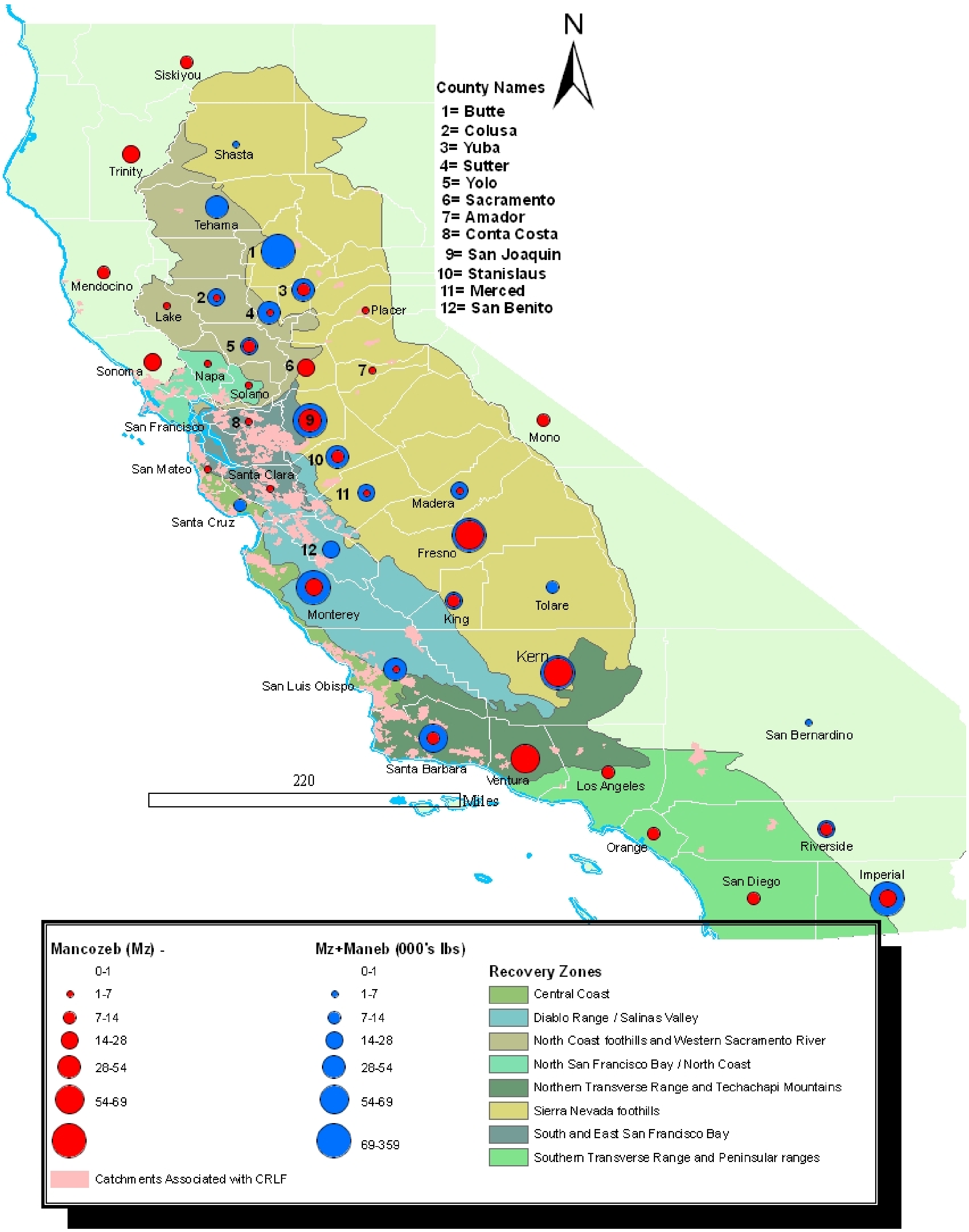


Figure 2-3 Mancozeb and maneb reported usage data in relation to CRLF (county level data/average of five years).

Finally, 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. Historical uses are not considered part of the federal action and, therefore, are not considered in this assessment.

2.5 Assessed Species

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

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

2.5.1 Distribution

The CRLF is endemic to CA and Baja California (Mexico) and historically inhabited 46 counties in CA 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 CA (USFWS 1996). The species has an elevation range of near sea level to 1,500 meters (5,200 feet) (Jennings and Hayes 1994); however, nearly all of the known CRLF populations have been documented below 1,050 meters (3,500 feet) (USFWS 2002).

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

The distribution of CRLFs within CA 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.a). 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.

2.5.1.1 Recovery Units

Eight recovery units have been established by USFWS for the CRLF. These areas are considered essential to the recovery of the species, and the status of the CRLF "may be considered within the smaller scale of the recovery units, as opposed to the statewide range" (USFWS 2002). Recovery units reflect areas with similar conservation needs and population statuses, and therefore, similar recovery goals. The eight units described for the CRLF are delineated by watershed boundaries defined by US Geological Survey hydrologic units and are limited to the elevation maximum for the species of 1,500 m above sea level. The eight recovery units for the CRLF are listed in Table 2-13 and shown in Figure 2-4.

Table 2-13 CRLF Recovery Units with Overlapping Core Areas and Designated Critical Habitat

Recovery Unit [1] (Figure 3)	*Core Areas [2,7] (Figure 3)*	*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)	**Feather River (1)**	BUT-1A-B	✓	
	Yuba River-S. Fork Feather River (2)	YUB-1		
	--	NEV-1	✓[6]	
	Traverse Creek/Middle Fork American River/Rubicon (3)	--	✓	
	Consumnes River (4)	ELD-1	✓	
	S. Fork Calaveras River (5)	--		✓
	Tuolumne River (6)	--		✓
	Piney Creek (7)	--		✓
	East San Francisco Bay (partial)(16)	--	✓	
North Coast Range Foothills and Western Sacramento River Valley (2)	**Cottonwood Creek (8)**	--	✓	
	Putah Creek-Cache Creek (9)	--		✓
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	✓	

Recovery Unit [1] (Figure 3)	*Core Areas [2,7] (Figure 3)*	*Critical Habitat Units [3]*	*Currently Occupied (post-1985) [4]*	*Historically Occupied [4]*
	Watsonville Slough- Elkhorn Slough (partial) (19)	SCZ-2 [5], MNT-1 [5]	✓	
	Carmel River-Santa Lucia (20)	MNT-2	✓	
	Estero Bay (22)	--	✓	
	Arroyo Grande Creek (23)	SLO-8	✓	
	Santa Maria River -Santa Ynez River (24)	--	✓	
Diablo Range and Salinas Valley (6)	**East San Francisco Bay (partial) (16)**	MER-1A-B	✓	
	--	SNB-1, SBB-2	✓[6]	
	Santa Clara Valley (17)	--	✓	
	Watsonville Slough- Elkhorn Slough (partial)(19)	--	✓	
	Carmel River-Santa Lucia (partial) (20)	--	✓	
	Gablan Range (21)	SNB-3	✓	
	Estrella River (28)	SLO-1	✓	
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
6 Critical habitat units that are outside of core areas, but within recovery units
7 Currently occupied core areas that are included in this effects determination are bolded.

Recovery Units

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

Core Areas

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

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

Figure 2-4 Recovery unit, core area, critical habitat, and occurrence designations for CRLF

2.5.1.2 Core Areas

USFWS has designated 35 core areas across the eight recovery units to focus their recovery efforts for the CRLF (Figure 2-4). 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 mancozeb or Maneb 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 2-13 (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.

2.5.1.3 Other Known Occurrences from the CNDBB

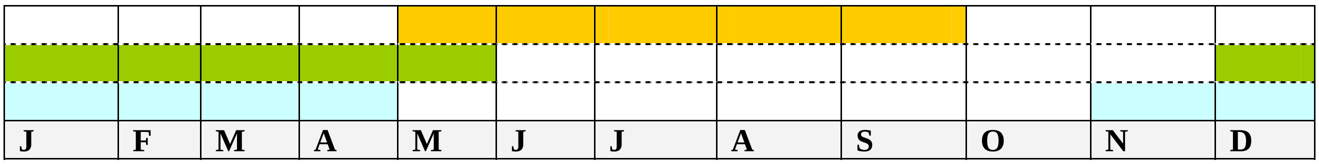
The CNDDB provides location and natural history information on species found in California. The CNDDB serves as a repository for historical and current species location sightings. Information regarding known occurrences of CRLFs outside of the currently occupied core areas and designated critical habitat is considered in defining the current range of the CRLF. See: for additional information on the CNDDB, refer to the web site stated below[11].

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 CA. 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

[11] http://www.dfg.ca.gov/bdb/html/cnddb_info.html

(Hayes and Miyamoto 1984). Egg masses contain approximately 2000 to 6000 eggs ranging in size between 2 and 2.8 mm (Jennings and Hayes 1994). Embryos hatch 10 to 14 days after fertilization (Fellers 2005a) depending on water temperature. Egg predation is reported to be infrequent and most mortality is associated with the larval stage (particularly through predation by fish); however, predation on eggs by newts has also been reported (Rathburn 1998). Tadpoles require 11 to 28 weeks to metamorphose into juveniles (terrestrial-phase), typically between May and September (Jennings and Hayes 1994, USFWS 2002); tadpoles have been observed to over-winter (delay metamorphosis until the following year) (Fellers 2005b, USFWS 2002). Males reach sexual maturity at 2 years, and females reach sexual maturity at 3 years of age; adults have been reported to live 8 to 10 years (USFWS 2002). Figure 2-5 depicts CRLF annual reproductive timing.



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

Figure 2-5 CRLF Reproductive Events by Month

2.5.3 Diet

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

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

2.5.4 Habitat

CRLFs require aquatic habitat for breeding, but also use other habitat types including riparian and upland areas throughout their life cycle. CRLF use of their environment varies; they may complete their entire life cycle in a particular habitat or they may utilize multiple habitat types. Overall, populations are most likely to exist where multiple breeding areas are embedded within varying habitats used for dispersal (USFWS 2002). Generally, CRLFs utilize habitat with perennial or near-perennial water (Jennings et al. 1997), dense vegetation close to water, shading, and water of moderate depth are habitat features that appear especially important for CRLF (Hayes and Jennings 1988).

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

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

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

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

2.6 Designated Critical Habitat

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

‘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 1**.

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

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

(1) Significant alteration of water chemistry or temperature to levels beyond the tolerances of the CRLF that result in direct or cumulative adverse effects to individuals and their life cycles.

(2) Significant increase in sediment deposition within the stream channel or pond or disturbance of upland foraging and dispersal habitat that could result in elimination or reduction of habitat necessary for the growth and reproduction of the CRLF by increasing the sediment deposition to levels that would adversely affect their ability to complete their life cycles.

(3) Significant alteration of channel/pond morphology or geometry that may lead to changes to the hydrologic functioning of the stream or pond and alter the timing, duration, water flows, and levels that would degrade or eliminate the CRLF and/or its habitat. Such an effect could also lead to increased sedimentation and degradation in water quality to levels that are beyond the CRLF's tolerances.

(4) Elimination of upland foraging and/or aestivating habitat or dispersal habitat.

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

(6) Alteration or elimination of the CRLF's food sources or prey base (also evaluated as indirect effects to the CRLF).

As previously noted in Section 2.1, the Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Because mancozeb and maneb are expected to directly impact living organisms within the action area, critical habitat analysis for mancozeb and maneb are limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes.

2.7 Action Area

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). It is recognized that the overall action area for the national registration of mancozeb and maneb is likely to encompass considerable portions of the United States based on the large array of uses for the two chemicals. 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 products under consideration and the types of effects that mancozeb and maneb may be expected to have on the environment, the exposure levels to mancozeb and maneb that are associated with those effects, and the best available information concerning the use of the two chemicals and their 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 mancozeb and maneb. An analysis of labeled uses and review of available product labels was completed. This analysis indicates that, for mancozeb and maneb, the following uses are considered as part of the federal action evaluated in this assessment:

(1) Foliar application of either mancozeb alone, maneb alone, or interchanged between maneb and mancozeb. Uses are summarized in Table 2-14.

Table 2-14 Summary of use patterns for mancozeb and maneb alone and maneb and mancozeb together

Mancozeb Use Only	*Maneb Use Only*	*Mancozeb or Maneb*
1. Row, field and vegetable crops		
Asparagus	Beans (Dried)	Corn (Sweet/Pop) (1-3 crops/year)
Cereal Grains [(1)]	Brassica (1-3 crop/year) [(2)]	Cucurbits [(3)]
Corn (Field & seed crop)	Brussels sprouts (1-2 crops/year)	Garlic
Cotton	Cabbage (Chinese)/Loose (1-3 crops/year)	Onion (Dried)
Fennel (1-2 crops)	Eggplant	Potatoes
Shallot	Kale (1-3 crops/year)	Sugar Beet
X-mass tree plantations	Lettuce, and Endive (1-2 crops/year)	Tomatoes
-	Onion (Green) (1-2 crops/year)	Ornamentals
-	Pepper	-
2. Orchards & Vineyards		
Crab apple, pear, and quince	Almonds	Apples
Plantains	Figs	Bananas
-	Walnuts	Grapes
-		Grapes (Wine)
-		Papayas
3. Residential Landscaping		
-	-	Ornamentals (Others) [(4)]
-	-	Ornamentals (Pachysandra)
-	-	Ornamentals (turf)
4. Turf		
-	-	Turf (sod farms) (1-2 crops/year)
-	-	Turf [(5)]
5. Forestry		
Forestry (Douglas Fir)	-	-

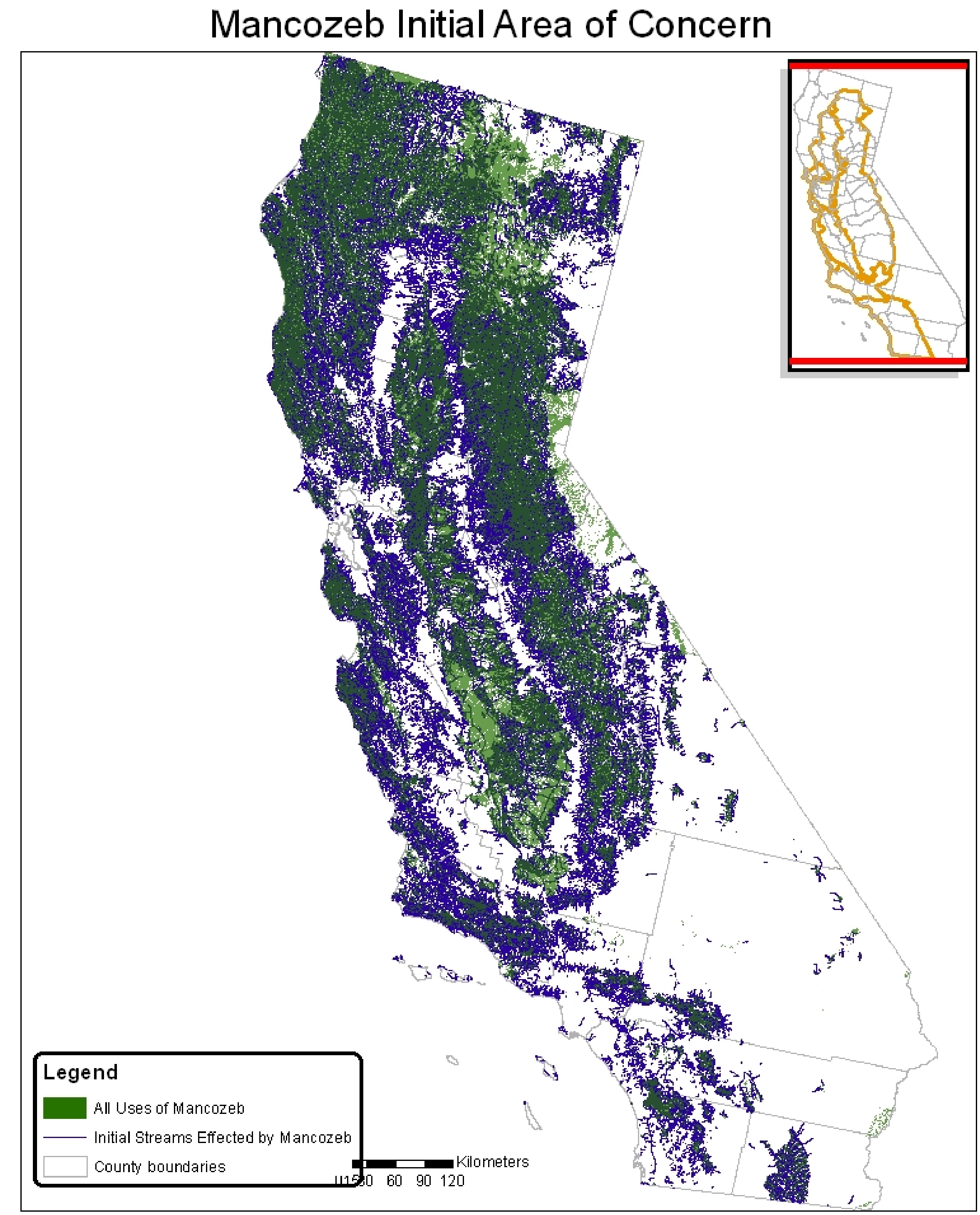
[(1)] Cereal grains include: wheat, barley, oats, rye, and triticale.
[(2)] Brassica include broccoli, cabbage and Chinese cabbage (tight head), cauliflower, and Kohlrabi
[(3)] Cucurbits: Mancozeb use only: muskmelon and gourds; Maneb only: squash (winter) and pumpkins; both: cantaloupe, honeydew, casaba, Crenshaw and winter melons.
[(4)] Ornamentals include shade trees, ground cover plants, herbaceous plants, non-flowering plants and woody plants, shrubs and vines.
[(5)] Turf includes commercial/industrial/recreational area lawns, golf course turf, and ornamental sod farm turf.

(2) Seed treatment with mancozeb or maneb interchangeably on eight crops that are also treated with foliar sprays later in the season. The crops are: cereal grains, except triticale; cotton; corn; and tomatoes. Triticale seeds can only be treated with mancozeb. Seed treatment alone (with no foliar treatment) is labeled for an additional four crops, namely: flax, safflower, sorghum, and rice.

(3) Pre-plant potatoes seed/seed pieces dip treatment with either mancozeb or maneb; and

(4) Dip treatment use for asparagus, Capri fig and pineapple using mancozeb only.

After a determination of which uses will be assessed, an evaluation of the locations of potential use sites that will be assessed is determined. The potential use sites represent the initial area of concern or "footprint" which 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 mancozeb and maneb use. The initial area of concern is defined as all land cover types that represent the labeled uses of mancozeb and maneb in the state of California. Therefore, a map representing all the land cover types that make up the initial area of concern is presented in Figure 2-6 for mancozeb alone use patterns, Figure 2-7 for maneb only use patterns, and Figure 2-8 for the interchangeable use of mancozeb and maneb.

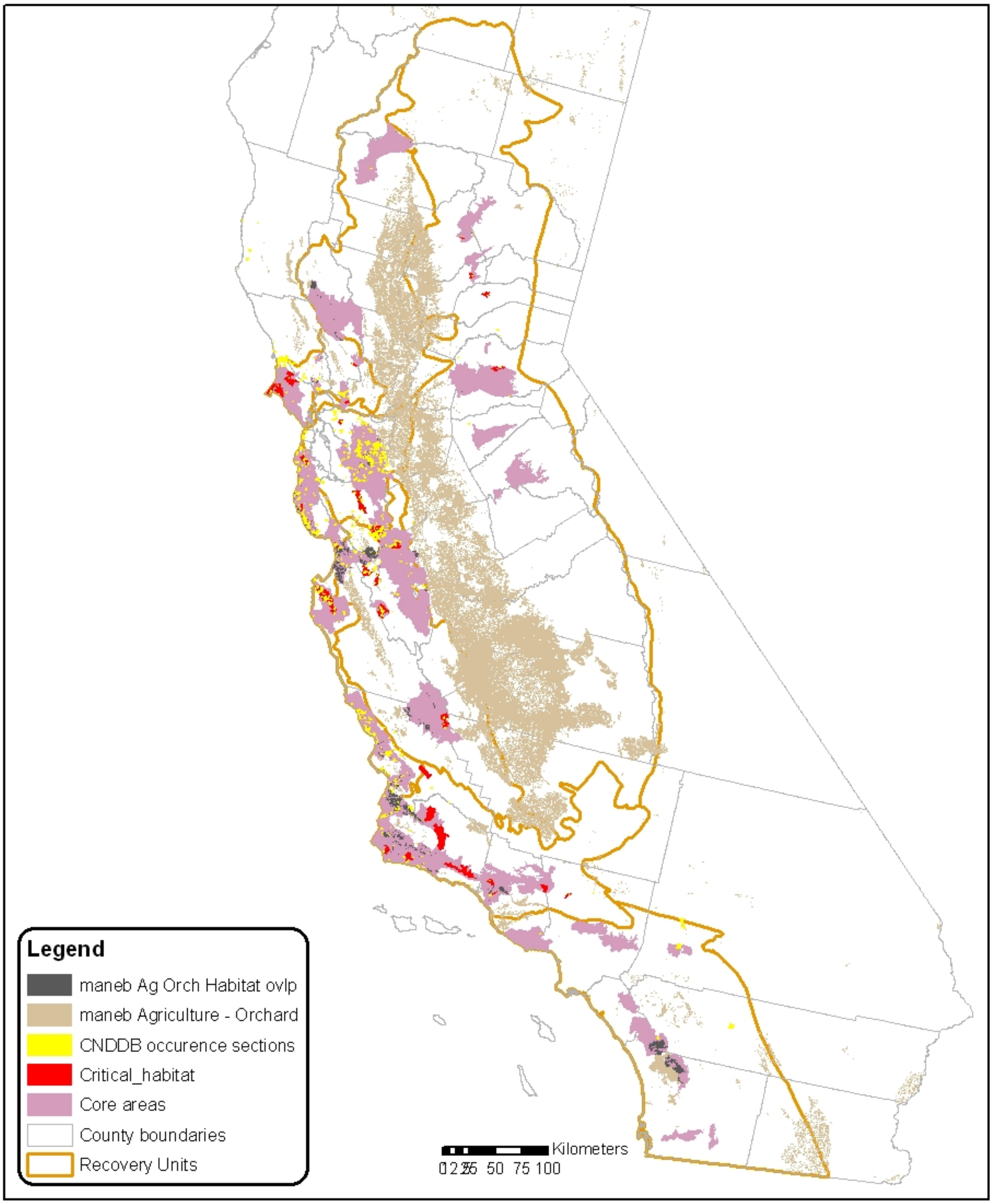


Compiled from California County boundaries (ESRI, 2002), USDA National Agriculture Statistical Service (NASS, 2002) Gap Analysis Program Orchard/ Vineyard Landcover (GAP) National Land Cover Database (NLCD) (MRLC, 2001)

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

Figure 2-6 Initial area of concern for the use of mancozeb alone

Maneb Initial Area of Concern



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. September, 2007. Projection: Albers Equal Area Conic USGS, North American Datum of 1983 (NAD 1983)

Figure 2-7 Initial area of concern for the use of maneb alone

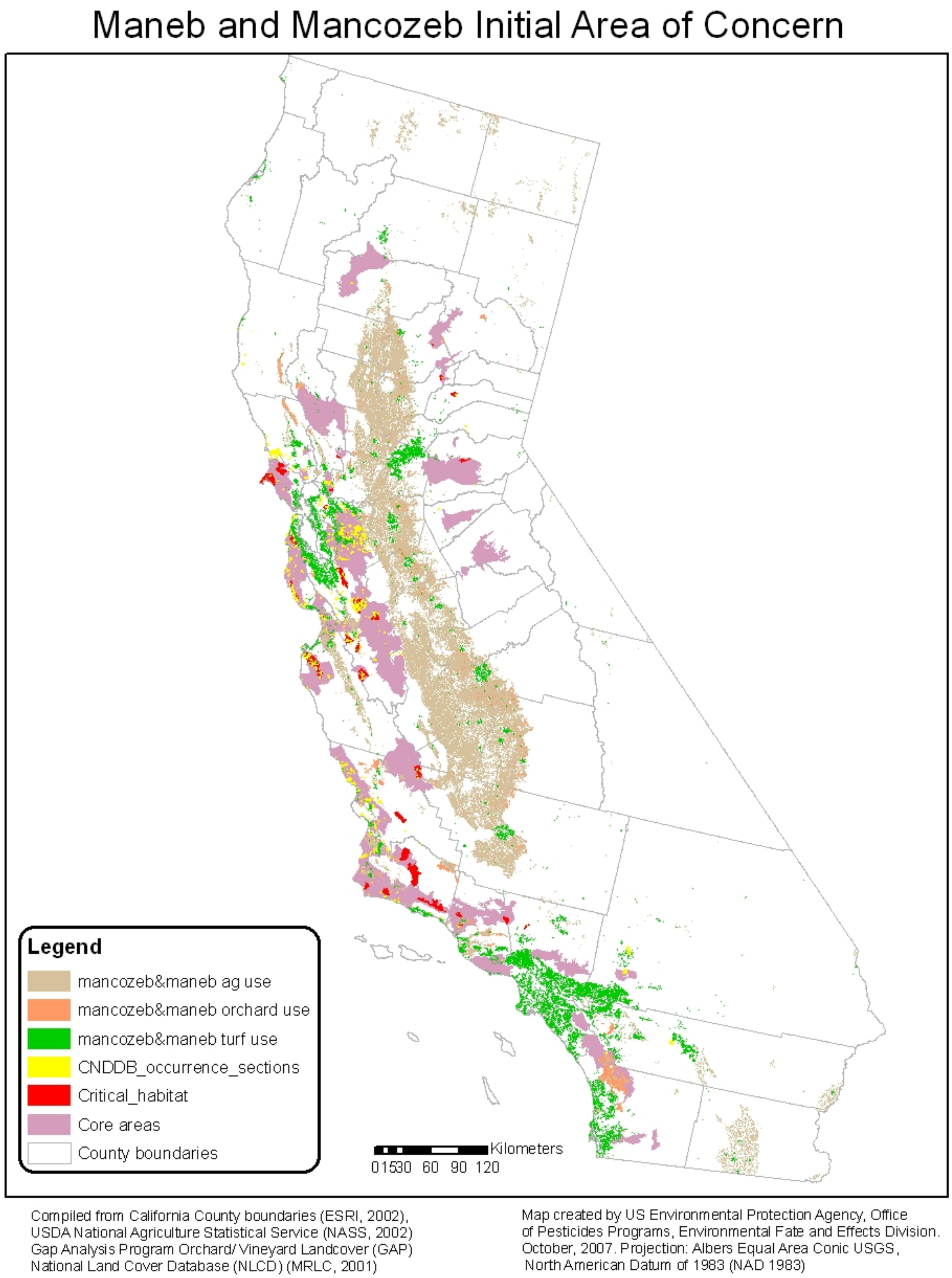


Figure 2-8 Initial area of concern for the interchangeable use of mancozeb or maneb

Once the initial area of concern is defined, the next step is to compare the extent of that area with the results of the screening level risk assessment. The screening level risk assessment will define which taxa, if any, are predicted to be exposed at concentrations above the Agency's Levels of Concern (LOC). The screening-level assessment includes an evaluation of the environmental fate properties of mancozeb and maneb to determine which routes of transport are likely to have an impact on the CRLF. The exposure routes for mancozeb and maneb most likely to affect non-target organisms are spray drift and runoff. To determine the action area for this assessment, the terrestrial and aquatic portions of the action area in California are determined separately and then are combined to produce a final action area. GIS maps for the final action area are included in **Appendix C** for mancozeb use, **Appendix I** for maneb use, and **Appendix L** for the combined mancozeb and maneb use.

2.8 Assessment of Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected"[12]. 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 mancozeb and maneb (e.g., runoff, spray drift, etc.), and the routes by which ecological receptors are exposed to mancozeb and maneb-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 or habitat modification. In addition, potential modification of critical habitat is assessed by evaluating potential effects to PCEs, which are components of the habitat areas that provide essential life cycle needs of the CRLF. Each assessment endpoint requires one or more "measures of ecological effect," defined as changes in the attributes of an assessment endpoint or changes in a surrogate entity or attribute in response to exposure to a pesticide. Specific measures of ecological effect are generally evaluated based on acute and chronic toxicity information from registrant-submitted guideline tests that are performed on a limited number of organisms. Additional ecological effects data from the open literature are also considered.

A complete discussion of all the toxicity data available for this risk assessment, including resulting measures of ecological effect selected for each taxonomic group of concern, is included in Section 4 of this document. A summary of the assessment endpoints and measures of ecological effect selected to characterize potential assessed direct and indirect CRLF risks associated with exposure to mancozeb and maneb is providedin Table 2-15.

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

Table 2-15 Summary of assessment endpoints and measures of ecological effects for direct and indirect effects of mancozeb/maneb on the CRLF

Assessment Endpoint	*Measures of Ecological Effects* [1]
Aquatic Phase (eggs, larvae, tadpoles, juveniles, and adults) [a and c]	
1. Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases	1a. Most sensitive fish or amphibian acute LC_{50} Mancozeb -Rainbow trout (*Oncorhynchus mykiss*) LC50 460 ppb, Maneb-*O. mykiss* LC50 42ppb 1b. Most sensitive fish or amphibian chronic ETU (chronic exposure) – freshwater fish NOAEC 37.32ppm (estimated ACR) 1c Most sensitive fish or amphibian early-life stage data (No guideline data available for ETU).
2. Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants)	2a. Most sensitive fish, aquatic invertebrate, and aquatic plant EC_{50} or LC_{50}Mancozeb-*Daphnid magna* LC50 580 ppb *Maneb D. magna* –LC_{50} = 120 ppb -*Mancozeb- O. mykiss LC50* = 460 ppb Maneb-*O. mykiss* LC50 42ppb Mancozeb *Pseudokirchneriella subcaptitatum* (formerly *Selenastrum Psedokirchneriella)* EC_{50} = 47 ppb Maneb *P. subcaptitatum* EC_{50} = 13.4 ppb 2b. Most sensitive aquatic invertebrate and fish chronic NOAEC (No early lifestage fish data available for ETU) *D. magna* NOAEC = 2.0 ppm
3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community)	3a. Vascular plant acute EC_{50} (No data available for mancozeb or maneb 3b. Non-vascular plant acute EC_5Mancozeb freshwater green algae (*P. subcaptitatum)* EC_{50} = 47 ppb; Maneb *P. subcaptitatum EC50* = 13.4 ppb.
4. Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation, required maintaining acceptable water quality and habitat in ponds and streams comprising the species' current range.	4a. Distribution of EC_{25} values for monocots -No data available on Mancozeb as single active ingredient of TEP. No data available for Maneb 4b. Distribution of EC_{25} values for dicots – No data available on mancozeb as single active ingredient of TEP. No data available for Maneb
Terrestrial Phase (Juveniles and adults) [b and c]	
5. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	5a.*)* Most sensitive bird or terrestrial-phase amphibian acute LC_{50} or LD_5 *Mancozeb*-English sparrow (*Passer domesticus)* acute oral LD50 ~ 1,500 mg/kgb Maneb –Northern bobwhite quail (*Colinus virginianus)* acute oral LD50 >2, 150 mg/kgb Maneb –Mallard duck (*Anas platyrhynchos) Subacute dietary* LC50 = >5,000 ppm 5b. Most sensitive bird or terrestrial-phase amphibian chronic NOAEC: Mancozeb *A.*

Assessment Endpoint	*Measures of Ecological Effects* [1]
	platyrhynchos reproduction NOAEC = 125 ppm Maneb, *Anas platyrhynchos reproduction NOAEC 20 ppm*
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} -Mancozeb-Honey bee ((*Apis mellifra)* 1396.2 ppm, Maneb - *Apis mellifra* acute contact- LD50= > 12.09, Mancozeb predatory mite (*Typhlodromus pyri) Residual toxicity LR50a = 0.01lb a.i./A* -Mancozeb Rattus norvegicus acute oral LD50 >5,000 mg/kg Maneb- *R. norvegicus* LD50 >5,000 mg/kg 6b. Most sensitive terrestrial invertebrate and vertebrate chronic NOAEC Mancozeb Rattus norvegicus reproductive NOAEL = 120 ppm Maneb *R. norvegicus* reproductive *NOAEC* =75ppm,
7. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.,* riparian vegetation)	7a. Distribution of EC_{25} for monocots -No data available on Mancozeb as single active ingredient of TEP Maneb – no data available 7b. Distribution of EC_{25} for dicots -No data available on Mancozeb as single active ingredient of TEP. Maneb – no data available

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

[1] All registrant-submitted and open literature toxicity data reviewed for this assessment is included in **Appendix D and H.**

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 mancozeb and maneb 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 mancozeb and maneb effects data are available.

Assessment endpoints and measures of ecological effect selected to characterize potential modification to designated critical habitat associated with exposure to mancozeb and maneb are provided in Table 2-16. 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 uses of mancozeb and maneb on critical habitat of the CRLF are described in Table 2-16. Some components of these PCEs are associated with physical abiotic features (e.g., presence and/or depth of a water body, or distance between two sites), which are not expected to be measurably altered by use of pesticides. Assessment endpoints used for the analysis of designated critical habitat are based on the adverse modification standard established by USFWS (2006).

Table 2-16 Summary of assessment endpoints and measures of ecological effect for primary constituent elements of the CRLF designated critical habitat

Assessment Endpoint	***Measures of Ecological Effect*** [1]
Aquatic Phase PCEs (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)	
Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.	a. Most sensitive aquatic plant EC_{50}Mancozeb - *P. subcaptitatum* EC50 = 47 ppb; maneb *P. subcaptitatum* EC50 = 13.4 ppb, b. Distribution of EC_{25} values for terrestrial monocots -No data available on mancozeb as single active ingredient of TEP Maneb – no data available c. Distribution of EC_{25} values for terrestrial dicots-No data available on mancozeb as single active ingredient of TEP. Mancozeb – no data available
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 [2]	a. Most sensitive EC_{50} values for aquatic plant-Mancozeb - *P. subcaptitatum* EC50 = 47 ppb, maneb *P. subcaptitatum* EC50 = 13.4 ppb, b. Distribution of EC_{25} values for terrestrial monocots -No data available on mancozeb as single active ingredient of TEP Maneb, no data available c. Distribution of EC_{25} values for terrestrial dicots -No data available on mancozeb as single

Assessment Endpoint	*Measures of Ecological Effect* [1]
	active ingredient of TEP. Maneb- no data available
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	a. Mancozeb *O. mykiss* LC50 = 460 ppb ; maneb-O. mykiss LC50 42ppb Mancozeb- *D. magna* EC50 580 ppb; maneb *D. magna* – LC50 = 120 ppb b. ETU – freshwater fish NOAEC 37.32ppm (estimated ACR) ETU *D. magna* NOAEC =2.0ppm
Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.,* algae)	a. Most sensitive aquatic plant EC_{50}Mancozeb P. *subcaptitatum* EC_{50} = 47 ppb; maneb *P. subcaptitatum* EC_{50} = 13.4 ppb,
Terrestrial Phase PCEs (Upland Habitat and Dispersal Habitat)	
Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance	a. Distribution of EC_{25} values for monocots -No data available on Mancozeb as single active ingredient of TEP b. Distribution of EC_{25} values for dicots No data available on Mancozeb as single active ingredient of TEP c. Lab rat acute oral: mancozeb and maneb LD50 >5000 = >5,000 mg/kg. Maneb- *R. norvegicus* LD50 >5,000 mg/kg . Rattus norvegicus Mancozeb reproductive NOAEL = 120 ppm Maneb reproductive *NOAEC* =75ppm, d. Honey bee acute contact Mancozeb LD5= 1396.2 ppm, Maneb - LD5= > 12.09, Mancozeb predatory mite (*Typhlodromus pyri)* Residual toxicity LR50a = 0.01lb a.i./A e. English sparrow (*P.domesticus)* Mancozeb acute oral LD_{50} ~ 1,500 mg/kg, Northern bobwhite quail Maneb acute oral LD_{50} >2, 150 mg/kgb Mallard duck Maneb*Subacute dietary* LC50 = >5,000 ppm ; Mallard duck reproduction Mancozeb NOAEC = 125 ppmb ,Maneb *NOAEC= 20 ppm* f. Rainbow trout Mancozeb LC50 460 ppb, Maneb- LC50 42ppb; chronic freshwater fish ETU NOAEC 37.32ppm (estimated ACR)
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal	
Reduction and/or modification of food sources for terrestrial phase juveniles and adults	
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	

[1] All toxicity data reviewed for this assessment are included in **Appendix D & H.**

[2] 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 Hypothesis

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 mancozeb and maneb to the environment. The following risk hypotheses are presumed for this endangered species assessment:

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

2.9.2 Diagram

The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the stressor 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 Figure 2-9 and Figure 2-10, and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in Figure 2-11and Figure 2-12. 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.

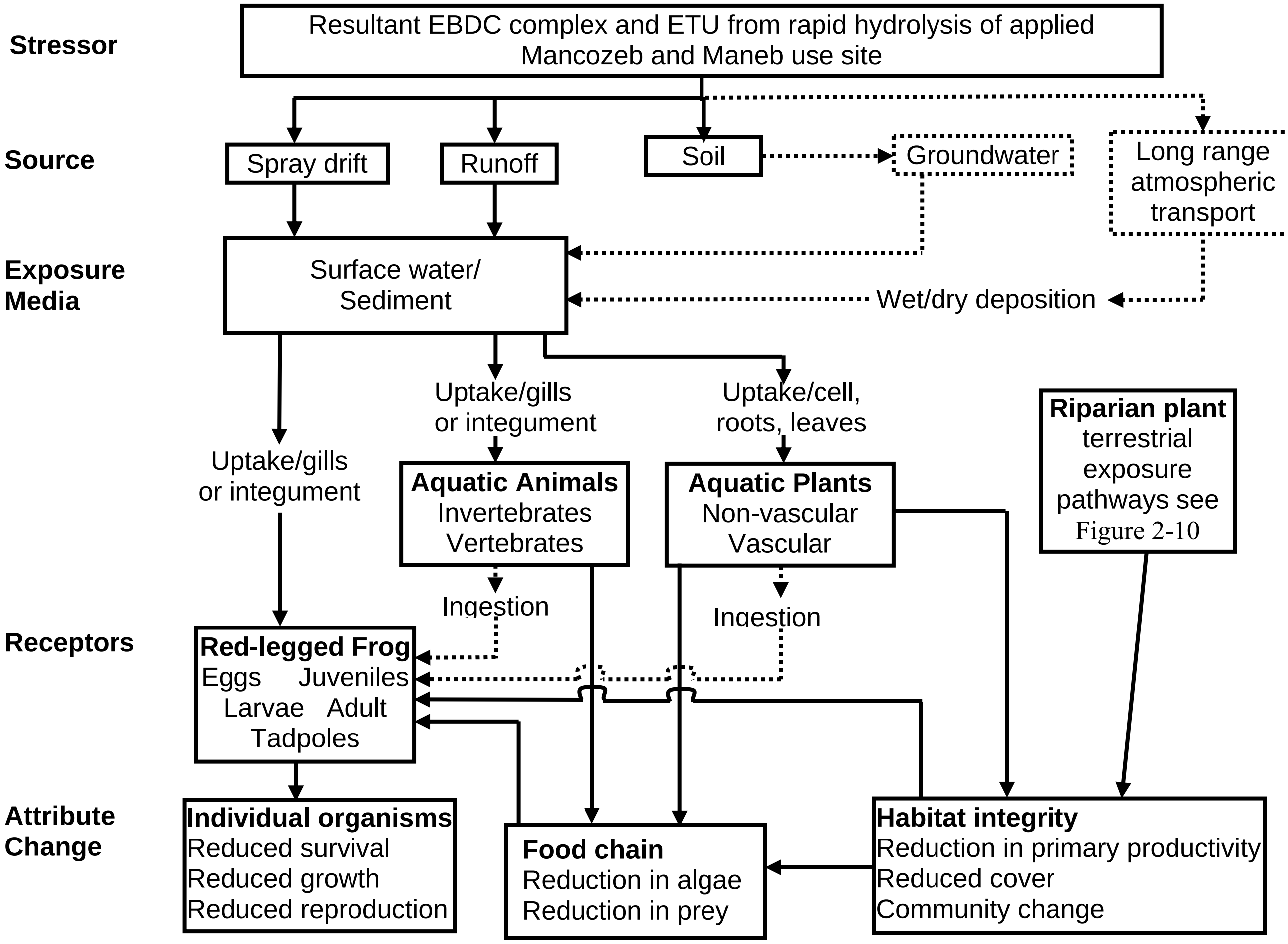


Figure 2-9 Conceptual model for pesticide effects on aquatic phase of the CRLF

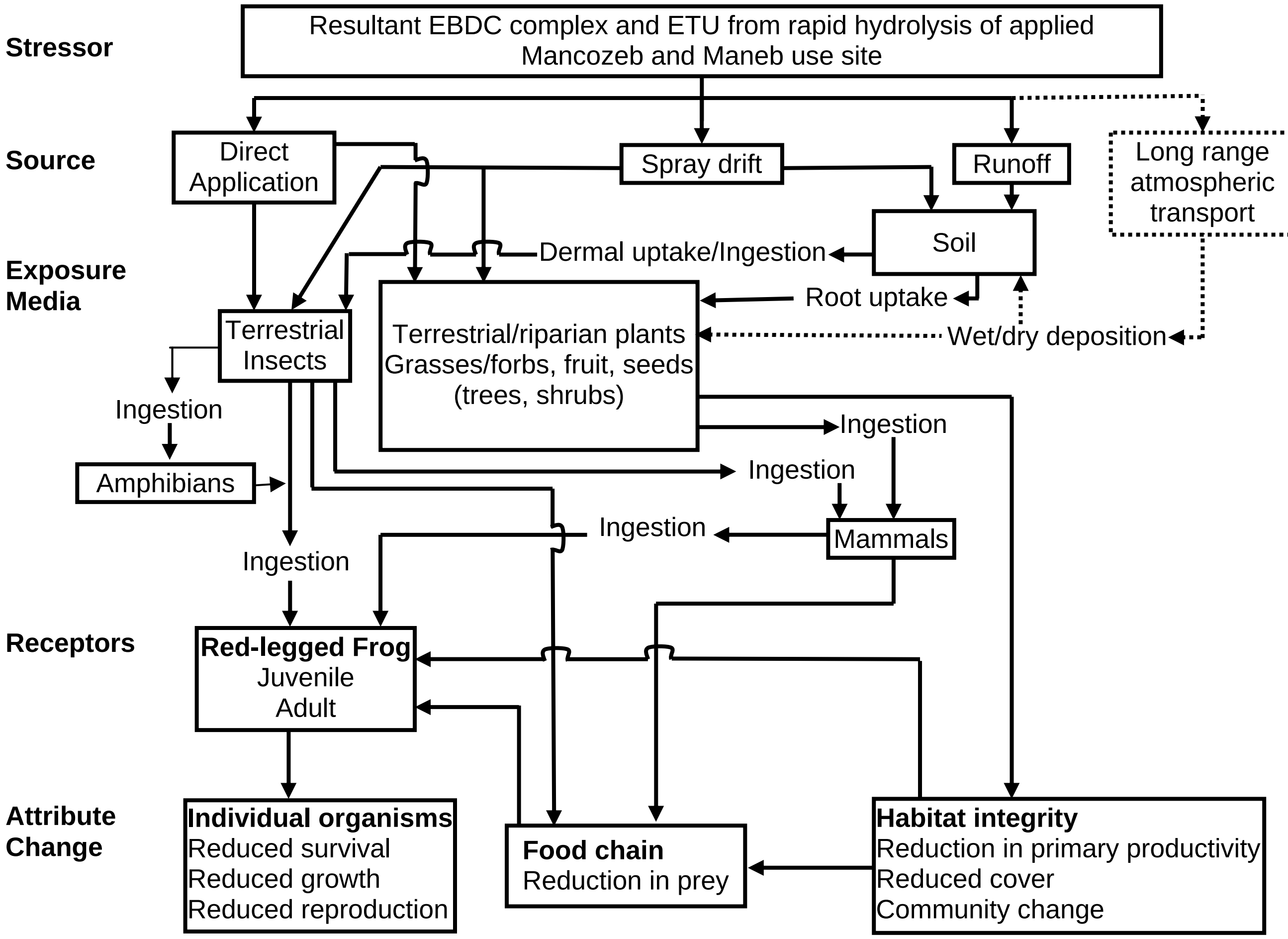


Figure 2-10 Conceptual model for pesticide effects on terrestrial phase of the CRLF

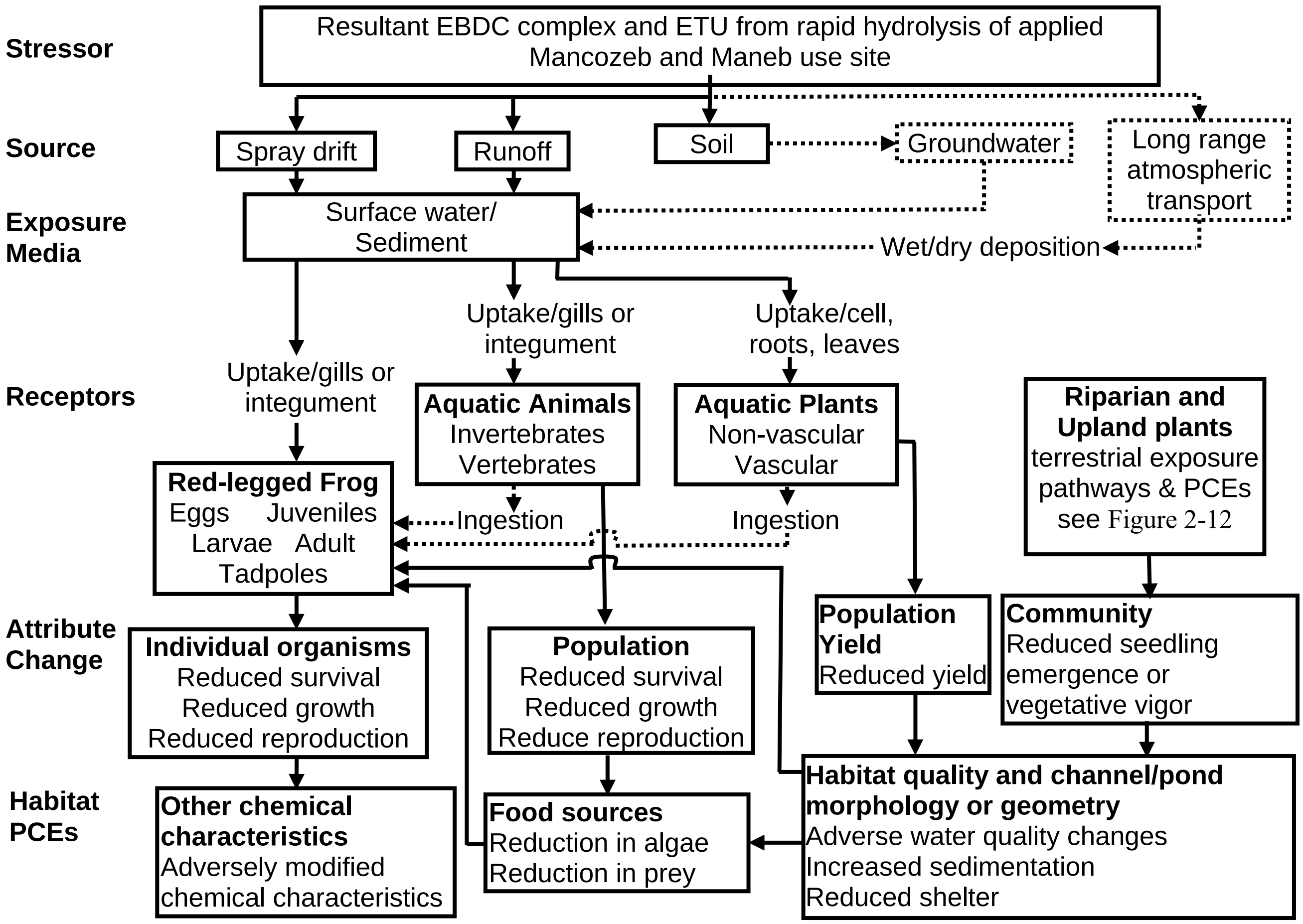


Figure 2-11 Conceptual model for pesticide effects on aquatic components of the CRLF critical habitat

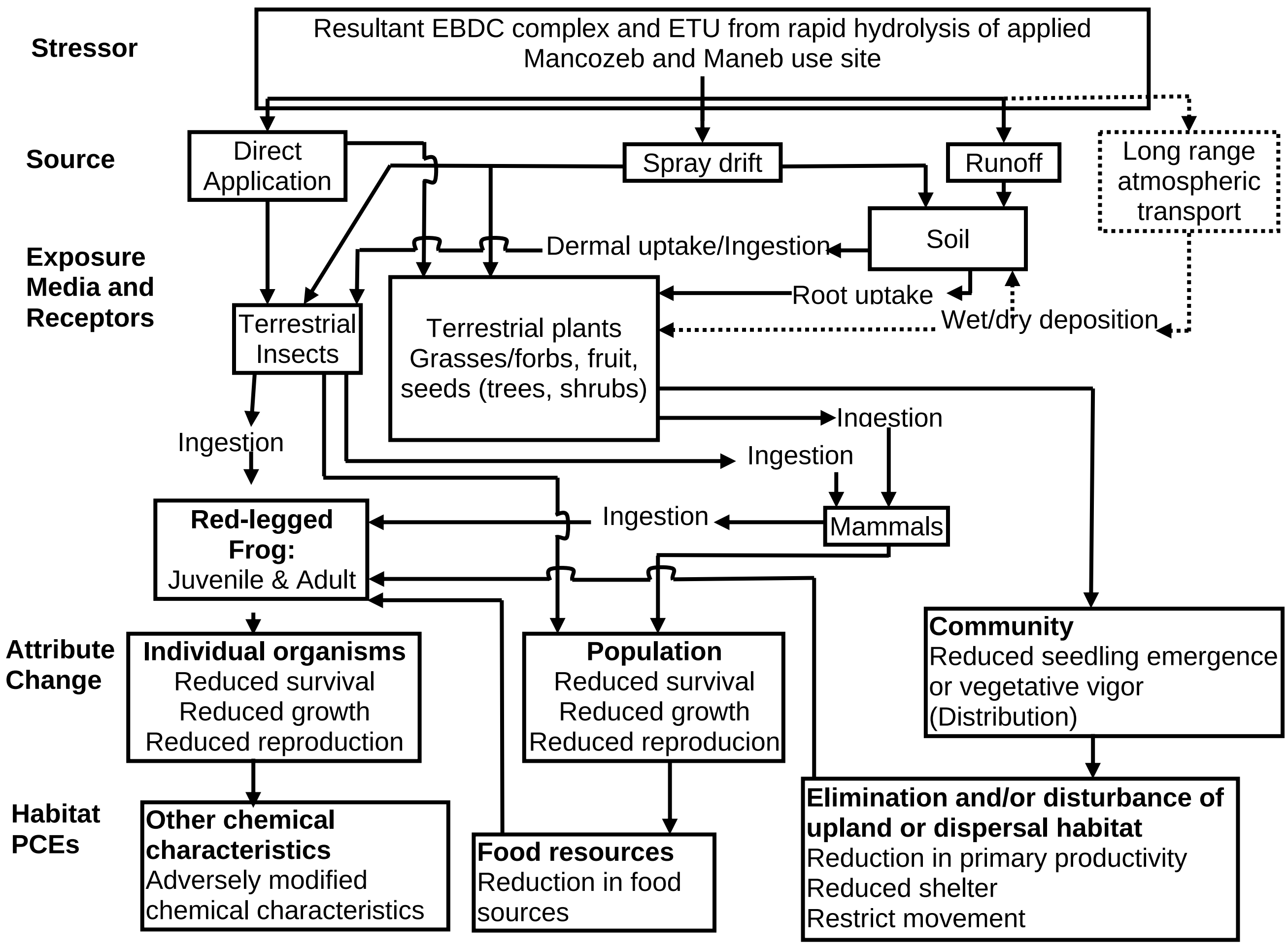


Figure 2-12 Conceptual model for pesticide effects on terrestrial components of the CRLF critical habitat

2.10 Analysis Plan

The analysis plan is the final step in Problem Formulation. During this step, measurements of effect and exposure used to evaluate the risk hypotheses are delineated, and uncertainties and assumptions required to address them are identified. The Analysis Plan provides a synopsis of measures that will be used to evaluate the risk hypotheses. There are three categories of measures: exposure, effects, and risk. This risk assessment represents a unique case because it covers two active ingredients and it is based on a modified procedure to accommodate the multi-chemical constituents of the assigned stressor, the EBDC complex.

First, the risk assessment of mancozeb and maneb was combined for two reasons:

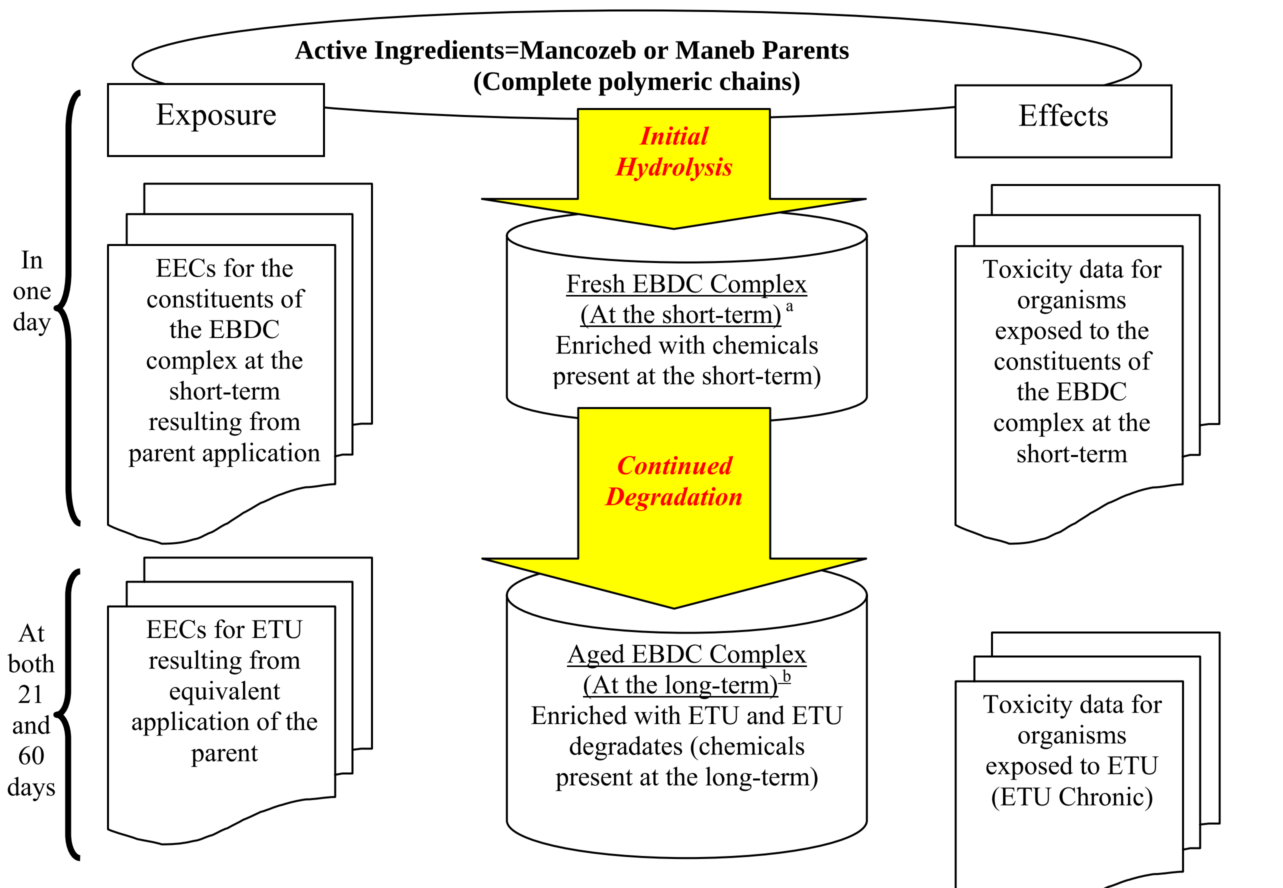
- Many uses can be interchanged meaning that either mancozeb or maneb can be used for the same use pattern; and
- The degradation pathway for the two chemicals is similar in resultant chemical species though rates mat differ. For example, rapid hydrolysis of maneb and mancozeb produce an EBDC complex consisting of similar constituents although maneb hydrolyze faster than mancozeb (neutral hydrolysis half-lives are 3 hours for maneb and 17 hours for mancozeb).

In this respect, the following describes how risks of mancozeb and maneb uses to CRLF will be assessed. If more than one product containing an EBDC active ingredient (mancozeb, maneb, or metiram) is used on a crop during the same growing season and the EBDC products used allow different maximum poundage of active ingredient per acre per season, then the total poundage of all such EBDC products used must not exceed the lowest specified individual EBDC product maximum seasonal poundage of active ingredient allowed per acre. If the EBDC products used allow the same maximum poundage of active ingredient per acre per season then the total poundage of all EBDC products used must not exceed any one of the specified individual EBDC product maximum application rate. Based on these limitations, mancozeb and maneb will be assessed together. The only deviation from this is where there are uses that are only for mancozeb or maneb. In that situation the chemicals will be assessed separately. Currently registered uses will be included in the risk assessment while proposed new uses or mitigation measures noted in the RED but that have not yet been adopted on pesticide labels, will be described in the risk characterization section.

Second, the unique chemical structure and degradation profiles of mancozeb and maneb require a unique process to be adopted to determine risk quotients (RQs). Unlike other chemicals, the two chemicals hydrolyze at a very rapid pace (within hours) in aquatic systems. This rapid degradation of parent chemicals requires that the numerator (EECs) and dominator (toxicities) of the acute and chronic RQs have to be assigned differently.

For each acute RQ, EEC of the EBDC complex is the value used for the numerator and acute toxicity of relevant parent is the value used for the dominator. This is because the EBDC complex is similar, in composition, to the EBDC complex that forms in laboratory media in which acute toxicity is measured. Acute toxicity to organisms in the laboratory is determined for dissolved mancozeb and maneb parents at concentrations below their solubility. At these concentrations, chemical species present are similar to those chemical species present in a freshly formed EBDC complex in the natural environment.

For each chronic RQ, EEC of ETU is the value used in the numerator and acute toxicity of ETU is the value used in the dominator. Therefore, it is assumed that chronic exposure EECs and toxicity are mainly related to ETU. This assumption is considered reasonable because of two reasons: (1) laboratory data suggests that the main constituents of aged EBDC complex are ETU and ETU degradate; and (2) modeled exposure EECs cover the two known sources of ETU: aging of the EBDC complex and limited release from degradation of bound species. In modeling for EECs, the simulation stared with an ETU rate that is molecularly equivalent to the application rate of either mancozeb or maneb (i.e., the exercise simulates, on molecular basis, degradation and transport of maximum concentrations of ETU that may be formed from applied parents). Figure 2-13 contains a summery of the above-described process for assigning acute and chronic values along with the basis for such assignments.



Rapid hydrolysis of applied mancozeb and maneb parents result in the formation of:

a= the fresh EBDC complex or the EBDC complex at the short-term. At this time, the complex is expected to be similar, in composition, to the fresh EBDC complex that forms in submitted mancozeb and maneb acute toxicity studies. In these studies, mancozeb and maneb parents were diluted to concentrations below, or up to, the solubility limit of 6 ppm for mancozeb and 120 ppm for maneb. At this short term, the major constituents of the complex are: variable/low molecular weight polymeric chains or polymer fragments, monomeric species and transient species.

Aging of this complex results in:

b= the aged EBDC complex or the EBDC complex at the long-term. At this time, the complex becomes relatively enriched with ETU and ETU degradates. Therefore, effects of this aged complex is expected to be similar to those observed in submitted ETU chronic toxicity studies on the reasonable assumption of toxicity being related to ETU and not ETU degradates. In these studies, ETU was used as the only test substance.

Figure 2-13 Summary of how modeled acute and chronic exposures in aquatic systems (acute and chronic EECs) were chosen so that they can be related to laboratory measured acute and chronic effects.

2.10.1 Measures of Exposure

Potential exposure pathways *(i.e.* runoff, spray drift, dietary residues on vegetation and insects) result from foliar applications of mancozeb and maneb to agricultural crops, seed treatments, horticulture and turf.

The measures of exposure will be estimated using models. Short and long-term aquatic exposures will consist of aquatic EECs using Tier II simulation models PRZM and EXAMS[13]. These simulations will be based on the constituents of the mancozeb/maneb complex. If available toxicity data indicate that a pesticide formulation may be more toxic to aquatic biota than indicated by active ingredient effects testing, and spray drift is a significant component of the aquatic exposure, it may be necessary to consider aquatic exposure to the formulation. If there are any "May effect" determinations in the aquatic exposure assessment, an analyses of spray drift buffers needed to get below concentrations that exceed the endangered species level of concern will be conducted and a dilution model will be used and described in the risk characterization section of this risk assessment.

Terrestrial exposure will be estimated using a model that assumes direct application to a variety of avian, mammalian and reptilian food items. The chronic exposure will be based on mancozeb, maneb, and ETU (the major degradate). A 90th percentile of the existing mancozeb and maneb foliar residue data from California and Washington states will be used to determine the foliar dissipation half life for terrestrial exposure assessments. Terrestrial wildlife exposure estimates are typically calculated for birds and mammals, which are surrogates for terrestrial-phase amphibians and reptiles. These estimates focus on potential dietary exposures to the pesticide active ingredient and are estimated assuming the organisms are exposed to a singe pesticide residue on food items in a given exposure scenario. Dietary residues will be modeled for mammals and birds (*e.g.* vegetation, insects, seeds) using the conceptual approach given in the model T-Rex (version 1.3.1, 2006). In addition, if there are any "may effect" determinations in the terrestrial exposure assessment, terrestrial exposure and risk for the terrestrial-phase of the CRLF will be estimated using T-HERPS (version 1.0, 2007), which is a modified version of T-REX (version 1.3.1*)* that allows for estimation of food intake for herptiles. Birds are typically used as surrogates for reptiles and terrestrial-phase amphibians. However, reptiles and terrestrial-phase amphibians (i.e., herptiles) tend to have much lower metabolic rates and lower caloric intake requirements than birds or mammals. As a consequence, birds are likely to consume more food than amphibians or reptiles on a daily dietary intake basis, assuming similar caloric content of the food item. T-REX (version 1.3.1.) has been altered to allow for an estimation of food intake for herptiles (T-HERPS) using the same basic procedure that T-REX uses to estimate avian food intake (see **Appendix E** for details).

2.10.2 Measures of Effect

Measures of effect are based on changes in the attribute of an entity in response to a stressor and are generally based on the results of a toxicity study, although monitoring data may also be used to

[13] http://epa.bov/oppefed1/models/water/index.htm

provide supporting lines of evidence for the risk characterization. Measures of acute effects (e.g. LC_{50}) and chronic effects (e.g., NOAEC) for aquatic and terrestrial organisms are derived from registrant submitted data, literature data obtained from ECOTOX, and incident data. The measures of effects will either be the results of tests on the specific organisms or will be derived or assumed based on extrapolated effects endpoints. Where data are lacking and extrapolated effects endpoints cannot be reliably estimated, risk will be presumed. In cases where risk is presumed, but cannot be quantified based on lack of data, best professional judgment will be used to make reasonable conservative assumptions.

2.10.3 Measures of Risk

Results of the exposure and toxicity effects data will be used to evaluate the likelihood of adverse ecological effects on the CRLF. These effects will be estimated quantitatively using a deterministic risk quotient approach based on application information provided on the product labels. The risk quotient (RQ) is the ratio of the estimated environmental concentration (EEC) of a chemical to a toxicity test effect (e.g., LC_{50}) for a given species. The RQ as an index of potential adverse effects is then compared to an Agency established Level of Concern (LOC) in order to identify when the potential adverse effect is a concern.

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 maneb or mancozeb on par with the acute toxicity endpoint selected for RQ calculation. 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.

Indirect effects to the CRLF as a result of effects to terrestrial invertebrates will be assessed by comparing the expected mancozeb and maneb residues on small and large insects (predicted by the T-REX model) to the acute contact toxicity information for the most sensitive terrestrial invertebrate.

Review of mesocosm study conducted with mancozeb will be used to characterize potential risks.

In the ecological risk assessment used to support the RED, EFED evaluated numerous mancozeb seed treatment uses. That evaluation considered use sites with only seed treatment, not seed and foliar treatments. The results of that evaluation indicated that acute risks to endangered species LOC would not be exceeded (RQs were below 0.01). Although maneb has numerous seed treatment uses these were not assessed separately but instead, the mancozeb seed treatment assessment was used for maneb as well. This would be protective of any potential risks from maneb seed treatment use because; 1) maneb toxicity to birds on an acute oral exposure basis is less than mancozeb (the avian acute oral LD_{50} of maneb (Bobwhite quail LD_{50} > 2,150 mg/kg) is practically nontoxic to birds and the avian acute LD_{50} for mancozeb (English sparrow LD50 ≈1,500 mg/kg, Mallard duck and Japanese quail LD50s >6400); and 2) the exposure (rates of application) from these seed treatment uses are similar for maneb and mancozeb. As is the case with terrestrial risk, potential aquatic risks are considered minimal based on negligible aquatic exposure resulting from seed treatment compared to the rate of application used for the assessed foliar treatment to the same crop. For example, seed treatments are equivalent to application rates of 0.002 to 0.315 lbs a.i/Acre compared to seasonal foliar treatment rates ranging from 4.8 to 18 lb a.i/Acre.

There are several scenarios for which we will not determine RQs. These and the rationale for not undertaking further work to determine RQs is presented below.

- Acute avian RQs will not be determined. EFED believes the acute dietary risk to birds from exposure to mancozeb is low because 1) dietary testing attempted on mallard ducks and bobwhite quail indicated an aversion to test diet (the birds would not consume the test material); 2) there is low acute toxicity of mancozeb to birds in multiple dosing LD_{50} studies; 3) there are no incidents showing mancozeb has been responsible for bird kills or poisonings; and 4) maneb (chemically related compound) is practically nontoxic to birds in dietary LC_{50} testing (mallard duck LC50 > 5,000 ppm and bobwhite quail LC50 > 10,000 ppm). The acute dietary risks to birds eating food items exposed to spray applications of maneb are also expected to be low. Therefore, mancozeb and maneb uses will have no effect to avian species on an acute dietary basis and will not be assessed further. .

- Acute mammalian RQs will not be determined. Chronic risks to terrestrial organisms associated with mancozeb and maneb use drive this assessment. The acute endpoints were not definitive. Also, EFED believes the acute dietary risk to mammals from exposure to mancozeb and maneb is low. The mammalian acute oral LD50 is >5,000 for mancozeb and maneb. Therefore, mancozeb and maneb uses will have no effect to mammalian species on an acute dietary basis and will not be assessed further.

- RQs will not be determined for any taxa based on dip treatments. Dip treatment to Capri figs, pineapples, and asparagus results in minimal potential risks. The intension of the dip treatment is to kill fungus present on the surfaces of the plant and or seed pieces. Exposure resulting from mancozeb and maneb dip treatments is considered very low because it is associated with minimal amount of active ingredient adsorbed to the surface of the plant parts; octanol water partitioning coefficient is very low for mane and mancozeb (Kow=5 and 21 respectively). Therefore, we have determined that use of mancozeb and maneb for dip treatments results in no effect to the CRLF and will not be further addressed in this assessment.

2.10.4 How Uncertainties are addressed in this Risk Assessment

Terrestrial Risks

- Terrestrial plant data are not available for mancozeb as a sole active ingredient in the Typical Enduse Product (TEP). There is also no terrestrial plant data for maneb. Terrestrial plant data for mancozeb is based on a TEP containing 60% mancozeb co-formulated with 9% dimethomorph. In these studies the EC_{25} is higher than the highest concentration tested. In this risk assessment the co-formulated data will be used qualitatively. Terrestrial plant incidents and estimated EECs will be used in characterization. The resulting conclusions of the assessment could be either an over or underestimation of risk.

Aquatic Risks

- There is uncertainty regarding the risks to freshwater invertebrates from exposure to the bound residues in sediment. The risk that might be associated with the sediment bound residue would probably be associated with its possible conversion into ETU at low concentrations. This ETU exposure is covered by the ETU modeling exercise. In this exercise, the application rate used represents 100% transformation to ETU from the total amount of the applied parent. Additionally, included in this assessment is a recently reviewed freshwater invertebrate toxicity study conducted with ETU. The approach used in this risk assessment to address this uncertainty results generally in an overestimation of risk.

- There are no chronic toxicity data for freshwater fish for ETU (the major degradate of mancozeb and maneb). An estimated chronic freshwater fish NOAEC of 37.32 ppm was determined using the acute-to-chronic ratio (ACR) approach. Acute and chronic invertebrate toxicity data conducted with ETU was used to develop the ACR and then the ACR was applied to acute freshwater fish toxicity data for ETU to estimate the chronic toxicity value for ETU. This approach generally is an overestimate of risk.

- One study has been submitted for a maneb technical formulation and mancozeb technical formulation using the freshwater green algae (*P. subcapitatum*). Typically, studies are available for duckweed (*Lemna gibba*), blue-green algae (*Anabaena flos-aquae*), freshwater green alga (*P. subcapitatum*), and a freshwater diatom species to assess a cross-section of the non-target freshwater aquatic plant population. This risk assessment will use the submitted *P. subcapitatum* studies with mancozeb and maneb for the aquatic freshwater plant endpoint and characterize the potential endangered species risk with available mixture data on freshwater aquatic plant species and incident data. This approach could result in an overestimation or under estimation of risk.

3 Exposure Assessment

3.1 Aquatic Exposure Assessment

For tier 2 surface-water assessments, two models are used in tandem. PRZM simulates fate and transport on the agricultural field. The version of PRZM (Carsel et al., 1997) used was 3.12 beta, dated May 24, 2001. The water body is simulated with EXAMS version 2.98.04, dated July 18, 2002 (Burns, 2004). Tier 2 simulations are run for multiple (usually 30) years and the reported EECs are the concentrations that are expected once in ten years based on the thirty years of daily values generated by the simulation. PRZM and EXAMS were run using the PE4 shell, dated May 14, 2003, which also summarizes the output. Spray drift was simulated using the AgDrift model version 2.01 dated May 24, 2001.

3.1.1 Aquatic Exposure Modeling

3.1.1.1 Modeling Approach

Mancozeb and maneb are highly vulnerable to hydrolysis and are not expected to persist in surface water as intact parents. Therefore acute and chronic aquatic exposures are expected to be associated with the resultant suite of hydrolytic products, which is the EBDC complex. For modeling, the time-line of aquatic exposure to the EBDC complex was categorized into short and long-term. In the *short-term*, aquatic exposure is expected to result from chemicals forming immediately after hydrolysis. In contrast, the *long-term* exposure is expected to be associated with chemicals related to the process of ETU formation and degradation, that is ETU, ETU degradates, and the bound residue (a suspected ETU producer; refer to mancozeb, maneb and ETU REDs:U.S. EPA a, b, and c). Short-term exposure was based on fate and transport parameters using laboratory-measured radioactivity associated with the group of chemicals present at this time line. Long-term exposure was based on the available fate and transport parameters of ETU (ETU was used as the test substance).

In order to produce aquatic EEC values for both the short and long-term, two separate modeling exercises were carried out using Tier II linked PRZM/EXAMS. The ***first*** modeling exercise consisted of model runs to arrive at EECs for the short-term constituents of the acute EBDC complex using laboratory determined fate and transport parameters. The ***second*** modeling exercise consisted of model runs to arrive at chronic

3.1.1.2 Modeling Inputs

The two modeling exercises were executed using crop specific or surrogate scenarios. Necessary inputs for each of these simulations consisted of the following:

First, A scenario that represents a crop or "group of crops" along with the maximum application rate, maximum number of applications, minimum application interval and the expected application date. Representative scenarios for various crop use patterns and application parameters used in the short and long term modeling are listed in Table 3-1.

Table 3-1 Representative scenarios and application parameters

California PRZM Scenario	*Crop (s) Represented*	*Chemical**	*MAR* (Kg/Ha)*		*MNA**	*MAI* (days)*	*Date* (dd-mm)*
			Short-term exercise	*Long-term exercise*			
Almond	Almonds	Mn	7.1744	0.6887	4	7	01-02
Cole crop	Brassica: Broccoli, Cabbage, Chinese Cabbage (tight head), Cauliflower, and Kohirabi	Mn	1.7936	0.1722	6	7	07-01
	Chinese Cabbage (loose head)	Mn	1.3452	0.1291	6	7	07-01
	Kale	Mn	1.7936	0.1722	2	7	07-01
Corn	Corn (field & seed crop)	Mz	1.3452	0.1291	10	4	01-05
	Corn (Sweet/Pop)	Mn	1.3452	0.1291	5	3	07-01
		Mz	1.3452	0.1291	5	4	07-01
Cotton	Cotton	Mz	1.7936	0.1722	4	10	15-06
Forestry	Forestry (Douglas Fir)	Mz	3.5872	0.3444	3	14	01-03
Fruit	Apples, Crab apple, Pear, and Quince	Mz	5.3808	0.5166	4	7	15-03
	Apples	Mn	5.3808	0.5166	4	7	15-03
	Bananas and Plantains	Mz	2.6904	0.2583	10	14	01-03
	Bananas	Mn	2.6904	0.2583	10	14	01-03
	Papayas	Mz	2.242	0.2152	14	14	15-02
		Mn	2.242	0.2152	14	14	15-02
	Figs	Mn	2.6904	0.2583	1	N/A	01-03
Garlic	Garlic	Mz	2.6904	0.2583	10	7	15-03
		Mn	2.6904	0.2583	10	7	15-03
Grapes	Grapes	Mz	2.242	0.2152	3	7	15-02
		Mn	2.242	0.2152	3	7	15-02
Lettuce	Lettuce (leaf & head) and Endive	Mn	1.7936	0.1722	4	7	07-01
	Brussels sprouts	Mn	1.7936	0.1722	6	7	07-01
Melons	Cucurbits	Mz	2.6904	0.2583	8	7	15-06
	Cucurbits	Mn	1.7936	0.1722	8	7	15-06
Nursery	X-mass tree plantations	Mz	3.5872	0.3444	3	14	01-04
	Ornamentals (Nursery)	Mz	1.51335	0.1453	3	7	01-03
		Mn	1.3452	0.1291	3	7	01-03
Onion	Onion (Dried) and Shallot	Mz	2.6904	0.2583	10	7	15-03
	Fennel	Mz	1.7936	0.1722	8	7	07-01
	Onion (Green)	Mn	2.6904	0.2583	7	7	07-01
Potato	Potatoes	Mz	1.7936	0.1722	7	3	15-03
		Mn	1.7936	0.1722	7	5	15-03
Residential/impervious surfaces	Ornamentals: Ground cover, Herbaceous, Non-flowering, Shade trees, and Woody shrubs and vines	Mz	1.51335	0.1453	5	7	15-03
		Mn	1.3452	0.1291	3	7	15-03
	Ornamentals (Pachysandra)	Mz	19.5054	1.8725	5	10	15-03
		Mn	15.5819	1.4959	4	7	15-03
	Turf (Residential)	Mz	21.4111	2.0555	4	5	15-03
		Mn	19.5054	1.8725	4	7	15-03
Row crop	Asparagus	Mz	1.7936	0.1722	4	10	01-03
	Beans (Dried)	Mn	1.7936	0.1722	6	5	01-04
	Pepper	Mn	1.7936	0.1722	6	7	01-03
Sugar beet	Sugar Beet	Mz	1.7936	0.1722	7	7	01-02
		Mn	1.7936	0.1722	7	7	01-02
Tomato	Tomatoes	Mz	1.7936	0.1722	4	7	01-03
		Mn	1.7936	0.1722	4	7	01-03
	Eggplant	Mn	1.7936	0.1722	7	7	15-05
Turf	Turf: commercial, Golf course,	Mz	21.4111	2.0555	4	5	07-01

California PRZM Scenario	Crop (s) Represented	Chemical*	MAR* (Kg/Ha) Short-term exercise	MAR* (Kg/Ha) Long-term exercise	MNA*	MAI* (days)	Date* (dd-mm)
	Industrial, recreational, and Sod farms	Mn	19.5054	1.8725	4	7	07-01
Wheat	Wheat, Barely, Oats, Rye, and Triticale	Mz	1.7936	0.1722	3	7	15-02
Wine grapes	Grapes (Wine)	Mz	2.242	0.2152	3	7	15-02
		Mn	2.242	0.2152	3	7	15-02

* Mz= Mancozeb; Mn= Maneb; MAR= Maximum application rate; MNA= Maximum number of applications; MAI= Minimum application interval; and Date= Application Date.

In modeling, the rate used for the short-term exercise is the parent mancozeb or maneb in kg a.i./ha (e.g., almonds rate= 6.4 lb a.i./A multiplied by 1.121= 7.174 kg/Ha). However the rate used for the long-term exercise is the ETU rate, which was calculated by assuming very rapid and complete degradation of applied EBDCs to ETU. The ETU rate was based on the maximum conversion rate of 9.6%[14] for parent mancozeb or maneb entering the soil system. For example the equivalent long-term rate for almonds in the table above= the short-term rate (7.174 kg/ha) multiplied by 0.096 giving a rate equal to 0.6887 kg/ha.

Second, the physiochemical, fate and transport properties along with other parameters necessary for modeling: Table 3-2 contains a summary of the inputs used in the short-term and long-term simulations.

Table 3-2 PRZM/EXAMS Input parameters for mancozeb and maneb for the short and long term simulations

Input Parameter	PRZM/EXAMS Parameters Used for Simulations [1] AT the Short-term: Mancozeb (Mz)	PRZM/EXAMS Parameters Used for Simulations [1] AT the Short-term: Maneb (Mn)	PRZM/EXAMS Parameters Used for Simulations [1] At the Long-term: ETU from Mz or Mn	Reference Or Study MRID Number
Molecular Wt. (grams)	**265**	**265.36**	**102.2**	Registrant data
Vapor Pressure (torr)	**1.003 e[-7]**	**7.577 e[-8]**	**9.728 e[-1]**	Registrant data
Bacterial Bio-lyses in the water column (days)	**44** 90th percentile From two values (38, and 41)	**24** 12x2=24	**6.28** 3.14x2=6.28	**Mz:** 462043-01 **Mn & ETU:** No studies

[14] This value of 9.6% was the maximum conversion rate observed in laboratory aerobic soil studies on a concentration basis (i.e., after multiplying the reported rate by 38.5%, the molar conversion of parent mancozeb or maneb to ETU).

Input Parameter	*PRZM/EXAMS Parameters Used for Simulations* [1]			*Reference Or Study MRID Number*
	AT the Short-term		*At the Long-term*	
	Mancozeb (Mz)	*Maneb (Mn)*	*ETU from Mz or Mn*	
Bacterial Bio-lyses in benthic sediment (days)	**0** (Stable)	**435** One value (145x3)	**447** One value (149x3)	**Mz**: See Note [2] **Mn:** 001633-35 **ETI:** 402582-03
Aerobic Soil Metabolism Half-life (days)	**29** 90th percentile From three values (29, 20, and 21)	**12** 90th percentile From three values (12, 8, and 8)	**3.14** 90[th] percentile three values (1.4, 3, and 3.2)	**Mz:** 457445-01 **Mn:** 405852-01, and 451452-02 **ETU:** 451564-01
Application Method	Aerial Or Ground			Product Label
Incorporation depth	0 (inches)			Product Label
Application Efficiency	0.95 (aerial) Or 0.99 (ground) as a fraction			Guidance
Spray Drift (fraction)	0.05 (aerial) Or 0.01 (ground) the short-term; and 0.123 (aerial) Or 0.025 (ground) the short-term			Guidance And Note [3]
Solubility (ppm)	**6**	**150**	**20,000**	Registrant data
Koc (L Kg-1)	**1,167** (Average value)	**946** (Average value)	**288** (Average value)	**Mz**: 405883-02 **Mn:** 405852-03, 400472-01, 455959-01, 455959-02 **ETU:** 002588-96, 000971-58
pH 7 Hydrolysis Half-life (days)	**4** (Same as Maneb)		**0** (Stable)	**Mz:** See Note [2] **Mn:** 453936-01 **ETU:** 404661-03
Photolysis Half-life (days)	**0** (Stable)		**1**	**Mz:** 001621-03 **Mn:** 404656-02 **ETU:** See Note [4]

[1] Values were chosen as per: Guidance for Chemistry and Management Practice Input Parameters For Use in Modeling the Environmental Fate and Transport of Pesticides, Version 2/November 7, 2000.
[2] Although there was an anaerobic aquatic study (MRID 000888-20) and hydrolysis studies (000971-62 and 402582-01) for mancozeb, the half-lives could not be calculated because of problems in identification of degradates using the TLC method.
[3] The ETU rate specified in the table is accurate only for the soil system and needs to be corrected for the aquatic system. Therefore, a correction factor of 2.458 was used and was affected by changing the drift from 0.05 (the default

value) to 0.123 (0.05x2.458) or from 0.01 (the default value) to 0.025 (0.01x2.458). Changing the drift fraction by the stated factor will result in an exact account for the observed 23.6% parent/ETU conversion rate in aquatic systems.
[4] Indirect photolysis in natural waters (1-4 days) as reported by: Sue Xu. 2000. Environmental Fate of Ethylenethiourea, California Department of Pesticide Regulations, CA, USA; and IUPAC. 1977. Ethylenethiourea, Pure & Appl. Chem. 49, 675-689.

3.1.1.3 Modeling Results

The results obtained from the two simulations are included in Table 3-3. EECs used for the aquatic risk assessment were the acute peak values from the short-term simulations and the chronic 21- and 60-day EECs from the long-term simulations.

Table 3-3 EECs for the short and long-term constituents of the EBDC complex resulting from mancozeb and maneb (ppb)

Crop	*Weather Station*	*Peak (short-term)*	*21-day (Long-term)*	*60-day (Long-term)*
(1) Crop patterns for mancozeb use				
Asparagus	San Francisco (W23234)	8.85	1.30	0.92
Cereal Grains (2)	Fresno, CA (W93193)	24.16	1.89	1.01
Corn (Field & seed crop)	Sacramento (W23232)	16.84	1.90	1.25
Cotton	Fresno, CA (W93193)	8.25	0.74	0.48
Crab apple, pear, and quince	Fresno, CA (W93193)	20.27	4.78	2.69
Fennel (one crop)	Bakersfield (W23155)	13.97	0.97	0.87
Fennel (two crops)	Bakersfield (W23155)	14.22	1.49	1.23
Forestry (Douglas Fir)	Arcata/Eureka (W24283)	40.55	3.34	2.09
Plantains	Fresno, CA (W93193)	10.83	1.63	1.47
Shallot	Bakersfield (W23155)	11.30	2.58	2.35
X-mass tree plantations	San Diego, CA (W23188)	32.02	2.61	1.57
(2) Crop patterns for maneb use				
Almonds	Sacramento (W23232)	45.62	7.19	4.26
Beans (Dried)	San Francisco (W23234)	10.64	2.08	1.21
Brassica (1) (one crop)	Sacramento (W23232)	32.09	2.97	2.12
Brassica (1) (three crops)	Sacramento (W23232)	38.09	3.01	2.79
Brassica (1) (two crops)	Sacramento (W23232)	38.09	3.00	2.78
Brussels sprouts (one crop)	Santa Maria (W 23273)	59.48	3.78	2.77
Brussels sprouts (two crops)	Santa Maria (W 23273)	59.89	4.29	3.72
Cabbage (Chinese)/Loose (one crop)	Sacramento (W23232)	35.95	3.38	1.79
Cabbage (Chinese)/Loose (three crops)	Sacramento (W23232)	63.69	5.28	4.11
Cabbage (Chinese)/Loose (two crops)	Sacramento (W23232)	51.84	4.80	3.09
Eggplant	Fresno, CA (W93193)	7.87	1.02	0.81
Figs	Fresno, CA (W93193)	6.71	0.90	0.41
Kale (one crop)	Sacramento (W23232)	20.28	1.92	0.92
Kale (three crops)	Sacramento (W23232)	32.09	2.97	2.12
Kale (two crops)	Sacramento (W23232)	24.54	2.90	1.53
Lettuce, and Endive (one crop)	Santa Maria (W 23273)	36.68	3.25	1.78
Lettuce, and Endive (two crops)	Santa Maria (W 23273)	59.48	4.13	3.26
Onion (Green) (one crop)	Bakersfield (W23155)	17.21	3.08	2.40
Onion (Green) (two crops)	Bakersfield (W23155)	17.35	3.19	3.04

Crop	*Weather Station*	*Peak (short-term)*	*21-day (Long-term)*	*60-day (Long-term)*
Pepper	San Francisco (W23234)	13.36	1.63	1.16
Walnuts	Sacramento (W23232)	16.32	2.64	2.37
(3) Crop patterns for interchangeable use of mancozeb or maneb (a) for modeling: mancozeb was assumed to be applied				
Apples	Fresno, CA (W93193)	20.27	4.78	2.69
Bananas	Fresno, CA (W93193)	10.83	1.63	1.47
Corn (Sweet/Pop) (one crop)	Sacramento (W23232)	57.09	3.64	1.88
Corn (Sweet/Pop) (three crops)	Sacramento (W23232)	95.04	5.02	3.85
Corn (Sweet/Pop) (two crops)	Sacramento (W23232)	71.51	4.93	3.16
Cucurbits (3)	Fresno, CA (W93193)	11.36	1.52	1.38
Garlic	San Diego, CA (W23188)	41.36	2.93	2.57
Grapes	Fresno, CA (W93193)	10.16	1.74	0.95
Grapes (Wine)	San Francisco (W23234)	11.84	1.83	0.93
Onion (Dried)	Bakersfield (W23155)	11.30	2.58	2.35
Ornamentals (Nursery)	San Diego, CA (W23188)	19.47	1.69	1.03
Ornamentals (residential) (4)	San Francisco (W23234)	0.72	0.08	0.04
Ornamentals (residential/Pachysandra)	San Francisco (W23234)	7.60	1.00	0.60
Ornamentals (Residential/turf)	San Francisco (W23234)	11.54	1.26	0.68
Papayas	Fresno, CA (W93193)	10.16	1.43	1.30
Potatoes	Bakersfield (W23155)	11.95	2.85	1.45
Sugar Beet	Fresno, CA (W93193)	22.26	1.91	1.42
Tomatoes	Fresno, CA (W93193)	9.56	1.78	0.99
Turf (5)	San Francisco (W23234)	103.51	23.30	12.68
Turf (sod farms only) (two crops)	San Francisco (W23234)	132.00	33.20	23.14
(b) for modeling: maneb was assumed to be applied				
Apples	Fresno, CA (W93193)	20.01	4.78	2.69
Bananas	Fresno, CA (W93193)	10.53	1.63	1.47
Corn (Sweet/Pop) (one crop)	Sacramento (W23232)	46.74	4.03	2.06
Corn (Sweet/Pop) (three crops)	Sacramento (W23232)	91.78	6.73	4.45
Corn (Sweet/Pop) (two crops)	Sacramento (W23232)	65.44	5.93	3.43
Cucurbits (3)	Fresno, CA (W93193)	5.78	1.02	0.92
Garlic	San Diego, CA (W23188)	37.93	2.93	2.57
Grapes	Fresno, CA (W93193)	10.03	1.74	0.95
Grapes (Wine)	San Francisco (W23234)	11.28	1.83	0.93
Onion (Dried)	Bakersfield (W23155)	9.77	2.58	2.35
Ornamentals (Nursery)	San Diego, CA (W23188)	13.76	1.29	0.65
Ornamentals (residential) (4)	San Francisco (W23234)	0.39	0.06	0.03
Ornamentals (residential/Pachysandra)	San Francisco (W23234)	4.71	0.68	0.49
Ornamentals (Residential/turf)	San Francisco (W23234)	6.22	1.01	0.56
Papayas	Fresno, CA (W93193)	9.05	1.43	1.30
Potatoes	Bakersfield (W23155)	9.36	2.40	1.86
Sugar Beet	Fresno, CA (W93193)	21.27	1.91	1.42
Tomatoes	Fresno, CA (W93193)	8.86	1.78	0.99
Turf (5)	San Francisco (W23234)	92.47	18.96	11.30
Turf (sod farms only) (two crops)	San Francisco (W23234)	111.07	22.91	19.24

Note 1: Brassica Include: broccoli, cabbage and Chinese cabbage (tight head), cauliflower, and kohlrabi
Note 2: Cereal grains include: wheat, barley, oats, rye, and triticale

Note 3: Cucurbits: cucumber, cantaloupe, honeydew, casaba melon, crenshaw melon, and watermelon for both mancozeb and maneb in addition to musk melon and gourds for mancozeb only; and winter squash and pumpkins for maneb
Note 4: Ornamentals used in residential landscaping including: shade trees, ground cover plants, herbaceous plants,
Note 5: Turf excludes residential turf but includes: commercial/industrial/recreational area lawns, golf course turf, and ornamental sod farm turf.

3.1.2 Aquatic Monitoring

Mancozeb and maneb are highly vulnerable to hydrolysis and are not expected to persist intact in surface water. Maneb is expected to hydrolyze faster than mancozeb and both are expected to produce a suite of chemicals referred to as the EBDC complex. A USGS/NAWQA [15] database search for mancozeb and maneb resulted in "no data returned for those criteria". The same results were obtained from EPA/STORET [16] and the CALDPR surface water database[17]. Additionally, the CALDPR [18] ground water database reported no detections of maneb in 583 wells in 27 counties (the cumulative well inventory report for the period from 1986-2003). In contrast to parents, sporadic detections of the main metabolite ETU have been reported in both surface and ground water. For example, a value of 16 ppb was recorded beneath an Iowa apple orchard, which had been treated with an EBDC fungicide (USGS/NAWQA). In California, it appears that no monitoring was executed for ETU in surface water, however, ETU was detected once at an unconfirmed concentration of 0.725 ppb in one well out of 583 (the cumulative well inventory report for the period from 1986-2003).

In a 2-year targeted surface water and ground water monitoring program conducted by the EBDC Task Force[19] many locations around the US (MRID 46145401). No ETU was measured above the limit of detection of 0.1 ppb in either raw or treated community surface water sources. Sampling was executed every 14-days during the historical EBDC use season. In the same study, targeted ground water monitoring indicated a peak of 0.21 ppb measured in a public drinking water well located in Lee County, Florida. In rural areas, the highest value measured by the EBDC Task Force was 0.57 ppb and was for ground water from a private well near an EBDC treated field in an apple growing region of New York. ETU concentrations in the range of 0.1 to 0.25 were also measured in 8 out of the 125 monitored rural wells.

3.1.3 Down-stream Dilution Analysis

Down-stream dilution analysis is necessary to define the full extent of the action area. This is because the action area is defined by the initial area of concern or "footprint" of potential uses which is extended by downstream dilution (this analysis) and by drift (see to 3.3.3, below). This analysis determines downstream extent of exposure in streams and rivers where the EEC could potentially be above levels that would exceed the highest RQ to LOC ratio. Based on all aquatic RQs, the greatest RQ to LOC ratio for all aquatic organisms (plants and animals) are determined for various use patterns (Table 3-4).

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[15] http://infotrek.er.usgs.gov/traverse/f?p=136:23:0:QUERY:NO
[16] http://www.epa.gov/storet/dw_home.html
[17] http://www.cdpr.ca.gov/docs/emon/surfwtr/surfcont.htm
[18] http://www.cdpr.ca.gov/docs/emon/grndwtr/wellinv/wirmain.htm
[19] The EBDC Task Force ia a task force consisted of the registrants of the EBDC chemicals mancozeb, maneb and metiram

Table 3-4 A summary of the highest RQ to LOC ratios for various use categories

Category	*Use Pattern*	*Species*	*RQ*	*LOC*	*Ratio*
(1) Mancozeb Use Only					
Cultivated crops	X-mass trees*		0.07		1.4
Orchards & Vineyards	Pear		0.04		0.8
Forestry	Forestry	Rainbow trout	0.09	0.05	1.8
(2) Maneb Use Only					
Cultivated crops	Loose Cabbage		1.09		21.8
Orchards & Vineyards	Almonds	Rainbow trout	1.52	0.05	30.4
(3) Mancozeb and Maneb Use					
Cultivated crops	Corn (sweet & pop)		2.19		43.8
Orchards & Vineyards	Grapes		0.24		4.8
Turf	Turf	Rainbow trout	2.64	0.05	52.8

* Note: GIS mapping considered this use pattern as part of the cultivated crops category.

The ratios in Table 3-4 would be used to determine the downstream extent of the action area. For example, the ratio of 1.4, for x-mass trees, is used to identify all stream reaches downstream from the initial area of concern where the Percent Cropped Area (PCA) for the land uses identified, for mancozeb only, are greater than 1/1.4 or 71%. All streams identified as draining upstream catchments greater than 71% of the land class of concern, would be considered part of the action area.

The total length of streams in the initial area of concern to the total length of California streams are: 57% (189,441 km) for mancozeb use, 18% (58,619 km) for maneb use, and 22% (72,553 km) for the combined mancozeb and maneb use. By applying the down stream approach described above, the total length added increased by 2% for mancozeb use, 9% for maneb use, and 10% for the combined mancozeb and maneb use. It is noted that stream lengths of the initial area of concern is the highest for mancozeb use followed by mancozeb and maneb use and finally by maneb use. This may be attributed to the use of mancozeb in forestry. In this respect, it is noted that there were no reported usage of mancozeb in the PUR data. Detailed analysis is included in **Appendix C,** for mancozeb use, **Appendix I** for maneb use, and **Appendix L** for the combined mancozeb and maneb use).

3.2 Terrestrial Animal Exposure Assessment

3.2.1 Terrestrial Exposure Modeling

The terrestrial exposure model, T-REX (Version 1.3.1, dated December 7, 2006), is used to estimate exposures and risks to terrestrial animals, including birds, mammals, and terrestrial invertebrates. Input values on chemical application, avian and mammalian toxicity as well as foliar dissipation half-life data are required to run the model. For the exposure estimate, the 90th percentile of the foliar residue data (mancozeb and maneb were both 20 days) was used to determine the half life.

Only the data from the Western states were used to account for information indicating half lives were typically twice as long in the west as in the east (Dole and Dawson, 2003). The mancozeb and maneb foliar residue data represented the parent chemical as well as ETU. The application rates for the; estimated lowest, middle and highest exposure uses for mancozeb, maneb, and joint mancozeb/maneb uses were modeled. To determine the chronic RQs, maneb's mammalian and avian chronic toxicity endpoints were used to represent the parent chemical and ETU for the joint mancozeb/maneb uses and the Maneb only uses. Mancozeb's mammalian and avian chronic toxicity endpoints were used to represent the parent chemical and ETU for mancozeb only uses. The toxicity endpoints for mammalian developmental and reproduction data for mancozeb, maneb and ETU indicate that the toxicity endpoint for ETU (5mg/kg-bw) is similar to maneb (3.75mg/kg-bw).

The T-REX model generates estimated environmental concentrations (EECs) and calculates risk quotients (RQs). Specifically, the models provides estimates of upper bound and mean concentrations of chemical residues on the surfaces of different food items that may be sources of dietary exposure to the CRLF in the terrestrial-phase (*e.g.,* small and large insects, small mammals and terrestrial invertebrates). The surface residue concentration (ppm) is estimated by multiplying the application rate (pounds active ingredient per acre) by a value specific to each food item. Information regarding the T-REX model can be found in **Appendix F**. Model inputs and estimated terrestrial dietary exposures are provided in Table 3-5**.**

Table 3-5 T-REX model inputs for Mancozeb and Maneb uses; Half-life was assumed to be 20 days[1] for all uses

Use	*Rate (lbs a.i./A)*	*Minimum Interval (Days)*	*Max. No. Applications Per Year*	*Upper-bound EECs (ppm)*			
				Short Grass	*Long Grass*	*Broadleaf Plants, Small Insects*	*Fruits, Pods, Seeds, Large Insects*
Turf[2]	17.4	7	4	12039.93	5518.30	6772.46	752.50
Cucumbers[2]	2.4	7	8	2289.96	1049.56	1288.10	143.12
Ornamentals (other)[2]	1.2	7	3	691.25	316.82	388.83	43.20
Almonds[3]	6.4	7	4	4428.48	2029.72	2491.02	276.78
Beans (dried)[3]	1.6	5	6	1560.21	715.10	877.62	97.51
Figs	2.4	N/A	1	576.00	264.00	324.00	36.00
Shallot[4]	2.4	7	10	2437.56	1117.21	1371.13	152.35
Fennel[4]	1.6	7	8	1526.64	699.71	858.73	95.41
Cereal Grains[4]	1.6	7	3	921.66	422.43	518.43	57.60

[1] For foliar degradation, foliar half-lives measurements used (Maneb: MRID #420449-04, #451946-01, #419615-01; Mancozeb MRID #s 449596-01, 418369-01, 411339-01, 418369-02, 449596-03, 449585-01). Assuming these values are distributed normally, the value which represents the one tail upper 90% confidence limit of the mean is 20 days.
[2] Joint Mancozeb/Maneb uses
[3] Maneb only uses
[4] Mancozeb only uses; Cereal grains: barley, oats, rye, triticale, and wheat

EECs on food items may be compared directly with dietary toxicity data or converted to an oral dose, as is done for small mammals. For mammals, the residue concentration is converted to daily oral dose based on the fraction of body weight consumed daily as estimated through mammalian allometric relationships. The base-line risk assessment for mancozeb and maneb uses upper bound predicted residues as the measure of exposure.

3.3.2 Terrestrial Atmospheric Monitoring

Air monitoring data reported by the CDPR show that only mancozeb was included in the monitoring program (Kollman, 2002). In this program, pesticide concentrations were measured in close proximity to a field at the short-term; during and after pesticide application (15-20 meters from the edge of the treated field during/just after pesticide application) and in the ambient community air at the long-term (at three sites further ">1 km" from the application site and within longer periods from the time of application). Although the study did not distinguish between the routes of transport associated with observed detections, the close proximity of the location of the air monitoring sites to the application site suggests that these detections are probably related to spray drift rather than long-range atmospheric transport. For mancozeb, the two types of monitoring were conducted in Kern County in 1993 after aerial application of mancozeb to a potato field. Mancozeb was not detected at the long-term monitoring (limit of detection= 2 ppt) while it was detected at the short-term in the range of 0.02 to 0.13 ppb in 46% of the 93 samples analyzed. Observed mancozeb detection level at the long-term was compared to the group of pesticides reported to have moved into the Sierra Nevada ecosystems (Fellers et al., 2004). In contrast to mancozeb no detection (over the concentration of 2 ppt), the reported long-range transport pesticides detections ranged from 6.7 to 56.9 ppt in more than 80% of the time). The comparison suggests that the potential for long-range transport of mancozeb is relatively small. Given similarities in the physiochemical properties between mancozeb and maneb, similar conclusions can probably be drawn for maneb.

For ETU, partitioning into the air from dry soil/plant surfaces is expected (vapor pressure= 9.728×10^{-1} torr). However, ETU's high water solubility results in relatively low Henry's law constant (3.4×10^{-7} atm. m^3 $mole^{-1}$) and renders such partition unimportant because ETU forms only when water is present (i.e. in wet soil or water bodies). Additionally, if ETU reaches air it is expected to partition into rain or is not expected to persist as it is affected by OH-radicals present in the air (a half-life of 0.9 hours was predicted by EPI suite). Data collected from a micro-agro-ecosystem chamber indicate that small amounts of ETU may volatilize from soil and plant surfaces (Nash and Beall, 1980). However, ETU was not detected in a US ambient air-monitoring study of the US EPA designated 189 Hazardous Air Pollutants (Kelly et al, 1994)

3.2.3 Drift Analysis

Spray drift analysis is necessary to define the full extent of the action area. This is because the action area is defined by the initial area of concern or "footprint" of potential uses which is extended by drift (this analysis) and downstream dilution (refer to 3.2.3, above). Spray drift analysis determines the additional distance from the treated area where listed species LOCs are exceeded as a result of spray drift. This distance is based on the taxonomic group that yields the largest RQ to LOC ratio. Both terrestrial and aquatic taxonomic groups are considered in this analysis.

For mancozeb, maneb, and mancozeb and maneb combined use patterns, the results of the screening-level assessment indicate that the mammalian "RQ to LOC ratio" is highest. The results of the spray drift analysis are summarized in Table 3-6 for the various use patterns.

Table 3-6 A summary of buffer distances obtained by AgDISP along with important parameters used in modeling (species used for calculating RQs is laboratory rat).

Use Category: Use Pattern	*Determination of Species with Largest RQ to LOC Ratio*					*Buffer (ft)**
	EEC (ppm)	*Toxicity (ppm)*	*RQ*	*LOC*	*Ratio*	
(1) Mancozeb Use Only						
Cultivated crops: Shallot	2,437.56	120	80.70	1	**80.70**	2,051 to 2,067
(2) Maneb Use Only						
Orchards & Vineyards: Almonds	4,428.48	75	234.57	1	**234.57**	2,913 to 3,002
(3) Mancozeb and Maneb Use						
Turf: Turf	12,039.93	75	637.73	1	**637.73**	3,494 to 3,615

- Range was obtained by changing the volume of product used to prepare a 15 gallons finished spray.

The ranges of buffers are expected to vary depending on the application parameters used as these parameters change not only with change in droplet size distribution but also with formulation type and % of a.i. among many others. **Appendix G** contains a summary of input parameters used in this analysis.

The total areas of the initial areas of concern are: 90,467 sq km for mancozeb use, 35,565 sq km for maneb use, and 43,834 sq km for the combined mancozeb and maneb use. The initial area of concern for mancozeb is the highest as a result of forestry use (no forestry use for maneb). Application of the maximum buffers distances in the above Table, results in an increase of the initial action area by nearly 80% for mancozeb use, 81% for maneb use, and 93% for mancozeb and maneb use. Detailed analysis is included in **Appendix C,** for mancozeb use, **Appendix I** for maneb use, and **Appendix L** for the combined mancozeb and maneb use).

4 Effects Assessment

This assessment evaluates the potential for mancozeb and maneb to adversely affect the California Red Legged Frog (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 or modification of its habitat. 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 birds are generally used as a surrogate for terrestrial-phase amphibians. 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. Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and a comprehensive review of the open literature on mancozeb, maneb and ETU.
As described in the Agency's Overview Document (U.S. EPA, 2004a), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include freshwater fish (surrogate for aquatic-phase amphibians), freshwater invertebrates, birds (surrogate for terrestrial-phase amphibians), mammals, terrestrial invertebrates, and aquatic plants. (See **Section 4.1.3** for more discussion).

Toxicity endpoints are established based on data generated from guideline studies submitted by the registrant, and from open literature studies that meet the criteria for inclusion into the ECOTOX database maintained by EPA/Office of Research and Development (ORD) (U.S. EPA, 2004). In order to be included in the ECOTOX database, papers must meet the following minimum criteria:

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

Data that pass the ECOTOX screen are evaluated along with the registrant-submitted data, and may be incorporated qualitatively or quantitatively into this endangered species assessment. In general, effects data in the open literature that are more conservative than the registrant-submitted data are considered. The degree to which open literature data are quantitatively or qualitatively characterized is dependent on whether the information is relevant to the assessment endpoints (*i.e.*, maintenance of CRLF survival, reproduction, and growth) identified in Section 2.8. For example, endpoints such as behavior modifications are likely to be qualitatively evaluated unless quantitative relationships between modifications and reduction in species survival, reproduction, or growth are available.

4.1 Toxicity of Mancozeb, Maneb and ETU to Aquatic Organisms

Table 4-1 summarizes the most sensitive aquatic toxicity endpoints for the CRLF, based on an evaluation of both the submitted studies and the open literature, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the CRLF is presented below. Additional information is provided in **Appendix D and H.**

Table 4-1 Aquatic Toxicity Profile for mancozeb, Maneb, and ETU

Assessment Endpoint	*Measures of Ecological Effects*	*MRID*	*Study Classification*
Direct toxicity to aquatic-phase CRLF	Mancozeb: Rainbow trout (Oncorhynchus mykiss) LC50 = 460 ppb (Probit slope assumed to be 4.5[5]). [4]	40118502	Acceptable
	Maneb : Oncorhynchus mykiss LC50 = 42 ppb (Probit slope = 2.8 ($p<0.05$) [2,3]	40706001	Supplemental
	ETU: Oncorhynchus mykiss estimated NOAEC =37.32ppm [1,2,3,4]	Estimated	
Indirect toxicity to aquatic-phase CRLF (via toxicity to prey items)	Mancozeb: Daphnid (*Daphnia magna*) LC50 =580ppb (Probit slope assumed to be 4.5[5]). [4]	40118503	Acceptable
	Maneb: *Daphnia magna EC*50 =120 ppb (lowest measured slope =4.2 ($p<0.05$))	40749402	Acceptable
	ETU: *Daphnia magna* NOAEC = .002ppb	46462901	Supplemental
	Mancozeb freshwater green algae (*Pseudokirchneriella ubcaptitatu*) *EC*50 = 47.0ppb	43664701	Acceptable
	Maneb (*Pseudokirchneriella subcaptitatum*) *EC*50 = 3.4ppb,	40943501	Acceptable

[1] Based on the acute-to-chronic ratio
[2] Joint Mancozeb/Maneb uses
[3] Maneb uses only
[4] Mancozeb uses only
[5] Raw data unavailable to estimate slope; Used default assumption cited in Urban and Cook (1986)

Acute toxicity to aquatic animals is categorized using the system shown in Table 4-2 (U.S. EPA, 2004). Toxicity categories for aquatic plants have not been defined. Based on these categories, mancozeb is classified as highly toxic to freshwater fish, invertebrates, and amphibians on an acute exposure basis and maneb is classified as very highly toxic to freshwater fish and highly toxic to freshwater invertebrates and amphibians on an acute exposure basis.

Table 4-2 Categories of Acute Toxicity for Aquatic Animals

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

4.1.1 Toxicity to Freshwater Vertebrates (Amphibians and Fish)

Freshwater fish toxicity data were used as a surrogate for aquatic-phase amphibians to assess potential direct effects to amphibians that may serve as prey of the CRLF. Effects to freshwater fish resulting from exposure to mancozeb or maneb are also assessed as potential prey for the CRLF. As discussed in **Section 2.5.3**, over 50% of the prey mass of the large adult terrestrial-phase CRLF may consist of vertebrates such as mice, frogs, and fish (Hayes and Tennant, 1985).

4.1.1.1 Aquatic-Phase Amphibians: Acute Exposure (Mortality) Studies

Available acute toxicity data indicate that mancozeb is moderately to highly toxic to the tested fish species. A static acute toxicity test (MRID # 40118502) revealed that the rainbow trout was the most sensitive of the fish species tested, with an LC_{50} of 460ppb. The other fish species tested, bluegill sunfish, was at least 10 times less sensitive (LC_{50} range 1350ppb-3850ppb). Most of the acute toxicity data indicate that maneb is highly toxic to tested fish. However, a static acute toxicity test (MRID# 40706001) on the most sensitive species tested, rainbow trout, suggested that maneb could be very highly toxic (LC_{50} 42.0ppb) to freshwater fish. In this study, conducted with an end-use product, a substantial decrease in test substance between the beginning and the end of the tests was noted. The concentration of maneb decreased as much as 55% of the nominal at the zero hour measurement, and the final measurements only averaged 13.1% of the nominal value (range was 9.6% to 22.5%). Because estimation of the actual exposures of the fish was not possible, EFED based the study results on the most conservative concentration, which was the final (lowest) measurement concentrations. The most sensitive endpoints derived from the rainbow trout tests conducted with mancozeb and maneb were used to assess potential direct effects to the CRLF.

*4.1.1.2 Aquatic-Phase Amphibians: Chronic Exposure (Growth, Reproduction) Studie*s

No chronic amphibian or freshwater fish toxicity data conducted with ETU (the major degradate of mancozeb and maneb) is available to make a quantitative assessment. However, using the acute-to-chronic ratio (ACR) approach with available ETU acute and chronic invertebrate and acute freshwater fish toxicity data yields an estimated chronic freshwater fish NOAEC of **37.32** ppm (see calculations below). This estimate indicates that the use of mancozeb and maneb could effect growth and reproduction of freshwater fish at the parts per million levels. The estimated chronic freshwater fish NOAEC was used to assess potential direct effects to the CRLF from mancozeb and maneb use (Table 4-3 and Table 4-4).

> ACR = acute invertebrate (26.9ppm)/chronic invert.(2.0ppm)=13.45
> Estimated freshwater fish NOAEC = 96-hour LC50 freshwater fish (>502ppm/ACR (13.45) = **37.32** ppm

The ETU acute LC50 value for freshwater fish was > 502ppm. For a bounding estimate of the freshwater fish NOAEC, the maneb LC50 freshwater fish toxicity endpoint was used in the calculations and the toxicity value was still at the parts per million levels.

> Estimated freshwater fish NOAEC = 96-hour LC50 freshwater fish (.042ppm)/ACR (13.45ppm) = 3.00 ppm

Table 4-3 Chronic toxicity of ETU to freshwater invertebrates during a life-cycle toxicity test

Species	*Purity (% a.i.)*	*NOAEC (µg/L)*	*LOAEC (µg/L)*	*Endpoints Affected*	*Study Classification*	*MRID*
Water flea *Daphnia magna*	96.2	2.0	4.1	Adult length, survival, no. young/adult/day	Supplemental	45462901

Table 4-4 Acute toxicity of ETU to freshwater fish and invertebrates

Species	*Purity (% a.i.)*	*LC50 (ppm/a.i.)*	*Toxicity Category*	*Study Classification*	*MRID*
Water flea *Daphnia magna*	99.6	269	Slightly toxic	Acceptable	45910302 or 4602090
Rainbow trout	99.1	>502	Practically nontoxic	Acceptable	45910401 or 46020903

A toxicity study conducted with ETU which evaluated the developmental stages of to *Xenapus laevis (*South African clawed frog) will be used qualitatively (Table 4-5). *Xenapus laevis* developmental stages were exposed to ETU via water column under static water conditions with daily renewal for 4 days. The developmental stages were from the blastulation (shortly after fertilization) to the free swimming tadpole stage. Developmental stages were assessed for morphological developmental, growth (length), and death during development at 0, 100, 250, 500, 750, and 100 mg/liter with 40 embryos per concentration. No adverse affects were observed at the highest concentration tested. The reason this study can only be used on a qualitative basis is because there was no indication if the gel was removed from the organisms during the blastulation stage; therefore, there is uncertainty regarding the amount of test substance the organism was actually exposed to.

Table 4-5 Chronic toxicity of ETU to aquatic-phase amphibians

Test Species	*Life Stage at Test Start*	*Test Chemical*	*Endpoint (mg a.i/L)*	*ECOTOX Ref/ MRID*	*Description of Use in Document*
South African clawed frog *Venous leaves*	4 days Post fertilization	ETU	4 day- LOAEL = > 1000 (highest tested concentration)	90116	Qualitative

4.1.1.3 Freshwater Fish: Acute Exposure (Mortality) Studies

The most sensitive endpoints derived from the rainbow trout tests conducted with mancozeb and maneb (LC_{50} 460ppb and LC_{50} 42.0ppb respectively) were used as a surrogate to aquatic-phase amphibians to assess potential direct effects and also to assess indirect effects to the CRLF via reduction of prey items. (See section 4.1.1.1 for more details)

4.1.1.4 Freshwater Fish: Chronic Exposure (Growth, Reproduction) Studies

The acute-to-chronic ratio (ACR) approach with available ETU acute and chronic invertebrate and acute fish toxicity data (an estimated chronic NOAEC of 37.32 ppm) was used as a surrogate to aquatic-phase amphibians as well as to assess indirect effects to the CRLF via reduction of prey items associated with adverse reproductive and growth affects associated with chronic exposure to ETU (See section 4.1.1.2 for more details).

4.1.1.5 Freshwater Vertebrates: Sub-lethal Effects

In some of the acute tests, fish were observed swimming at the surface of the water. Also numerous open literature studies have indicated thyroid related sub-lethal affects in amphibians such as histological changes. Nevertheless, these effects are difficult to quantify because they are not clearly tied to the assessment endpoints for the CRLF (*i.e.*, survival, growth, and reproduction of individuals). In addition, differences in habitat and behavior of the tested fish species compared with the CRLF suggest that the results may not be readily extrapolated to frog. Furthermore, there is uncertainty associated with extrapolating effects observed in the laboratory to more variable exposures and conditions in the field. Therefore, potential sub-lethal effects on fish are evaluated qualitatively in this assessment and are not used as part of the quantitative risk characterization consistent with the Overview Document (U.S. EPA 2004) and the US Fish and Wildlife Service review of EPA's methodology for assessing potential risks to listed species (USFWS/NMFS 2004).

4.1.2 Toxicity to Freshwater Invertebrates

Freshwater aquatic invertebrate toxicity data were used to assess potential indirect effects of mancozeb and maneb to the CRLF. Effects to freshwater invertebrates resulting from exposure to mancozeb or maneb may indirectly affect the CRLF via reduction in available food items. As discussed in Section 2.5.3, the main food source for juvenile aquatic- and terrestrial-phase CRLFs is thought to be aquatic and terrestrial invertebrates found along the shoreline and on the water surface, such as larval alderflies, pillbugs, water striders, and particularly the sowbug.

A summary of available acute and chronic freshwater invertebrate data is provided below in Sections 4.1.2.1 through 4.1.2.3. (A summary of toxicity values are in **Appendix D**).

4.1.2.1 Freshwater Invertebrates: Acute Exposure (Mortality) Studies

Available freshwater invertebrate acute toxicity studies suggest that both mancozeb and maneb are highly toxic to aquatic invertebrates. The only species tested for both chemicals was daphnid (*Daphnia magna*). The most sensitive endpoint for mancozeb (LC_{50} 580ppb) was determined from a static 46 hour LC_{50} test. The endpoint derived from the only submitted maneb study was an EC_{50} of 120ppb. In this study (TEP), a substantial decrease in test substance concentration was noted between the beginning and end of the test (final values averaged 34% of nominal), therefore, test results were based on the most conservative concentration, which was the final measured concentration). The most sensitive endpoints derived from the *Daphnia magna* test conducted with mancozeb and maneb were used to assess potential indirect effects to the CRLF via reduction of prey items (freshwater invertebrates).

4.1.2.2 Freshwater Invertebrates: Chronic Exposure (Growth, Reproduction) Studies

A chronic freshwater invertebrate toxicity test conducted with ETU (the major degradate of mancozeb and maneb) adversely affected growth and reproduction of *Daphnia magna* at 4.1ppm with a NOAEC of 2.0ppm. Adult length, survival, and fecundity (mean number of young per adult per reproductive day) were significantly reduced at the 4.1ppm treatment level (Table 4-6). The detection limit for young/adult/day was approximately 30% due to the limited number of replicates (two instead of the recommended four). The most sensitive endpoint derived from the *Daphnia magna* test conducted with ETU was used to assess potential indirect effects to the CRLF via reduction of prey items (freshwater invertebrates).

Table 4-6 Chronic toxicity of ETU to freshwater invertebrates during a life-cycle toxicity test

Species	*Purity (% a.i.)*	*NOAEC (µg/L)*	*LOAEC (µg/L)*	*Endpoints Affected*	*Study Classification*	*MRID*
Water flea *Daphnia magna*	96.2	2.0	4.1	Adult length, survival, no. young/adult/day	Supplemental	45462901

4.1.3 Toxicity to Aquatic Plants

One study has been submitted for a mancozeb technical formulation using the freshwater green algae. *P. subcaptitatum* (MRID 40943501). The EC_{50} for *P. subcaptitatum* was 47.0 ppb based on growth inhibition; the NOAEC was <22.0 ppb. Four end-use formulations with mancozeb co-formulated with dimethomorph or dimethomorph/zoxamide using *P. subcaptitatum,* freshwater diatom *(Navicula pelliculosa),* and freshwater blue-green algae *(Anabaena flosaquae)* were also submitted. The EC_{50s} ranged from 13.71ppb-130.0ppb. The NOAEC ranged from 2.88ppb-28.0ppb. One study has been submitted for a maneb technical formulation using the freshwater green algae *P. subcaptitatum* (MRID 40943501). The EC_{50} for *P. subcaptitatum* was 13.4 ppb based on growth inhibition; the NOAEC was 5 ppb. Results were based on nominal concentrations, even though the study author reported that maneb was unstable in the test media (at 120 hours it averaged 15% of the nominal). The most sensitive endpoints derived from the *P. subcaptitatum* test conducted with mancozeb Technical (EC_{50} 47.0ppb) and maneb Technical (EC_{50} 47.0ppb, NOAEC 5ppb) were used to assess potential indirect effects to the aquatic phase tadpole CRLF via reduction of food source (freshwater aquatic plants). (A summary of toxicity values are in **Appendix D**)

4.1.4 Freshwater Field Studies

A mesocosm study conducted with mancozeb is available (Table 4-7). This study followed the Society of Environmental Toxicology and Chemistry (SETAC) "Guidance Document on Testing Procedures for Pesticides in Freshwater Mesocosms" (July 1991) and employed the regression approach. Ten outdoor fiberglass tanks (mesocosms) were used in this study - 3 controls and 7 treatment tanks. Each mesocosm was approximately 2 m in diameter and 1.6 m deep with an approximate volume of 5 m3. The treatment tanks received eight simulated spray drift applications of Penncozeb 80 WP (80% mancozeb a.i.) each separated by one week. The nominal concentrations selected for each treatment tank were: 1.25, 4.0, 12.5, 40, 125, 400, and 1250 ppb of Penncozeb 80 WP. The results were based upon nominal concentrations of the formulated product and not measured concentrations of the actual test material in the treatment tanks.

Since the mesocosm study was conducted using non-replicated treatments, dose response values (EC20 and EC50) were derived by employing non-linear regression analysis. The EC20 was regarded as the threshold level, below which no ecologically relevant effects occur. The following table provides the toxicity of Penncozeb 80 WP to various aquatic species in this study.

Table 4-7 Toxicity of Penncozeb 80 WP to various aquatic species

Species	Period	ppb Penncozeb 80 WP)	
		EC_{20}	EC_{50}
Zooplankton			
Daphnia magna	Application	252	408
Daphnia longispina	Application	332	398
Chydorus sphaericus	Application	67	134
Scapholeberis mucronata	Application	188	263
Copepod nauplii	Application	29	57
Brachionus leydigi	Application	5.5	9.2
Keratella quadrata	Application	22	27
Hexarthra sp.	Application Post-Application	12 12	12 12
Cephalodella sp.	Application	15	31
Phytoplankton			
Volvox sp.	Application	1.6	4.8

It should be noted that EPA's "Aquatic Mesocosm Tests to Support Pesticide Registrations_EPA 540/09-88-035" (March 1988) requires three replicates per treatment level, a mesocosm size of 300 m3 in volume and the inclusion of viable finfish in the study. These three major departures from EPA guideline requirements are noted at this time. Despite these deficiencies, the study does provide some supplemental information for characterizing the risk.

4.2 Toxicity of Mancozeb and Maneb to Terrestrial Organisms

Table 4-8 summarizes the most sensitive terrestrial toxicity endpoints for the CRLF, based on an evaluation of submitted studies. A brief summary of submitted data considered relevant to this ecological risk assessment for the CRLF is presented below. (A summary of toxicity values are in **Appendix D**)

Table 4-8 Terrestrial toxicity profile for mancozeb and maneb

Assessment Endpoint	*Measures of Ecological Effects*	*MRID or Reference*	*Study Classification*
Direct toxicity to terrestrial-phase CRLF	Mancozeb-English sparrow (*Passer domesticus*) acute oral LD50 = ~1500 mg a.i./kg	00036094	Supplemental
	Maneb-Northern bobwhite quail acute oral LD_{50} = >2,150	0657001	Acceptable
	Maneb-Mallard duck (*Anas platyrhynchos)* subacute dietary LC50 = >5,000 ppm	40657002	Acceptable
	Mancozeb - *Anas platyrhynchos* chronic reproduction NOAEC = 125.0ppm	41948401	Acceptable
	Maneb - *Anas platyrhynchos* chronic reproduction NOAEC = 20ppm	4358650	Acceptable
Indirect toxicity to terrestrial-phase CRLF (via toxicity to prey items)	Mancozeb-Honey bee (*Apis mellifra)* acute contact- LD5= 1396.2 ppm	00018842	Acceptable
	Maneb - *Apis mellifra* acute contact- LD5= > 12.09	00036935	Acceptable
	Mancozeb – Mite *(Typhlodromus pyri)*- Residual toxicity LR50a = 0.01lb a.i./A	45577201	Acceptable
	Mancozeb laboratory rat *Rattus norvegicus* acute oral LD50 >5,000 mg/kg	00142522	Acceptable
	Maneb - *Rattus norvegicus* acute oral LD50 >5,000 mg/kg	41975601	Acceptable
	Mancozeb Rattus norvegicus reproductive NOAEL 120ppm	41365201	Acceptable
	Maneb *Rattus norvegicus reproductive NOAEL 75ppm*	42049401	Supplemental

Acute toxicity to terrestrial animals is categorized using the system shown in Table 4-9 (U.S.EPA, 2004). Toxicity categories for terrestrial plants have not been defined. Based on these categories, mancozeb is classified as slightly to practically non-toxic and maneb nontoxic to birds on an acute oral basis. Both mancozeb and maneb are classified as practically non-toxic to mammals on an acute exposure basis.

Table 4-9 Qualitative descriptors for avian and mammalian acute toxicity

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

4.2.1 Toxicity to Birds

Acute and chronic avian toxicity data were used to assess the potential direct effects to the terrestrial phase CRLF. (A summary of toxicity values are in **Appendix D**)

4.2.1.1 Birds: Acute Exposure (Mortality) Studies

Acute oral toxicity data for three avian species indicate that mancozeb is slightly to practically nontoxic to avian species. The one avian study available for maneb indicates that maneb is practically nontoxic on an acute oral basis. The most sensitive species for mancozeb, English sparrow, has an LD_{50} of ~1500mg/kg. This was an approximated LD_{50} value because the studies conducted with mancozeb were multiple oral dose studies instead of the more common single oral dose study and regurgitation made determination of toxicity dosages difficult. The acute oral study for Northern bobwhite quail conducted with maneb used a single oral dose and the LD_{50} was >2,150 mg/kg. Mallard duck is the most sensitive avian species on a sub-acute dietary toxicity basis for maneb, with an LC_{50} of >5,000. Based on this endpoint, maneb is practically nontoxic to birds on a sub-acute dietary basis. Dietary testing was attempted with mancozeb on mallard ducks and bobwhite quail; however, the birds had an aversion to the test diet and would not consume the test material.

4.2.1.2 Birds: Chronic Exposure (Growth, Reproduction) Studies

4.2.2 Toxicity to Mammals

As discussed in **Section 2.5.3**, over 50% of the prey mass of the terrestrial phaseCRLF may consist of vertebrates such as mice, frogs, and fish (Hayes and Tennant, 1985). Therefore, toxicity to mammals is used to assess the potential for indirect effect to the CRLF as a result of effects to its mammalian prey base.

A summary of available acute and chronic mammalian data is provided in Sections 4.2.2.1 through 4.2.2.3. (A summary of toxicity values are in **Appendix D**)

4.2.2.1 Mammals: Acute Exposure (Mortality) Studies

Acute oral toxicity mammalian studies with the laboratory rat were submitted for mancozeb (four studies;Table 4-10 and maneb (one study; Table 4-11). The LD_{50} for all five studies was >5,000 mg/kg. Based on this endpoint, mancozeb and maneb are categorized as practically nontoxic to mammals on an acute oral basis. In the mancozeb LD_{50} study (MRID # 0014522) there were ten rats tested and all animals survived. The only clinical signs were mild constipation, tan-stained muzzles, and brown-stained anogenital areas. In the maneb LD_{50} study of the ten rats tested there were three male deaths at the 5,000 mg/kg dose and 2 male deaths at the 6060 mg/kg dose, and all of the females survived until study termination. Clinical symptoms included lethargy, ataxia, hypothermia, diarrhea, and staining, decreased defecation, and hair loss.

Table 4-10 Mammalian acute oral toxicity for mancozeb

Species	*% a.i.*	*LD_{50} (mg a.i /kg)*	*Toxicity Category)*	*Affected Endpoints*	*MRID or Accession (AC) Number*
		Technical			
Laboratory rat (Rattus norvegicus) laboratory mouse *(Mus musculus)*l	80.0	>5,000 (male)	practically nontoxic	mortality	AC259044
laboratory rat (Rattus norvegicus)	72.6	>5,000 (male & female) Probit slope = 4.5 (default)[1]	practically nontoxic	mortality	00142522
Laboratory rat (Rattus norvegicus)	70.0 & 75.0	>5,000	practically nontoxic	mortality	AC254377
		End-Use Formulation - Mancozeb			
Laboratory rat (Rattus norvegicus)	36.0	>5,000 (male)	practically nontoxic	mortality	AC238564

[1] Raw data unavailable to estimate slope; Used default assumption cited in Urban and Cook (1986).

Table 4-11 Mammalian acute toxicity for maneb

Species	*% a.i.*	*Test Type*	*LD_{50} (mg a.i /kg))*	*Toxicity Category)*	*Affected Endpoints*	*MRID*
			Technical			
Laboratory rat (Rattus norvegicus)	not reported	oral - single dose	>5,000	practically nontoxic	mortality	41975601

Sub-chronic toxicity data are available for two mammal species for mancozeb. They indicate that extended exposure to mancozeb via the diet at levels of 250 ppm will cause decreased serum thyroxin levels in females and body weight decrements, changes in thyroid hormones, changes in liver enzymes, microscopic changes in the liver and thyroids, increased absolute and relative thyroid weights, and increased relative liver weights in males. (A summary of toxicity values are in **Appendix D**)

4.2.2.2 Mammals: Chronic Exposure (Growth, Reproduction) Studies

Chronic mammalian data are available for two species for mancozeb and one species for maneb. The most sensitive species for both chemicals is the laboratory rat, with a reproductive NOAEC of 125 ppm (mancozeb), and 75 ppm (maneb). The LOAEC of 1200ppm from the reproductive study conducted with mancozeb was based on body weight decrements, increased relative thyroid weights, and increased incidence of thyroid follicular cell hyperplasia (parental effects). There were no adverse offspring effects attributed to mancozeb in this study. The developmental study conducted with mancozeb resulted in gross developmental defects, central nervous system defects, skeletal defects, cryptorchidism, abortions, and decreased fetal weight at a LOAEC of 500ppm and a NOAEC of 128ppb. The LOAEL of 300 ppm (NOAEL = 75 ppm) in the reproductive study on rats using maneb was based on slight delay in the startle response in the offspring (fetal effects) and parental effects included an increase in lung and liver weight and an increased incidence of diffuse follicular epithelial hypertrophy/hyperplasia. The LOAEL of 1,000ppm (NOAEL = 200ppm) for the developmental rat study was based on increased post-implantation (embedding of fertilized egg in uterine lining) loss, increased re-sorption (total and re-sorption per dam), and decreased fetal viability. (A summary of toxicity values are in **Appendix D**)

4.2.2.3 Mammals – Sub-lethal effects

OPP has determined that there is sufficient evidence to group the EBDCs (mancozeb, maneb, and metiram) based on a common mechanism for the induction of thyroid effects. Submitted and open literature mammalian studies have noted thyroidal effects such as thyroid weight increase, follicular cell hyperplasia, and decreased thyroid hormone levels. Nevertheless, these effects are difficult to quantify because they are not clearly tied to the assessment endpoints for the CRLF (*i.e.*, survival, growth, and reproduction of individuals). In addition, differences in habitat and behavior of the tested fish species compared with the CRLF suggest that the results may not be readily extrapolated to frogs. Therefore, potential sub-lethal effects on fish are evaluated qualitatively in this assessment and are not used as part of the quantitative risk characterization consistent with the Overview Document (U.S. EPA 2004) and the US Fish and Wildlife Service review of EPA's methodology for assessing potential risks to listed species (USFWS/NMFS 2004).

4.2.3 Toxicity to Terrestrial Invertebrates

Terrestrial invertebrates are a food source for terrestrial phase CRLF. Therefore, toxicity to terrestrial invertebrates as a result of mancozeb and maneb use is assessed to determine whether there may be indirect effects to the CRLF via reduction in available food.

4.2.3.1 Terrestrial Invertebrates: Acute Exposure (Mortality) Studies

The use of mancozeb and maneb on agricultural crops may result in exposure to non-target beneficial insects, such as the honey bee. Acute contact studies suggest that mancozeb and maneb are practically nontoxic to honey bees. The acute contact honey bee LD_{50} = >179 µg/bee (converted to 1396.2 ppm based on Mayer and Johansen, 1990) for mancozeb and LD_{50} = 12.09 µg/bee (converted to 94.30 ppm based on Mayer and Johansen, 1990) is used to assess potential indirect effects to the terrestrial-phase CRLF. Additionally, a mite (*Typhlodromus pyri*) and honey bee residue on foliage studies conducted with mancozeb was submitted. The residue concentration on foliage causing 50% lethality was 0.01 lb ai/acre for *Typhlodromus pyri* and 0.27 lb ai.acre for honeybee. (A summary of toxicity values are in **Appendix D**)

4.2.4 Toxicity to Terrestrial Plants

Terrestrial plant data are not available for mancozeb as a sole active ingredient in the TEP. There are also no terrestrial plant data for maneb. Terrestrial plant data for mancozeb are based on a TEP containing 60% mancozeb co-formulated with 9% dimethomorph. The non-target terrestrial plant seedling emergence toxicity (Tier 1) and vegetative vigor toxicity (Tier 1) studies were conducted on four monocot species and six dicot species, none of the species exposed displayed 25%inhibition for the parameters tested. For seedling emergence, soybean and tomato are the most sensitive dicots with 4% plant dry weight inhibition; onion is the most sensitive monocot with 12% dry weight inhibition when compared to the controls at the application rate of 1.38 and 0.02 lb a.i./A of mancozeb and dimethomorph, respectively. For vegetative vigor, tomato is the most sensitive dicot with a 6% plant dry weight inhibition, corn and onion are the most sensitive monocots with 2% plant dry weight inhibition when compared to the controls at the application rate previously indicated. (A summary of toxicity values are in **Appendix D**)

4.2.5 Terrestrial Field Studies

No field studies were submitted.

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

The Agency uses the probit dose response relationship as a tool for providing additional information on the potential for acute direct effects to individual listed species and aquatic animals that may indirectly affect the listed species of concern (U.S. EPA, 2004). As part of the risk characterization, an interpretation of acute RQs 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 mancozeb/maneb 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. A statement regarding the confidence in the estimated event probabilities is also included. 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 (lower and upper bounds of 2 to 9) (Urban and Cook, 1986) is used.

Individual effect probabilities are calculated using 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. Results of the probit slope analyses are described in Section 5.2.

4.4 Incident Database Review

4.4.1 Terrestrial Incidents

No terrestrial incidents associated with mancozeb and maneb use in the United States were located.

4.4.2 Plant Incidents

There were a total of five plant incidents in the United States found in the Ecological Incident Information System (EIIS)[20] . In one reported incident, a tank mixture of mancozeb and benomyl applied to apple trees may have caused leaves and blossoms to drop from the trees. The certainty index for this incident was possible. In a second incident there was reported possible fruit and vegetable garden damage resulting from spray drift while neighbor's birch trees were sprayed. The extent of damage was not reported. Chemical analysis showed a trace of applied pesticide. The certainty index for this incident was probable. The third incident report indicated plant damage to 50 acres of a crop of ornamentals resulting from direct application of mancozeb and trifloxystrobin. The application rate and method was not reported for mancozeb but was reported for trifloxystrobin. The certainty index for this incident was possible for mancozeb and probable for trifloxystrobin. Terrestrial plant data for trifloxystrobin resulted in an EC_{25} greater than the highest concentration tested; therefore an assessment of risks was not possible. However, another strobilurin fungicide is highly toxic to terrestrial plants. In a fourth incident, damage was reported to an onion field resulting from aerial application of diazinon, metalaxyl, mancozeb, and chlorothalonil. The certainty index for this incident was possible for all the chemicals. Terrestrial plant data for mancozeb conducted with a TEP containing 60% mancozeb co-formulated with 9% dimethomorph does not suggest toxicity to terrestrial plants. The non-target seedling emergence study resulted in a 12% dry weight inhibition for onions and the non-target terrestrial plant vegetative vigor toxicity (Tier 1) study resulted in 2% dry weight inhibition. The fifth reported incident was 46% plant damage to 240 acres of potatoes resulting from seed treatment with mancozeb and fludioxonil. The product had been applied to seed but no mention was made of the type of damage that occurred with the plants. The certainty index for this incident was possible for both chemicals. Terrestrial plant data for mancozeb conducted with TEP containing 60% mancozeb co-formulated with 9% dimethomorph does not suggest toxicity to terrestrial plants. There is no available non-target terrestrial plant data for fludioxonil; however, there is numerous terrestrial plant incidents associated with this chemical. More details can be found in **Appendix J**.

4.4.3 Aquatic Incidents

The Ecological Incident Information System (EIIS) reported mancozeb in three fish kill incidents. One incident occurred in 1970, another in 1992 and the latest occurred in 1995. In the 1970 and 1992 incidents, mancozeb had been applied with an insecticide highly toxic to fish and, because of sample analysis, EFED classified mancozeb as unlikely to have been responsible for these fish kills. The third incident in 1995 involved a mancozeb accidental spill into a stream that was the source water for a salmon hatchery which resulted in a fish kill at the salmon hatchery. Although EFED has

[20] http://www.epa.gov/oppefed1/general/databasesdescription.htm#eiis)

classified mancozeb to be a probable contributory cause to the kill; the exposure associated with accidental spills are much higher than label use rates for mancozeb.

The Ecological Incident Information System (EIIS) reported maneb in three fish kill incidents. An incident, occurring in August, 1973, reported by the Oregon Department of Agriculture showed some fish in a 15 acre pond had been killed. Presumably drift from an aerial application of maneb and endosulfan to potatoes caused the kill. No analysis of the dead fish was rovided. Both maneb and endosulfan are very highly toxic to freshwater fish [maneb rainbow trout LC50 = 42.0 ppb and endosulfan rainbow trout LC50 = 0.37 ppb (US EPA. 2001)] and both pesticides could have been responsible for the fish kill, if in fact the kill was pesticide related. However, the inadequate information provided with this reported incident and the lack of laboratory analyses makes it difficult to determine the cause.

The second maneb related incident occurred in June, 1994 and was reported by the North Carolina Department of Agriculture. The incident reported a fish kill in a 2.5 acre commercial fishpond resulting from spray drift applications of maneb, trifluralin, imazaquin, pendimethalin, and acephate aerially applied to corn and soybean fields near the pond. The analyzed samples did not confirm the presence of maneb or the other pesticides listed. Based on the investigation and the analysis of samples, it is unlikely that maneb contributed to this fish kill.

The third maneb related incident, occurring in August, 1994, was reported by the Maine Department of Agriculture. In this incident roughly 10,000 newly released brook trout were killed in a pond that borders New Brunswick, Canada and Maine. Three pesticides (maneb, esfenvalerate, and chlorothalonil) recently applied to potatoes surrounding this pond were suspected in this fish kill. Tissue samples of the fish confirmed the presence of all three pesticides (maneb at 169 ppb, esfenvalerate at 4.2 ppb, and chlorothalonil at 20 ppb) in the fish. These fish samples were taken from both the pond and brooks feeding the pond. All three of the pesticides are very highly toxic to freshwater fish. Maneb's rainbow trout LC50 is 42.0 ppb, esfenvalerate's rainbow trout LC50 is 0.26 ppb (Hicks, L. May, 1995) and chlorothalonil's rainbow trout LC50 is 42.3 ppb (US EPA. 1998)]. The submitter of the incident report pointed out there were severe thunderstorms in the area preceding the fish kill which suggest pesticide runoff may have been a factor in this incident. Based on sampling evidence, EFED believes maneb may have been a contributory cause in this incident. More details can be found in **Appendix J**.

5 Risk Characterization

Risk characterization is the integration of the exposure and effects characterizations to determine the likelihood of direct and indirect effects on the California Red Legged Frog from registered uses of mancozeb and maneb. The risk characterization provides an estimation and description of the likelihood of adverse effects; articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the effects determination (*i.e.*, "no effect," "likely to adversely affect," or "may affect, but not likely to adversely affect") for the CRLF.

5.1 Risk Estimation

Risk is estimated by calculating the ratio of estimated exposure (EEC) to toxicity, which is referred to as a risk quotient (RQ). Except for terrestrial insects, both an acute and chronic RQ are calculated for animals (Table 5-1). For plants a non-listed species RQ and a listed species RQ are calculated. The estimate of exposure is the same for both of these values, they differ in the toxicity value used (e.g., terrestrial plants listed species RQ uses NOAEL whereas non-listed species RQ uses EC_{25}). The RQ is then compared to pre-established presumptive levels of concern (LOCs) for each category evaluated (Table 5-1).

RQs were not determined for dip treatment to Capri figs, pineapples, and asparagus due to minimal potential risks resulting from negligible exposure. The method of application itself does not result in release to the environment and all active ingredient applied is expected to be tightly adsorbed to the surface of the plant parts or seed pieces making it also unavailable for dissolution and transport. Dietary exposure to residues on these items to the CRLF is highly unlikely as these are not food items of the CRLF. Therefore, dip treatment uses are considered to have "no effect" on the CRLF (see section 5.2.1.1).

With regard to seed treatment uses, potential aquatic risks are considered minimal based on negligible aquatic exposure resulting from seed treatment compared to the rate of application used for the assessed foliar treatment to the same crop. In making this comparison, mancozeb use on grains, which is the highest lb a.i./Acre, is below concentrations with any listed acute RQ exceedance. Therefore, these too should not exceed (see section 6.1.5.4). Potential terrestrial risks associated with seed treatment use are also considered minimal. In the previous terrestrial risk assessment (2005 mancozeb and maneb REDs), RQ values were calculated for numerous mancozeb seed treatment uses. That evaluation considered seed treatment only use sites, not foliar use sites. The results indicated that the acute risk to endangered species LOC would not be exceeded (RQs < 0.01). Although maneb also has numerous seed treatment uses, the mancozeb seed treatment uses assessed would be protective because; 1) maneb toxicity to birds on an acute oral exposure basis is less than mancozeb; and 2) the exposure (rates of application) from these seed treatment uses are similar for maneb and mancozeb. Therefore, all mancozeb and maneb seed treatment uses are considered to have "no effect" on the CRLF.

Acute avian and mammalian RQs were not determined for mancozeb and maneb uses. The acute dietary risk to birds eating food items exposed to spray applications of mancozeb and maneb is expected to be low based on the avian acute toxicity data. The acute dietary risk to birds from exposure to mancozeb and maneb is low because; 1) dietary testing attempted on mallard ducks and bobwhite quail with mancozeb indicated an aversion to test diet (the birds would not consume the test material); 2) there is low acute toxicity of mancozeb to birds in multiple dosing LD_{50} studies; 3) there are no incidents showing that mancozeb or maneb have been responsible for bird kills or poisonings; and 4) maneb (chemically related compound) is practically nontoxic to birds in dietary LC_{50} testing (mallard duck LC50 >5,000 ppm and bobwhite quail LC50 >10,000 ppm). EFED believes the acute dietary risk to mammals from exposure to mancozeb and maneb is low. The five available mammalian acute oral toxicity studies for mancozeb (4 studies) and maneb (1 study) resulted in LD50 >5,000. A "no effect" determination is made for survival of CRLF individuals via direct effects on terrestrial phase adults and juveniles for all mancozeb and maneb uses.

Table 5-1 RQ calculation methodology and LOC values

Risk Presumption	*RQ*	*LOC*
Birds and Wild Mammals		
Acute Risk	Dietary based: EEC [a] (ppm [b]) / LC_{50} (ppm) Dose based: EEC (mg/kg-bw/d) / LD_{50} (mg/kg-bw/d[c])	0.5
Acute Listed Species	Dietary based: EEC (ppm) / LC_{50} (ppm) Dose based: EEC (mg/kg-bw/d) / LD_{50} (mg/kg-bw/d)	0.1
Chronic Risk	Dietary based: EEC (ppm) / NOAEC (ppm) Dose based: EEC (mg/kg-bw/d) / NOAEL (mg/kg-bw/d)	1.0
Aquatic Animals		
Acute Risk	EEC (ppb) / (LC_{50} (ppb) or EC_{50} (ppb))	0.5
Acute Listed Species	EEC (ppb) / (LC_{50} (ppb) or EC_{50} (ppb))	0.05
Chronic Risk	EEC (ppb) / NOAEC (ppm)	1.0
Terrestrial Plants and Plants Inhabiting Semi-Aquatic Areas		
Non-listed Species	EEC (lbs ai/A) / EC_{25} (lbs ai/A)	1.0
Listed Species	EEC (lbs a.i./A) / (EC_{05} or NOAEL (lbs a.i./A))	1.0
Aquatic Plants		
Non-listed Species	EEC (ppb) / EC_{50} (ppb)	1.0
Listed Species	EEC (ppb) / (EC_{05} or NOAEC (ppb))	1.0

[a] EEC = estimated environmental concentration
[b] ppb = parts per billion
[c] mg/kg-bw/d = milligrams per kilogram of body weight per day

5.1.1 Direct Effects to the CRLF

5.1.1.1 Aquatic-phase of the CRLF

Acute (peak) EECs of short-term constituents and chronic (60-d) EECs of long-term constituents in surface water (Table 3.5) were used to calculate acute and chronic RQ values, respectively, for the CRLF. For acute RQ values, where the parent material is expected to predominate short-term, the use of mancozeb or maneb results were based on the following: 1) joint mancozeb-maneb applications and maneb only uses the most sensitive acute fish (surrogate for CRLF) toxicity endpoint for maneb was used; and 2) for mancozeb only uses, the most sensitive acute fish mancozeb toxicity endpoint was used. ETU data, representative of long-term degradate constituents, was used to calculate the chronic RQ for both mancozeb and maneb uses alone or together.

<u>All uses except seed and dip treatment</u>

Direct effect acute RQ values for the aquatic-phase CRLF are presented in Table 5-2 for mancozeb-maneb joint application uses, in Table 5-3 for mancozeb alone application uses, and in Table 5-4 for maneb alone application uses. Acute RQ values for joint mancozeb-maneb application uses except for ornamental uses (ground cover, herbaceous, non-flowering shade trees, woody shrubs & vines) and all maneb application only uses exceed the listed species acute LOC; however, none of the mancozeb application only uses except Christmas tree plantations and Forestry (Douglas Fir) uses exceed the listed species acute LOC (0.05).

Direct effect chronic RQ values for the aquatic-phase CRL are presented in Table 5-5. Based on the projected 60-day mean aquatic ETU EEC for turf (the highest application rate) and the estimated reproductive ETU NOAEC, none of the chronic RQs for mancozeb or maneb uses exceed the Agency's chronic LOC of 1.0.

Table 5-2 Direct effect acute RQs for the aquatic-phase CRLF, mancozeb-maneb jointly used

Use	*Peak EEC(ppb)*[1]	*Acute RQ*[2]	*Listed Species LOC Exceedance?*[3]
Corn (sweet/Pop), 3crops per year	91.78	2.19	yes
Apples	20.01	0.48	yes
Bananas	10.53	0.25	yes
Papayas	9.05	0.21	yes
Garlic	37.93	0.90	yes
Grapes	10.03	0.24	yes
Cucurbits (Cucumber, cantaloupe, casaba, crenshaw, honeydew, muskmelon, summer squash, watermelon, winter melon	5.78	0.14	yes
Ornamentals (Nursery)	13.76	0.33	yes
Onion (Dried)	9.77	0.23	yes
Potatoes	9.36	0.22	yes
Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs & Vines	0.39	0.01	no
Ornamentals (Pachysandra)	4.71	0.11	yes
Ornamental Residential Turf	6.22	0.15	yes
Sugar Beet	21.27	0.51	yes

Use	Peak EEC(ppb)[1]	Acute RQ[2]	Listed Species LOC Exceedance?[3]
Tomatoes	8.86	0.21	yes
Turf (Commercial, Golf course, Industrial, Recreational, Sod farms)	92.46	2.20	yes
Turf (sod farms), 2 crops per year	111.07	2.64	yes
Grapes (Wine)	10.03	0.24	yes

[1] Peak EECs are from Table 3-3 .
[2]Acute RQ = peak EEC/acute LC_{50} (Table 5-1); the acute maneb LC_{50} used is Rainbow trout 96-hour LC_{50} = 42 ppb (MRID# 40706001)
[3] For acute exposures, the listed species acute LOC is 0.05 (Table 5-1).

Table 5-3 Direct effect RQs for the aquatic-phase CRLF, mancozeb used alone

Use	Peak EEC (ppb)[1]	Acute RQ[2]	Listed Acute LOC Exceedance?[5]
Corn (Field, Seed crop)	16.84	0.04	no
Cotton	8.25	0.02	no
Forestry (Douglas Fir)	40.55	0.09	yes
Pome fruits (Crab apple, pear, quince)	20.27	0.04	no
Plantains	10.83	0.02	no
Cucurbits (muskmelon, gourds)	11.36	0.02	no
Christmas tree plantations	32.02	0.07	yes
Shallot	11.30	0.02	no
Fennel, 2 crops per year	14.22	0.03	no
Asparagus	8.85	0.02	no
Cereal grains (Wheat, barley, oats, rye, triticali)	24.16	0.05	no

[1] Peak EECs are from Table 3-3.
[2] Acute RQ = peak EEC/acute LC_{50} (Table 5-1); the acute mancozeb LC_{50} is Rainbow trout 96-hour LC_{50} = 460 ppb MRID# 40118502
[3] For acute exposures, the listed species acute LOC is 0.05 (Table 5-1).

Table 5-4 Direct effect RQs for the aquatic-phase CRLF, maneb used alone

Use	Peak EEC (ppb)[1]	Acute RQ[2]	Listed Acute LOC Exceedance?[3]
Almonds	45.62	1.09	yes
Brassica (Broccoli, Chinese cabbage, cauliflower, kohirabi) 3 crops per year	38.09	0.90	yes
Loose leaf Chinese cabbage, 3 crops per year	63.69	1.52	yes
Kale, 3 crops per year	32.09	0.76	yes
Figs	6.71	0.16	yes
Brussels sprouts 2 crops per year	59.89	1.43	yes
Endive (Escarole) and Lettuce (leaf & head) 2 crops per year	59.48	1.42	yes
Pumpkin and Winter squash	5.78	0.14	yes
Onion (Green), 2 crops per year	17.35	0.41	yes
Beans (Dried)	10.64	0.25	yes
Pepper	13.36	0.32	yes
Eggplant	7.87	0.19	yes

[1] Peak EECs are from Table 3-3.
[2]Acute RQ = Peak EEC/ acute LC_{50} (Table 5-1); the acute maneb LC_{50} is Rainbow trout 96-hour LC_{50} = 42 ppb (MRID# 40706001)
[3] For acute exposures, the listed species acute LOC is 0.05 (Table 5-1).

Table 5-5 Direct effect RQs for the aquatic-phase CRLF, mancozeb and maneb all uses (highest long-term constituent exposure concentration)

Use	*60-d EEC (ppb)* [2]	*Chronic RQ*[3]	*Chronic LOC Exceedance?* [4]
Turf (Sod farm) 2 crops per year[1]	23.14	<0.01	no

[1]The turf (sod farm) use represents the use with the highest long-term constituent exposure
[2] 60-d EEC is from Table 3-3
[3]Chronic RQ = 60-d EEC/chronic NOAEC (Table 5-1); the estimated chronic ETU freshwater fish NOAEC = 3,732 ppb (see section 4.1.1.2)
[4] For chronic risk, the chronic LOC is 1.0 (Table 5-1)

5.1.1.2 Terrestrial-phase of the CRLF

Chronic RQ values, based on exposure from residues on prey items, for direct dietrary effects to the terrestrial-phase CRLF were calculated using upper-bound EECs for small and large insects. Avian chronic toxicity data and exposure estimates served as a surrogate for the terrestrial-phase CRLF. **Appendix I** contains specific dose- and dietary-based acute and chronic RQ calculations.

All uses except seed and dip treatment

The chronic RQs for direct effects to the terrestrial-phase CRLF exceed the chronic LOC of 1.0 for all of the assessed mancozeb and maneb uses (Table 5-6).

Table 5-6 Direct effect dietary-based chronic RQs for the terrestrial-phase CRLF

Use	*Rate (lbs a.i./A)*	*Number of Apps.*	*Minimum Interval (Days)*	*Chronic RQ*[4]	*Chronic LOC Exceedance?* [5]
Turf[1]	17.4	4	7	37.62-602.00	Yes
Cucumbers[1]	2.4	8	7	7.16-64.41	Yes
Ornamentals(other) [1]	1.2	3	7	2.16-19.44	Yes
Almonds[2]	6.4	4	7	13.84-124.55	Yes
Beans (dried) [2]	1.6	6	5	4.88-43.88	Yes
Figs[2]	2.4	1	N/A	1.80-28.80	Yes
Shallot[3]	2.4	10	7	1.22-10.97	Yes
Fennel[3]	1.6	8	7	0.76-6.87	Yes
Grains (barley, oats, rye, triticale, and wheat) [3]	1.6	3	7	0.46-4.15	Yes

[1]Joint Mancozeb/Maneb uses. Chronic toxicity endpoint based on maneb's mallard duck chronic reproduction NOAEC = 20 ppm (MRID # 43586502
[2]Maneb uses only. Chronic toxicity endpoint based on maneb's mallard duck chronic reproduction study NOAEC = 20 ppm (MRID # 43586502
[3]Mancozeb uses only. Chronic toxicity endpoint based on mancozeb's mallard duck chronic reproduction study NOAEC =125 ppm (MRID # 41948401)
[4]The RQ values shown as a range of values between fruits/pods/seeds/large insects-broadleaf plants/small insects.
[5]Chronic LOC = 1 (Table 5-1)

5.1.2 Indirect Effects to the CRLF

5.1.2.1 Evaluation of Potential Indirect Effects via Reduction in Food Items (Freshwater Fish)

Acute (peak) EECs of short-term constituents and chronic (60-d) EECs of long-term constituents in surface water (Table 3.5) were used to calculate acute and chronic RQ values, respectively, for freshwater fish. For acute RQ values, where the parent material is expected to predominate short-term, the use of mancozeb or maneb results were based on the following: 1) joint mancozeb-maneb applications and maneb only uses the most sensitive acute fish toxicity endpoint for maneb was used; and 2) for mancozeb only uses, the most sensitive acute fish mancozeb toxicity endpoint was used. ETU data, representative of long-term degradate constituents, was used to calculate the chronic RQ for both mancozeb and maneb uses alone or together.

<u>All uses except seed and dip treatment</u>

Indirect effect RQs for the aquatic-phase CRLF via effects to freshwater fish, which are potential prey items, are presented in Table 5-7 for mancozeb-maneb joint application uses, in Table 5-8 for mancozeb alone application uses, and in Table 5-9 for maneb alone application uses. Acute RQ values for all joint mancozeb-maneb application uses on corn (sweet/Pop), garlic, ornamentals (nursery), sugar beet, turf (commercial, golf course, industrial, recreational, sod farms), and turf (sod farms) and all of the maneb only application uses except figs, pumpkins, winter squash, beans, and eggplants exceed the non-listed species freshwater fish LOC. None of the mancozeb only application uses exceed the non-listed species freshwater fisn LOC.

Chronic RQ values for freshwater fish are presented in Table 5-10. Based on projected 60-day aquatic ETU EECs and the estimated freshwater fish reproductive ETU NOAEC (see section (cite Table and Section), none of the chronic RQs for mancozeb or maneb uses exceed the Agency's chronic LOC of 1.0.

Table 5-7 Indirect effects for the aquatic-phase CRLF via acute effects on freshwater fish, joint mancozeb-maneb application uses

Use	*Peak EEC(ppb)*[1]	*Acute RQ*[2]	*Listed Species Acute LOC Exceedance?*[3]	*Non-listed Species Acute LOC Exceedance?*[4]
Corn (sweet/Pop), 3crops per year	91.78	2.19	yes	yes
Apples	20.01	0.48	yes	no
Bananas	10.53	0.25	yes	no
Papayas	9.05	0.21	yes	no
Garlic	37.93	0.90	yes	yes
Grapes	10.03	0.24	yes	no
Cucurbits (Cucumber, cantaloupe, casaba, crenshaw, honeydew, muskmelon, summer squash, watermelon, winter melon	5.78	0.14	yes	no
Ornamentals (Nursery)	13.76	0.33	yes	no
Onion (Dried)	9.77	0.23	yes	no
Potatoes	9.36	0.22	yes	no
Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs	0.39	0.01	no	no

Use	*Peak EEC(ppb)*[1]	*Acute RQ*[2]	*Listed Species Acute LOC Exceedance?*[3]	*Non-listed Species Acute LOC Exceedance?*[4]
& Vines				
Ornamentals (Pachysandra)	4.71	0.11	yes	no
Ornamental Residential Turf	6.22	0.15	yes	no
Sugar Beet	21.27	0.51	yes	yes
Tomatoes	8.86	0.21	yes	no
Turf (Commercial, Golf course, Industrial, Recreational, Sod farms)	92.46	2.20	yes	yes
Turf (sod farms), 2 crops per year	111.07	2.64	yes	yes
Grapes (Wine)	10.03	0.24	yes	no

[1] Peak EECs are from Table 3-3
[2]Acute RQ = Peak EEC//acute LC_{50} (Table 5-1); the acute maneb LC_{50} used is Rainbow trout 96-hour LC_{50} = 42 ppb (MRID# 40706001)
[3] For acute exposures, the listed species acute LOC is 0.05 (Table 5-1)
[4] For acute exposures, the non-listed species acute LOC is 0.5 (Table 5-1)

Table 5-8 Indirect effects for the aquatic-phase CRLF via acute effects to freshwater fish, mancozeb application only uses

Use	*Peak EEC (ppb)*[1]	*Acute RQ*[2]	*Listed Species Acute LOC Exceedance?*[3]	*Non-listed Species Acute LOC Exceedance?*[4]
Corn (Field, Seed crop)	16.84	0.04	no	no
Cotton	8.25	0.02	no	no
Forestry (Douglas Fir)	40.55	0.09	yes	no
Pome fruits (Crab apple, pear, quince)	20.27	0.04	no	no
Plantains	10.83	0.02	no	no
Cucurbits (muskmelon, gourds)	11.36	0.02	no	no
X-mass tree plantations	32.02	0.07	yes	no
Shallot	11.30	0.02	no	no
Fennel, 2 crops per year	14.22	0.03	no	no
Asparagus	8.85	0.02	no	no
Cereal grains (Wheat, barley, oats, rye, triticali)	24.16	0.05	no	no

[1] Peak EECs are from Table 3-3
[2]Acute RQ = acute LC_{50} (Table 5-1); the acute mancozeb LC_{50} is Rainbow trout 96-hour LC_{50} = 460 ppb MRID# 40118502
[3] For acute risks, the listed species acute LOC is 0.05 (Table 5-1)
[4] For acute risks, the non-listed species acute LOC is 0.50 (Table 5-1)

Table 5-9 Indirect effects for the aquatic-phase CRLF via acute effects to freshwater fish, maneb application only uses

Use	*Peak EEC (ppb)*[1]	*Acute RQ*[2]	*Listed Species Acute LOC Exceedance?*[3]	*Non-listed Species Acute LOC Exceedance?*[4]
Almonds	45.62	1.09	yes	yes
Brassica (Broccoli, Chinese cabbage, cauliflower, kohirabi) 3 crops per year	38.09	0.90	yes	yes
Loose leaf Chinese cabbage, 3 crops per year	63.69	1.52	yes	yes
Kale, 3 crops per year	32.09	0.76	yes	yes

Figs	6.71	0.16	yes	no
Brussels sprouts 2 crops per year	59.89	1.43	yes	yes
Endive (Escarole) and Lettuce (leaf & head) 2 crops per year	59.48	1.42	yes	yes
Pumpkin and Winter squash	5.78	0.14	yes	no
Onion (Green), 2 crops per year	17.35	0.41	yes	no
Beans (Dried)	10.64	0.25	yes	no
Pepper	13.36	0.32	yes	no
Eggplant	7.87	0.19	yes	no

[1] Peak EECs are from Table 3-3
[2]Acute RQ = Peak EEC/ acute LC_{50} (Table 5-1); the acute maneb LC_{50} is Rainbow trout 96-hour LC_{50} = 42 ppb (MRID# 40706001)
[3] For acute exposures, the listed species acute LOC is 0.05 (Table 5-1)
[4] For acute exposures, the non-listed species acute LOC is 0.5 (Table 5-1)

Table 5-10 Indirect effects for the aquatic-phase CRLF via chronic effects to freshwater fish, all mancozeb and maneb uses (highest long-term constituent exposure concentration)

Use	*60-d EEC (ppb)* [2]	*Chronic RQ*[3]	*Chronic LOC Exceedance?* [4]
Turf (sod) 2 crops per year[1]	23.14	<0.01	No

[1]The turf (sod farm) use represents the use with the highest long-term constituent exposure.
[2] 60-d EEC is from Table 3-3
[3]Chronic RQ= 60-d EEC/chronic NOAEC (Table 5-1); the estimated chronic ETU freshwater fish NOAEC =,732 ppb(see section 4.1.1.2)
[4] For chronic risk, the chronic LOC is 1.0 (Table 5-1)

5.1.2.2 Evaluation of Potential Indirect Effects via Reduction in Food Items (Freshwater Invertebrates)

Acute (peak) EECs of short-term constituents and chronic (21-d) EECs of long-term constituents in surface water (Table 3.5) were used to calculate acute and chronic RQ values, respectively, for freshwater invertebrates. For acute RQ values, where the parent material is expected to predominate short-term, the use of mancozeb or maneb results were based on the following: 1) joint mancozeb-maneb applications and maneb only uses the most sensitive acute freshwater invertebrate toxicity endpoint for maneb was used; and 2) for mancozeb only uses, the most sensitive acute freshwater invertebrate mancozeb toxicity endpoint was used. ETU data, representative of long-term degradate constituents, was used to calculate the chronic RQ for both mancozeb and maneb uses alone or together.

<u>All uses except seed and dip treatment</u>

Indirect effect RQs for the aquatic-phase CRLF via effects to freshwater invertebrates, which are potential prey items, are presented in Table 5-11 for joint mancozeb-maneb application uses; in Table 5-12 for mancozeb application alone use; and in Table 5-13 for maneb application alone uses. None of the joint mancozeb-maneb application uses except turf (commercial, golf course, industrial, recreational, sod farms), turf (sod farms), and corn and none of the mancozeb application only uses exceed the non-listed species acute LOC (0.50). All of the maneb application only uses exceed the acute risk LOC of 0.50.

Chronic RQ values for freshwater invertebrates are presented in Table 5-14. Based on projected 21-day mean aquatic ETU EEC on turf (the highest application rate use) and the estimated freshwater invertebrate reproductive NOAEC none of the chronic RQs for mancozeb or maneb uses exceed the chronic LOC of 1.0.

Table 5-11 Indirect effects for the aquatic-phase CRLF via acute effects to freshwater invertebrates, joint mancozeb-maneb application uses

Use	*Acute EEC(ppb)*[1]	*Acute RQ*[2]	*Acute Listed Species LOC Exceedance?*[3]	*Acute Non-listed Species LOC Exceedance?*[4]
Corn (sweet/Pop), 3crops per year	91.78	0.76	yes	yes
Apples	20.01	0.17	yes	no
Bananas	10.53	0.09	yes	no
Papayas	9.05	0.07	yes	no
Garlic	37.93	0.32	yes	no
Grapes	10.03	0.08	yes	no
Cucurbits (Cucumber, cantaloupe, casaba, crenshaw, honeydew, muskmelon, summer squash, watermelon, winter melon	5.78	0.05	no	no
Ornamentals (Nursery)	13.76	0.11	yes	no
Onion (Dried)	9.77	0.08	yes	no
Potatoes	9.36	0.08	yes	no
Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs & Vines	0.39	<0.01	no	no
Ornamentals (Pachysandra)	4.71	0.04	no	no
Ornamental Residential Turf	6.22	0.05	no	no
Sugar Beet	21.27	0.18	yes	no
Tomatoes	8.86	0.07	yes	no
Turf (Commercial, Golf course, Industrial, Recreational, Sod farms)	92.46	0.77	yes	yes
Turf (sod farms), 2 crops per year	111.07	0.93	yes	yes
Grapes (Wine)	10.03	0.08	yes	no

[1] Peak EECs are from Table 3-3.
[2]Acute RQ = Peak EEC/acute EC_{50} (Table 5-1); the *D. magna* acute maneb 48-hour EC_{50} used is 120 ppb (MRID# 4074902)
[3] For acute risk, the listed species LOC is 0.05 (Table 5-1).
[4] For acute risks, the non-listed species acute risk LOC is 0.5 (Table 5-1).

Table 5-12 Indirect effects for the aquatic-phase CRLF via effects to freshwater invertebrates, mancozeb only application uses

Use	*Acute EEC(ppb)*[1]	*Acute RQ*[2]	*Acute Listed Species LOC Exceedance*[3]	*Acute Non-listed Species LOC Exceedance*[4]
Corn (Field, Seed crop)	16.84	0.03	no	no
Cotton	8.25	0.01	no	no
Forestry (Douglas Fir)	40.55	0.07	yes	no

Use	Acute EEC(ppb)[1]	Acute RQ[2]	Acute Listed Species LOC Exceedance[3]	Acute Non-listed Species LOC Exceedance [4]
Pome fruits (Crab apple, pear, quince)	20.27	0.03	no	no
Plantains	10.83	0.02	no	no
Cucurbits (muskmelon, gourds)	11.36	0.02	no	no
X-mass tree plantations	32.02	0.05	no	no
Shallot	11.30	0.02	no	no
Fennel, 2 crops per year	14.22	0.02	no	no
Asparagus	8.85	0.01	no	no
Cereal grains (Wheat, barley, oats, rye, triticali)	24.16	0.04	no	no

[1] Peak EECs are from Table 3-3
[2] Acute RQ = Peak EEC/acute EC_{50} (Table 5.1); the *Daphnia magna* acute mancozeb EC_{50} = 580ppb (MRID40118503); acute peak EECs from **Table 3.5**
[3] For acute risks, the listed species LOC is 0.05 (Table 5.1)
[4] For acute risks, the non-listed species acute risk LOC is 0.5 (table 5.1)

Table 5-13 Indirect effect RQs for the aquatic-phase CRLF, via direct effects to freshwater invertebrates, maneb application uses

Use	Acute EEC (ppb)[1]	Acute RQ[2]	Acute Listed Species LOC Exceedance [3]	Non-listed Species LOC Exceedance [4]
Almonds	45.62	0.38	yes	no
Brassica (Broccoli, Chinese cabbage, cauliflower, kohirabi) 3 crops per year	38.09	0.32	yes	no
Loose leaf Chinese cabbage, 3 crops per year	63.69	0.53	yes	no
Kale, 3 crops per year	32.09	0.27	yes	no
figs	6.71	0.06	yes	no
Brussels sprouts 2 crops per year	59.89	0.50	no	no
Endive (Escarole) and Lettuce (leaf & head) 2 crops per year	59.48	0.50	no	no
Pumpkin and Winter squash	5.78	0.05	no	no
Onion (Green), 2 crops per year	17.35	0.15	yes	no
Beans (Dried)	10.64	0.09	yes	no
Pepper	13.36	0.11	yes	no
Eggplant	7.87	0.06	yes	no

[1] Peak EECs are from Table 3-3
[2]Acute RQ = Peak EEC/acute EC_{50} (Table 5-1); the *D. magna* acute maneb 48-hour EC_{50} used is 120 ppb (MRID# 4074902)
[3] For acute risk, the listed species LOC is 0.05 (Table 5-1)
[4] For acute risks, the non-listed species acute risk LOC is 0.5 (Table 5-1)

Table 5-14 Indirect effect RQs for the aquatic-phase CRLF, via chronic effects to freshwater invertebrates, all mancozeb and maneb uses (highest long-term constituent exposure concentration

Use	*21-d EEC (ppb)* [2]	*Chronic RQ*[3]	*Chronic LOC Exceedance?* [4]
Turf (sod) 2 crops per year	33.20	0.17	no

[1]The turf (sod farm) use represents the use with the highest long-term constituent exposure.
[2] 21-d EEC is from Table 3-3
[3]Chronic RQ =21-d EEC/chronic NOAEC (Table 5-1); the *Daphnia magna* chronic ETU NOAEC = 200 ppb (MRID# 46462901)
[4] For chronic risk, the chronic LOC is 1.0 (Table 5-1)

5.1.2.3 Evaluation of Potential Indirect Effects for the aquatic-phase CRLF via Reduction in Food Items (freshwater aquatic plants)

Indirect effect RQs for the aquatic-phase CRLF via effects to algae, which is a food resource to pre-metamorphs, are presented in Table 5-15 for mancozeb-maneb joint application uses; in Table 5-16 for mancozeb alone application uses; and in Table 5-17 for maneb alone application uses. Based on the projected peak aquatic EECs and aquatic plant toxicity data, the RQs exceed the non-listed aquatic plant species LOC of 1.0 for joint mancozeb-maneb application uses on corn (sweet/Pop), apples, garlic, ornamentals (nursery), sugar beet, turf (commercial, golf course, industrial, recreational, sod farms), and turf (sod farms) and all of the maneb only application uses except figs, pumpkins, winter squash, beans, and eggplants. None of the mancozeb only application uses exceed the non-listed species aquatic plant LOC.

Table 5-15 Indirect effects for the aquatic-phase CRLF via effects to freshwater aquatic plants, joint mancozeb-maneb application uses

Use	*Peak EEC (ppb)*[1]	*Plant RQ*[2]	*Non-listed species LOC Exceedance?* [3]
Corn (sweet/Pop), 3crops per year	91.78	6.85	yes
Apples	20.01	1.49	yes
Bananas	10.53	0.79	no
Papayas	9.05	0.68	no
Garlic	37.93	2.83	yes
Grapes	10.03	0.75	no
Cucurbits (Cucumber, cantaloupe, casaba, crenshaw, honeydew, summer squash, watermelon, winter melon	5.78	0.43	no
Ornamentals (Nursery)	13.76	1.03	yes
Onion (Dried)	9.77	0.73	no
Potatoes	9.36	0.70	no
Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs & Vines	0.39	0.03	no
Ornamentals (Pachysandra)	4.71	0.35	no
Ornamental Residential Turf	6.22	0.46	no
Sugar Beet	21.27	1.58	yes
Tomatoes	8.86	0.66	no

Turf (Commercial, Golf course, Industrial, Recreational, Sod farms)	92.46	6.90	yes
Turf (sod farms), 2 crops per year	111.07	8.29	yes
Grapes (Wine)	10.03	0.75	no

[1] Peak EECs are from Table 3-3
[2] Plant RQ = peak EEC/aquatic plant EC_{50}; used freshwater green algae (*P. subcaptitatum)* EC_{50} = 13.4 ppb (MRID# 40943501) (maneb value)
[3] For aquatic plant exposures, the non-listed species LOC is 1 (Table 5-1

Table 5-16 Indirect effects for the aquatic-phase CRLF via effects to freshwater aquatic plants, mancozeb only application uses

Use	*Peak EEC (ppb)*[3]	*Plant RQ*[4]	*Non-listed species LOC Exceedance?*[5]
Corn (Field, Seed crop)	16.84	0.36	no
Cotton	8.25	0.18	no
Forestry (Douglas Fir)	40.55	0.86	no
Pome fruits (Crab apple, pear, quince)	20.27	0.43	no
Plantains	10.83	0.23	no
Cucurbits (muskmelon, gourds)	11.36	0.24	no
X-mass tree plantations	32.02	0.68	no
Shallot	11.30	0.24	no
Fennel, 2 crops per year	14.22	0.30	no
Asparagus	8.85	0.32	no
Cereal grains (Wheat, barley, oats, rye, triticali)	24.16	0.51	no

[1] Peak EECs are from Table 3-3
[3]Non-listed aquatic plant species RQ = peak EEC/aquatic plant EC_{50}; used freshwater green algae (*P. subcaptitatum)* EC_{50} = 47.0 ppb (MRID# 43664701)
[4] For aquatic plant exposures, the non-listed species risk LOC is 1.0 (Table 5-1)

Table 5-17 Indirect effects for the aquatic-phase CRLF via effects to freshwater aquatic plants, maneb only application uses

Use	*EEC (ppb)*[1]	*Plant RQ*[2]	*Non-listed Species LOC Exceedance?*4
Almonds	45.62	3.40	yes
Brassica (Broccoli, Chinese cabbage, cauliflower, kohirabi) 3 crops per year	38.09	2.84	yes
Loose leaf Chinese cabbage, 3 crops per year	63.69	4.47	yes
Kale, 3 crops per year	32.09	2.39	yes
figs	6.71	0.54	no
Brussels sprouts 2 crops per year	59.89	4.47	yes
Endive (Escarole) and Lettuce (leaf & head) 2 crops per year	59.48	4.33	yes
Pumpkin and Winter squash	5.78	0.43	no
Onion (Green), 2 crops per year	17.35	1.29	yes
Beans (Dried)	10.64	0.79	no
Pepper	13.36	1.00	yes
Eggplant	7.87	0.59	no

Use	EEC (ppb)[1]	Plant RQ[2]	Non-listed Species LOC Exceedance?4
[1]Peak EECs are from Table 3-3 [2]Non-listed species plant RQ = peak EEC/aquatic plant EC_{50}; used freshwater green algae (*P. subcaptitatum) EC_{50}* = 13.4 ppb (MRID# 40943501) (maneb value) [3] For aquatic plant exposures, the non-listed and listed species LOC is 1 (Table 5-1)			

5.1.2.4 Evaluation of Potential Indirect Effects via Reduction in Food Items (Small Mammals)

Small mammals are potential prey items for the terrestrial-phase CRLF. Chronic RQ values, based on exposure from dietary residues, for effects to small mammals were calculated using upper-bound EECs for dietary items and mammalian chronic toxicity data. **Appendix I** contains specific dietary-based chronic RQ calculations.

<u>All uses except seed and dip treatment</u>

Chronic RQs exceed the chronic LOC of 1.0 for all of the assessed mancozeb and maneb uses (Table 5-18)

Table 5-18 Indirect effects for the terrestrial-phase CRLF via dietary-based exposure effects to mammals

Use	*Rate(lbs a.i./A)*	*Number of Applications*	*Minimum Interval (Days)*	*Chronic RQs*[4]	*Chronic LOC Exceedance?* [5]
Turf [1]	17.4	4	7	8.86-637.73	Yes
Cucumbers[1]	2.4	8	7	1.91-121.29	Yes
Ornamentals(other) [1]	1.2	3	7	0.58-36.61	Yes
Almonds[2]	6.4	4	7	3.69-234.57	Yes
Beans (dried) [2]	1.6	6	5	1.30-82.64	Yes
Figs[2]	2.4	1	N/A	0.42-30.51	Yes
Shallot [3]	2.4	10	7	1.27-80.70	Yes
Fennel[3]	1.6	8	7	0.80-50.54	Yes
Grains (barley, oats, rye, triticale, and wheat)[3]	1.6	3	7	7 - 1002	Yes

[1]Joint Mancozeb-Maneb application uses. Used chronic toxicity endpoint based on lab rat reproduction study - NOAEC = 75 ppm (MRID # 42049401) conducted with maneb
[2]Maneb uses only. Chronic toxicity endpoint based on lab rat reproduction study - NOAEC = 75ppm (MRID # 42049401conducted with maneb
[3]Mancozeb uses only. Chronic toxicity endpoint based on lab rat reproduction study mallard duck chronic reproduction study NOAEC =120ppm (MRID #41365201)
[4]Since the EECs are estimated for several scenarios (e.g., short grass, tall grass, broadleaf plants, seeds, etc.), the RQs are shown as a range of values. For details, see **Appendix I**
[5]Chronic risk LOC = 1

5.1.2.5 Evaluation of Potential Indirect Effects via Reduction in Food Items (Terrestrial Invertebrates)

Indirect effects to the CRLF as a result of effects to terrestrial invertebrates were assessed by comparing the expected mancozeb and maneb residues (mg/kg-insect) on small and large insects (predicted by the T-REX model) to the acute contact toxicity information for the most sensitive terrestrial invertebrate species tested, which was the honey bee.

All uses except seed and dip treatment

The acute contact RQs exceed the terrestrial invertebrate listed species LOC of 0.05 for all uses except for maneb use on almonds or mancozeb use on grains for large insects (Table 5-19).

Table 5-19 Indirect effect RQs for the terrestrial-phase CRLF via direct effects to terrestrial invertebrates

Use	*Rate(lbs a.i./A)*	*No. Apps.*	*Minimum Interval (Days)*	*Large Insect EEC (ppm)*	*Small Insect EEC (ppm)*	*Large Insect RQ*	*Small Insect RQ*[4]
Turf[1]	17.4	4	7	752.50	6772.46	7.98	71.82
Cucumbers[1]	2.4	8	7	143.12	1288.10	1.52	13.66
Ornamentals(other) [1]	1.2	3	7	43.20	388.83	0.46	4.12
Almonds[2]	6.4	4	7	276.78	2491.02	**0.02**[5]	26.41
Beans (dried) [2]	1.6	6	5	97.51	877.62	1.03	9.31
Figs[2]	2.4	1	N/A	36.00	324.00	0.38	3.44
Shallot[3]	2.4	10	7	152.35	1371.13	0.11	0.98
Fennel[3]	1.6	8	7	95.41	858.73	0.07	0.62
Grains (barley, oats, rye, triticale, and wheat)[3]	1.6	3	7	57.60	518.43	**0.04**[5]	0.37

[1] Joint Mancozeb/Maneb uses. Based on honey bee $LD_{50=}$ = 12.09 µg/bee = 94.30 ppm (MRID# 00036935 conducted with maneb
[2] Maneb uses only. Based on honey bee $LD_{50=}$ = 12.09 µg/bee = 94.30 ppm (MRID# 00036935 conducted with maneb
[3] Mancozeb uses only. Based on honey bee $LD_{50=}$ > 179 µg/bee = 1396.2 ppm (MRID# 45577201 conducted with mancozeb
[4] Acute listed species LOC = 0.05
[5]Does not exceed the cute listed species LOC = 0.05 (in bold)

5.1.3 Effects to Primary Constituent Elements of Designated Critical Habitat

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

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

- Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.
- Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.

- Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.,* algae) Affects in aquatic habitat from reduction in aquatic plants will be assessed using the risk estimation values in section 5.1.2.3.

The remaining aquatic-phase PCE is "alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source." To assess the impact of mancozeb and maneb on this PCE, acute and chronic freshwater fish and invertebrate toxicity endpoints are used as measures of effects. RQs for these endpoints were calculated in Sections 5.1.2.1 and 5.1.2.2. Freshwater fish acute RQs exceed the LOC for; 1) all joint mancozeb/maneb uses except Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs & Vines); 2) none of the mancozeb only uses; and 3) none of the maneb only uses except almonds, brassica, loose leaf Chinese cabbage, kale, Brussels sprouts, lettuce and endive. Freshwater invertebrate acute RQs exceed the LOC for;1) none of the joint mancozeb/maneb uses except turf (commercial, golf course, industrial, recreational, sod farms), Turf (sod farms), and corn; 2) none of the mancozeb only uses; and 3) all of the maneb only uses.

5.1.3.2 Terrestrial-Phase (Upland Habitat and Dispersal Habitat)

Similar to the aquatic-phase PCEs, three of the four assessment endpoints for the terrestrial-phase PCEs of designated critical habitat for the CRLF are related to potential effects to aquatic and/or terrestrial plants:

- Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or drip line surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance
- Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal
- Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.

There are no terrestrial plant toxicity data available on mancozeb as a sole active ingredient in the TEP. There is also no terrestrial plant toxicity data for maneb. The terrestrial plant toxicity data used in this effects determination for mancozeb are based on a TEP containing 60% mancozeb co-formulated with 9% dimethomorph. (See **Appendix D**) In the seedling emergence (Tier I) and non-target vegetative vigor studies conducted with this TEP the EC_{25} was higher than the highest concentration tested, 1.38 lbs a.i./A. EECs, based on the highest application rate use (turf), were estimated from the TerrPlant model to help determine what the toxicity concentration would need to be to exceed the non-listed species plant LOC of 1. Details of the modeling exercise are included in **Appendix K**. The EECs for spray drift alone, total (spray drift plus run-off) for dry areas, and total for semi-aquatic areas were 0.191, 0.382, and 2.101 lbs a.i./A, respectively. The EECs associated with the spray drift alone and dry areas are below the 1.38 lb/a.i./A; therefore, RQs would be below 1. Given the observed 12 % dry weight inhibition with the most sensitive species in the seedling emergence study, it may not be unreasonable for some slopes to expect a 25% inhibition at the semi-aquatic EEC of 2.2 lbs a.i./A. However, this was the most sensitive species tested of 10 species. The next highest % inhibition response was 6% in a seedling emergence test on tomatoes.

There were a total of five plant incidents in the United States found in the Ecological Incident Information System (EIIS:

(1) A tank mixture of mancozeb and benomyl applied to apple trees may have caused leaves and blossoms to drop from the trees. The certainty index for this incident was possible.

(2) There was a report of possible fruit and vegetable garden damage resulting from spray drift while neighbor's birch trees were sprayed. The extent of damage was not reported. Chemical analysis showed a trace of applied pesticide. The certainty index for this incident was probable.

(3) There was a reported plant damage incident to 50 acres of a crop of ornamentals resulting from direct application of mancozeb and trifloxystrobin. The application rate and method was not reported for mancozeb but was reported for trifloxystrobin. The certainty index for this incident was possible for mancozeb and probable for trifloxystrobin. Terrestrial plant data for trifloxystrobin resulted in an EC_{25} greater than the highest concentration tested; therefore an assessment of risks was not possible. However, another strobilurin fungicide is highly toxic to terrestrial plants.

(4) There was damage reported to an onion field resulting from aerial application of diazinon, metalaxyl, mancozeb, and chlorothalonil. The certainty index for this incident was possible for all the chemicals. Terrestrial plant data for mancozeb conducted with TEP containing 60% mancozeb co-formulated with 9% dimethomorph does not suggest toxicity to terrestrial plants. The non-target seedling emergence study resulted in a 12% dry weight inhibition for onions and the non-target terrestrial plant vegetative vigor toxicity (Tier 1) study resulted in 2% dry weight inhibition.

(5) There was a report of 46% plant damage to 240 acres of potatoes resulting from seed treatment with mancozeb and fludioxonil. The product had been applied to seed but no mention was made of the type of damage that occurred with the plants. The certainty index for this incident was possible for both chemicals.

    Terrestrial plant data for mancozeb conducted with TEP containing 60% mancozeb co-formulated with 9% dimethomorph does not suggest toxicity to terrestrial plants. There is no available non-target terrestrial plant data for fludioxonil; however, there a numerous terrestrial plant incidents associated with this chemical. There are no terrestrial plant data available on mancozeb as a sole active ingredient in the TEP. There is also no terrestrial plant data for maneb.

5.2 Risk Description

5.2.1 Introduction

This section covers the overall conclusions regarding risk to the CRLF and its habitat. These conclusions are based on calculated RQs for various uses of mancozeb, maneb, and the interchangeable use of the two EBDCs. In this respect, it is important to re-emphasize that the risk assessment for the two EBDCs are combined in one assessment that uses a unique process to assess risk to the CRLF. It was necessary to follow this procedure because of the nature of these EBDCs, similarities in fate and transport properties and interdependency of regulatory decisions on their use. The latter reason is associated with the fact that EBDCs produce a common degradate ethylenethiourea (ETU); a human carcinogen. ETU is of human health concern and therefore it played an important role in regulatory decisions concerning use of the EBDCs (e.g., maximum seasonal or yearly labeled uses for mancozeb were set as maximum for EBDCs not mancozeb). As for the fate of EBDCs parents (i.e., mancozeb and maneb), the two chemicals are highly vulnerable to hydrolytic reactions that cause their instability (hydrolysis half-life in hours). Therefore, potential acute and chronic aquatic exposure is associated with resultant hydrolytic products; a suite of chemicals referred to as the EBDC complex. With time, the EBDC complex is expected to progressively be dominated by ETU and ETU degradates. Therefore, the short-term acute aquatic exposure is related to the freshly formed EBDC complex (modeled peak EECs of the EBDC complex). In contrast, the long-term chronic aquatic exposure is assumed to be related to ETU (21- and 60-day EECs of ETU); in the long-term the EBDC complex is enriched with ETU. These acute and chronic EECs are chosen because they can be closely related to submitted measures of acute and chronic aquatic effects (acute and chronic aquatic fresh water and invertebrates' toxicity data).

5.2.2 Effects Determination

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

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

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

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

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

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

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

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

Table 5-20 contains summaries for the effects determinations for the CRLF. A description of the risk and effects determination for each of the established assessment endpoints for the CRLF is provided in the following sections. Table 5-21 summarizes the effects determinations for the critical habitat.

Table 5-20 Effects determination summary for direct and indirect effects of mancozeb and maneb on the CRLF

Assessment Endpoint	*Effects Determination*	*Basis*
Aquatic-Phase (Eggs, Larvae, Tadpoles, Adults)		
Direct Effects of Mancozeb and Maneb on the Aquatic Phase CRLF		
Survival of CRLF individuals via direct effects on aquatic phases. (Surrogate Fish)	**No effect** Joint Mancozeb-Maneb uses Ornamentals (ground cover, herbaceous, non-flowering shade trees, woody shrubs & vines) Mancozeb only uses corn, cotton; pome fruits(crab apple, pear, quince), plantains, cucurbits (muskmelon, gourds), shallot; fennel; asparagus; cereal grains (wheat; barley; oats; rye; triticali)	Using the surrogate freshwater fish toxicity data, the acute RQ does not exceed the listed species acute LOC of 0.05 or the chronic LOC.
	Likely to Adversely Affect Mancozeb/Maneb uses corn (sweet and pop) apples, bananas, papayas, garlic, grapes, cucurbits, ornaments (nursery, pachysandra, residential turf), onion (dried), potatoes, sugar beet tomatoes, turf, and grapes Mancozeb only uses Forestry(Douglas firs), x-mass tree plantations Maneb only uses	Using the surrogate freshwater fish toxicity data, the acute RQ exceeded the listed species LOC of 0.05. Considering there is an overlap between areas of the expected adverse affect and where the species is located and the probability of occurrence, the effect can not be discounted.

Assessment Endpoint	*Effects Determination*	*Basis*
	almonds, brassica, kale, figs, brussels sprouts, endive, lettuce, pumpkin, winter squash, onion (green), beans, pepper, eggplant	
	No Effect All dip and seed treatment uses	
Growth and reproduction of CRLF individuals via direct effects on aquatic phases. (Surrogate Fish)	**No effect** All uses for mancozeb and maneb	None of the chronic RQs exceed the chronic LOC of 1.0. Also an amphibian study was used qualitatively.
Reduction of Prey as Indirect Effects of Mancozeb and Maneb on the Aquatic Phase CRLF		
Survival of CRLF individuals via effects to food supply (*i.e.,* aquatic vertebrates and amphibians, freshwater invertebrates, non-vascular plants)	Freshwater vertebrates and amphibians **No effect** Mancozeb/Maneb uses Ornamentals (ground cover, herbaceous, non-flowering shade trees, woody shrubs & vines) Mancozeb only uses Corn (field, seed crop), cotton, forestry, pome fruits, plantains, cucurbits, shallot, fennel, asparagus, cereal grains	Using the freshwater fish toxicity data, the acute RQs do not exceed the listed species acute LOC of 0.05 or the chronic LOC.
	Likely to Adversely Affect Mancozeb/Maneb uses Corn (sweet/Pop); turf	Using the freshwater fish toxicity data, the acute RQs are above the non-listed species acute LOC of 0.5
	Mancozeb/Maneb uses Apples	Using the freshwater fish toxicity data, the acute RQ is close to (0.48) the non-listed acute LOC of 0.5 and the estimated reduction in population was 19% for the most sensitive species
	Maneb only uses almonds, brassica, kale, brussels sprouts, endive, lettuce	Using the freshwater fish toxicity data, the acute RQs are above the non-listed species acute LOC of 0.5.
	Maneb only uses onion (green)	Using the freshwater fish toxicity data, the acute RQ is between the listed species LOC of 0.05 and the non-listed acute LOC of 0.5, based on the concentration-response the estimated reduction in population was 14% for the most sensitive species
	Not Likely to Adversely Affect Mancozeb/Maneb and Maneb only uses bananas, papayas, garlic, grapes, cucurbits, ornaments (nursery, pachysandra, residential turf), onion (dried), potatoes, sugar beet tomatoes, turf, grapes, beans, pepper, eggplant	Using the freshwater fish toxicity data, the acute RQs are below the non-listed species acute LOC of 0.50, the estimated reduction in population ranges from (0.4%-9%) for the most sensitive species and the chronic LOC is not exceeded.
	Mancozeb only uses X-mass tree plantations; forestry	Using the freshwater fish toxicity data, the acute RQs are below the non-listed species acute LOC of 0.50, the estimated reduction in

Assessment Endpoint	Effects Determination	Basis
		population is <0.001% for the most sensitive species and the chronic LOC is not exceeded
	No Effect All dip and seed treatment uses	e
	Freshwater invertebrates **No Effect** Mancozeb/Maneb uses Cucurbits, Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs & Vines), ornamental pachysandra and residential turf Mancozeb only uses Corn(field seed crop); cotton, pome fruits, plantain, X-mass tree plantations, cucurbits (muskmelon, gourds); shallot, fennel asparagus, cereal grains, Maneb only uses Endive; lettuce (leaf & Head) Pumpkin; Squash (Winter)	Using the freshwater invertebrate toxicity data, the acute RQs are below the listed species acute risk LOC of 0.05 and the chronic LOC is not exceeded
	Likely to Adversely Mancozeb/Maneb use Corn; turf Maneb only use Chinese loose leaf cabbage	Using freshwater invertebrate toxicity data the acute RQ exceeds the non-listed species acute LOC of 0.5.
	No Effect All seed and dip treatment uses	
	Not likely to Adversely Affect Mancozeb and maneb uses apples, bananas, papayas, garlic, grapes, ornaments (nursery), onion (dried), potatoes, sugar beet, tomatoes, turf, and grapes; almonds, brassica, kale, figs, onion (green), beans, pepper, eggplant, forestry	Using the freshwater invertebrate toxicity data, the acute RQs are below the non-listed species acute LOC of 0.50 and the estimated reduction in population ranges between <0.0001%-4% and the chronic LOC is not exceeded.
	Non-vascular aquatic plants **No Effect** Joint Mancozeb/Maneb use Ornamentals (ground cover, herbaceous, non-flowering, shade trees, woody shrubs & vines, Pachysandra, residential turf),, Bananas, papayas, grapes, cucurbits, onion (dried), potatoes, tomatoes Maneb only uses Figs, pumpkin, winter squash, beans eggplant Mancozeb only uses All of the uses	Using aquatic plant toxicity data the RQ does not exceed the non- listed species LOC of 1.0.

Assessment Endpoint	Effects Determination	Basis
	Likely to Adversely <u>Joint Mancozeb/Maneb uses</u> corn (sweet/Pop), apples, garlic, ornamentals (nursery), , sugar beet, and turf (commercial, golf course, industrial, recreational, sod farms), <u>Maneb only uses</u> almonds, brassica, kale, Brussels sprouts, endive, lettuce, green onion, pepper	Using the aquatic plant toxicity data the RQs exceed the non-listed species LOC of 1.0.
	No Effect <u>Mancozeb and maneb uses</u> Seed and dip treatment	
Growth, and reproduction of CRLF individuals via effects to food supply (*i.e.,* aquatic vertebrates and amphibians, freshwater invertebrates	<u>Freshwater aquatic vertebrates and amphibians</u> **No Effect** All Mancozeb and Maneb uses	None of the chronic RQs exceed the chronic LOC of 1.0
	<u>Freshwater invertebrates</u> **No Effect** All Mancozeb and Maneb uses	None of the chronic RQs exceed the chronic LOC of 1.0
Reduction of Habitat, Cover , and/or Primary Productivity as Indirect Effects of Mancozeb and Maneb on the Aquatic Phase CRLF		
Survival growth and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.,* aquatic plant community)	<u>Non-vascular plants</u> **No Effect** <u>Joint Mancozeb/Maneb use</u> Bananas, papayas, grapes, cucurbits, onion (dried), potatoes, ornamentals (ground cover, herbaceous, non-flowering, shade trees, woody shrubs & vines, pachysandra, residential turf); tomatoes <u>Mancozeb only uses</u> All of the uses <u>Maneb only uses</u> Figs, pumpkin, winter squash, beans eggplant	Using aquatic plant toxicity data the RQ does not exceed the non-listed species LOC of 1.0.
	Habitat Modification <u>Joint Mancozeb/Maneb uses</u> corn (sweet/Pop), apples, garlic, ornamentals (nursery), sugar beet, and turf (commercial, golf course, industrial, recreational, sod farms) <u>Maneb only uses</u> almonds, brassica, kale, Brussels sprouts, endive, lettuce, green onion, pepper	Using aquatic plant toxicity data the RQ exceeds the non-listed species LOC of 1.0.
	No Effect <u>Mancozeb and maneb uses</u> Seed and dip treatment	
Reduction of Riparian Vegetation as Indirect Effects of Mancozeb and Maneb on the Aquatic Phase CRLF		
Survival, growth and reproduction of CRLF individuals via effects to riparian vegetation, required to maintain acceptable water		
	No Effect All mancozeb only uses.	Evaluation of terrestrial plant data available on co-formulated mancozeb TEP, estimated exposure used to determine toxicity concentration required to exceed

Assessment Endpoint	*Effects Determination*	*Basis*
		plant LOC, and incident data.
quality and habitat in ponds and streams comprising the species' current range.	**Habitat Modification** All joint mancozeb/maneb uses and maneb uses except dip and seed treatments	Presume risk because of lack of terrestrial plant data on maneb.
Terrestrial Phase (Juveniles and adults)		
Survival, growth and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles (surrogate birds)	**No Effect** All mancozeb and maneb uses	No effect on survival was observed at dietary residue levels greater than 5,000 ppm
	Likely to Adversely Affect Growth and Reproduction All Mancozeb and Maneb uses except	Chronic RQs exceed the chronic LOC of 1 for direct effects using birds as a surrogate. There is an overlap between areas of the expected adverse affect and where the species is located; therefore, the effect can not be discounted.
	No Efffect Seed treatments; Dip treatments	
Reduction of Prey as Indirect Effects of Mancozeb and Maneb on the Terrestrial Phase CRLF		
Survival, growth and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial vertebrates, including mammals and terrestrial phase amphibians)	<u>Terrestrial invertebrates</u> **No Effect** All dip and seed treatment uses **Likely to Adversely Affect** All Mancozeb and Maneb uses except dip and seed treatment	Acute contact RQs exceed the listed species terrestrial invertebrate LOC of 0.05.
	No Effect Seed treatments; Dip treatments	
	<u>Terrestrial mammals</u> **No Effect** All mancozeb and maneb uses **Likely to Adversely Affect for Growth and Reproduction** All mancozeb and maneb uses except dip and seed treatment	No effect on survival was observed at dietary residue levels greater than 5,000 ppm
	No Effect Seed treatments; Dip treatments	
	<u>Terrestrial phase amphibians</u> **No Effect** All mancozeb and maneb uses **Likely to Adversely Affect Growth and Reproduction** All Mancozeb and Maneb uses except dip and seed treatments	No effect on survival was observed at dietary residue levels greater than 5,000 ppm Chronic RQs exceed the chronic LOC of 1 for direct effects using birds as a surrogate
	No Effect Seed treatments; Dip treatments	

Assessment Endpoint	***Effects Determination***	***Basis***
Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.,* riparian vegetation)	Terrestrial plants **Not Likely to Adversely Affect** All mancozeb only uses.	Evaluation of terrestrial plant data available on co-formulated mancozeb TEP, estimated exposure used to determine toxicity concentration required to exceed plant LOC, and incident data.
	Likely to Adversely Affect All joint mancozeb/maneb uses and maneb uses except dip and seed treatments	Presume risk do to lack of terrestrial plant data on maneb.

Table 5-21 Effects determination summary for the critical habitat impact analysis

Assessment Endpoint	*Effects Determination*	*Basis*
Aquatic Phase PCEs (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)		
Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.	Non-vascular plants **No Effect** Joint Mancozeb/Maneb use Bananas, papayas, grapes, cucurbits, onion (dried), potatoes, ornamentals (ground cover, herbaceous, non-flowering, shade trees, woody shrubs & vines, pachysandra, residential turf); tomatoes Mancozeb only uses All of the uses Maneb only uses Figs, pumpkin, winter squash, beans eggplant	Using aquatic plant toxicity data the RQ does not exceed the non-listed species LOC of 1.0.
	Habitat Modification Joint Mancozeb/Maneb uses corn (sweet/Pop), apples, garlic, ornamentals (nursery), sugar beet, and turf (commercial, golf course, industrial, recreational, sod farms) Maneb only uses almonds, brassica, kale, Brussels sprouts, endive, lettuce, green onion, pepper	Using aquatic plant toxicity data the RQ exceeds the non-listed species LOC of 1.0.
	No Effect Mancozeb and maneb uses Seed and dip treatment	
	Terrestrial plants **No Effect** All mancozeb only uses.	Evaluation of terrestrial plant data available on co-formulated mancozeb TEP, estimated exposure used to determine toxicity concentration required to exceed plant LOC, and incident data.
	Habitat Modification All joint mancozeb/maneb uses and maneb uses except dip and seed treatments	Presume risk because of lack of terrestrial plant data on maneb.
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.[21]	Non-vascular aquatic plants **No Effect** Joint Mancozeb/Maneb use Bananas, papayas, grapes, cucurbits, onion (dried), potatoes, ornamentals (ground cover, herbaceous, non-flowering, shade trees, woody shrubs & vines, pachysandra, residential turf); tomatoes Mancozeb only uses All of the uses Maneb only uses Figs, pumpkin, winter squash, beans eggplant	Using aquatic plant toxicity data the RQ does not exceed the non-listed species LOC of 1.0.

[21] Physicochemical 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.

Assessment Endpoint	*Effects Determination*	*Basis*
	Habitat Modification Joint Mancozeb/Maneb uses corn (sweet/Pop), apples, garlic, ornamentals (nursery), sugar beet, and turf (commercial, golf course, industrial, recreational, sod farms) Maneb only uses almonds, brassica, kale, Brussels sprouts, endive, lettuce, green onion, pepper	Using aquatic plant toxicity data the RQ exceeds the non-listed species LOC of 1.0.
	No Effect Mancozeb and maneb uses Seed and dip treatment	
	Terrestrial plants **No Effect** All mancozeb only uses.	Evaluation of terrestrial plant data available on co-formulated mancozeb TEP, estimated exposure used to determine toxicity concentration required to exceed plant LOC, and incident data.
	Habitat Modification All joint mancozeb/maneb uses and maneb uses except seed treatment uses	Presume risk because of lack of terrestrial plant data on maneb.
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	Habitat Modification -Freshwater invertebrates **No Effect** Mancozeb/Maneb uses Cucurbits, Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs & Vines), ornamental pachysandra and residential turf Mancozeb only uses Corn(field seed crop); cotton, pome fruits, plantain, X-mass tree plantations, cucurbits (muskmelon, gourds); shallot, fennel asparagus, cereal grains, Maneb only uses Endive; lettuce (leaf & Head) Pumpkin; Squash (Winter)	Using the freshwater invertebrate toxicity data, the acute RQs are below the listed species acute risk LOC of 0.05 and the chronic LOC is not exceeded
	Habitat Modification Mancozeb/Maneb use Corn; turf Maneb only use Chinese loose leaf cabbage	Using freshwater invertebrate toxicity data the acute RQ exceeds the non-listed species acute LOC of 0.5.
	No Effect All seed and dip treatment uses	
	Mancozeb and maneb uses apples, bananas, papayas, garlic, grapes, ornaments (nursery), onion (dried), potatoes, sugar beet, tomatoes, turf, and grapes; almonds, brassica, kale, figs, onion (green), beans, pepper, eggplant, forestry	Using the freshwater invertebrate toxicity data, the acute RQs are below the non-listed species acute LOC of 0.50 and the estimated reduction in population ranges between <0.0001%-4% and the chronic LOC is not exceeded.

Assessment Endpoint	*Effects Determination*	*Basis*
Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)	Habitat modification Non-vascular aquatic plants **No Effect** Joint Mancozeb/Maneb use Bananas, papayas, grapes, cucurbits, onion (dried), potatoes, ornamentals (ground cover, herbaceous, non-flowering, shade trees, woody shrubs & vines, pachysandra, residential turf); tomatoes Mancozeb only uses All of the uses Maneb only uses Figs, pumpkin, winter squash, beans eggplant	Using aquatic plant toxicity data the RQ does not exceed the non-listed species LOC of 1.0.
	Habitat Modification Joint Mancozeb/Maneb uses corn (sweet/Pop), apples, garlic, ornamentals (nursery), sugar beet, and turf (commercial, golf course, industrial, recreational, sod farms) Maneb only uses almonds, brassica, kale, Brussels sprouts, endive, lettuce, green onion, pepper	Using aquatic plant toxicity data the RQ exceeds the non-listed species LOC of 1.0.
	No Effect Mancozeb and maneb uses Seed and dip treatment	
Terrestrial Phase PCEs (Upland Habitat and Dispersal Habitat)		
Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or drip line surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance	Non-vascular plants **No Effect** Joint Mancozeb/Maneb use Bananas, papayas, grapes, cucurbits, onion (dried), potatoes, ornamentals (ground cover, herbaceous, non-flowering, shade trees, woody shrubs & vines, pachysandra, residential turf); tomatoes Mancozeb only uses All of the uses Maneb only uses Figs, pumpkin, winter squash, beans eggplant	Using aquatic plant toxicity data the RQ does not exceed the acute risk or listed species LOC of 1.0.
	Habitat Modification Joint Mancozeb/Maneb uses corn (sweet/Pop), apples, garlic, ornamentals (nursery), sugar beet, and turf (commercial, golf course, industrial, recreational, sod farms) Maneb only uses almonds, brassica, kale, Brussels sprouts, endive, lettuce, green onion, pepper	Using aquatic plant toxicity data the RQ exceeds the acute risk and listed species LOC of 1.0
	No Effect Mancozeb and maneb uses Seed and dip treatment	
Elimination and/or disturbance of dispersal habitat: Upland or		

Evaluation of terrestrial plant data available on co-formulated

Assessment Endpoint	Effects Determination	Basis
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	Terrestrial plant **No Effect** All mancozeb only uses.	mancozeb TEP, estimated exposure used to determine toxicity concentration required to exceed plant LOC, and incident data.
	Habitat Modification All joint mancozeb/maneb uses and maneb uses except dip and seed treatments	Presume risk because of lack of terrestrial plant data on maneb.
Reduction and/or modification of food sources for terrestrial phase juveniles and adults	**Habitat modification**	Mancozeb and maneb uses pose acute risks to prey items of the CRLF, including freshwater fish and invertebrates, other amphibians and terrestrial invertebrates; and chronic risk to prey items of the CRLF, including small mammals, other amphibians, and terrestrial invertebrates.
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	**Habitat modification**	Mancozeb and maneb uses pose chronic risk to prey items of the CRLF, including small mammals, other amphibians, and terrestrial invertebrates... Also acute risks to prey items of the CRLF, including freshwater fish and invertebrates, and terrestrial invertebrates; .Since mancozeb and maneb pose chronic risk to mammals, the CRLF may be affected via alteration or reduction of refugia in the form of small mammal burrows.

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

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

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

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

Mancozeb and maneb use-specific direct effects determinations are summarized in Table 5-22 while indirect effects are summarized in Table 5-23.

Table 5-22 Mancozeb and maneb use-specific direct effects determinations[1]

Use	*Aquatic phase frogs*		*Terrestrial-phase frogs*	
	Acute	*Chronic*	*Acute*	*Chronic*
"no effect" determination is made for all mancozeb and maneb dip and seed treatment uses				
Joint mancozeb/maneb uses				
Corn	LAA	NE	NE	LAA
Apples	LAA	NE	NE	LAA
Bananas	LAA	NE	NE	LAA
Papayas	LAA	NE	NE	LAA
Garlic	LAA	NE	NE	LAA
Grapes	LAA	NE	NE	LAA
Cucurbits	LAA	NE	NE	LAA
Ornamentals (Nursery)	LAA	NE	NE	LAA
Onion (Dried)	LAA	NE	NE	LAA
Potatoes	LAA	NE	NE	LAA
Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs & Vines	NE	NE	NE	LAA
Ornamentals (Pachysandra)	LAA	NE	NE	LAA
Ornamental Residential Turf	LAA	NE	NE	LAA
Sugar Beet	LAA	NE	NE	LAA
Tomatoes	LAA	NE	NE	LAA
Turf (Commercial, Golf course, Industrial, Recreational, Sod farms)	LAA	NE	NE	LAA
Turf (sod farms), 2 crops per year	LAA	NE	NE	LAA
Mancozeb only uses				
Corn	NE	NE	NE	LAA
Cotton	NE	NE	NE	LAA
Forestry	LAA	NE	NE	LAA
Pome fruits)	NE	NE	NE	LAA
Plantains	NE	NE	NE	LAA
Cucurbits (muskmelon gourds)	NE	NE	NE	LAA
X-mass tree plantations	LAA	NE	NE	LAA
Shallot	NE	NE	NE	LAA
Fennel,	NE	NE	NE	LAA
Asparagus	NE	NE	NE	LAA
Cereal grains	NE	NE	NE	LAA
Maneb only uses				
Almonds	LAA	NE	NE	LAA
Brassica	LAA	NE	NE	LAA
Loose leaf Chinese	LAA	NE	NE	LAA
Kale,	LAA	NE	NE	LAA
figs	LAA	NE	NE	LAA
Brussels sprouts	LAA	NE	NE	LAA
Endive) and Lettuce	LAA	NE	NE	LAA
Pumpkin and Winter squash	LAA	NE	NE	LAA
Onion (Green),	LAA	NE	NE	LAA
Beans (Dried)	LAA	NE	NE	LAA
Pepper	LAA	NE	NE	LAA
Eggplant	LAA	NE	NE	LAA

Table 5-23 Mancozeb and maneb use-specific indirect effects determinations[1] based on effects to pray

Use	Algae	Aquatic Invertebrates		Terrestrial Invertebrates (Acute)	Aquatic phase frogs and fish		Terrestrial-phase frogs		Small Mammals	
		Acute	Chronic		Acute	Chronic	Acute	Chronic	Acute	Chronic
"no effect" determination is made for all mancozeb and maneb seed and dip treatment uses.										
Joint mancozeb/maneb use										
Corn	LAA	LAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Apples	LAA	NLAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Bananas	NE	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Papayas	NE	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Garlic	LAA	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Grapes	NE	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Cucurbits	NE	NE	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Ornamentals (Nursery)	LAA	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Onion (Dried)	NE	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Potatoes	NE	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Ornamentals (Ground cover, Herbaceous, Non-flowering, Shade trees, Woody shrubs & Vines	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
Ornamentals (Pachysandra)	NE	NE	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Ornamental Residential Turf	NE	NE	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Sugar Beet	LAA	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Tomatoes	NE	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Turf (Commercial, Golf course, Industrial, Recreational, Sod farms)	LAA	LAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Turf (sod farms), 2 crops per year	LAA	LAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Mancozeb only use										
Corn	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
Cotton	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
Forestry	NE	NLAA	NE	LAA	NE	NE	NE	LAA	NE	LAA
Pome fruits)	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
Plantains	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
Cucurbits (muskmelon gourds)	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
X-mass tree plantations	NE	NE	NE	LAA		NE	NE	LAA	NE	LAA
Shallot	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
Fennel,	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
Asparagus	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA
Cereal grains	NE	NE	NE	LAA	NE	NE	NE	LAA	NE	LAA

Use	Algae	Aquatic Invertebrates		Terrestrial Invertebrates (Acute)	Aquatic phase frogs and fish		Terrestrial-phase frogs		Small Mammals	
		Acute	Chronic		Acute	Chronic	Acute	Chronic	Acute	Chronic
Maneb only uses										
Almonds	LAA	NLAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Brassica	LAA	NLAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Loose leaf Chinese	LAA	LAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Kale,	LAA	NLAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
figs	NE	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Brussels sprouts	LAA		NE	LAA	LAA	NE	NE	LAA	NE	LAA
Endive) and Lettuce	LAA	NE	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Pumpkin and Winter squash	NE	NE	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Onion (Green),	LAA	NLAA	NE	LAA	LAA	NE	NE	LAA	NE	LAA
Beans (Dried)	NE	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Pepper	LAA	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA
Eggplant	LAA	NLAA	NE	LAA	NLAA	NE	NE	LAA	NE	LAA

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

5.2.3 Direct Effects

5.2.3.1 Aquatic-phase

Based on surrogate freshwater fish toxicity data, there is a potential for direct adverse effects of aquatic-phase CRLF individuals from the following mancozeb and maneb uses in California (CA) as a result of acute exposure: 1) joint mancozeb/maneb uses- corn (sweet and pop), apples, bananas, papayas, garlic, grapes, cucurbits, ornaments (nursery, pachysandra, residential turf), onion (dried), potatoes, sugar beet tomatoes, turf, and grapes; 2) mancozeb only uses- forestry (Douglas Fir) and X-mass tree plantations; and 3) maneb only uses- almonds, brassica, kale, figs, brussels sprouts, endive, lettuce, pumpkin, winter squash, onion (green), beans, pepper, eggplant. Therefore, there is a potential for direct effects to aquatic-phase CRLF from some agricultural, and orchard uses of mancozeb and maneb. When calculating the RQs for the joint mancozeb/maneb uses a conservative assumption was made that maneb (not mancozeb) would primarily be used. Freshwater fish are more sensitive to maneb (LC_{50} = 42 ppb) than mancozeb (LC_{50} 460 ppb); therefore, if mancozeb was primarily used many of the joint mancozeb/maneb uses would not exceed the endangered species LOC. However, this assumption was made because the label allows for both mancozeb and maneb to be used on a crop in a growing season.

None of the chronic RQs for mancozeb or maneb uses exceed the chronic LOC of 1.0; therefore a "no effect" determination is made for all uses of mancozeb and maneb for growth and reproduction of CRLF individuals via direct effects on aquatic phases. Developmental stages were assessed for morphological developmental, growth (length), and death during development. No adverse affects were observed at the highest concentration tested (100mg/liter). The reason this study can only be used in a qualitative basis is because there was no indication if the gel was removed from the organisms during the blastulation stage; therefore, there is uncertainty regarding the amount of test substance the organism was actually exposed to. In this assessment there is some uncertainty associated with what substance the CRLF would be exposed to on a chronic basis. On a chronic basis it would primarily be exposed to ETU and degradates; however the mancozeb/maneb short term complex has a half life of about 4 days. Mancozeb and maneb have application intervals which range from 4 to 14 days. Therefore, there would be some amount of exposure to the mancozeb/maneb short term complex. Based on the surrogate freshwater fish toxicity profile, mancozeb/maneb short term complex is more toxic on a chronic basis (2.19 ppb and 6.1 ppb respectively in fish early life stage studies) than ETU (3,732 ppb based on acute-to-chronic ratio).

An analysis of the likelihood of individual direct mortality indicates that at the listed species LOC, *i.e.*, RQ=0.05, the likelihood of individual mortality for mancozeb is 1 in 418,000,000 and 1 in 7,420 for maneb (Table 5-24). An analysis of the likelihood of individual direct mortality for the uses listed below indicates that the likelihood of individual mortality for mancozeb/maneb joint uses is 1 in 6 -1 in 275, for mancozeb only uses is 1 in 7,701,000 – 1 in 9,880,000, and for maneb only uses is 1in 7- 1 in 119. There is a "likely to adversely affect" determination made for the mancozeb and maneb uses listed below for survival of CRLF individuals via direct effects on aquatic phases. The adverse affect can not be discounted because there is an overlap in space and time between areas of the expected adverse affect and species location as well as the probability of occurrence.

Table 5-24 Mancozeb and maneb uses that exceed the endangered species LOC (based on freshwater fish toxicity data)

Use	*LOC or RQ*	*Likelihood of Individual Effect (1 in …)*	*Probability of Population Affect*
Acute Endangered Species LOC mancozeb/maneb uses and maneb use only[1]	0.05	~1 in 7.42E +03	0.01%
Corn (sweet/Pop), 3crops per year[14]	2.19		
Apples[1]	0.48	~1 in 5.37E+00	19%
Bananas[1]	0.25	~1 in 2.18E+01	5%
Papayas[1]	0.21	~1 in 3.46E+01	2%
Garlic[14]	0.90		
Grapes[1]	0.24	~1 in 2.42E+01	4%
Cucurbits (Cucumber, cantaloupe, casaba, crenshaw, honeydew, muskmelon, summer squash, watermelon, winter melon [1]	0.14	~1 in 1.19E+02	0.8%
Ornamentals (Nursery) [1]	0.33	~1 in 1.13E+01	9%
Onion (Dried) [1]	0.23	~1 in 2.71E+01	
Potatoe[1]	0.22	~1 in 3.05E+01	3%
Ornamentals (Pachysandra) [1]	0.11	~1 in2.75E+02	0.4%
Ornamental Residential Turf[1]	0.15	~1 in 9.50E+01	1%
Sugar Beet[14]	0.51		
Tomatoes[1]	0.21	~1 in 3.46E+01	3%
Turf (Commercial, Golf course, Industrial, Recreational, Sod farms) [14]	2.20		
Turf (sod farms), 2 crops per year[14]	2.64		
Acute Endangered Species LOC mancozeb only uses[3]	0.05	~1 in 4.18 E+08	
Forestry[3]	0.09	~1 in 7.91 E+05	0.0001%

Use	*LOC or RQ*	*Likelihood of Individual Effect (1 in …)*	*Probability of Population Affect*
X-mass Trees[3]	0.07	~1 in 9.88 E+06	0.00001%
Almonds[2]	1.09		
Brassica (Broccoli, Chinese cabbage, cauliflower, kohirabi) 3 crops per year[24]	0.90		
Loose leaf Chinese cabbage, 3 crops per year[24]	1.52		
Kale, 3 crops per year[24]	0.76		
figs[2]	0.16	~1 in 7.74E+00	1%
Brussels sprouts 2 crops per year[24]	1.43		
Endive (Escarole) and Lettuce (leaf & head) 2 crops per year[2]	1.42		
Pumpkin and Winter squash[2]	0.14	~1 in 1.19E+02	0.84%
Onion (Green), 2 crops per year[2]	0.41	~1 in 7.19E+00	14%
Beans (Dried) [2]	0.25	~1 in 2.18E+01	4%
Pepper[2]	0.32	~1 in 1.21+01	8%
Eggplant[2]	0.19	~1 in 4.6E+01	2%

[1]Joint Mancozeb/Maneb uses, Rainbow trout 96-hour LC_{50} = 42ppb (MRID# 40706001)
Probit slopes 2.8
[2] Maneb only uses, Rainbow trout 96-hour LC_{50} = 42ppb (MRID# 40706001)
Probit slopes 2.8
[3]Mancozeb only uses, Rainbow trout 96-hour LC_{50} =460ppb MRID# 40118502, Probit slope 4.5 (default)
[4] Chance of individual effect and probability of population affect were only calculated if the LOC was between 0.05-0.5

Mancozeb and maneb dip and seed treatments were previously determined to have "no effect" on the CRLF.

The Mancozeb and maneb usage data in CA from 2002-2005 suggest that almost 98% of the total quantity of the two EBDCs was used to treat 15 use patterns, which represents nearly 98% of the total treated acreage. Based on the assessed potential for direct adverse effects of aquatic-phase CRLF individuals, these uses are "likely to adversely affect" CRLF. The usage data also indicates that approximately ⅓ of the total amounts of the two EBDCs used was mancozeb and that this quantity of mancozeb was used to treat nearly ⅓ (29%) of the total area treated. As described below, nearly 99% of the amount used and total acres treated with mancozeb and maneb represent their top 10 uses, only differing by the percentage treated.

Applied mancozeb (a total of 483,302 lbs) distributed as follows: grapes (22%); onions (13%), turf/sod (13%); tomatoes (12%); potatoes (12%); landscaping (11%); pears (6%); nursery plants (5%); apples (4%); and wheat (1%). In terms of total acreage treated (257,258 Acres): grapes (29%); potatoes (19%); tomatoes (19%); onions (14%); nursery plants (9%); pears (4%); apples (3%); turf/sod (2%) and wheat (1%); with no acreage reported for landscaping.

Applied maneb (a total of 985,311 lbs): lettuce (52%); walnuts (25%), almonds (11%); onion (4%); tomatoes (3%); cole crops (2%); and potatoes, turf/sod/nursery and dried beans (4% total, 1% each). In terms of total acreage treated (634,506 Acres): lettuce (59%); walnuts (23%), almonds (6%); onion (3%); tomatoes (4%); cole crops (2%); and potatoes, turf/sod/nursery and dried beans (4% total, 1% each).

5.2.3.2 Terrestrial-phase

Based on the T-REX modeled dietary exposures and the surrogate avian toxicity data, the chronic RQs for direct effects to the terrestrial-phase CRLF exceed the chronic LOC of 1.0 for all of the assessed mancozeb and maneb uses. Thus, a "may affect" determination is made based on chronic impaired survival of terrestrial-phase CRLF.

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

In order to explore influences of amphibian-specific food intake equations on dietary-based exposures of the terrestrial-phase CRLF to mancozeb and maneb, T-HERPS was used. Also to provide bounding estimates the same crops and application rates assessed in T-REX was used for T-HERPS. All of the assessed mancozeb and maneb uses exceed the chronic LOC of 1 and a "likely to adversely affect" determination is made based on chronic impaired survival of terrestrial-phase CRLF. However, as indicated in Table 5-25, there are a few uses in which some of the food items do not exceed the chronic level of concern. For example; for high exposure mancozeb uses (represented by the shallot use), the chronic risk associated with small insectivore and terrestrial phase amphibians does not exceed the LOC and chronic risks associated with fruits/pods/seeds/large insects, small insectivore and terrestrial phase amphibians as food items for the medium and low exposure mancozeb uses (represented by the fennel and grain uses) do not exceed the LOC.

Table 5-25 Direct CRLF Effects- upper bound Kenaga chronic terrestrial Herpetofauna RQs (from T-HERPS)

Use	*Broadleaf Plants/ Small Insects RQ*	*Fruits/Pods/ Seeds/ Large Insects RQ*	*Small Herbivore Mammals RQ*	*Small Insectivore Mammal RQ*	*Small Terrestrial Phase Amphibians RQ* [4]
Turf[1]	338.62	37.62	396.68	24.79	11.75
Cucumbers[1]	64.41	7.16	75.45	4.72	2.24
Ornamentals(other) [1]	19.44	2.16	22.77	1.42	**0.67**[4]
Almonds[2]	124.55	13.84	145.91	9.12	4.32
Beans (dried) [2]	43.88	4.88	51.40	3.21	1.52
Figs[2]	19.44	2.16	22.77	1.42	**0.67**[4]
Shallot[3]	10.97	1.22	12.85	**0.80**[4]	**0.38**[4]
Fennel[3]	6.87	**0.76**	8.05	**0.50**[4]	**0.2**[4]
Grains (barley, oats, rye, triticale, and wheat) [3]	4.15	**0.46**	4.86	**0.30**[4]	**0.14**[4]

Use	Broadleaf Plants/ Small Insects RQ	Fruits/Pods/ Seeds/ Large Insects RQ	Small Herbivore Mammals RQ	Small Insectivore Mammal RQ	Small Terrestrial Phase Amphibians RQ [4]

[1] Joint Mancozeb/Maneb uses; Chronic toxicity endpoint based on maneb's mallard duck chronic reproduction NOAEC = 20ppm (MRID # 43586502
[2] Maneb uses only; Chronic toxicity endpoint based on maneb's mallard duck chronic reproduction study NOAEC = 20ppm (MRID # 43586502
[3] Mancozeb uses only; Chronic toxicity endpoint based on mancozeb's mallard duck chronic reproduction study NOAEC =125ppm (MRID # 41948401)p
[4] RQs that do not exceed the LOC of 1.

Acute avian RQs were not determined for mancozeb and maneb uses. EFED believes that based on the avian acute toxicity data, which is used as a surrogate for the terrestrial-phase amphibian, there is minimal terrestrial risk associated with all mancozeb and maneb uses. The acute dietary risk to birds from exposure to mancozeb is low because; 1) dietary testing attempted on mallard ducks and bobwhite quail indicated an aversion to test diet (the birds would not consume the test material); 2) there is low acute toxicity of mancozeb to birds in multiple dosing LD_{50} studies; 3) there are no incidents showing mancozeb has been responsible for bird kills or poisonings; and 4) maneb (chemically related compound) is practically nontoxic to birds in dietary LC_{50} testing (mallard duck LC50 > 5,000 ppm and bobwhite quail LC50 > 10,000 ppm). The acute dietary risk to birds eating food items exposed to spray applications of maneb is also expected to be low. A "no effet" determination is made for survival of CRLF individuals via direct effects on terrestrial phase adults and juveniles for all mancozeb and maneb uses.

Acute mammalian RQs were not determined for mancozeb and maneb uses. Chronic terrestrial risks drive this assessment and the acute endpoints are not definitive. Also, EFED believes the acute dietary risk to mammals from exposure to mancozeb and maneb is low. The five available mammalian acute oral toxicity studies for mancozeb (4 studies) and maneb (1 study) resulted in LD50 >5,000. A "no effect" determination is made for survival of CRLF individuals via direct effects on terrestrial phase adults and juveniles for all mancozeb and maneb uses.

Mancozeb and maneb dip and seed treatments uses have been determined to have a "no effect" determination effect to CRLF.

5.2.4 Indirect Effects (through effects to prey)

As discussed in section 2.5.3, the diet of CRLF tadpoles is composed primarily of unicellular aquatic plants and detritus. Based on RQs for algae (Table 5-26), applications of mancozeb and maneb are expected to affect this food source. Therefore, indirect effects of mancozeb and maneb to CRLF tadpoles by reductions in phytoplankton are expected based on the animal's diet during this life stage for joint mancozeb-maneb application uses on corn (sweet/Pop), apples, garlic, ornamentals (nursery), sugar beet, turf (commercial, golf course, industrial, recreational, sod farms), and turf (sod farms) and all of the maneb only application uses except figs, pumpkins, winter squash, beans, and eggplants. None of the mancozeb only application uses exceed the non-listed species aquatic plant LOC. (see section 5.5.2.3).

When CRLF reach juvenile and adult stages, the CRLF diet is composed of aquatic and terrestrial invertebrates, when in aquatic and terrestrial habitats, respectively. RQ values representing acute exposure to aquatic and terrestrial invertebrates indicate that some mancozeb and maneb uses can potentially result in adverse effects to invertebrates.

Based on freshwater invertebrate toxicity data, there is a potential for indirect adverse effects of aquatic-phase CRLF individuals from the following mancozeb and maneb uses in CA as a result of acute exposure: 1) joint mancozeb/maneb uses- corn (sweet and pop) apples, bananas, papayas, garlic, grapes, ornaments (nursery), onion (dried), potatoes, sugar beet, tomatoes, turf, and grapes; 2) mancozeb only uses- forestry (Douglas Fir); and 3) maneb only uses- almonds, brassica, Chinese loose leaf cabbage, kale, figs, onion (green), beans, pepper, eggplant. The joint mancozeb maneb uses for corn and turf and the maneb use only Chinese loose leaf cabbage exceed not only the endangered species LOC of 0.05 but also the acute risk LOC of 0.5. A "likely to adversely affect" determination is made for these uses. An analysis of potential adverse aquatic invertebrate population affects was assessed for joint mancozeb/maneb uses as well as maneb only uses between the endangered species LOC and the acute risk LOC by using the *Daphnia magna* study with a LC_{50} value of 120ppb and a probit slope of 4.2. Based on this assessment, the potential reduction in abundance of aquatic invertebrates as food for these uses would be approximately 4% at most (range 0.000006%-4%); therefore a "not likely to adversely affect" determination can be made. An analysis was also conducted for mancozeb use on forestry with a *Daphnia magna* study with a LC_{50} value of 580ppb and a default probit slope of 4.5 which resulted in 0.00001% reduction in abundance of aquatic invertebrates as food for this use. A "not likely to adversely affect" determination is made for mancozeb use on forestry based on the estimated 0.00001% reduction (Table 5-26)

Based on chronic freshwater invertebrate toxicity data on ETU, none of the chronic RQs for mancozeb or maneb uses exceed the Agency's chronic LOC of 1.00; therefore a "no effect" determination is made for all uses of mancozeb and maneb for growth and reproduction of CRLF individuals via direct effects on aquatic phases.

Table 5-26 Mancozeb and maneb uses that exceed the endangered species LOC (based on freshwater invertebrate toxicity data)

Use	*LOC or RQ*	*Likelihood of Individual Effect (1 in …)*	*Probability of Affect*
Acute Endangered Species LOC mancozeb/maneb uses and maneb use only[1]	0.05	~1 in 4.30E +07	
Corn (sweet/Pop), 3crops per year[14]	0.76		
Apples[1]	0.17	~1 in 1.63E+03	0.06%
Bananas[1]	0.09	~1 in 1.78E+05	0.0006%
Papayas, Tomatoes[1]	0.07	~1 in 1.62E+06	0.00006%
Garlic [1]	0.32	~1 in 5.31E+01	2%
Grapes, Onion (dried), Potatoes [1]	0.08	~1 in 4.9E+05	0.0002%
Ornamentals (Nursery) [1]	0.11	~1 in 3.53E+04	0.003%
Sugar beet	0.18	~1 in 1.14E+03	0.09%
Turf (Commercial, Golf course, Industrial, Recreational, Sod farms) [14]	0.77		
Turf (sod farms), 2 crops per year[14]	0.93		

Use	*LOC or RQ*	*Likelihood of Individual Effect (1 in …)*	*Probability of Affect*
Acute Endangered Species LOC mancozeb only uses[3]	0.05	~1 in 4.18E+08	
Forestry (Douglas Fir)[3]	0.07	~1 in 9.88E+06	0.00001%
Almonds[2]	0.38	~1 in 2.58E+01	4%
Brassica (Broccoli, Chinese cabbage, cauliflower, kohirabi) 3 crops per year[2]	0.32	~1 in 5.31E+01	2%
Loose leaf Chinese cabbage, 3 crops per year[24]	0.53		
Kale, 3 crops per year[2]	0.27	~1 in 1.18E+02	0.85%
Figs, Eggplant[2]	0.06	~1 in 6.97E+06	0.00001%
Onion (Green), 2 crops per year[2]	0.15	~1 in 3.71E+03	0.03%
Beans (Dried)[2]	0.09	~1 in1.78E+05	0.0006%
Pepper[2]	0.11	~1 in 3.53E+04	0.003%

[1] Joint Mancozeb/Maneb uses, *Daphnia magna* LC_{50} =120ppb (MRID# 4074902); Probit slope 4.2
[2] Maneb only uses, *Daphnia magna* LC_{50} =120ppb (MRID# 4074902); Probit slope 4.2
[3] Mancozeb only uses, *Daphnia magna* LC_{50} = 580ppb (MRID# 40118503), Probit slope 4.5 (default)
[4] Chance of individual effect and probability of affect were only calculated if the LOC was between 0.05-0.5

Based on terrestrial invertebrate toxicity data and estimated dietary exposure, the RQs exceed the terrestrial invertebrate LOC of 0.05 for all uses; however, the RQs are not exceeded for maneb use on almonds or mancozeb use on grains if the large insect EEC is assumed. (See **Table 5.6** in the risk estimation section). A "likely to adversely affect" determination is made for indirect effects to aquatic-phase CRLF via direct effects to terrestrial invertebrates for all mancozeb and maneb uses except dip and seed treatments.

Life history data also indicate that large adult frogs consume aquatic and terrestrial vertebrates, including: fish, frogs and mice. RQ values representing direct exposures of mancozeb and maneb to CRLF can also be used to represent exposures of mancozeb and maneb to fish and frogs in aquatic habitats. Based on estimated exposures resulting from use of mancozeb and maneb, acute risks to fish and aquatic-phase frogs are possible for some uses and RQs representing exposures of mancozeb and maneb to mice (small mammals) and terrestrial-phase frogs (that are prey) indicate chronic risks resulting from all uses of mancozeb and maneb. Therefore, indirect effects are possible to large CRLF adults, through decreases in prey, in both aquatic and terrestrial habitats.

Based on the freshwater fish toxicity data, there is a potential for indirect adverse effects of aquatic-phase CRLF individuals by direct effects to freshwater fish and aquatic-phase amphibians from the following mancozeb and maneb uses in CA as a result of acute exposure: 1) joint mancozeb/maneb uses- corn (sweet and pop) apples, bananas, papayas, garlic, grapes, cucurbits, ornaments (nursery, Pachysandra, residential turf), onion (dried), potatoes, sugar beet tomatoes, turf, and grapes; 2) maneb only uses- almonds, brassica, kale, figs, brussels sprouts, endive, lettuce, pumpkin, winter squash, onion (green), beans, pepper, eggplant. Based on ETU's estimated reproductive toxicity value for freshwater fish (acute-to-chronic ratio), none of the chronic RQs for mancozeb or maneb uses exceed the Agency's chronic LOC of 1.00; therefore, there is "no effect" determination for chronic indirect effects to CRLF from direct effects to freshwater fish and aquatic-phase invertebrates.

The joint mancozeb maneb uses for corn and turf exceed not only the endangered species LOC of 0.05 but also the acute risk LOC of 0.5. A "likely to adversely affect" determination is made for these uses. An analysis of potential adverse aquatic vertebrate population affects was conducted on uses with LOCs between the endangered species and acute risk. For joint mancozeb/maneb uses and maneb only uses a Rainbow trout study with a LC_{50} value of 42ppb and a probit slope of 2.8 was used and resulted in the an estimated potential reduction in abundance of aquatic vertebrates as food for all of the uses except apples and green onion between 0.4%-9%. The majority of the uses had approximate reductions below 5%. Joint mancozeb/maneb use on apples and maneb use on green onion resulted in an estimated 19% and 14% reduction respectively. A "likely to adversely affect" determination is made for indirect effects to aquatic-phase CRLF via direct effects to aquatic vertebrates for joint mancozeb maneb use on apples and maneb use on green onion. A "not likely to adversely affect" determination is made for indirect effects to aquatic-phase CRLF via direct effects to aquatic vertebrates for the other joint mancozeb maneb uses and maneb uses assessed based on discountable affects. For mancozeb only uses forestry and X-mass trees exceeded the endangered species LOC but not the acute risk LOC. A Rainbow trout study LC_{50} value of 460ppb and default probit slope of 4.5 was used to evaluated potential adverse aquatic vertebrate population affects and the results indicate that approximately 0.0001% (forestry) and 0.00001% (X-mass trees) of the aquatic vertebrate population potentially would be reduced as a result of mancozeb use. A "not likely to adversely affect" determination is made for indirect effects to aquatic-phase CRLF via direct effects to aquatic vertebrates for the forestry and x-mass tree mancozeb only uses based on discountable affects. (See table)

In order to explore influences of amphibian-specific food intake equations on potential dietary based exposures of amphibians (prey of CRLF) to mancozeb and maneb, T-HERPS is used. The Pacific tree frog is used to represent amphibian prey species. The weight of the animal is assumed to be 2.3 g, and its diet is assumed to be composed of small and large insects. When considering chronic risk associated with dietary-based exposures to the Pacific tree frog, the chronic risk LOC is exceeded for frogs consuming small and large insects for all of the uses except mancozeb use on fennel and grains. For these uses the chronic risk LOC is not exceeded for frogs consuming large insects (See Table 5-27). A "likely to adversely affect determination is made for indirect chronic effects to terrestrial-phase CRLF via direct effects to terrestrial vertebrates for all mancozeb and maneb uses.

Table 5-27 Indirect CRLF Effects- upper bound Kenaga chronic terrestrial Herpetofauna RQs (from T-HERPS)

Use	***Broadleaf Plants/ Small Insects RQ***	***Fruits/Pods/ Seeds/Large Insects RQ***
Turf[1]	338.62	37.62
Cucumbers[1]	64.41	7.16
Ornamentals(other) [1]	19.44	2.16
Almonds[2]	124.55	13.84
Beans (dried) [2]	43.88	4.88
Figs[2]	19.44	2.16
Shallot[3]	10.97	1.22
Fennel[3]	6.87	**0.76**[4]
Grains (barley, oats, rye, triticale, and wheat) [3]	4.15	**0.46**[4]

[1]Joint Mancozeb/Maneb uses. Chronic toxicity endpoint based on maneb's mallard duck chronic reproduction NOAEC = 20ppm (MRID # 43586502
[2]Maneb uses only. Chronic toxicity endpoint based on maneb's mallard duck chronic reproduction study NOAEC = 20ppm (MRID # 43586502
[3] Mancozeb uses only; Chronic toxicity endpoint based on mancozeb's mallard duck chronic reproduction study NOAEC =125ppm (MRID # 41948401)
[4] RQs that do not exceed the LOC of 1

5.2.5 Indirect Effects (through effects to habitat)

As discussed in section 2.5.4, the habitat of the CRLF varies during its life cycle, with the CRLF surviving in aquatic, riparian and upland areas. Adults rely on riparian vegetation for resting, feeding, and dispersal. Egg masses are typically attached to emergent vegetation, such as bulrushes (*Scirpus* spp.) and cattails (*Typha* spp.) or roots and twigs, and float on or near the surface of the water (Hayes and Miyamoto 1984).

Based on presumed affects due to lack of terrestrial plant data for maneb, there is a "likely to adversely affect" CRLF through effects to plants composing the riparian and terrestrial habitats for all maneb and joint mancozeb/maneb uses except seed and dip treatment uses. Based on: 1) the results of non-target seedling emergence (Tier 1) and non-target vegetative vigor (Tier 1) studies conducted with TEP containing 60% mancozeb co-formulated with 9% dimethomorph (the EC_{25} is higher than the highest concentration tested, 1.38 lbs a.i./A); 2) an estimation of the toxicity concentration required to exceed the plant LOC of 1 (with the use of TerrPlant to estimate the EEC, an EC_{25} .at 1.38 lbs a.i. concentration would be required to exceed the plant LOC); and 3) the certainty categorization of the five reported terrestrial plants incident as only possible [4 of the incidents were associated with exposure to other active ingredients, only one showed trace amounts of mancozeb during chemical analysis]; a "not likely to adversely affect" determination is made for CRLF through effects to plants composing the riparian and terrestrial habitats due to discountable effects for mancozeb only uses.

5.2.6 Primary Constituent Elements of Designated Critical Habitat

5.2.6.1 Aquatic-Phase (Aquatic breeding habitat and aquatic non-breeding habitat)

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

- Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.
- Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.
- Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.,* algae)

The assessment of these endpoints is described in section 5.2.5.

The remaining aquatic-phase PCE is "alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source." To assess the impact of mancozeb and maneb on this PCE, risk associated with acute and chronic freshwater fish and invertebrate exposure is required. Based on the assessment for freshwater fish and invertebrates (section 5.5.2), corn, apples, and turf of the joint mancozeb/maneb uses and all of the maneb only uses except figs, pumpkin and winter squash, beans, pepper, seed and dip treatment, and eggplant would result in a determination of "habitat modification".

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

Similar to the aquatic-phase PCEs, three of the four assessment endpoints for the terrestrial-phase PCEs of designated critical habitat for the CRLF are related to potential effects to aquatic and/or terrestrial plants:

- Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or drip line surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance
- Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal
- Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.

The assessment of these endpoints is the same as in Section 5.2.6.1 above.

The remaining terrestrial-phase PCE is "reduction and/or modification of food sources for terrestrial phase juveniles and adults." To assess the impact of mancozeb and maneb on this PCE, risk associated with acute and chronic exposures to terrestrial invertebrates, mammals, and terrestrial-phase frogs. Chronic RQs for mammals and terrestrial-phase frog's endpoints exceed the LOC for all foliar uses; therefore, a determination of habitat modification of upland and dispersal habitat.

6 Uncertainties

6.1 Exposure Assessment Uncertainties

6.1.1 Maximum Use Scenario

The baseline-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 fungal resistance, timing of applications, cultural practices, and market forces.

6.1.2 Joint Mancozeb/Maneb Use

When calculating the RQs for the joint mancozeb/maneb uses a conservative assumption was made that maneb (not mancozeb) would primarily be used. Based on available toxicity data, freshwater fish, (LC_{50} = 42 ppb, LC_{50} 460 ppb for maneb and mancozeb respectively), freshwater invertebrates (EC_{50} 120ppb, EC_{50} 580ppb for maneb and mancozeb respectively), and freshwater aquatic plants (EC_{50} 13.4ppb, EC_{50} 47.0ppb for maneb and mancozeb respectively) are more sensitive to maneb than mancozeb. Therefore, if mancozeb was primarily used many of the joint mancozeb/maneb uses would not exceed the endangered species LOC labels allows for mancozeb and maneb to be used on a single crop in a growing season.

6.1.3 Action Area Overlap with Species Range

Action area overlap with the CRLF species range is identified using GIS mapping by measuring the overlap occurring between the established range area of the CRLF and the action area (initial area of concern plus the maximum buffer). This overlap area (in sq km and percent), for each CRLF recovery unit and county, is included in **Appendix C,** for mancozeb use, **Appendix I** for maneb use, and **Appendix L** for the combined mancozeb and maneb use. In total, the percent use overlap is 79% for mancozeb use, 16% for maneb use, and 27% for mancozeb and maneb use.

6.1.4 CDPR Usage Information

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

6.1.5 Aquatic Exposure

6.1.5.1 Models and Model Inputs

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 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 have agreed that the existing EXAMS pond represents the best currently available approach for estimating aquatic exposure to pesticides (USFWS/NMFS 2004).

6.1.5.2 Long-term Chronic Exposure

There is uncertainty associated with what substance the CRLF would be exposed to on a chronic basis. Based on fate and transport data, it is assumed that it would primarily be exposed to ETU and degradates. Giving this assumption, two uncertainities may be identified concerning exposure to the long-term bound residue and the short-term EBDC complex. These two uncertainities are explained hereunder.

(a) Exposure to the Bound Residue in Sediment

There is uncertainty regarding the risks to freshwater invertebrates from exposure to the bound residues in sediment. The risk that might be associated with the sediment bound residue would probably be associated with its possible conversion into ETU at low concentrations. This ETU exposure is covered by the ETU modeling exercise. In this exercise, the application rate used represents 100% transformation to ETU from the total amount of the applied parent. Additionally, included in this assessment is a recently reviewed freshwater invertebrate toxicity study conducted with ETU. The approach used in this risk assessment to address this uncertainty results generally in an overestimation of risk.

(b) Exposure to the EBDC complex

The mancozeb and maneb short-term complex (the EBDC complex) has a half life is about 4 days and mancozeb and maneb have application intervals which range from 4 to 14 days. The 4 day half life and short application intervals would result in periodic pulses of the short term complex in the aquatic media. Based on the freshwater fish early life stage studies with pulsed mancozeb or maneb, the short term complex is more toxic on a chronic basis (2.19 ppb and 6.1 ppb respectively) than the estimated ETU (3,732 ppb). There is uncertainty regarding what impact the toxicity associated with exposure to the short term complex would have on the growth and reproductive effects of aquatic organisms because, chronic exposure to the short term complex in the field would not be constant, and there is no laboratory data which demonstrates the effect of a single pulse of the short term complex on reproductive success. Also, the acute freshwater fish ETU toxicity value used to estimate chronic freshwater fish toxicity was a greater than value (i.e. LC_{50}> 502ppm), thus the resultant chronic value will be an overestimate of risk. Therefore, the use of ETU to reflect chronic exposure to aquatic organisms could potentially be either an over or underestimate of chronic risk.

6.1.5.3 Timing of Application

There is uncertainty in the PRZM/EXAMS application timing relative to rainfall/runoff events. An attempt was made to model applications during the wet season (winter/early spring), but changing application dates even within a season can result in variable EECs. Usage data suggests that mancozeb and maneb may be used throughout the year on most crops, but the highest usage appears to be during the early spring. To the extent that applications made in the summer are subject to less runoff than those made during the rainy season, EECs presented in this assessment may over-predict exposures.

For example, according to the CA crop profile for tomatoes[22], typical fungicide application windows are from March 1 to November 30 for the fresh market tomatoes crop, July 1 to October 31, and January 1 to May 30 for the other types. Therefore, the combined application window may extend from January 1 to November 30 with no application in April. EECs were determined for assumed applications covering the whole application window and results are summarized in Figure 6-1. Results show that EECs were highest for applications through the month of January (between 21 and 14 ppb), levels off between April and August (around 7 ppb) and finally increase to the 14 ppb level. It is thus expected that higher EECs would be obtained for application during the raining season. In

[22] http://pestdata.ncsu.edu/croptimelines/pdf/CAfreshtomato.PDF

this assessment, considerations were given to available crop profiles and weather data (varies with the location of the scenario).

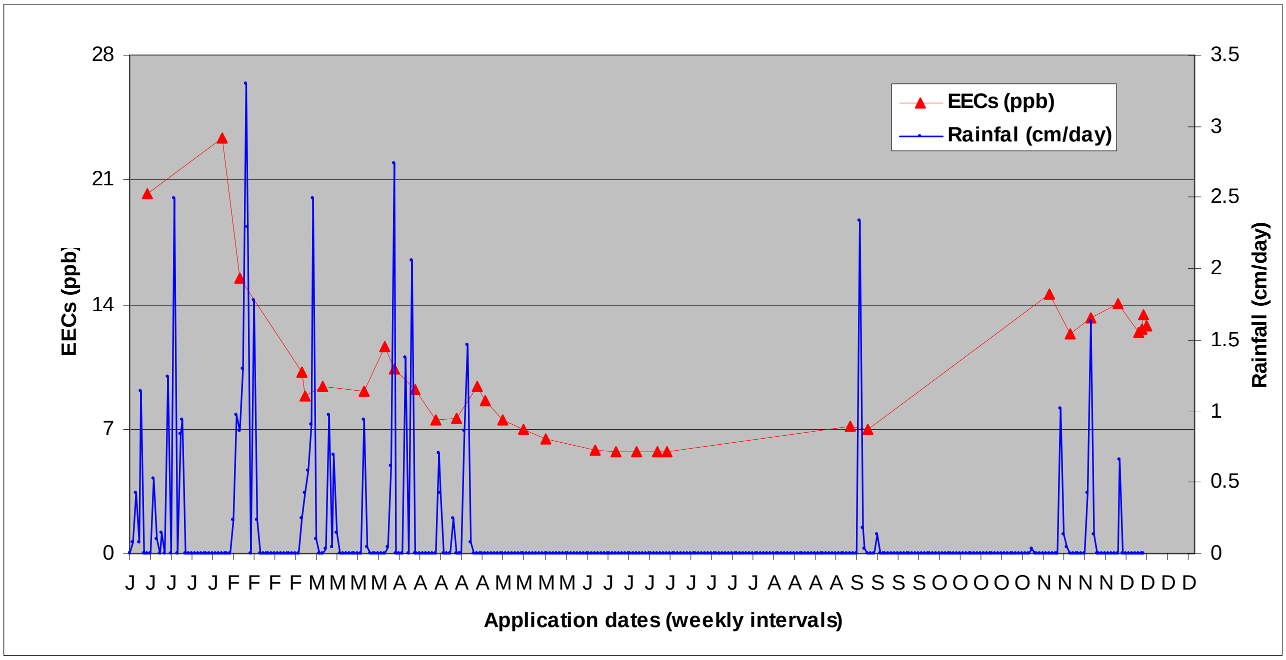

Figure 6-1 Effect of application timing on modeled EECs for tomatoes

6.1.5.4 Multiple Cropping

Mancozeb product labels specify application rates on a per crop basis (not on a per annual basis). Information from BEAD indicates that many crops can be grown more than one time/year in California. Since standard PRZM scenarios consist of only one crop per year, multiple applications were executed to represent multiple cropping. Therefore, if a pesticide is applied three times per growing season and the crop is planted two times per year; six consecutive applications were modeled. Additionally, all crops with multiple cropping were modeled with the first application on January because the crop has to be planted early and this application timing results in conservative estimates of the EECs. There is uncertainty in this approach as it is believed to be highly conservative because it does not consider the time between the first crop and the other and multiple cropping are usually associated with more than one crop on the same area.

6.1.5.5 Seed Treatment

The amount of mancozeb and maneb applied to seed is relatively small compared to the amount applied to the crop later (foliar spray, if any). Therefore it is expected that environmental exposure from seed treatment would be insignificant compared to exposure from foliar spray. However, to reduce uncertainty that may arise from this exposure route, EECs were modeled for a selection of crops and the results indicate insignificance except for cereal grains (peak increased by 1 ppb or by 4%; Table 6-1). In this respected it is pointed out that variation are expected to be much larger as a result of timing of application (refer to the tomatoes example in 6.1.5.3)

Table 6-1 Comparison between application rates and EECs for foliar spray and seed treatment (ST)

Crop	*Chemical*	*Seed Treatment(ST) Rate**	*Peak EECs (ppb)*		*ST EECs as % of Foliar treatment EECs*
			Foliar Application	*Seed Application*	
Tomatoes	Mancozeb	0.03%	9.56	0.0009	0.01%
	Maneb	0.03%	8.86	0.0001	0.001%
Cotton	Mancozeb	0.49%	8.25	0.1253	1.5%
	Maneb	No Foliar *	No Foliar *	0.0007	No Foliar *
Corn	Mancozeb	0.50%	16.84	0.1112	0.66%
	Maneb	0.83%	46.74	0.0640	0.14%
Cereals	Mancozeb	6.67%	24.16	0.9880	4.1%
	Maneb	No Foliar *	No Foliar *	0.0079	No Foliar *

* ST rate= seed treatment rate as % of foliar treatment rate; No Foliar= no foliar application for this crop.

6.1.5.6 Irrigation Scenarios

Even though many agricultural practices in California rely on irrigation, non-irrigated scenarios were used for this assessment since there is a known bug in the irrigation routines in the current version of PRZM. EECs from irrigated scenario could be higher or lower than those predicted in this assessment.

6.1.5.7 Exposure to Trace Elements

Degradation of mancozeb and maneb will result in the release of ions of the trace elements Mn^{+2} and Zn^{+2} from mancozeb and Zn^{+2} from maneb. EECs, for these trace elements, were estimated using amounts expected to be associated with determined EECs for the EBDC complex (20% metallic Mn plus 2.4% metallic Zn for mancozeb and 20.6% metallic Mn for maneb). Calculated EECs for Mn are expected to range from 0.08 to 26.4 ppb and Zn from 0.01 to 27.2 ppb. This is based on a range of 0.39 to 132 ppb of the EBDC complex (Maximum and minimum peak EECs of 8.2 to 40.55 ppb for mancozeb, 6.71 to 63.69 ppb for maneb, and 0.39 to 132 ppb for mancozeb/maneb). Results indicate that these concentrations are much lower than those monitored in the natural environment (Table 6-2).

Table 6-2 Monitored Mn and Zn concentrations in CA surface waters (USGS/NAWQA data) [23]

Statistics	***Zinc concentration in ppb***			***Manganese concentration in ppb***		
	Water	***Sediment***	***Biota***	***Water***	***Sediment***	***Biota***
Average	9	198	128	71	1,187	53
Minimum	0	34	17	0	520	3
Maximum	391	520	749	9,833	9,000	450
SD	23	124	132	390	1,085	96
%Dev	253%	63%	103%	551%	91%	179%

SD= Standard deviation from the mean (the average); and %Dev= % deviation from the mean

[23] http://infotrek.er.usgs.gov/traverse/f?p=136:23:0:QUERY:NO

6.1.5.8 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.

6.1.5.9 Aquatic Exposure Estimates

In general, the linked PRZM/EXAMS model produces estimated aquatic concentrations that are expected to be exceeded once within a ten-year period. The Pesticide Root Zone Model is a process or "simulation" model that calculates what happens to a pesticide in 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 approximately 90 percent of the time. Mobility input values are chosen to be representative of conditions in the environment. The natural variation in soils adds to the uncertainty of modeled values. Factors such as application date, crop emergence date, and canopy cover can also affect estimated concentrations, adding to the uncertainty of modeled values. Factors within the ambient environment such as soil temperatures, sunlight intensity, antecedent soil moisture, and surface water temperatures can cause actual aquatic concentrations to differ for the modeled values.

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

6.1.6 Terrestrial Exposure

6.1.6.1 Incidental Releases Associated With Use

This risk assessment was based on the assumption that the entire treatment area is subject to pesticide application at the rates specified on the label. Uneven application of the pesticide through changes in calibration of application equipment, spillage, and localized releases at specific areas of the treated field that are associated with specifics of the type of application equipment were not accounted for in this assessment.

6.1.6.2 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 reflects residues averaged over entire above ground plants in the case of grass and forage sampling.

6.1.6.3 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. However, how these behaviors relate to amphibians is not clear.

T-HERPS uses avian toxicity data as a surrogate for toxicity to amphibians and reptiles. Actual toxicity data on amphibian and reptiles is frequently unavailable. Although differences in sensitivity may be expected, the lack of available toxicity data on reptiles and amphibians precludes a robust comparison to birds. This represents a source of uncertainty in the estimated risks to amphibians and reptiles. For this assessment, no terrestrial-phase amphibian toxicity data were available so birds were used as a surrogate for the terrestrial-phase CRLF.

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 an agricultural field since many birds may gorge themselves when food items are available. Whether amphibians exhibit this type of gorging behavior is unclear. 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.

6.1.6.4 Location of Wildlife Species

For this baseline terrestrial risk assessment, a generic bird or mammal was assumed to occupy either the treated field or adjacent areas receiving a treatment rate on the field. Actual habitat requirements of any particular terrestrial species were not considered, and it was assumed that species occupy, 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.

6.2 Effects Assessment Uncertainties

6.2.1 Estimated Effects Endpoints

6.2.1.1 Use of Acute-to- Chronic Ratio Approach
There are no chronic toxicity data for freshwater fish for ETU (the major degradate of mancozeb and maneb). An estimated chronic freshwater fish NOAEC of 37.32 ppm was determined using the acute-to-chronic ratio (ACR) approach. Acute and chronic invertebrate toxicity data conducted with ETU was used to develop an ACR for ETU (13.45) and then this ACR was applied to the most sensitive acute freshwater fish toxicity data for ETU to estimate the chronic toxicity value for ETU. Because the acute fish ETU value was a greater than value (i.e. LC_{50}> 502ppm), the resultant chronic value will be an overestimate of risk.

6.2.1.2 Use of Surrogate Data for Terrestrial-Phase Amphibians

There is uncertainty associated with lack of toxicity data for terrestrial-phase amphibians. In this assessment bird toxicity data will be used as a surrogate for terrestrial-phase amphibians based on the assumption that birds are more sensitive, or at least as sensitive, as terrestrial- amphibians to mancozeb, maneb, and ETU.

6.2.1.3 Use of Surrogate Data for Aquatic-Phase Amphibians

There is uncertainty associated with lack of toxicity data for aquatic-phase amphibians. In this assessment freshwater fish toxicity data will be used as a surrogate for aquatic-phase amphibians based on the assumption that freshwater fish are more sensitive, or at least as sensitive, as aquatic-phase amphibians to mancozeb, maneb, and ETU.

6.2.2 Aquatic Plant Effects

One study has been submitted for a maneb technical formulation and a mancozeb technical formulation using the freshwater green algae (*P. subcapitatum*). Typically, studies are available for duckweed (*Lemna gibba*), blue-green algae (*Anabaena flos-aquae*), freshwater green alga (*P. subcapitatum*), and a freshwater diatom species to assess a cross-section of the non-target freshwater aquatic plant population. This risk assessment used the submitted *P. subcapitatum* studies with mancozeb and maneb for the aquatic freshwater plant endpoint and characterized the potential endangered species risk with available mixture data on freshwater aquatic plant species. There were no aquatic plant incident data reported. The approach used in this risk assessment is either an overestimate or underestimate of risk.

6.2.3 Terrestrial Plant Effects

Terrestrial plant data are not available for mancozeb as a sole active ingredient in the Typical Enduse Product (TEP). There is also no terrestrial plant data for maneb. Terrestrial plant data for mancozeb is based on a TEP containing 60% mancozeb co-formulated with 9% dimethomorph. In these studies the EC_{25} is higher than the highest concentration tested. In this risk assessment the co-formulated data was used qualitatively. Terrestrial plant incidents and estimated EECs were used in characterization. The resulting conclusions of the assessment could be either an over or underestimation of risk.

6.2.4 Sub-lethal Effects

For an acute risk assessment, the screening risk assessment relies on the acute mortality endpoint as well as a suite of sub-lethal responses to the pesticide, as determined by the testing of species response to chronic exposure conditions and subsequent chronic risk assessment. Consideration of additional sub-lethal data in the assessment is exercised on a case-by-case basis and only after careful consideration of the nature of the sub-lethal effect measured and the extent and quality of available data to support establishing a plausible relationship between the measure of effect (sub-lethal endpoint) and the assessment endpoints.

6.3.5 Age Class and Sensitivity of Effects Thresholds

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

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

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