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

Pesticide Effects Determination

Environmental Fate and Effects Division
Office of Pesticide Programs
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1. Executive Summary

This ecological risk assessment evaluates the potential for the use of the insecticide malathion (PC#057701) to affect the California red-legged frog (CRLF) (*Rana aurora draytonii*), and/or modify its designated critical habitat. The CRLF was Federally listed as a threatened species by the U.S. Fish and Wildlife Service (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). Final critical habitat for the CRLF was designated by USFWS on April 13, 2006 (USFWS 2006; 71 FR 19244-19346). The frog is endemic to California and Baja California (Mexico) and historically inhabited 46 counties in California, including the Central Valley and both the coastal and interior mountain ranges (USFWS 1996). Its range has been reduced by approximately 70%, and it currently inhabits 22 counties in California (USFWS 1996). This assessment is one of a series of ecological risk assessments developed for, and consistent with, the settlement for the court case *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 02-1580-JSW(JL)).

Malathion is an organophosphate insecticide that has been used in the U.S. since the 1950's. It is currently registered for use on more than 100 food and feed crops as well as many non-agricultural uses (forestry, mosquito control, nurseries, public health, residential, rights-of-way, and turf). Though malathion has been manufactured by a variety of companies, all technical malathion used in the U.S. is marketed and distributed by *Cheminova* since 1994.

In agreement with the Reregistration Eligibility Document (RED) for malathion (USEPA 2006), this assessment finds that malathion has the potential to adversely impact non-target biota. The magnitude of these adverse impacts tends to be greater in the current assessment than those presented in the RED for two reasons. First, the application rates in the RED are based on an agreement between the U.S. Dept of Agriculture's Inter-regional Team # 4 (IR-4) and the registrant, *Cheminova*, to support lower agricultural application rates, in general, than occurred on malathion labels at the time of that agreement. Because the current risk assessment is based on current labels, which to a large extent do not reflect these lower application rates yet, the agricultural application rates used in the current assessment are higher than in the RED. Second, this assessment identified many more sensitive endpoints than used in the RED, which lowers the concentration levels at which adverse affects are assumed to occur.

1.1 Fate Summary

Under many intended use conditions, malathion shows little persistence in the environment. Based on registrant data and open literature reports, the Environmental Fate and Effects Division (EFED) of the Office of Pesticide Programs (OPP) concludes that the primary routes of dissipation of malathion in surface soils appear to be microbially-mediated soil metabolism and hydrolysis under neutral or basic conditions.

There are some conditions, however, under which malathion is more persistent. Hydrolysis of malathion is likely to be much slower under acidic conditions.

Additionally, open literature studies suggest persistence on soil is longer under dry, sandy, low nitrogen, low carbon, and acidic conditions (Walker and Stojanovic 1973).

Maloxon (also commonly spelled as mal*a*oxon), which is both an impurity and degradate of malathion, is the only degradate/impurity of malathion that occurs in sufficient concentration and has sufficient toxicity to potentially exceed the ecological risk posed by malathion, itself. Malathion applied to artificial surfaces may be more persistent and result in higher levels of maloxon production. Under dry and microbially inactive environmental conditions maloxon concentrations have been found at levels up to 10.7% of the malathion level applied (CaEPA 1993). Monitoring studies conducted during medfly control programs in urban areas show high levels of maloxon (> 328 μg/L) in runoff water (CaDFG 1982).

Typically in risk assessments, conservative assumptions (over-protective) are purposefully made to ensure protection of the entity considered (the CRLF in this case). However, comparisons of model estimated environmental concentrations (EECs) used in this assessment with available targeted surface water monitoring data show the conservative assumptions (maximum label application rate used, application to an entire water body's watershed on a single day, etc.) made in this assessment do not appear to result in EECs that exceed targeted monitoring measured concentrations. Therefore, the EECs used in the risk assessment may not be conservative enough to be protective of the CRLF under all circumstances. The reasons why the EECs modeled for this assessment appear to under-predict targeted monitoring data are unknown.

1.2 Effects Summary

This risk assessment considers both direct effects of malathion use to the CRLF itself and indirect effects on the CRLF and its critical habitat. Both the aquatic and upland (terrestrial) habitat of the CRLF is assessed because the CRLF requires both to complete its life cycle and the exposure and effects differ between habitat types. The aquatic phase of the CRLF's life cycle includes eggs, larvae, tadpoles, juveniles, and adults. Although juveniles and adults spend a significant amount of time in terrestrial habitats, they also use the aquatic portion of their habitat, especially during breeding. The terrestrial phase evaluation includes juveniles and adults. Components of the ecosystem addressed in the assessment include aquatic plants, aquatic invertebrates, fish, terrestrial plants, terrestrial invertebrates, and terrestrial vertebrates (*i.e.,* small mammals and birds) in addition to the various life stages of the CRLF itself.

Malathion's mode of action is similar to other organophosphate insecticides in that malathion, and its degradate/impurity maloxon, inhibit acetyl cholinesterase, an enzyme critical to the proper functioning of the central nervous system. Not surprisingly, malathion and maloxon were found to have much greater adverse affects both directly to the CRLF and its animal prey base than to the vegetative portions of the CRLF's diet and habitat.

After completing the analysis of the effects of malathion and maloxon on the Federally listed CRLF in accordance with methods delineated in the Overview Document (USEPA

2004), EFED concludes that the use of malathion may affect, and is likely to adversely affect the CRLF, based on direct affects to the CRLF and indirect effects to the prey base of the CRLF. These effects of the current label uses of malathion insecticide in California are anticipated to occur or could occur throughout the state of California, and therefore, throughout the entire range of the CRLF in the United States. Rationale for each component assessed is provided in Table 1, which summarizes the "effect determinations" (findings of this risk assessment) of malathion use to the federally listed CRLF, and throughout the remainder of this document.

Table 1. Summary of effects determinations and the basis for those determinations for the California Red-legged Frog (CRLF) from malathion and its degradate/impurity maloxon.

Assessment Endpoint	Exposure (Duration, Habitat)	Effects Determination[1]	Basis for Determination
Direct effects to CRLF	Acute, aquatic	LAA	- Acute LOC[2] is exceeded for most uses based on estimated concentrations of malathion in water and on the most sensitive surrogate vertebrate data. - At the highest estimated concentration of malathion in water, the likelihood of individual mortality is well in excess of 1 in 2. - Maximum observed concentrations of malathion in surface waters are sufficient to exceed the LOC.
	Chronic, aquatic	LAA	- Chronic LOC is exceeded for all uses based on estimated concentrations of malathion in water and on the most sensitive surrogate vertebrate data extrapolated to a chronic endpoint through the application of an acute to chronic ratio (ACR).
	Acute, terrestrial	LAA	- Using the avian surrogate approach the acute listed species LOC is exceeded for 53 of 68 use scenarios. - Refined estimates of exposure based on CRLF-specific diet considerations result in listed species LOC exceedances for dose-based or dietary-based exposures for 53 uses and reduces uses exceeding the non-listed LOC to 8.
	Chronic, terrestrial	LAA	- Chronic LOC is exceeded for all uses, except the papaya and residential ornamental and lawn uses, based on the most sensitive surrogate bird data. - Refined estimates of exposure based on CRLF-specific diet considerations result in LOC exceedances for dietary-based exposures except for papaya and residential ornamental and lawns.

Assessment Endpoint	Exposure (Duration, Habitat)	Effects Determination[1]	Basis for Determination
Indirect effects to tadpole CRLF via reduction of primary production based food (*i.e.*, algae)	Aquatic	NLAA	- Only the listed species LOC is exceeded for some uses of malathion. - However, the listed species LOC is only applicable for indirect effects to listed species with an obligate relationship to a specific plant, which is not applicable to the CRLF which is a generalist herbivore.
Indirect effects to juvenile and adult CRLF via reduction of prey (*i.e.*, invertebrates)	Acute, aquatic	LAA	- Acute LOC is exceeded for all uses based on estimated concentrations of malathion in water and on the most sensitive surrogate invertebrate data. - Estimated concentrations of malathion in water resulting from all uses result in a likelihood of individual mortality of 50% to 100% for the most sensitive species tested. - Considering species sensitivity distributions for aquatic vertebrates and estimated exposure concentrations for malathion, all uses may affect substantial numbers of invertebrate species at 50% or greater mortality.
	Chronic, aquatic	LAA	- Chronic LOC is exceeded for all uses based on estimated concentrations of malathion in water and the most sensitive surrogate invertebrate data.
	Acute, terrestrial	LAA	Malathion is an insecticide with a highly varied suite of agricultural and non-agricultural uses. Field effects data show that label relevant application rates can reduce invertebrate populations at sites of treatment.
Indirect effects to adult CRLF via reduction of prey (*i.e.*, fish, frogs, and mice)	Acute, aquatic	LAA	- Acute LOC is exceeded for several uses based on estimated concentrations of malathion in water and the most sensitive surrogate vertebrate data. - At the highest estimated concentration of malathion in water (resulting from use on lettuce), the level of effects on exposed populations exceeds 50%. - Maximum observed concentrations of malathion in surface waters are sufficient to exceed the LOC. - Considering species sensitivity distributions for aquatic vertebrates and estimated exposure concentrations for malathion, several uses (gooseberry, rice/wild rice, watercress, forestry, and mosquito control) may affect substantial numbers of fish species at 50% or greater mortality.

Assessment Endpoint	Exposure (Duration, Habitat)	Effects Determination[1]	Basis for Determination
	Chronic, aquatic	LAA	- Chronic LOC is exceeded for all uses based on estimated concentrations of malathion in water and on the most sensitive surrogate vertebrate data.
	Acute, terrestrial	LAA	- Acute LOC is exceeded for all uses based on the most sensitive surrogate amphibian data. - Refined estimates of exposure based on amphibian-specific diet considerations result in LOC exceedances for dietary-based and dose-based exposures. - For foliar uses, effects determination based on acute effects to mice is NLAA.
	Chronic, terrestrial	LAA	- Chronic LOC is exceeded for all foliar uses based on the most sensitive surrogate mammalian and amphibian data. - Refined estimates of exposure based on amphibian-specific diet considerations result in LOC exceedances for dietary-based exposures.
Indirect effects to CRLF via reduction of habitat and/or primary productivity (*i.e.*, plants)	Aquatic	NE	- Only the listed species LOC is exceeded for some uses of malathion. - However, the listed species LOC is only applicable for indirect effects to listed species with an obligate relationship to a specific plant, which is not applicable to the CRLF (a generalist herbivore).
	Terrestrial	NE	-There are no data to support any finding that field relevant effects on terrestrial plants occur with any field relevant application of malathion.

[1]LAA = likely to adversely affect; NLAA = not likely to adversely affect; NE = no effect
[2]LOC (level of concern) is the risk level below which there are no agency concerns.

Aquatic phase CRLF effects. Direct effect levels of concern (LOCs) were exceeded for CRLF aquatic life stages. Both acute and chronic LOCs were exceeded for aquatic prey and are of sufficient magnitude to have a significant detrimental impact of prey base of the CRLF. No observed effect concentration (NOEC) based LOCs were exceeded only for non-vascular aquatic plants and only for some uses. Reductions of aquatic non-vascular plant biomass or populations are expected to be temporary and are not anticipated to measurably affect CRLF present in affected water bodies. Similarly, malathion and maloxon are not anticipated to significantly impact riparian plant communities. Vegetation provides habitat (aquatic vegetation) and protects water quality (riparian vegetation) for the aquatic phase of the CRLF.

Terrestrial phase CRLF effects. Direct terrestrial effects were assessed using EFED's T-Herps model which incorporates amphibian/reptile specific allometric equations to more accurately assess affects to CRLF. Acute dose-based RQs exceeded LOCs for small (1.4 g), medium (37 g), and large (238 g) CRLF. Acute and chronic dietary-based RQs exceeded LOCs for small frogs, which constitutes both direct (on the CRLF itself) and indirect (on frogs that may be CRLF prey) effects. Other indirect terrestrial effects were assessed using EFED's T-Rex model. Dose-based acute and chronic RQs exceeded LOCs for small mammals. Dietary-based acute and chronic RQs and dose-based acute RQs exceeded LOCs for small birds. Small mammals, birds, and herptiles are prey items of the CRLF. Again, malathion and maloxon are not anticipated to significantly impact riparian plant communities, which also provide habitat and food sources for terrestrial phase CRLF.

Table 2 summarizes the impacts of malathion to CRLF critical habitat. Designation of critical habitat is based on habitat areas that provide essential life cycle needs of the species or areas that contain 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.

Table 2. 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 CRLF.	No effect	Risk of malathion to plants assumed to be negligible with no expected effects on terrestrial vegetation and extremely limited effects on aquatic vegetation that would be pertinent only to obligate animals.
Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLF and their food source.[1]	No effect	Risk of malathion to plants assumed to be negligible based on presumed low phytotoxicity and mode of action.
Alteration of other chemical characteristics necessary for normal growth and viability of CRLF and their food source.	Habitat modification	RQs exceeded for acute and chronic effects for CRLF and prey items (invertebrates, fish, and aquatic phase amphibians).
Reduction and/or modification of aquatic-based food sources (*e.g.,* algae) for pre-metamorphs.	No effect	Aquatic plant effects are only at a level critical for obligate animals, no habitat modification relavent to the generalist CRLF.
Terrestrial Phase PCEs (Upland Habitat and Dispersal Habitat)		
Elimination and/or disturbance of upland habitat; ability of habitat to support food sources of CRLF: 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 provide the CRLF shelter, forage, and predator avoidance.	No effect	No effects expected for terrestrial plants.

Assessment Endpoint	Effects Determination	Basis
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.	No effect	No effects expected for terrestrial plants.
Reduction and/or modification of food sources for terrestrial phase juveniles and adults.	Habitat modification	Malathion poses acute and chronic risk to prey items of the CRLF (terrestrial invertebrates, mice, and terrestrial-phase frogs).
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLF and their food sources.	Habitat modification	Malathion poses acute and chronic risk to prey items of the CRLF (terrestrial invertebrates, mice, and terrestrial-phase frogs).

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

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 CRLF and its resources (*i.e.*, food and habitat) are not expected to be uniform across the action area or uniform over time. Risks to the CRLF and its resources are expected to decrease with increasing distance away from the treated field or site of application because both spray drift through air and dilution with downstream transport in surface water will cause the pesticide exposure to attenuate with distance.

For sites distant from the site of malathion application, the adverse effects may be intermittent because malathion is not expected to persist in most environments and the conditions that cause it to exceed LOCs (*e.g.*, right wind direction, heavy rain immediately after application, etc.) may occur infrequently. Theses sites may experience long periods of recovery between exposures of sufficient magnitude to cause any adverse effects.

For sites closer to the site of malathion application, adverse conditions would be expected to be more severe, causing mortality to both the CRLF and to the prey items on which the CRLF depends, and more frequent, providing little time to recover before adverse conditions re-occur. Because malathion has many uses and most of those uses would cause adverse effects, it is expected that malathion would cause a larger proportion of sites to experience severe adverse effects at greater frequency than pesticides that have fewer uses and less severe effects. Additionally, because malathion does have so many uses, it is possible that some sites are impacted by multiple uses.

Evaluation of the implication of this non-uniform distribution of risk to the CRLF 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 extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population within the geographical areas where those effects are predicted to occur. Additionally, such population-specific information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individual CRLF.
- *Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase CRLF*. While existing information indicates 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 identify geographical limits to those effect thresholds. This information could be used together with the density data (discussed above) to characterize the likelihood of adverse effects to individual CRLF.
- *Information on population responses of prey base organisms to malathion*. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth, or reproductive impairment of prey base organisms immediately following exposure to malathion. Potentially, more ecologically relevant effects to the prey base (*e.g.*, the degree to which repeated exposure events and inherent demographic characteristics of the prey population limit the extent to which prey resources may recover) can not currently be predicted. An enhanced understanding of long-term prey responses to pesticide exposure would allow for an estimate of the magnitude and duration of resource impairment to be made. Combining such an estimate with the information described above might provide a more comprehensive prediction of effects to individual frogs and potential modification to critical habitat.

2. Problem Formulation

Problem formulation provides a strategic framework for the risk assessment. By identifying the important components of the problem, it focuses the assessment on the most relevant life history stages, habitat components, chemical properties, exposure routes, and endpoints. This assessment was completed in accordance with the August 5, 2004 Joint Counterpart Endangered Species Act (ESA) Section 7 Consultation Regulations specified in 50 CFR Part 402 (USFWS/NMFS 2004; FR 69 47732-47762). The structure of this risk assessment is based on guidance contained in U.S. EPA's *Guidance for Ecological Risk Assessment* (U.S. EPA 1998), the Services' *Endangered Species Consultation Handbook* (USFWS/NMFS 1998), and procedures outlined in the Overview Document (U.S. EPA 2004).

2.1 Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the federally threatened CRLF arising from the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulatory actions[1] regarding use of malathion. In addition, this assessment evaluates whether malathion use is expected to result in modification of the CRLF's critical habitat. This ecological risk assessment has been prepared as part of the *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 02-1580-JSW(JL)) settlement entered in the Federal District Court for the Northern District of California on October 20, 2006.

In this risk assessment, direct and indirect effects to the CRLF and potential modification to its critical habitat are evaluated in accordance with the methods described in the Agency's Overview Document (U.S. EPA 2004). Screening level methods include use of standard models such as PRZM-EXAMS, TREX, TerrPlant, AgDrift, and AgDisp, all of which are described at length in the Overview Document. Additional refinements include a modification of TREX (THERPS) to evaluate effects on terrestrial-phase frogs and an analysis of the usage data. 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 malathion is based on an action area. The action area is the area directly or indirectly affected by the federal action, as indicated by the exceedance of OPP's

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[1] Federal actions arising from FIFRA, or other laws, etc. must comply with the National Environmental Policy Act (NEPA). NEPA's basic policy is to assure that all federal agencies consider the environment prior to approving federal actions. Specifically, NEPA requires federal agencies to evaluate the potential environmental effects of their actions prior to approving them. Moreover, NEPA requires federal agencies to consider measures to minimize adverse effects of their actions, and to solicit and consider public input as part of the environmental review process.

Levels of Concern (LOCs). It is acknowledged that the action area for a national-level FIFRA regulatory decision associated with a use of malathion may potentially involve numerous areas throughout the United States and its Territories. However, for the purposes of this assessment, attention will be focused on the section of the action area that intersects with 1) locations where CLRF is known to occur[2], 2) currently occupied core areas for the CLRF[3], and 3) designated critical habitat.

As part of the "effects determination," one of the following three conclusions will be reached regarding the potential use of malathion in accordance with current labels:

- "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 the CRLF are aquatic and upland areas where suitable breeding and non-breeding aquatic habitat is located, interspersed with upland foraging and dispersal habitat.

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

If a determination is made that use of malathion within the action area(s) associated with the CRLF "may affect" this species and/or its designated critical habitat, additional information is considered to refine the potential for exposure and for effects to the CRLF and other taxonomic groups upon which these species depend (*e.g.*, aquatic and terrestrial vertebrates and invertebrates, aquatic plants, riparian vegetation, etc.). Additional information, including spatial analysis (to determine the co-occurrence of CRLF habitat with malathion exposure) and further evaluation of the potential impact of malathion on the PCEs is also used to determine whether modification to designated critical habitat may occur. Based on the refined information, the Agency uses the best available information to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that "may affect and are likely to adversely affect" the CRLF and/or the PCEs of its designated critical habitat. This information is presented as part of the Risk Characterization in Section 5 of this document.

The Agency believes 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

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[2] As documented in the California Natural History Database

[3] As described in the CRLF recovery plan.

malathion is expected to directly impact living organisms within the action area (defined in Section 2.7), critical habitat analysis for malathion is limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes (*i.e.*, the biological resource requirements for the listed species associated with the critical habitat or important physical aspects of the habitat that may be reasonably influenced through biological processes). Activities that may modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the species. Evaluation of actions related to use of malathion 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 and jeopardize the continued existence of the species have been identified by the Services (USFWS and NMFS) and are discussed further in Section 2.6.

2.2 Scope

Malathion is an organophosphate insecticide currently registered in the U.S. for the following uses:

<u>Exclusively outdoor uses:</u>

Aquatic food and non-food uses: lakes/ponds/reservoirs (with or without human or wildlife use), intermittently flooded areas/water, polluted water, rice, swamps/marshes/wetlands/stagnant water, and wild rice;

Forestry (forest/shelterbelt) uses: cottonwood, poplar, red cedar, and slash pine;

Outdoor residential uses: household/domestic dwellings outdoor premises, refuse/solid waste containers (garbage cans), and urban areas;

Terrestrial feed crop uses: alfalfa, bermudagrass, bluegrass, canarygrass, cereal grains, clover, corn, grass forage/fodder/hay, lentils, lespedeza, lupine, millet (foxtail), pastures, peas (including vines), rangeland, sorghum, sudangrass, timothy, trefoil, and vetch;

Terrestrial food crop uses: agricultural/farm structures/buildings and equipment, anise, apricot, asparagus, avocado, beets, blackberry, blueberry, boysenberry, broccoli, broccoli raab, Brussel sprouts, cabbage, caneberries, carrot (including tops), cantaloupe melon, cauliflower, celery, celtuce, cherry, chervil, chestnut, chinese amaranth, chinese broccoli, chinese cabbage, collards, corn salad, cranberry, cucumber, cucurbit vegetables, currant, dandelion, date, dewberry, dock (sorrel), eggplant, endive (escarole), fennel, fig, filbert (hazelnut), food processing plant premises (nonfood contact), garden purslane, garland chrysanthemum, garlic, green onions, gooseberry, guava, head lettuce, honeydew melon, horseradish, kale, kohlrabi, leaf lettuce, leek, loganberry, macadamia nut (bushnut), mango, meat processing plant premises (nonfood contact), melons, mint, musk melon, mustard, mustard cabbage (gai choy/pak-choi), nectarine, okra, onion, orach (mountain spinach), papaya, parsley, passion fruit (granadilla), peach, pear, pecan, pepper, pineapple, plum, prune, pumpkin, quince, radish, raspberry (black or red), roquette (arrugula), rutabaga, salsify, shallot, spinach, squash (all or unspecified), strawberry, sweet corn, sweet potato, Swiss chard, walnut (English/black), water cress, water melon, winter melons (casaba/crenshaw/honeydew/persian), and winter purslane;

Terrestrial food and feed crop uses: almond, apple, barley, beans, canola\rape, cereal grains, citrus, citrus hybrids other than tangelo, compost/compost piles, corn (unspecified), cotton (unspecified), cowpea/black-eyed pea, dried beans, field corn, field peas, flax, grape leaves, grapefruit, grapes, hops, kumquat, lemon, lentils, lime, manure, mint, mustard, oats, orange, parsnip, peanuts (unspecified), peas (unspecified), peppermint, pineapple, pop corn, rice, rye, safflower (unspecified), salsify, sorghum, soybeans (unspecified), spearmint, succulent beans (lima), succulent beans (snap), sugar beet, sweet corn, tangelo, tangerines, tomato, turnip, wheat, wild rice, and white/irish potato;

Terrestrial non-food crop uses: agricultural fallow/idle land, automobiles/taxis/limousines/recreational vehicles and tires, Christmas tree plantations, citrus, clover, commercial/institutional/industrial premises/equipment (outdoor), cull piles, golf course turf, meat processing plant premises (nonfood contact), nonagricultural areas (public health use), nonagricultural outdoor buildings/structures, nonagricultural rights-of-way/fencerows/hedgerows, nonagricultural uncultivated areas/soils, ornamental and/or shade trees, ornamental herbaceous plants, ornamental non-flowering plants, ornamental woody shrubs and vines, pine (seed orchard), refuse/solid waste sites (outdoor), tobacco, urban areas, and wide area/general outdoor treatment (public health use);

Terrestrial non-food and outdoor residential uses: cull piles, fencerows/hedgerows, nonagricultural rights-of-way/fencerows/hedgerows, ornamental and/or shade trees, ornamental herbaceous plants, ornamental lawns and turf, ornamental non-flowering plants, ornamental woody shrubs and vines, and urban areas;

<u>Exclusively indoor uses:</u>

Greenhouse food crop uses: beans, cucumber, eggplant, endive (escarole), head and leaf lettuce, mushrooms, onion, pepper, and tomato;

Indoor food uses: agricultural/farm structures/buildings and equipment, almond, barley, barns/barnyards/auction barns, beef/range/feeder cattle (meat), cereal grains, citrus pulp (processed), commercial transportation facilities-feed/food-empty, corn (unspecified), dairy cattle (non-lactating), feed/food storage areas-empty, field corn, food processing plant premises (nonfood contact), goats (meat), goats (wool/angora animal), empty grain/cereal/flour elevators and storage areas, hog/pig/swine (meat), livestock, meat processing plant premises (nonfood contact), mushrooms, oats, peanuts, pop corn, poultry (egg/meat), rice, rye, seed houses/stores/storage areas/warehouses, seeds, sheep (meat), sorghum, sunflower, and wheat;

Indoor non-food uses: non-feed/non-food commercial transportation facilities, sheep, and wide area/general indoor treatment;

Indoor residential uses: household/domestic dwellings indoor premises and refuse/solid waste sites (indoor);

Indoor and outdoor uses:

Terrestrial and greenhouse food crop uses: beans, cucumber, dried beans, eggplant, endive (escarole), green onions, head lettuce, leaf lettuce, onion, pepper, squash (all or unspecified), succulent beans (lima), succulent beans (snap), sweet corn, and tomato;

Terrestrial and greenhouse non-food crop uses: ornamental and/or shade trees, ornamental herbaceous plants, and ornamental woody shrubs and vines

The scope of this assessment includes all of the "exclusively outdoor" and "indoor and outdoor" uses for the active ingredient malathion (and its impurity and degradate, maloxon), but does not address other inert ingredients which may be present in an end-use product or tank mixture. Exclusively "indoor" uses are assumed to have "no effect" on the CRLF if used in accordance with the label and are not considered further in this risk assessment.

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

Although current registrations for malathion allow for use nationwide, this ecological risk assessment is for currently registered uses of malathion in portions of the action area that are reasonably assumed to be biologically relevant to the CRLF and its designated critical habitat.[4]

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).

[4] Technical labels also exist, which may include crops not listed on end use labels. Technical products are used to make formulated end use products. Because these technicals cannot be applied directly, use sites on these labels are not considered at part of the Federal action.

Malathion has registered products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD50 data for multiple active ingredient products relative to the single active ingredient is provided in Appendix A. The results of this analysis show that an assessment based on the toxicity of the single active ingredient of malathion is appropriate.

2.3 Previous Assessments

Both malathion and the CRLF have been subjects of previous ecological risk assessments. The Agency has completed a RED (U.S. EPA 2006)[5] for malathion. The malathion ecological risk assessment for the RED identified an exceedence of the endangered species risk level of concern (LOC) for fish, aquatic invertebrates, birds, and mammals. Furthermore, the RED document concluded that concerns for risks to endangered species of terrestrial invertebrates and plants could not be precluded based on available data and baseline risk assessment methods.

Assessment endpoints in this document are lower than those used in the malathion RED. Although the RED was published in 2006, following completion of the organophosphate cumulative assessment, this ecological risk assessment was compiled in 1999, prior to the regular incorporation of open literature (ECOTOX) data into EFED risk assessments. Review of the open literature data resulted in a number of lower endpoints. Risk conclusions are similar, in that a listed species LOCs are exceeded, but the risk quotients (RQs) presented in this document are higher than corresponding RQs in the RED.

The Agency is currently developing a number of risk assessments for the CRLF, each addressing a different pesticide active ingredient. A total of 66 pesticides[6] will be assessed. Malathion is among the second group of 10 pesticides to be completed. For information regarding other pesticides, please see the relevant document.

2.4 Malathion Characteristics, Fate, and Transport

Malathion has specific properties and uses which help delineate when and where the active ingredient and/or any impurities/degradates may co-occur temporally and spatially with the CRLF with sufficient intensity (sufficient concentration) to affect the CRLF. For reasons explained in Section 2.4.6, only malathion and one of its degradates (also an impurity), maloxon, are included in this risk assessment. Sections 2.41 through 2.4.7

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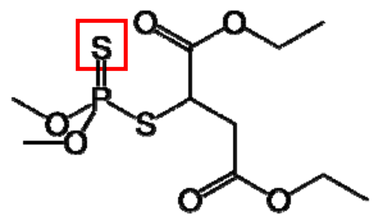
[5] Available via the internet at http://www.epa.gov/oppsrrd1/reregistration/REDs/malathion_red.pdf
[6] Other chemicals being assessed include 1,3-dichlorpropene, 2,4-D, acephate, alachlor, aldicarb, atrazine, azinphos-methyl, bensulide, bromacil, captan, carbaryl, chloropicrin, chlorothalonil, chlorpyrifos, chlorthal-dimethyl (DCPA), DEF (tribufos), diazinon, dicofol, diflubenzuron, dimethoate, disulfoton, diuron, endosulfan, EPTC, esfenvalerate, fenamiphos, glyphosate, hexazinone, imazypyr, iprodione, linuron, mancozeb, maneb, metam sodium, methamidophos, methidathion, methomyl, methoprene, methyl parathion, metolachlor, molinate, myclobutanil, naled, norflurazon, oryzalin, oxamyl, oxydemeton-methyl, oxyfluoren, paraquat dichloride, pendimethalin, permethrin, phorate, phosmet, prometryn, propanil, propargite, propyzamide (pronamide), rotenone, simazine, strychnine, thiobencarb, triclopyr, trifluralin, vinclozolin, and ziram.

summarize a wealth of fate data discussed in the RED (USEPA 2006). For a more detailed discussion of the available fate data, please see that document.

2.4.1 Chemical Profile

The basic physical and chemical properties and structure of malathion are presented in Table 3. Maloxon differs structurally from malathion by the substitution of a doubly-bonded oxygen to phosphorus in place of the doubly bonded sulfur (identified by red box in chemical structurediagram) and has a slightly lower molecular weight of 314.29 g/mol. Throughout this assessment many of the properties of malathion are assumed to apply to maloxon due to the similarities in chemical structure. This assumption is made necessary due to the dearth of information on maloxon relative to the amount of information available for malathion.

Table 3. Physical/chemical properties of malathion (O,O-dimethyl phosphorodithioate of diethyl mercaptosuccinate).

Physical/Chemical Property	Value/Description	Chemical Structure
Molecular formula	$C_{10}H_{19}O_6PS_2$	
Molecular weight	330.3 g/mol	
Physical state	Clear amber liquid	
Melting point	2.85^{o} C	
Boiling point (0.7 mm Hg)	156 - 157^{o} C	
Specific gravity (25^{o} C)	1.23	
Vapor pressure (30^{o} C)	4 x 10^{-5} mm Hg	
Solubility (25^{o}C)	145 mg/l water	

2.4.2 Mechanism of Action

Several reviews of malathion and organophosphate toxicology exist including Matsumura (1985).

Malathion's mode of action is through acetylcholinesterase (AChE) inhibition which disrupts nervous system function. AChE is an enzyme which cleaves the neurotransmitter acetylcholine that resides within nervous system junctions. Inhibiting this enzyme leads to accumulation of the neurotransmitter thus causing signals in the nervous system to persist longer than normal. Typical symptoms for exposure to pesticides which act in this manner are defecation, urination, lacrimation, muscular twitching and weakness, and halted respiration.

Malathion, along with other phosphorodithioate insecticides (those containing two sulfur atoms bonded to phosphorus) must be oxidized before they have inhibitory potency and toxicity. Oxidation occurs via cytochrome p450 and results in the conversion of the P=S group in malathion to P=O forming its oxon, maloxon (Murphy *et al* 1968). This alteration of the phosphate group enables the molecule to covalently bind AChE resulting in long lasting inhibition of the enzyme.

Maloxon binds to AChE by mimicking the structure of enzyme's natural substrate, acetylcholine. The similarity between the size, shape, and properties of maloxon and the neurotransmitter allow it to "fit" in the acetylcholine binding site on the enzyme. Altering the structure of maloxon or malathion reduces the ability of the oxon to bind AChE resulting in detoxification of the molecule.

Detoxification reactions may be a result of enzyme or chemical action on the molecule and occurs very rapidly in mammals giving pure malathion a very low acute toxicity [LD_{50} in rats is 12,500 mg/kg (Fukuto 1983)]. Common detoxification reactions for malathion (and maloxon) are ester hydrolysis, demethylation, and phosphorothiolate ester hydrolysis. When one or more of these detoxification steps are blocked by another chemical the toxicity of malathion is increased and the added chemical is considered to synergize malathion toxicity. Chemicals which increase the rate of malathion's conversion to maloxon may also be synergists.

Important detoxification steps occur through nonspecific esterase enzymes which are capable of cleaving malathion to less toxic degradates. Biological and environmental degradates of malathion with greatly lowered toxicity include malathion α, β, and diacids, and O-desmethyl malathion (Matsumura 1985).

Because organophosphate insecticides are inhibitors of esterases (most specifically AChE) they possess the ability to block detoxification enzymes. Several organophosphate impurities present in technical malathion are known to synergize malathion toxicity probably through blocking malathion detoxification. The toxicity of several malathion impurities alone is also very high (*e.g.*, the LD_{50} of O,O,S-trimethyl phosphorothioate in rats is 15 mg/kg, or 833 times more toxic than pure malathion) and cause delayed toxicity suggesting a mode of action other than AChE inhibition. Impurities can be produced through improper storage of malathion as evidenced by a 35% increase in the acute toxicity of technical malathion stored at 40^{o}C for 6 months (Fukuto 1983).

2.4.3 Malathion Products with Additional Active Ingredients

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).

Malathion has registered products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD_{50} data (and available open literature for malathion) for multiple active ingredient products relative to the single active ingredient is provided in Appendix A. The results of this analysis show that an assessment based on the toxicity of the single active ingredient of malathion is appropriate.

2.4.4 Environmental Fate Assessment

CRLF may be exposed to malathion and its degradates through contamination of food, water, and air (by suspended particles) which can result from off-target drift, runoff, and direct application. Increased toxicity may be brought about through oxidation (to maloxon). Limited data are available on toxic degradates and impurities, but the fate data provided to EFED for malathion was found to be acceptable for performing risk assessment (USEPA 2006) and shows that malathion, typically, will have little persistence in the environment.

Based on registrant submitted data and open literature reports, EFED concludes the primary routes of dissipation of malathion in surface soils appear to be microbially-mediated soil metabolism (half-lives measured as <1 to 2.5 days) and hydrolysis (pH 7 and 9 half-lives of 6.21 days and 12 hours, respectively). Malathion monoester, ethyl hydrogen fumarate, diethyl thiosuccinate, malathion mono- and dicarboxylic acids, demethyl mono- and di-carboxylic acids, and CO_2 are known degradates.

2.4.4.1 Degradation

Hydrolysis: Several open literature studies (Mulla *et al* 1981, Howard 1991) are consistent with data presented by the registrant showing that malathion is unstable under alkaline conditions and increasingly stable under acidic conditions. Malathion is stable to hydrolysis at pH 5 ($T_{1/2}$ = 107 days), to aqueous photolysis ($T_{1/2}$ = 94 and 143 days, corrected for dark control) and to soil photolysis ($T_{1/2}$ = 173 days) and does not volatilize appreciably (≤5.1% of applied volatilized after 16 days). Open literature studies suggest persistence on soil is longer under dry, sandy, low nitrogen, low carbon, and acidic conditions (Walker and Stojanovic 1973).

The phosphorothiolate ester bond of maloxon may be more susceptible to cleavage via hydrolysis than the analogous phosophorodithioate ester in malathion. Greater susceptibility would lead to reduced persistence for maloxon relative to malathion.

2.4.4.2 Metabolism

Aerobic soil Metabolism: Aerobic soil metabolism is an important route of malathion degradation. Malathion persistence under aerobic soil conditions has been examined in several open literature studies which are reviewed in Table 4. Reported half-life values (from field and laboratory studies) vary from hours to 11 days. Persistence is decreased with microbial activity, moisture, and high pH.

Table 4. Open literature studies reporting aerobic soil metabolism degradation rates.

Source	Degradation Rate Value	Comments
Miles and Takashima 1991	$t_{½}$ = 8.2 h (laboratory) $t_{½}$ = 2 h (field)	Malathion was mixed with Lihue soil and incubated at 22°C in lab experiment. Sterilization decreased rate by 2-fold.

Source	Degradation Rate Value	Comments
Walker and Stojanovic 1974	47-95% at 7 days	Malathion was incubated with various *Arthrobacter* species. Degradation in the presence of the 5 most efficient species was reported.
Walker and Stojanovic 1973	$t_{½}$ = ~ 2 days under non-sterile unfavorable degradation conditions.	In 3 Mississippi soils examined at 25-26°C, soil microflora were important in degradation. Slowest degradation occurred in soils with low nitrogen, moisture, and carbon content and increased acidity.
CalEPA 1994	DT_{50} = 4.2-6.9 days on sand	Measured at 5 sites under the conditions of the medfly eradication program. Each site consisted of 10 aluminum trays containing 500g of playground sand. Between applications trays were covered.
CalEPA 1993	DT_{50} < 12 h on sand	Application was under controlled conditions, but temperature was not noted.
CalEPA 1993	soil: 38% remaining at 12 hours 15% remaining at 20 days	66% sand, 24% silt, 10% clay, 0.78% water, pH 6.3. Malathion was applied under controlled conditions. Degradation was biphasic.
Kearney *et al* 1969	75-100% degradation in 1 week	Field persistence
Lichtenstein and Schultz 1964	85% dissipation in 3 days	Conducted under field conditions
Howard 1991	Reported average literature $t_{½}$ = 6 d	In this review, persistence is stated to vary with moisture content and pH.
USDA	$t_{½}$ = 3 days used for modeling	This value was chosen for modeling malathion in the Boll Weevil Eradication Program based on a personal communication with a previous malathion registrant.

In the registrant submitted study [2,3-^{14}C]malathion degraded with a calculated half-life of approximately 0.2 days in two aerobic metabolism experiments using loam soil (pH 6.1) incubated in the dark at 22 ± 2°C and 75% of field capacity. An ancillary experiment was conducted to determine the rate of degradation of malathion in sterile soil. At 4 days post-treatment, malathion comprised close to 100% of the applied radioactivity (97.84% of the extractable radioactivity). The difference between half lives of the sterile and non-sterile treatments indicates that microorganisms are important in the rapid degradation of malathion in soil under acidic aerobic conditions (MRID 41721701, 43166301).

Numerous degradates were identified in the soil extracts and are identified as follows as a percent of applied radioactivity: dicarboxylic acid of malathion (18.7 - 36.7%), the beta monocarboxylic acid of malathion (2.8 - 7.3%), the alpha monocarboxylic acid of malathion (1.9 - 2.5%), and maloxon (0.6 - 1.8%).

Anaerobic Aquatic Metabolism: An open literature study (Bourquin 1977) and the registrant's study suggest that malathion persistence in anaerobic environments is short, however, due to the high pH in the registrant's study a quantitative assessment of the degradation and degradation products cannot be performed.

In the registrant submitted anaerobic aquatic metabolism study [2,3-^{14}C]- and technical grade-malathion added to a sandy loam soil degraded with a registrant-calculated half-life of approximately 2.5 days in sediment (pH 7.8) and water (pH 8.7). This study provides useful information, but hydrolysis was probably the main route of degradation in the study since the pH of the system was in the basic range which favors hydrolysis. Although most of the residues remained in the water phase (less than 20% of the applied radioactivity was associated with the soil at any sampling interval), the degradation products were similar in both sediment and water phases. The degradation products at maximum concentrations in the water phase were the monocarboxylic acid of malathion (MCA, 28% at Day 4), demethyl monocarboxylic acid (21% at Day 7), dicarboxylic acid (21 % at Day 14) and the demethyl dicarboxylic acid metabolite (39% at Day 45). The degradation products at maximum concentrations in the sediment were the monocarboxylic acid of malathion (4.5% at 6 hours), demethyl monocarboxilic acid (8.1% at Day 45), and dicarboxylic acid (5.2% at Day 4). The EFED calculated half-life for malathion monocarboxylic acid was 11 days.

Aerobic Aquatic Metabolism: A USGS monitoring study (1997) shows detections of malathion in large rural and urban streams. Many open literature studies have been conducted on the fate and persistence of malathion in the aquatic environment. Reported degradation rates vary and are likely to be significantly increased by biodegradation and pH. Eichelberger and Lichtenberg (1971) found 75% and 90% degradation in river water in one and two weeks, respectively. Guerrant *et al* (1970) found malathion half lives in pond, lake, river and other natural waters varied from 0.5 to 10 days and was dependent on pH. Other studies are summarized in Mulla *et al* (1981) and Howard (1991).

Registrant submitted studies were conducted under alkaline conditions which favor hydrolysis. Thus, degradation rate and products may not be representative of acidic aquatic conditions. In the registrant submitted aerobic aquatic metabolism study, a mixture of [2,3-^{14}C]- and technical grade-malathion added to a sandy loam soil rapidly degraded in the aerobic aquatic environment with half-lives of approximately 1.09 days in the water phase (pH 7.8) and 2.55 days in sediment (pH 8.5). As mentioned previously, hydrolysis was probably the main route of degradation in the study since the pH of the system was in the basic range and hydrolysis occurs most rapidly at pH 9. Major degradates in water and soil were similar: mono- and dicarboxylic acids of malathion, demethyl monoacid and demethyl diacid, while in sediment no demethyl diacid was detected. The EFED calculated half-life for malathion monocarboxylic acid was 3 days.

2.4.4.3 Dissipation

Data from the field dissipation studies indicate that malathion dissipates rapidly when applied in the field.

Terrestrial field dissipation: Open literature studies provide varying rates of terrestrial dissipation. Mulla *et al* (1981) summarizes degradation results from several field studies including: no residues after 6 months (Roberts *et al* 1962), and 85% degradation in 3 days and 97% in 8 days (Lichtenstein and Schulz 1964). The fastest route of terrestrial field dissipation is generally accepted to be microbial degradation.

In the registrant submitted field dissipation study using a rate of 1.16 lb ai/A, malathion or maloxon residues were detected at ≤10 µg/kg in the 0-6" layer in cotton/bare ground sites in GA. Due to the sampling depth it is not possible to determine how much malathion remained at the soil surface relative to that which moved through the first six inches. Residues detected in the plots in the 6-12" layer after the 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} treatments averaged 35, 37, 5.6, and 9.4 µg/kg, respectively. Malathion was detected in the 12-18 inch soil depth at 16 µg/kg in one replicate soil sample; however, the detection was attributed to contamination. The detection of malathion below six inches along with the low K_d values reported for malathion make it feasible that leaching below 12 inches may have occurred in the field dissipation studies.

The terrestrial field dissipation half-life could not be determined due to the rapid dissipation of malathion, although it is probably <1 day (MRID 41748901, 43042401, 43166301).

In a field dissipation study located in California, malathion was applied at a maximum rate of 1.16 lb ai/A once a week for 6 weeks. The resulting dissipation half-life was <0.2 days. In certain instances, malathion was detected below the 12 inch soil depth (MRID 41727701, 43042402, 43166301).

Aquatic field dissipation: Open literature references detailing persistence in aquatic environments are briefly mentioned under the aquatic metabolism section.

In the first registrant aquatic field dissipation study located in Missouri, malathion was applied at a maximum rate of 0.58 lb ai/A in three weekly applications to a flooded rice paddy (soil pH 6.1, water pH not stated). Malathion residues detected in water samples collected after the first and second application had dissipated to below the detection limit (10 µg/L) in samples taken prior to the second and third applications. In water samples collected one day after the last application, malathion concentrations averaged 17 µg/L and had decreased to 10 µg/L by the second sampling day. Maloxon residues were 10 µg/L at all sampling dates.

The data indicate a very rapid dissipation of malathion in water, probably <1 day; however, an accurate half-life could not be determined because of the rapid dissipation (MRID 42058402, 43166301).

In the second aquatic field dissipation study performed in California (soil pH 7.4, water pH not stated), malathion was applied at a rate of 0.58 lb ai/A in three weekly applications to flooded plots. The resulting dissipation half-life could not be determined in the California plot because it was probable that only 1-2% of the intended amount of malathion was applied (MRID 42058401, 43166301).

2.4.4.4 Accumulation in Fish

Aquatic bioconcentration factors ranging from 7.36 (lake trout), 29.3 (coho salmon), 869 (white shrimp), to 959 (brown shrimp) are summarized in Howard (1991).

The registrant submitted study shows [^{14}C]malathion residues did not significantly accumulate in bluegill sunfish exposed to 0.99 µg/L [^{14}C]malathion in a flow-through system for 28 days. Average concentrations of malathion were 3.9 to 18 µg/kg in the edible portions of fish, 21 to 130 µg/kg for whole fish, and 34 to 200 µg/kg in the non-edible tissue. [^{14}C]malathion residue equivalents in the edible fish tissue during depuration ranged from 18 µg/kg at the start to 4.8 µg/kg by day 14. Whole fish concentrations decreased from 110 to 4.5 µg/kg and non-edible fish concentrations decreased from 150 to 5.8 µg/kg after day 14. Approximately 73, 96, and 96% of the radioactivity depurated by day 28 from the edible, whole, and non-edible portions of fish, respectively. The non-depurated radioactivity consisted of up to 22 other components present in concentrations <10% of total applied radioactivity and were not further identified.

The only residue detected in fish tissue at >10% of total radioactive residues (TRR) was malathion monocarboxylic acid (MCA) in concentrations of 33.3-35.9% (44.8-61.2 µg/kg) of TRR. Up to 22 other components were present in levels of 0.1 to 5.7% (0.1 to 7.7 µg/kg) and included malathion dicarboxylic acid (MDCA), maloxon, desmethyl malathion, monoethylfumarate and oxalacetic acid. Maloxon was present in concentrations ≤2.7 µg/kg; while parent malathion was present in concentrations of 0.2 µg/kg.

Maximum BCFs, as a function of radioactive residues present, ranged from 4.2 to 18, 23 to 135, and 37 to 204 for edible, whole fish, and non-edible, respectively (MRID 43106401, 43106402, 43340301).

2.4.5 Environmental Transport Summary

Other important routes of dissipation from soil suggested by the data include leaching, plant uptake, and surface runoff. Malathion and its degradates, in general, are soluble and do not adsorb strongly to soils.

Acceptable leaching data on parent malathion indicate that it is mobile in all soils tested (K_ds of 0.82 - 2.47). Acceptable terrestrial field dissipation data indicate rapid dissipation ($T_{1/2}$ = <2 days). One detection of malathion below 12 inches was found in a terrestrial field dissipation study, indicating leaching as a likely route of dissipation. Similarly, column leaching studies demonstrated that malathion and its degradates, malathion mono- and dicarboxylic acids are very mobile in soil. Data presented to the Agency and in the "Pesticides and Groundwater Database" (USEPA 1992) demonstrate that malathion has the potential to leach to ground water. Malathion has been detected in ground water in three states (California, Mississippi, and Virginia) at levels ranging from 0.03 to 6.17 µg/L. Based on these data and the low K_d values, it is clear that malathion has the potential to leach to ground water.

Although little or no maloxon production is observed in registrant submitted aquatic studies, maloxon has been detected in surface waters and the potential for maloxon runoff may be heightened relative to malathion because it is expected to have higher solubility. EFED is not aware of reports of maloxon groundwater contamination. However, malathion has contaminated groundwater in several states and has the potential to contaminate surface water through runoff. The increased polarity of maloxon due to the substitution of oxygen for sulfur increases the expected potential of this chemical to be mobile in soil.

It is clear that under many circumstances malathion degrades rapidly to compounds of lower toxicity, usually through microbial metabolism and hydrolysis. However, in urban areas (*e.g.*, aerial and ground application for mosquito control), it is likely that malathion will contact dry, microbially inactive, and low organic content surfaces such as concrete, asphalt, dry soil, roofing material, and glass. It is expected that maloxon production will be increased on these surfaces as malathion is exposed to air for extended periods until it is washed away by rain. This is supported by maloxon monitoring data in urban streams after malathion treatments to urban areas showing similar or higher levels of maloxon than malathion in some instances (CaEPA, 1981). CaEPA has published two studies measuring maloxon production on dry soil (CaEPA 1993) and steel sheets (CaEPA 1996). Both of these studies showed higher maloxon production than registrant submitted studies, but maximal levels of maloxon production were not achieved. On the steel surface a rainfall event removed most of the malathion after only 2 days. On the dry soil maloxon production did not decrease by the time the study was terminated at 22 days.

CaEPA has published a study describing maloxon production on low organic content soil (0.6%) with a moisture content less than 1% (CaEPA 1993) showing higher maloxon production than registrant submitted studies using soils with higher organic (2-2.7%) and moisture (75% of water holding capacity, capacity not stated) content. Based on the CaEPA data, it appears that maloxon production is favored on dry soils and thus may represent a higher risk scenario for maloxon production and runoff.

Leaching/adsorption/desorption: The short soil persistence of malathion reduces the risk of leaching to groundwater however it has been detected in the groundwater of at least three states (USEPA 1992). Demethyl and carboxylic acid degradates are expected to be highly mobile particularly in alkaline soils.

Based on batch equilibrium (adsorption/desorption) studies, unaged [^{14}C]malathion was determined to be very mobile in sandy loam, sand, loam, and silt loam soils, with Freundlich K_{ads} values of 0.83 - 2.47 and K_{oc} values from 151-183. Adsorption was correlated with organic carbon content. Values for 1/n for K_{ads} were clustered in the range of 0.904 - 0.978 (MRID 41345201).

Maloxon was not detected in any leachate or soil extracts in concentrations ≥0.12% (≥6 µg/L) of applied radioactivity (MRID 43868601, 41345201, 43166301)

Laboratory volatility: Three different malathion formulations [Ready To Use (RTU), Ultra Low Volume (ULV), and Emulsifiable Concentrate (EC)] added to a silt loam soil did not undergo any appreciable volatilization, when measured under different soil moisture regimes or air flow rates. No more than 5.1% of the applied radioactivity volatilized during the 16 days of the study.

Spray Drift: No registrant-submitted spray drift studies were reviewed. A study conducted for the Boll Weevil Eradication Program at Pennsylvania State University (1993) examined malathion drift under conditions of boll weevil control (1 lb/A = 112 mg/m^2) with an ultra-low volume (ULV) formulation. Deposition up to 21.0, 11.5, 2.9, and 0.7% of that applied was observed at 100, 200, 500, and 1000 meters downwind, respectively. Due to the size of the particles generated, the ULV formulation is expected to produce the highest levels of drift.

EFED policy is to assume spray drift is equal to 1% of the applied spray volume from ground applications and 5% from aerial and orchard airblast applications at 100 feet downwind. It is important to note that drift studies on ULV malathion show significantly higher levels of drift.

2.4.6 Degradates and impurities

Technical malathion contains impurities that account for up to 5% of the insecticide. California Department of Food and Agriculture has reported 15 impurities in a representative ultra low volume malathion formulation (CaEPA 1981). These impurities include:

Diethyl fumarate (0.90%);
Diethylhydroxysuccinate (0.05%);
O,O-dimethylphosphorothioate (0.05%);
O,O,O-trimethyl phosphorothioate (0.45%);
O,O,S-trimethyl phosphorodithioate (1.20%);
Ethyl nitrite (0.03%);
Diethyl-bis (ethoxycarbonyl) mercaptosuccinate (0.15%);
S-1,2-ethyl-O,S-dimethyl phosphorodithioate [isomalathion] (0.20%);
S-(1-methoxycarbonyl-2-ethoxycarbonyl)ethyl-O,O-dimethyl phosphorodithioate (0.60%);
Bis-(O,O-dimethyl thionophosphoryl) sulfide (0.30%);
Diethyl methylthiosuccinate (1.00%);
S-ethyl-O,O-dimethyl phosphorodithioate (0.10%);
S-1,2-bis (ethoxycarbonyl) ethyl-O,O-dimethyl phosphorothioate [maloxon] (0.10%);
Diethyl ethylthiosuccinate (0.10%); and
Sulfuric acid (0.05%).

Some malathion (and other organophosphate) impurities can potentiate malathion toxicity and also are toxic alone, but there is almost no data available on their environmental fate. The persistence of a phosphorothioate impurity (O,O,S-trimethyl phosphorothioate) was shown to be 18.7 times longer than malathion in an aerobic soil metabolism study (Miles and Takashima 1991). Some phosphorothioates and -dithioates have been intensively studied and induce a delayed toxic effect to mammals at much lower levels than pure malathion (Ali Fouad and Fukuto 1982, Umetsu *et al* 1977, Fukuto 1983, Aldridge *et al* 1979, Toia *et al* 1980). A phosophorothioate and -dithioate impurity identified by CaEPA (1981) is of lower toxicity than impurities reported in older formulations (Toia *et al* 1980). One hydrolysis product, diethyl fumarate, which is also present as an impurity in technical malathion is approximately 3 times more toxic to fathead minnows than malathion (Bender 1969). No guideline studies have been conducted and little open literature data exist to define the fate and persistence of impurities of malathion, however, most of the highly toxic impurities identified in past studies on malathion (Ali Fouad and Fukuto 1982, Umetsu *et al* 1977, Fukuto 1983, Aldridge *et al* 1979, Toia *et al* 1980) have not been identified or are present only at low levels in more recently produced technical malathion (CaEPA 1981 and confidential information provided by the registrant).

The relative concentration of malathion impurities can vary dramatically depending not only on manufacturing processes but also storage conditions. Umetsu *et al* (1977) concluded "Storage of technical malathion for 3 to 6 months at 40 degrees C resulted in materials which were noticeably more toxic to mice." Therefore, the composition and toxicological properties of the technical malathion are not only affected by initial purity, but also by storage conditions.

One impurity and degradate of malathion is the oxon analog, maloxon, which is also the active acetyl cholinesterase inhibiting component *in vivo*. EFED does not have a complete environmental fate database for maloxon but based on its chemical similarity to malathion (sulfur is replaced by oxygen), the parent and its degradate are expected to have similar chemical properties. The aerobic half-life of maloxon has been reported as 3 and 7 days in basic and acidic soils, respectively (Paschal and Neville 1976). This longer half-life relative to malathion is proposed to be a result of maloxon's biocidal effect on soil microbes which contribute to malathion's degradation.

Malathion impurities and degradates were evaluated for inclusion in the current risk assessment. Because the expected effects of most impurities/degradates (based on their expected concentrations and toxicity) did not exceed the expected effects of malathion, almost all of the malathion impurities/degradates will not be considered further in this risk assessment. Only maloxon is included in this risk assessment as both a degradate and an impurity.

2.4.7 Use Profile

The current labeled uses for malathion represents the FIFRA regulatory action; therefore, use sites and application rates specified on the label form the basis of this assessment. The assessment of use information is critical to the development of the action area and selection of appropriate modeling scenarios and inputs.

The Office of Pesticides Programs' Biological and Economic Analysis Division (BEAD) provides an analysis of both national- and county-level usage information using state-level usage data obtained from USDA-NASS[7], Doane[8], and the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[9]. CDPR PUR is considered a more comprehensive source of usage data within California than USDA-NASS or EPA proprietary databases, and thus the usage data reported by county in this California-specific assessment were generated using CDPR PUR data. From the CDPR PUR data, BEAD generated summaries of average and total usage by year, county, and crop for the years 2001 – 2005 (the most recent data available.)

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

The total pounds of malathion applied in California varies greatly between uses according to the CDPR PUR data set (2001 – 2005). Of the 139 use categories for which malathion was applied, 2 crops (alfalfa and strawberries) accounted for 48% of the total California malathion usage between 2001 and 2005 (Figure 1). Including an additional eight crops (head lettuce, walnut, leaf lettuce, celery, orange, date, lemon, and broccoli) accounts for almost 80% of the total California malathion usage. The combined usage of the 75 crops with the lowest average pounds applied per year only account for slightly less than 1% of the total California malathion usage.

[7] 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.

[8] (www.doane.com; the full dataset is not provided due to its proprietary nature)

[9] 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.

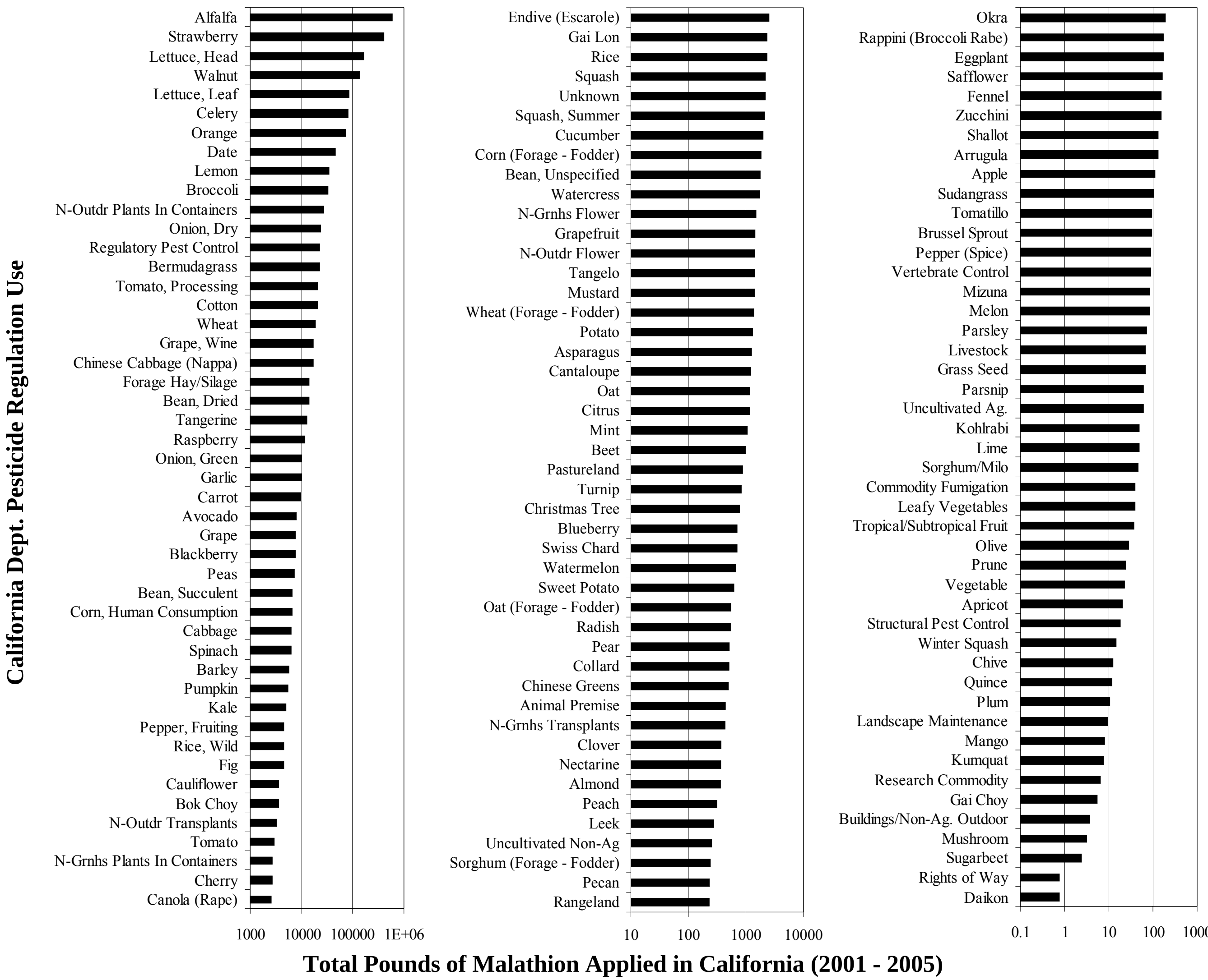


Figure 1. Total pounds of malathion applied for all uses identified in the California Dept. of Pesticide Regulation database from 2001 through 2005.

Based on data reported in the CA PUR database, malathion application varies temporally within years in California (Figure 2). Months with the lowest and highest pounds of malathion applied per month across California are December and August, respectively. Therefore in general, the breeding/egg mass and tadpole phases of the CRLF life cycle tend to occur when less malathion is being applied, while the young juvenile phases occur when more malathion is being applied.

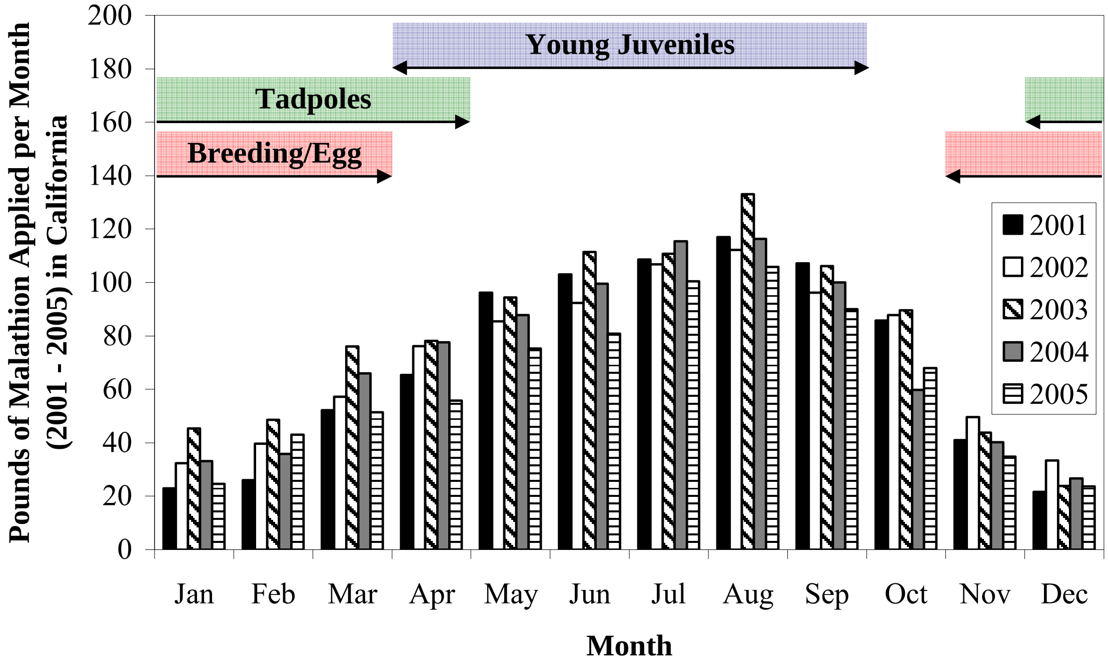


Figure 2. Comparison of phases of the California Red-legged Frog (CRLF) life cycle to total malathion usage in California by month for years 2001 through 2005.

Fifty-three of California's 58 counties reported some usage of malathion from 2001 to 2005. Of the malathion applied in California over this time period, almost 93% was applied in 21 counties (Figure 3). Highest usage (greater than 6% of total California use in each county) was reported in Monterey (14,200 lbs. malathion per year), Imperial (13,700), Kern (12,900), Santa Barbara (10,100), Fresno (7600), and Riverside (6600) counties.

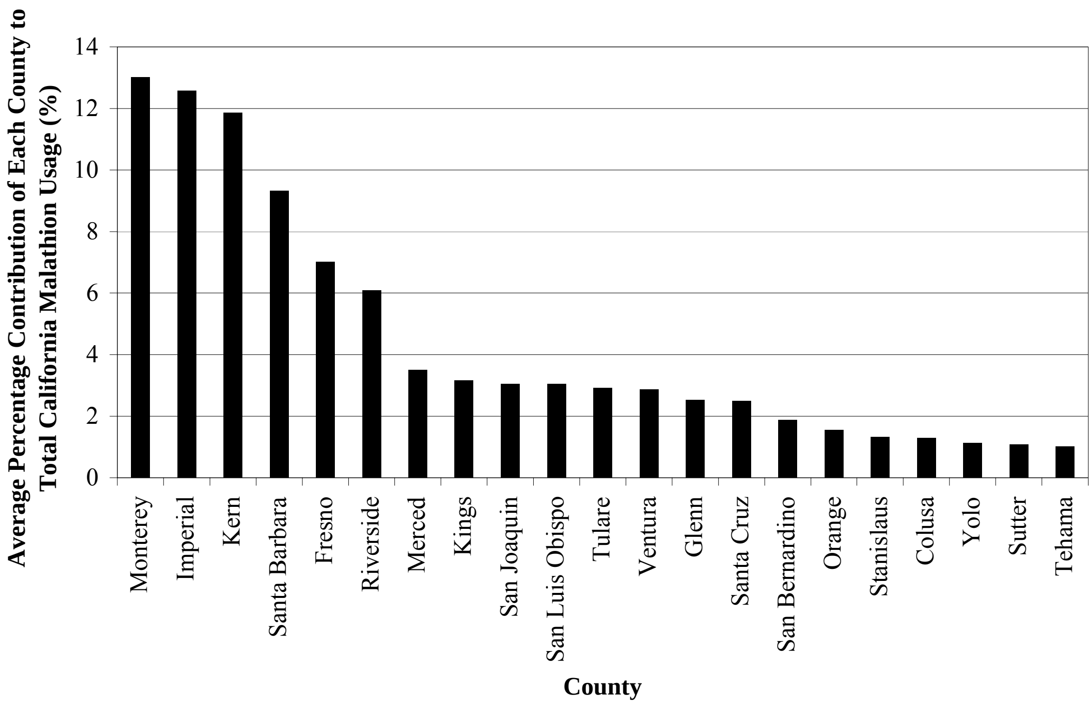


Figure 3. Average percent contribution of counties to total California malathion usage based on 2002 through 2005 California Dept. of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) use data (33 counties contributing less than 1% each are not shown).

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). Final critical habitat for the CRLF was designated by USFWS on April 13, 2006 (USFWS 2006; 71 FR 19244-19346). A brief discussion of distribution, reproduction, diet, and habitat requirements follows, with more detailed information provided in Attachment 1.

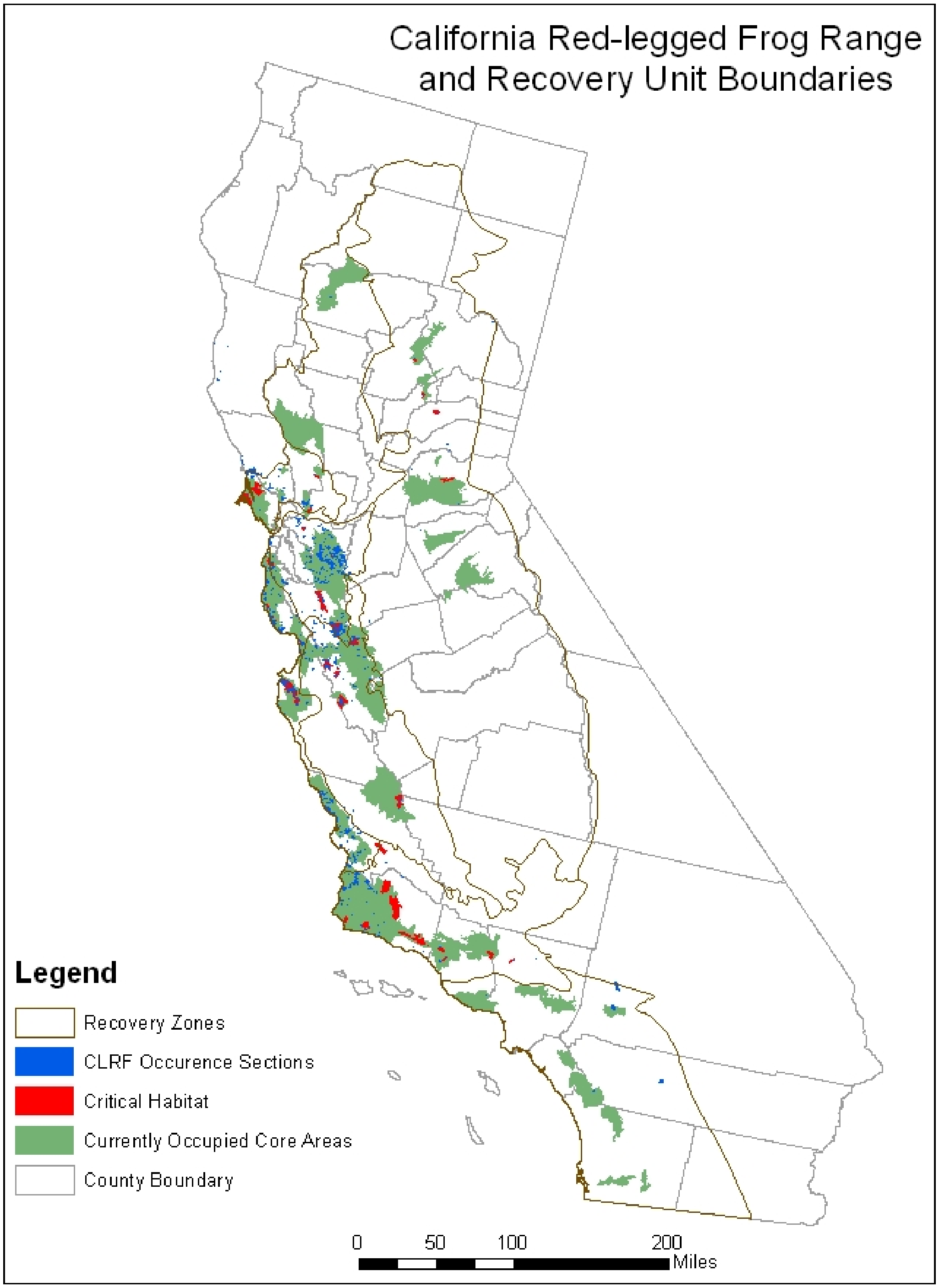
Distribution: The CRLF is endemic to California and Baja California (Mexico) and historically inhabited 46 counties in California, including the Central Valley and both the coastal and interior mountain ranges (USFWS 1996). Spatially, its range has been reduced by approximately 70%, and it currently inhabits 22 counties in California (USFWS 1996). Additionally, 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 populations have been documented below 1,050 meters (3,500 feet) (USFWS 2002).

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

The distribution of CRLF within California is addressed in this assessment using four categories of location. Three of these categories were designated by the USFWS in the recovery plan (recovery units, core areas, and designated critical habitat). The fourth category is known occurrences as reported in the California Natural Diversity Database (CNDDB) (Figure 4). 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. 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 the range of the species.

Recovery Units: Eight recovery units have been established by USFWS for the CRLF. These areas are considered essential to the recovery of the species. 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 status, and therefore, similar recovery goals. The eight recovery units 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.

Core Areas: USFWS has designated 35 core areas to focus recovery efforts. The core areas, which are distributed throughout portions of the historic and current range of the species, are intended to provide for long-term viability of existing populations and reestablishment of populations within the 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.



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

Map created by U.S. Environmental Protection Agency, Office of Pesticides Programs, Environmental Fate and Effects Division. May 5, 2007 (PDB). Projection: Albers Equal Area Conic USGS, North American Datum of 1983 (NAD 1983)

Figure 4. California Red-legged Frog (CRLF) distribution within the United States.

Designated Critical Habitat: Critical habitat was designated for the CRLF on April 13, 2006 (USFWS 2006; 71 FR 19244-19346). Critical habitat was selected for the species based on areas: 1) that are occupied by CRLF; 2) where source populations of CRLF occur; 3) that provide connectivity between source populations; and 4) that are ecologically significant. Designation of critical habitat is based on habitat areas that provide essential life cycle needs of the species or areas that contain primary constituent elements (PCEs) (as defined in 50 CFR 414.12(b)) The designated critical habitat areas for the CRLF are considered to have the following PCEs that justify critical habitat designation (USFWS 2006):

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

Critical habitat does not include certain areas where existing management is sufficient for CRLF protection. For the CRLF, all designated critical habitat units contain all four PCEs and were occupied by the CRLF at the time of listing.

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. For the CRLF specifically, these include, but are not limited to, the following:

- Alteration of water chemistry or temperature;
- Increased sedimentation;
- Alteration of channel or pond morphology;
- Elimination of upland foraging areas;
- Introduction of non-native species; and
- Degradation of prey base.

The critical habitat designation 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.

Other Known CRLF Occurrences: The CNDDB[10] provides location and natural history information on species found in California. It is the best available information for historical and current species location sightings (Figure 4).

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[10] See: http://www.dfg.ca.gov/bdb/html/cnddb_info.html for additional information on the CNDDB.

2.6 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 malathion is likely to encompass considerable portions of the United States based on the large array of agricultural uses and non-agricultural uses. However, the scope of this assessment limits consideration of the overall action area to those portions that may be applicable to the protection of the CRLF and its designated critical habitat within the state of California. Deriving the geographical extent of this portion of the action area is the product of consideration of the types of effects that malathion may be expected to have on the environment, the exposure levels to malathion that are associated with those effects, and the best available information concerning the use of malathion and its fate and transport within the state of California.

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

> All outdoor uses that result in spray drift or run-off exposure are included in the initial area of concern. Indoor uses are not considered part of the action area since exposure of the CRLF is unlikely.

After a determination of which uses will be assessed, an evaluation of the potential "footprint" of the use pattern should be determined. This "footprint" represents the initial area of concern and is based on available land cover data for labeled outdoor uses. Local land cover data available for the state of California were analyzed to refine the understanding of potential malathion use. The initial area of concern is defined as all land cover types that represent the labeled uses described above. Because malathion uses can occur on all of these land cover types, the initial area of concern is considered to be the entire state of California.

Once the initial area of concern is defined, the next step is to compare the extent of that area with the results of the screening level risk assessment. 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 malathion to determine which routes of transport are likely to have an impact on the CRLF.

LOC exceedances are used to describe how far effects may be seen from the initial area of concern. Factors considered include: spray drift, downstream run-off, atmospheric transport, etc. Because LOC exceedances would be expected to occur on all land cover types, the final action area is determined to be the entire state of California.

2.7 Assessment Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected."[11] Selection of the assessment endpoints is based on valued entities (*e.g.*, CRLF, organisms important in the life cycle of the CRLF, and the PCEs of its designated critical habitat), the ecosystems potentially at risk (*e.g.*, water bodies, riparian vegetation, and upland and dispersal habitats), the migration pathways of malathion (*e.g.*, runoff, spray drift, etc.), and the routes by which ecological receptors are exposed to malathion related contamination (*e.g.*, direct contact, etc).

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

A complete discussion of all the toxicity data available for this risk assessment, including resulting measures of ecological effect selected for each taxonomic group of concern, is included in Section 4 of this document. A summary of the assessment endpoints and measures of ecological effect selected to characterize potential assessed direct and indirect CRLF risks associated with exposure to malathion is provided in Table 5.

Table 5 Assessment endpoints and measures of ecological effects.

Assessment Endpoint	Measures of Ecological Effects
Aquatic Phase (Eggs, larvae, tadpoles, juveniles, and adults)[a]	
Direct Effects	
1. Survival, growth, and reproduction of CRLF	Acute malathion: Indian bullfrog larval LC_{50} 0.59 µg/L Acute maloxon: Indian bullfrog larval LC_{50} 0.59 µg/L adjusted for oxon potency (0.59/92.9) Chronic malathion: Fish ACR 40.6 applied to acute endpoint (0.59/40.6) Chronic maloxon: as above divided by 92.9

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

Assessment Endpoint	Measures of Ecological Effects
Indirect Effects and Critical Habitat Effects	
2. Survival, growth, and reproduction of CRLF individuals via indirect effects on aquatic prey food supply (*i.e.,* fish, freshwater invertebrates, and non-vascular plants)	Acute malathion: rainbow trout LC_{50} 4 µg/L Acute maloxon: rainbow trout LC_{50} 4 µg/L adjusted for oxon potency (4/92.9) Chronic malathion: Fish ACR 40.6 applied to acute endpoint (4/40.6) Chronic maloxon: as above divided by 92.9 Acute malathion: daphnid EC_{50} 0.01 µg/L Acute maloxon: daphnid EC_{50} 0.01 µg/L adjusted for oxon potency (0.01/92.9) Chronic malathion: Invertebrate ACR 392 applied to acute endpoint (0.01/392) Chronic maloxon: as above divided by 92.9 Non-vascular plant (freshwater algae) acute EC_{50} 2040 µg/L and NOEC 500 µg/L (malathion and oxon equipotent)
3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community)	Malathion and oxon assumed equipotent Vascular plant acute EC_{50} not available, NOAEC 24,065 µg/L for acute endpoint Non-vascular plant (freshwater algae) acute EC_{50} 2040 µg/L and NOEC 500 µg/L
4. Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation	No adverse effects assumed based on available toxicity data
Terrestrial Phase (Juveniles and adults)	
Direct Effects	
5. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles[b]	Malathion acute: Ring-necked pheasant LD_{50} 1485 mg/kg-bw Maloxon acute: Acute malathion endpoint divided by 92.9 potency adjustment (1485/92.9) Malathion chronic: Bobwhite quail chronic NOAEC 110 mg/kg-diet Maloxon chronic: malathion acute endpoint divided by 92.9 potency adjustment (110/92.9)
Indirect Effects and Critical Habitat Effects	
6. Survival, growth, and reproduction of CRLF individuals via effects on terrestrial prey (*i.e.,* terrestrial invertebrates, small mammals, and frogs)	Invertebrate: alfalfa leafcutter bee 96hr LD_{50} 0.000285 µg/animal assumed equipotency malathion and maloxon Malathion acute: rat LD_{50} 3400 mg/kg-bw Maloxon acute: malathion acute endpoint divided by 92.9 potency (3400/92.9) Malathion chronic: rat reproduction NOAEC 240 mg/kg/day Maloxon chronic: malathion chronic endpoint divided by 92.9 potency (240/92.9) Malathion acute: Ring-necked pheasant LD_{50} 1485 mg/kg-bw Maloxon acute: Acute malathion endpoint divided by 92.9 potency adjustment (1485/92.9) Malathion chronic: Bobwhite quail chronic NOAEC 110 mg/kg-diet Maloxon chronic: malathion acute endpoint divided by 92.9 potency adjustment (110/92.9)

Assessment Endpoint	Measures of Ecological Effects
7. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.,* riparian vegetation)	No adverse effects assumed based on available toxicity data

[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.

Measures of effect and assessment endpoints defined for indirect effects also apply to critical habitat. Assessment endpoints used for the analysis of designated critical habitat are based on the adverse modification standard established by USFWS (2006).

Assessment endpoints and measures of ecological effect selected to characterize potential modification to designated critical habitat associated with exposure to malathion are listed below. Adverse modification to the critical habitat of the CRLF includes the following, as specified by USFWS (2006):

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

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.

2.8 Risk Assessment Conceptual Model

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 malathion to the environment.

2.8.1 Risk Hypotheses

The following risk hypotheses are presumed for this listed species assessment:

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

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

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

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

- Labeled uses of malathion 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 malathion 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 CRLF;

- Labeled uses of malathion 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 malathion 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 malathion 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 CRLF.

2.8.2 Assessment Diagrams

The assessment diagrams are graphic representations of the structure of the risk assessment. It specifies the stressor (malathion) release mechanisms, biological receptor types, and effects endpoints of potential concern. Exposure routes shown in dashed lines are not quantitatively considered because the resulting exposures are expected to be so low as not to cause adverse effects to the CRLF.

The conceptual model for *direct* effects to the aquatic phase of the CRLF's life cycle from malathion uses is shown in Figures 5. Long-range atmospheric transport is not expected due to the non-volatility and non-persistent nature of malathion. Groundwater transport is considered quantitatively through PRZM model, but is considered to be a relatively minor source due to the non-persistence of malathion, even when its mobility in soil is considered. Lastly, adverse affects of malathion to riparian terrestrial vegetation and aquatic vegetation are likely to be negliglble because malathion is an insecticide used to protect a wide variety of crops to which it is directly applied and its mechanism of action (Section 2.4.2) is not expected to affect vegetation. The operative routes of exposure will be spray drift at the time of application and run-off due to precipitation within a few days of application.

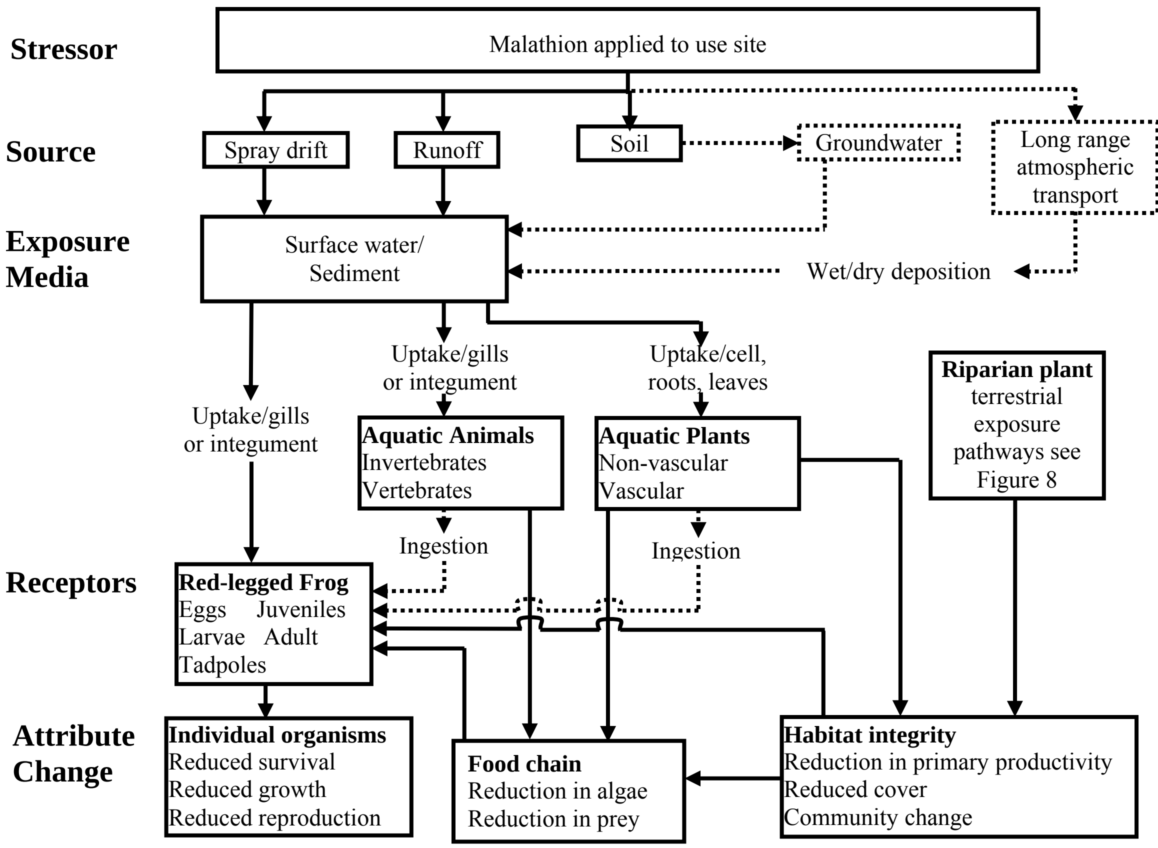


Figure 5. Conceptual model for direct malathion effects on the aquatic phase of the California Red-Legged Frog. Compartments and pathways in dashed lines are considered possible but not of sufficient significance to warrant quantification in the assessment.

The conceptual model for *direct* effects to the terrestrial phase of the CRLF's life cycle from malathion uses is shown in Figures 6. Again, long-range atmospheric transport is not expected due to the non-volatility and non-persistent nature of malathion, and adverse affects of malathion to vegetation are not expected. The operative routes of exposure will be through direct application and spray drift at the time of application.

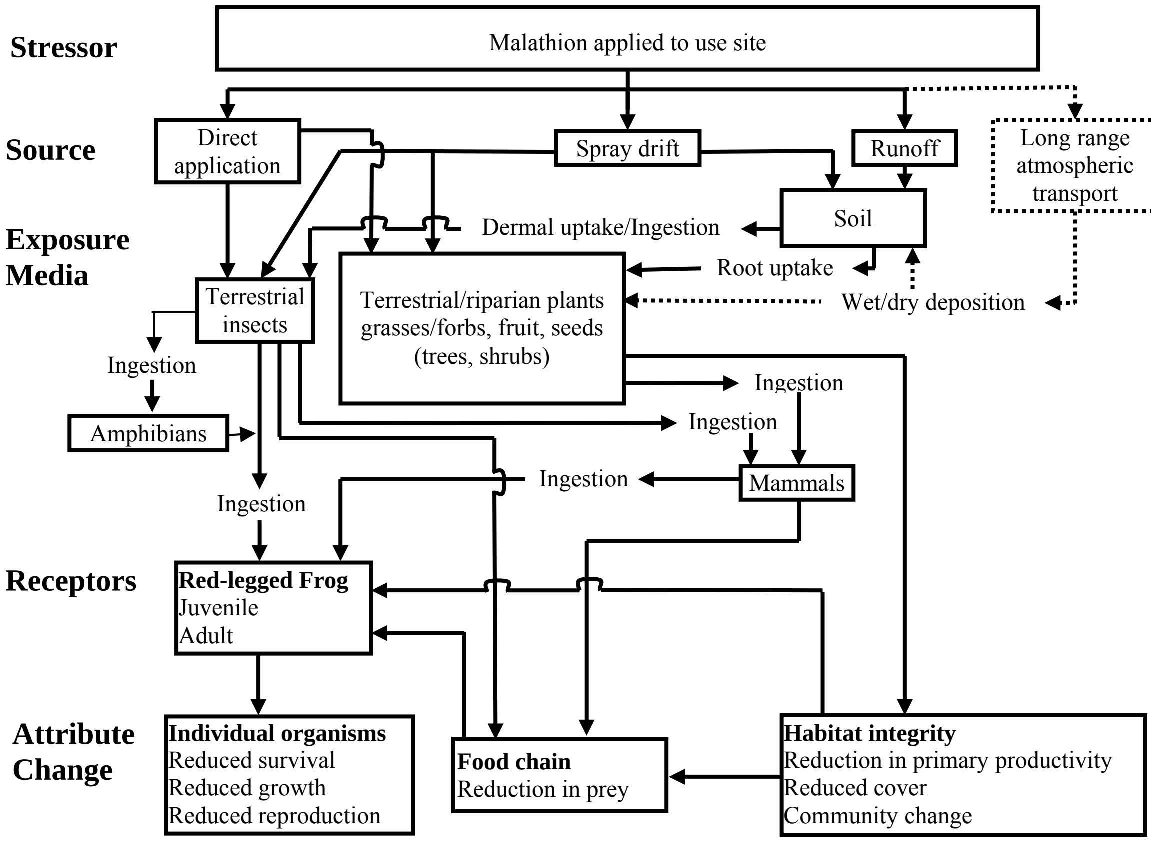


Figure 6. Conceptual model for malathion effects on the terrestrial phase of the California Red-legged Frog. Compartments and pathways in dashed lines are considered possible but not of sufficient significance to warrant quantification in the assessment.

The conceptual model for *indirect* effects to the aquatic phase of the CRLF's critical habitat from malathion uses is shown in Figures 7. Long-range atmospheric transport is not expected due to the non-volatility and non-persistent nature of malathion. Groundwater transport is considered quantitatively through PRZM model, but is considered to be a relatively minor source due to the non-persistence of malathion, even when its mobility in soil is considered. Lastly, adverse affects of malathion to riparian terrestrial vegetation and aquatic vegetation are likely to be negliglble because malathion is an insecticide used to protect a wide variety of crops to which it is directly applied and its mechanism of action (Section 2.4.2) is not expected to affect vegetation. The operative routes of exposure will be spray drift at the time of application and run-off due to precipitation within a few days of application.

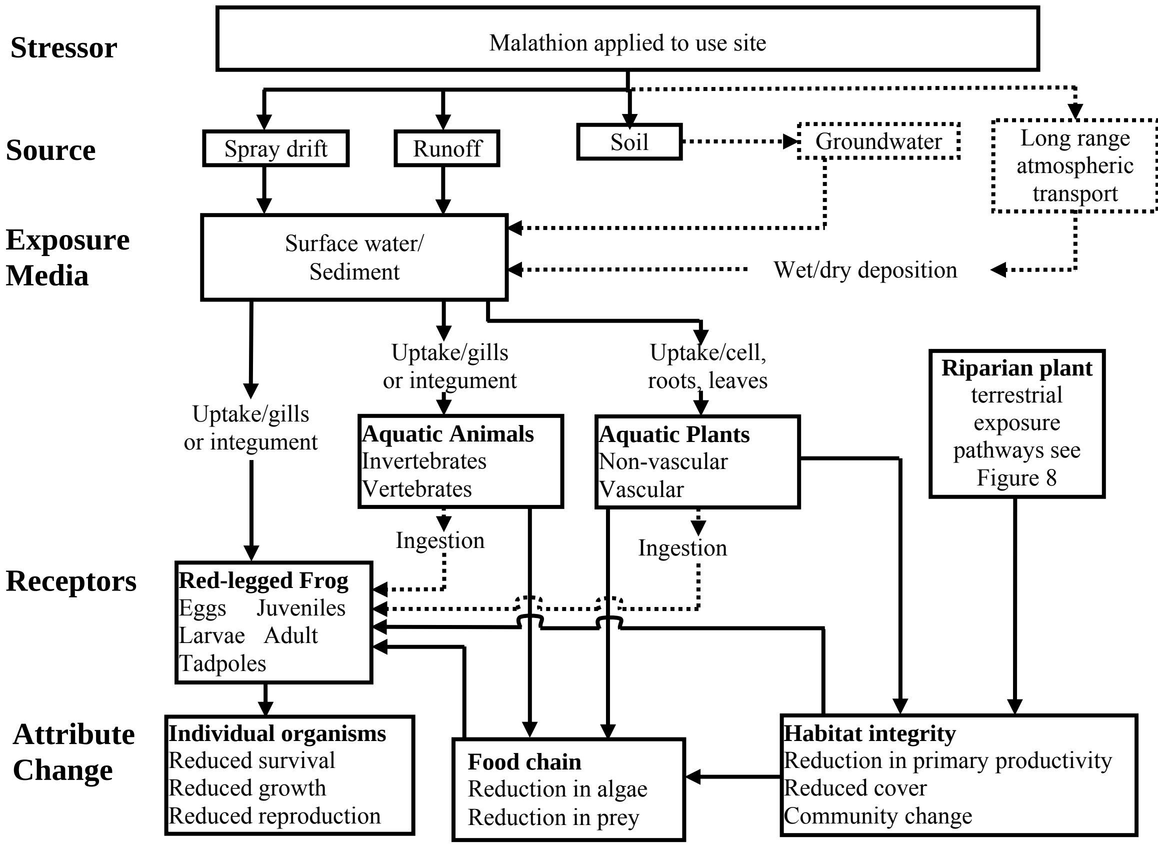


Figure 7. Conceptual model for malathion effects on the aquatic component of California Red-legged Frog critical habitat. Compartments and pathways in dashed lines are considered possible but not of sufficient significance to warrant quantification in the assessment.

The conceptual model for *indirect* effects to the terrestrial phase of the CRLF's critical habitat from malathion uses is shown in Figures 8. Again, long-range atmospheric transport is not expected due to the non-volatility and non-persistent nature of malathion, and adverse affects of malathion to vegetation are not expected. The operative routes of exposure will be through direct application and spray drift at the time of application.

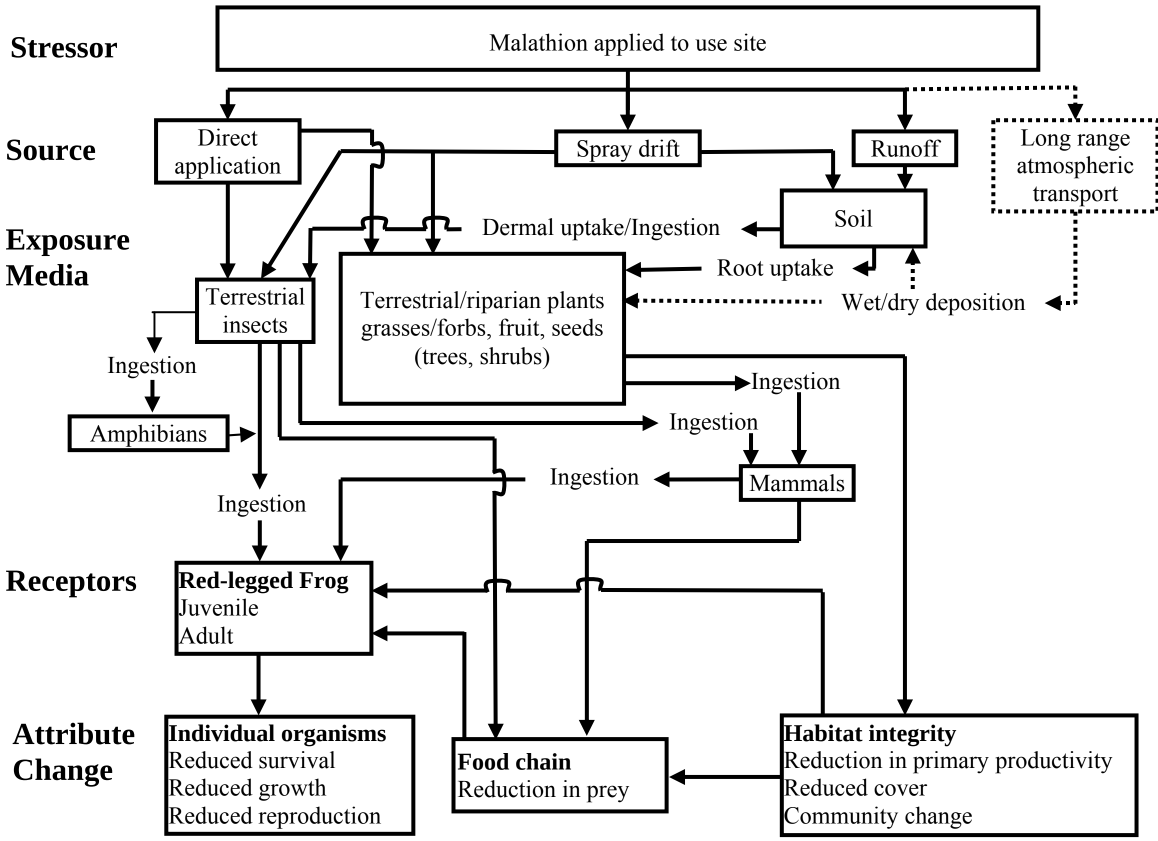


Figure 8. Conceptual model for malathion effects on the terrestrial component of California Red-legged Frog critical habitat. Compartments and pathways in dashed lines are considered possible but not of sufficient significance to warrant quantification in the assessment.

2.9 Analysis Plan

Analysis of risks to the California Red-Legged Frog (both direct and indirect) and to its critical habitat will be assessed consistent with the Overview Document (USEPA, 2004) and Agency guidance for ecological risk assessments (USEPA 1998).

There are a number of labeled uses for malathion for indoor applications. These applications have been considered. There is no exposure pathway from indoor applications to the CRLF or its habitat and therefore, indoor applications are determined to have No Effect on the CRLF.

2.9.1 Exposure Analysis

Direct effects to the aquatic phase CRLF will be assessed by comparing modeled surface water exposure concentrations of malathion and its impurity/degradate maloxon to acute and chronic effect concentrations for aquatic phase amphibians from laboratory studies (see the Effects Analysis section below). Effects to aquatic dietary food resources (aquatic invertebrates, algae) of the aquatic phase CRLF or effects to aquatic habitat that support the CRLF will also be assessed by comparing modeled surface water exposure concentrations of total malathion residues to laboratory established effect levels appropriate for the taxa.

Surface water concentrations of malathion and maloxon will be quantified using PRZM-EXAMS. The standard EXAMS water body of 2 meters maximum depth, and 20,000 cubic meters volume, will be used. Because malathion is applied by numerous application methods, the model accounts for loading of malathion into the surface water via spray drift, run-off and erosion. Agricultural scenarios appropriate for labeled malathion uses will be used to account for local soils, weather and growing practices which impact the magnitude and frequency of malathion and maloxon loading to the surface water. Maximum labeled application rates, with maximum number of applications and shortest intervals, will be used to help define (1) the Action Area within California for the Federal Action and (2) for evaluating effects to the CRLF.

Concentrations of malathion/maloxon estimated by PRZM-EXAMS represent malathion/maloxon loading in water bodies adjacent to any treated field and assume that the concentration applies to any water body within the treated area.

Risks to the terrestrial phase CRLF will be assessed by comparing modeled exposure to effect concentrations from laboratory studies. Exposure in the terrestrial phase will be quantified using the TREX model, which automates the calculation of dietary exposure according to the Hoerger-Kenaga nomogram, as modified by Fletcher (1994). The nomogram tabulates the 90th and 50th percentile exposure expected on various classes of food items, and scales the exposure (in dietary terms) to the size and daily food intake of several size classes of birds and mammals. Birds are also used as surrogates to represent reptiles and terrestrial-phase amphibians. A foliar decay half-life of 5.5 days, the maximum for malathion found in Willis and McDowell (1987) will be substituted for the default 35-day value. Effects from maloxon are not considered quantitatively as LOC is expected to be exceeded for parent malathion.

2.9.2 Effects Analysis

As previously discussed in Section 2.7, assessment endpoints for the frog include direct toxic effects on survival, reproduction, and growth of the species itself, as well as indirect effects, such as reduction of the prey base and/or modification of CRLF habitat. Direct effects to the CRLF are based on toxicity information for freshwater fish and birds, which are generally used as a surrogate for aquatic and terrestrial phase amphibians, respectively. The open literature will be screened also for available frog toxicity data. Indirect effects to the CRLF are assessed by looking at available toxicity information relative to the frog's prey items and habitat requirements (freshwater invertebrates, freshwater vertebrates, aquatic plants, terrestrial invertebrates, terrestrial vertebrates, and terrestrial plants). Both guideline and open literature toxicity data will be identified and evaluated for use in determining RQ values.

Toxicity studies for malathion degradates (where available) will be discussed for exposure to the aquatic phase of the CRLF and incorporated into this risk assessment.

2.9.3 *Action Area Analysis*

The Action Area for the federal action is the geographic extent of exceedence of Listed species Levels of Concern (LOC) for any taxon or effect (plant or animal, acute or chronic, direct or indirect) resulting from the maximum label-allowed use of malthion. To define the extent of the Action Area, the following exposure assessment tools will be used: PRZM-EXAMS, TREX, AgDrift, and ArcGIS, a geographic information system (GIS) program. Other tools may be used as required if these are inadequate to define the maximum extent of the Action Area.

To determine the downstream extent of the Action area for any aquatic effects, malathion residues are also estimated for downstream from the treated areas by assuming dilution with stream water (derived from land area) from unaffected sources propagating downstream, until a point is reached beyond which there are no relevant LOC exceedances. Once the distribution of predicted stream water concentrations is obtained, it is further processed using a model that calculates expected dilution in the stream according to contributing land area. As the land area surrounding the field on which malathion is applied is enlarged, it encompasses a progressively greater drainage area; in effect, a progressively larger 'sub-watershed' is created, with a concomitant increase in dilution at the drainage point. This drainage point moves down-gradient along the stream channel as the sub-watershed is expanded. At a certain point the predicted stream concentrations will fall below the LOC. The area below this point is then assumed not to be at risk, with the upstream areas (up to the initial application area) assumed to present the potential for (direct and indirect) impact on the RLF. Additional malathion inputs within the same watershed will cause the area bounded by (that is, within) the LOC to increase, extending the length of stream that is likely to be impacted.

In order to determine the extent of the action area downstream from the initial area of concern, the Agency will need to complete the screening level risk assessment. Once all aquatic risk quotients (RQs) are calculated, the Agency determines which RQ to level of concern (LOC) ratio is greatest for all aquatic organisms (plant and animal). For example, if both fish and aquatic plants have the same RQ of 1, the fish RQ to LOC ratio (1/0.05) would be greater than for plants (1/1). Therefore, the Agency would identify all stream reaches downstream from the initial area of concern where the PCA (percent cropped area) for the land uses identified for malathion are greater than 1/20, or 5%. All streams identified as draining upstream catchments greater than 5% of the landclass of concern, will be considered part of the action area.

3. Exposure (Fate) Assessment

Exposure is the contact or co-occurrence between a stressor (malathion) and a receptor (the CRLF and the habitat upon which it depends). The objective of exposure assessment is to describe exposure in terms of intensity, space, and time in units that can be combined with the effects assessment (USEPA 1998) presented in section 4.

3.1 Label Application Rates and Intervals

There are many currently permitted uses for malathion listed on pesticide labels. Each use will potentially provide a different exposure of CRLF to malathion and/or its degradates in terms of intensity, space, and time.

EFED uses models to estimate the intensity and duration of exposure of organisms to chemicals concentrations in the environment that are appropriate for locations at which the exposure of malathion and/or its degradates will co-occur with the CRLF. Because it would be unwieldy and impractical to evaluate each individual malathion use, uses that produce similar exposures (in terms of intensity, space, and time) are grouped together and evaluated as a single exposure scenario. In this way, the large number of malathion uses that vary greatly in terms of potential exposure can be grouped into a more manageable number of exposure scenario groups (60) that relatively accurately reflect the exposure expected from each of the label-permitted malathion uses.

Because the purpose of the exposure assessment is to determine if the currently permitted label uses do not harm the CRLF, worst case, yet realistic, scenarios (conservative assumptions) are developed for each use. However as shown in subsequent sections, the paucity of information given on many malathion labels regarding the time of year when malathion can be applied, the number of applications per year or crop-cycle, and the minimum time until additional malathion treatments could be applied required that assumptions be made in the design of these “realistic, yet conservative, scenarios”.

3.1.1 Application Rates

Maximum application rates were used in each scenario in order to ensure the scenarios were conservative (protective of CRLF). However, up to three different kinds of maximum application rates were identified for each scenario group in Table 6 – home and garden rate (labeled “H&G” in the following tables), aerial (labeled “air”), and rates that were not considered to be a home and garden or aerial rate (labeled “other”). Home and garden malathion uses often have application rates when converted to lbs. ai/A that are much higher than the corresponding agricultural uses, but are applied to much smaller areas (and therefore, assumed to be applied to only a portion of the watershed of the standard pond that EFED uses to assess aquatic impacts). The maximum home and garden rates from each crop/site were evaluated collectively and used to develop the residential exposure scenario. Air uses are those uses for which EFED policy applies a default spray drift fraction of 5% for modeling purposes. These uses include aircraft and air blast application methods. Other uses are those uses for which EFED policy applies a default spray drift fraction of 1% for modeling purposes.

Table 6. A partial listing[a] of applicable labels and maximum aerial (air), home and Garden (H&G), and non-aerial (other) for each crop/site grouping.

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
	Agricultural Uses	
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 50% Emulsifiable (19713-330), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 2 Other: 2 H&G: 2
2. Macadamia Nut (Bushnut)	Cythion 8 Aquamul (34704-474), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: 15 Other: 15 H&G: 15
3. Pecan and Walnut (English/Black)	Atrapa 5E (4787-44), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: 12.5 Other: 12.5 H&G: 12.5
4. Chestnut	Clean Crop Malathion 57EC (34704-108) and Cythion 8 Aquamul (34704-474)	Air: 5 Other: 5 H&G: 5
5. Almond	Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), and Malathion ULV Concentrate Insecticide (CA83001200)	Air: 1.25 Other: 4 H&G: 4
6. Date	Clean Crop Malathion 8 EC Insecticide (34704-119), Gowan Malathion 5 Dust (10163-142), and Niagara Malathion 5 Dust (34704-721)	Air: 1 Other: 2 H&G: 2
7. Filbert (Hazelnut)	Clean Crop Malathion 57EC (34704-108) and Malathion ULV Concentrate Insecticide (CA83001200)	Air: .625 Other: .625 H&G: .625
8. Avocado	Atrapa 5E (4787-44), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: 9 Other: 9 H&G: 9

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 25 Other: 25 H&G: 25
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 2.5 Other: 2.5 H&G: 25.8
11. Corn (Unspecified, Field, Pop, and Sweet), and Millet (Foxtail)	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 1.5 Other: 1.5 H&G: 12.9
12. Cotton	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 50% Emulsifiable (19713-330), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 4 Other: 4 H&G: 4
15. Apricot	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 10 Other: 10 H&G: 10

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
16. Nectarine and Peach	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 9 Other: 9 H&G: 9
17. Cherry	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 8 Other: 8 H&G: 8
18. Fig	Atrapa 5E (4787-44), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: 2.5 Other: 2.5 H&G: 2.5
19. Apple, Pear, and Quince	Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Malathion ULV Concentrate Insecticide (CA83001200), and ProKil Malathion 25-WP (10163-61)	Air: 1.25 Other: 1.5 H&G: 1.5
20. Guava, Mango, Plum, and Prune	Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: .75 Other: 1.5 H&G: 1.5
21. Papaya	Malathion ULV Concentrate Insecticide (CA83001200) and Prentox 5lb Malathion Spray (655-777)	Air: .175 Other: .175 H&G: 1.25
22. Garlic and Leek	Atrapa 5E (4787-44), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 8E (10163-21)	Air: 2 Other: 2 H&G: 21.5

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
23. Grapes	Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 2.75 Other: 27.47 H&G: 2.75
26. Brussel Sprouts and . Dandelion	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 2.5 Other: 2.5 H&G: 12.9
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 2 Other: 2 H&G: 21.5
28. Peppermint	Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 8E (10163-21)	Air: 1 Other: 1 H&G: 10.75
29. Eggplant	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), and Prentox Malathion 57% E.C. (655-794)	Air: 3.5 Other: 3.5 H&G: 21.5
30. Pumpkin	Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 25-WP (10163-61)	Air: 2 Other: 2 H&G: 21.5

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 1.875 Other: 1.875 H&G: 21.5
32. Onion (Unspecified and Green), Radish, and Shallot	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 2 Other: 2 H&G: 17.2
33. Potato - White/Irish	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 3 Other: 3 H&G: 17.2
34. Turnip	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 25-WP (10163-61)	Air: 2.5 Other: 2.5 H&G: 12.9
35. Parsnip and Rutabaga	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 2 Other: 2 H&G: 12.9
36. Sweet Potato	Atrapa 5E (4787-44), Clean Crop Malathion 57EC (34704-108), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 8E (10163-21)	Air: 1.875 Other: 1.875 H&G: 21.5

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
37. Bermudagrass, Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 1.25 Other: 1.25 H&G: 1.25
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 50% Emulsifiable (19713-330), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV (19713-540), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 2.5 Other: 2.5 H&G: 25.8
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 2 Other: 2 H&G: 17.2
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion ULV (10163-44)	Air: 1.75 Other: 1.75 H&G: 12.9

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
43. Celery	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 1.5 Other: 1.5 H&G: 10.75
44. Asparagus and Safflower (Unspecified)	Clean Crop Malathion 57EC (34704-108), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), and ProKil Malathion 25-WP (10163-61)	Air: 1.25 Other: 1.25 H&G: 1.25
45. Anise	Drexel Malathion 5EC (19713-217), Prentox 5lb Malathion Spray (655-777), and Prentox Malathion 57% E.C. (655-794)	Air: .9375 Other: .9375 H&G: 10.75
46. Strawberry	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Penco Malathion W-25 (655-549), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), ProKil Malathion 25-WP (10163-61), and ProKil Malathion 8E (10163-21)	Air: 2 Other: 2 H&G: 17.2
47. Sugar Beet	Clean Crop Malathion 57EC (34704-108) and Clean Crop Malathion 8 EC Insecticide (34704-119)	Air: 1.875 Other: 1.875 H&G: 1.875
48. Tomato	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 25-WP (10163-61)	Air: 3.5 Other: 3.5 H&G: 37.63
49. Okra	Atrapa 5E (4787-44), Clean Crop Malathion 57EC (34704-108), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 8E (10163-21)	Air: 1.5 Other: 1.5 H&G: 12.9

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
51. Sorghum	Atrapa 5E (4787-44), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 1.5 Other: 1.5 H&G: 1.5
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 25-WP (10163-61), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 1.25 Other: 1.25 H&G: N.A.
53. Gooseberry	Clean Crop Malathion 57EC (34704-108), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: 16 Other: 16 H&G: 16
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Penco Malathion W-25 (655-549), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: 4 Other: 4 H&G: 7
55. Blueberry	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 2.5 Other: 2.5 H&G: 2.5

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
56. Caneberries and Currant	Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: 2 Other: 2 H&G: 2
57. Passion Fruit (Granadilla)	Cythion 8 Aquamul (34704-474), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion ULV Concentrate Insecticide (CA83001200), and ProKil Malathion 8E (10163-21)	Air: .75 Other: .75 H&G: .7813
58. Mint and Spearmint	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 8E (10163-21)	Air: 1 Other: 1 H&G: 10.75
59. Rice and Wild Rice	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), Prentox 5lb Malathion Spray (655-777), ProKil Malathion 8E (10163-21), and ProKil Malathion ULV (10163-44)	Air: 1.5625 Other: 1.5625 H&G: 2
61. Water Cress	Atrapa 5E (4787-44), Clean Crop Malathion 8 EC Insecticide (34704-119), Cythion 8 Aquamul (34704-474), Drexel Malathion 5EC (19713-217), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), Prentox Malathion 57% E.C. (655-794), and ProKil Malathion 8E (10163-21)	Air: 2 Other: 2 H&G: 12.9
Non-agricultural Uses		
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Atrapa 5E (4787-44), Cythion 8 Aquamul (34704-474), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: 3.2 Other: 3.2 H&G: N.A.
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Atrapa 5E (4787-44), Atrapa 8E (4787-46), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Cythion 8 Aquamul (34704-474), Cythion ULV Concentrate Insecticide (19713-288), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 5EC (66330-220), Malathion 8EC (66330-248), Prentox 5lb Malathion Spray (655-777), and ProKil Malathion 8E (10163-21)	Air: .6 Other: .6 H&G: .6
Nursery. Outdoor Nursery	N.A.	Air: 2.25[b] Other: 2.25[b]

Scenario Group. Crop/Site	**Labels with Crop/Site (Registration Numbers)**	**Maximum Lbs. ai/A**
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion ULV Concentrate Insecticide (19713-288), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), and ProKil Malathion ULV (10163-44)	Air: .6119 Other: .1361 H&G: N.A.
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Atrapa 5E (4787-44), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion ULV Concentrate Insecticide (19713-288), Malathion 55 Insecticide Premimum Grade (34704-3), Malathion 8EC (66330-248), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (CA83001200), ProKil Malathion 25-WP (10163-61), and ProKil Malathion ULV (10163-44)	Other: .25[c]
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Atrapa 8E (4787-46), Clean Crop Malathion 57EC (34704-108), Clean Crop Malathion 8 EC Insecticide (34704-119), Clean Crop Malathion 8E Insecticide (34704-452), Clean Crop Malathion ULV Concentrate Insecticide (34704-565), Cythion ULV Concentrate Insecticide (19713-288), Malathion Insecticide (ULV) (66330-219), Malathion ULV (19713-540), Malathion ULV Concentrate Insecticide (34704-18), and Prentox 5lb Malathion Spray (655-777)	Air: .9281 Other: .9281 H&G: 2.5
Turf. Golf Course Turf	Atrapa 8E (4787-46) and Malathion 8EC (66330-248)	Air: 1.25 Other: 1.25

[a] Because of the large number of malathion labels, only a select subset of labels (see text) was evaluated. Additional current labels may include these crop/sites, but should not exceed the maximum application rates indicated in this table.

[b] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).

[c] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

No label rates appear to specifically address outdoor nursery uses, while the CDPR PUR data indicates that such uses exist. (In this case, it is assumed that such uses are permitted under numerous label uses.) An outdoor nursery scenario group was created to address this use. To estimate a suitable application rate, the average application rate of 2.23 lbs/A as indicated in the 2001-2005 CDPR PUR data was rounded upward to 2.25 lbs. ai/A for this scenario group (Table 6).

A residential scenario was constructed based on the maximum home and garden application rates. The citrus home and garden application rate of 25 lbs. ai/A was used. It is assumed that only one hundredth of the standard 10 acre residential watershed (0.1 acre) would be treated at such a rate on any given week, but that similar applications might occur every week over ten consecutive weeks. (Each week's application(s) may be to the same or different portions of the watershed.). The application rate is adjusted to reflect that only one hundredth of the watershed has malathion applied to it by dividing the application rate by 100 to get an effective application rate of 0.25 lbs. ai/A applied over the entire watershed (Table 6).

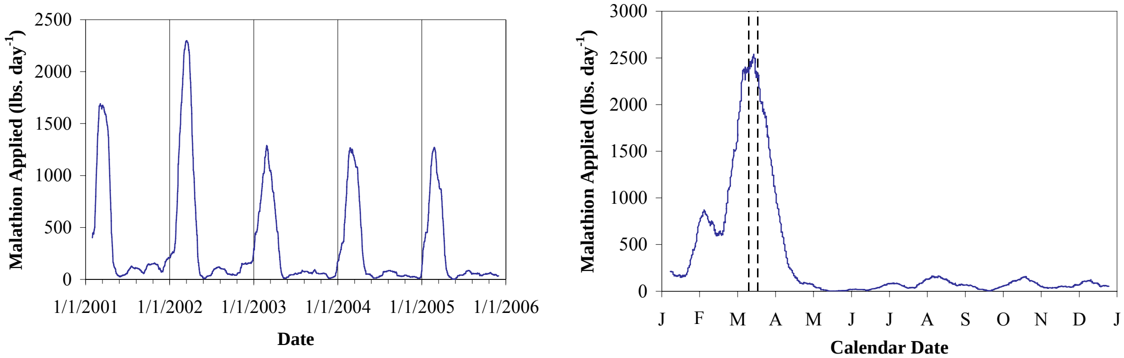
3.1.2 Application Timing

Two different sources of information were used to determine the timing of malathion applications for each scenario group. The maximum number of applications per growing season and minimum days before re-treatment with malathion were obtained from the Label Use Information System (LUIS) report produced by OPP, BEAD. Because the majority of the current labels do not provide this information, the maximum number of applications and minimum days before re-treatment provided on any of the labels listed for each exposure scenario group in Table 6 were used (missing values excluded). Where no label relevant to the exposure scenario group provides this information, the applications per growing season and re-treatment interval were estimated from the most similar scenario groups (Table 8).

Application dates for each crop/site were derived from the CDPR PUR data set. For each exposure scenario group, trends in malathion application (lbs/day) were obtained using moving averages (Figure 9). Inter-year variation in malathion application are depicted using a 60-day moving average for CDPR PUR data from 2001-2005 in the left graphs of Figure 9. This graph provides some indication of whether intra-annual temporal trends in malathion applications are consistent between years. The right-hand graphs show a 16-day moving average calculated across all 5 years of CDPR PUR data. (This can be thought of as the *average* moving-average for these years.) The peak of the right graph is used to calculate the midpoint of the malathion application period used in each PRZM scenario. Using this peak value and the applications per growing season and re-treatment intervals from Table 8, the first and last scenario application days (dashed lines in Figure 9) are calculated to bracket the peak of the malathion application for each exposure scenario group.

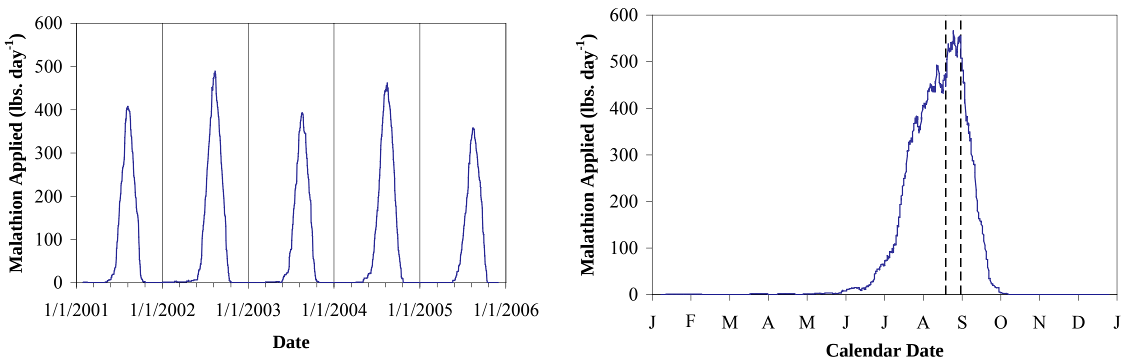
Agricultural Uses

1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch



2. Macadamia Nut (Bushnut) – *No data in CaPUR*

3. Pecan and Walnut (English/Black)



4. Chestnut – *No data in CaPUR*

5. Almond

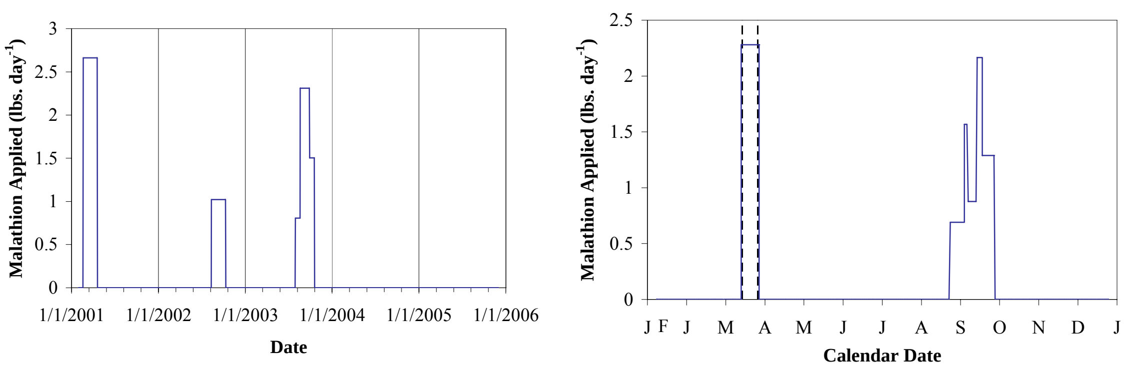
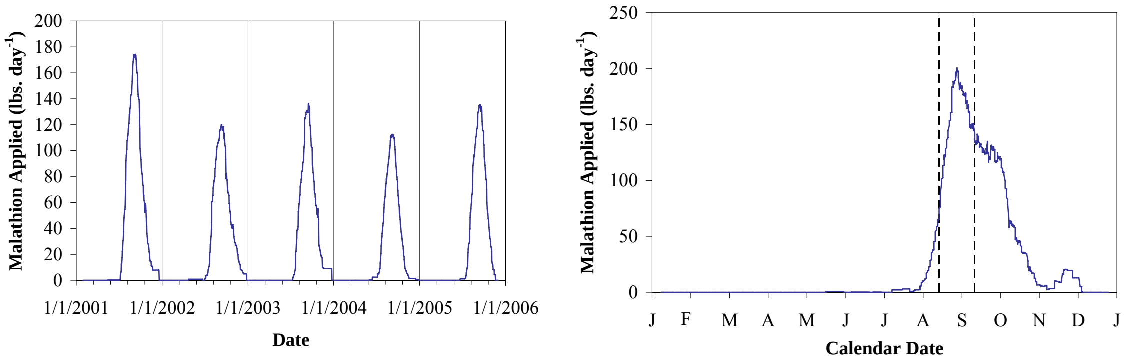


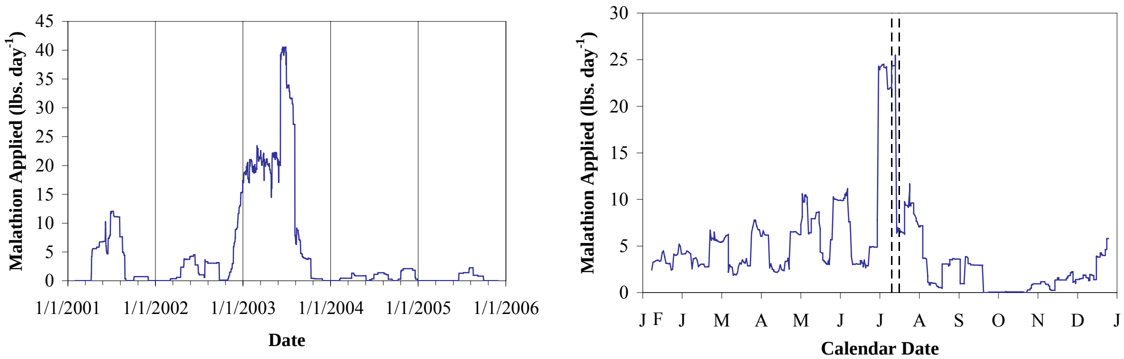
Figure 9. Variation in malathion application timing across years (left graph) and generalized within-year application timing (right graph) by crop use according to the CDPR PUR data. Malathion application period (first to last applications), according to each scenario, is indicated by dashed black vertical lines (right graph only).

6. Date



7. Filbert (Hazelnut)– *No data in CaPUR*

8. Avocado



9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines

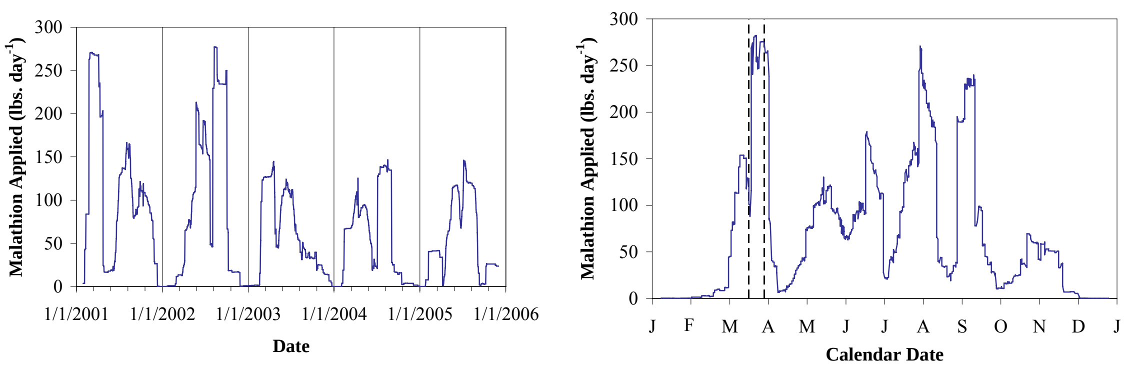
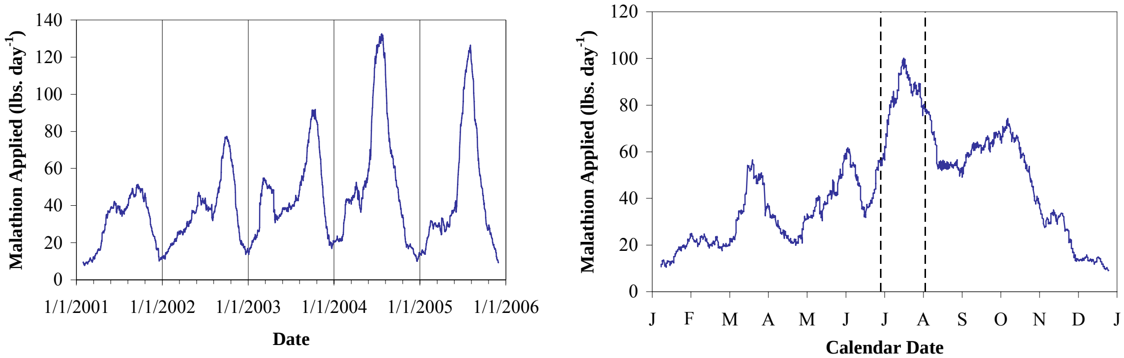
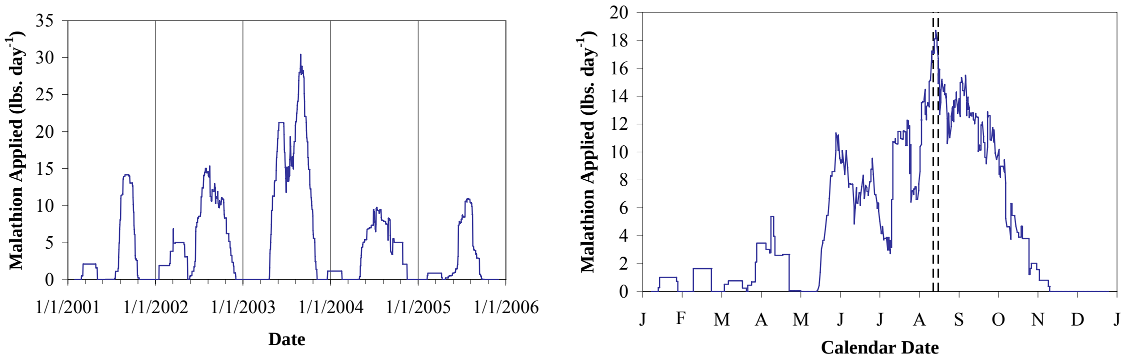


Figure 9. Continued.

10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)



11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)



12. Cotton

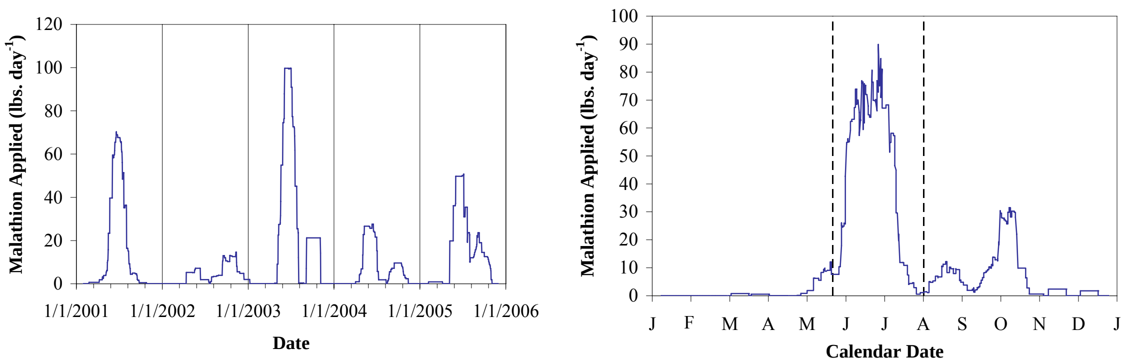
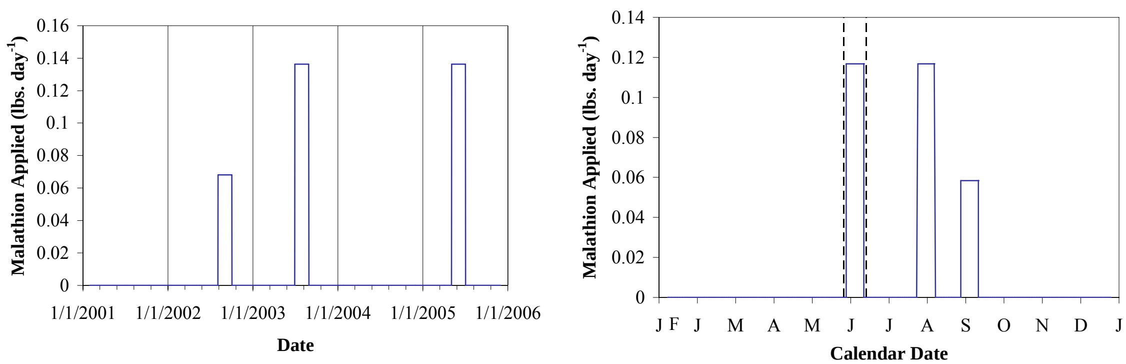
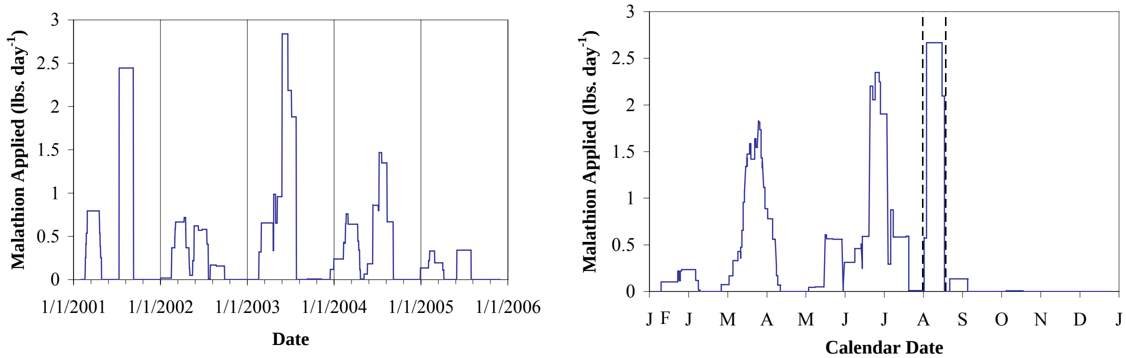


Figure 9. Continued.

15. Apricot



16. Nectarine and Peach



17. Cherry

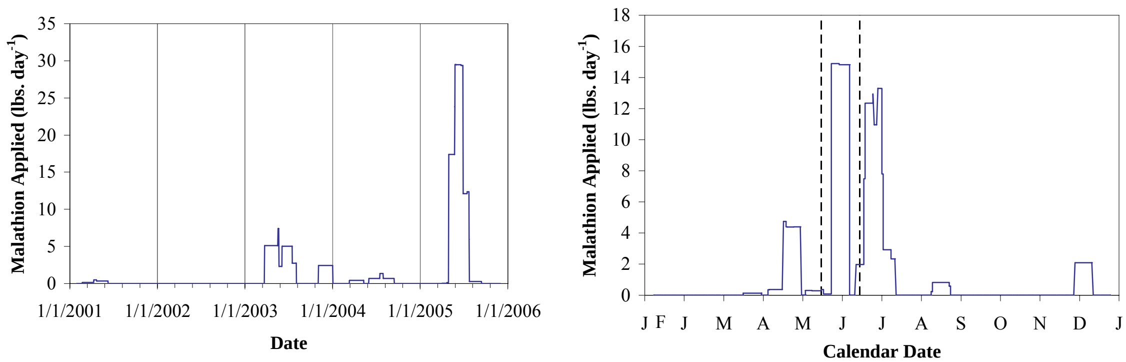
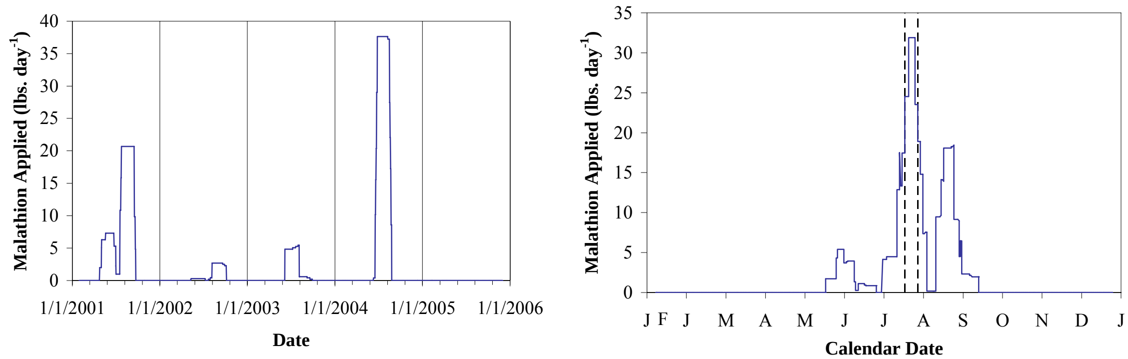
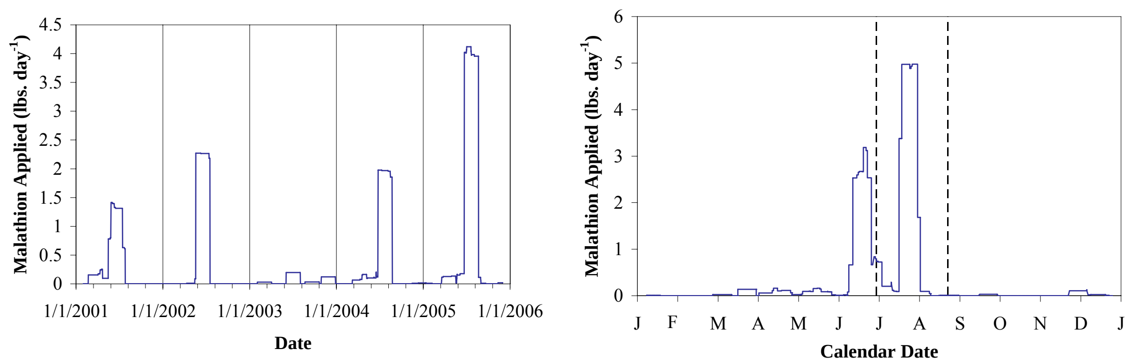


Figure 9. Continued.

18. Fig



19. Apple, Pear, and Quince



20. Guava, Mango, Plum, and Prune

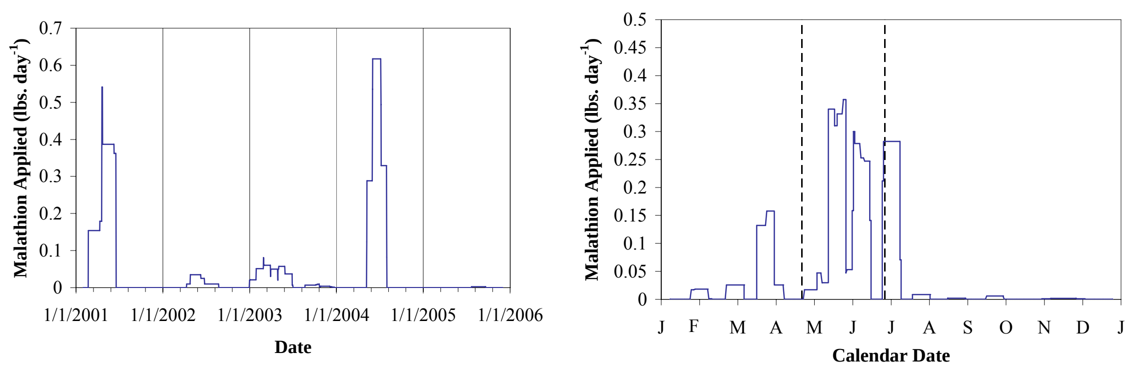
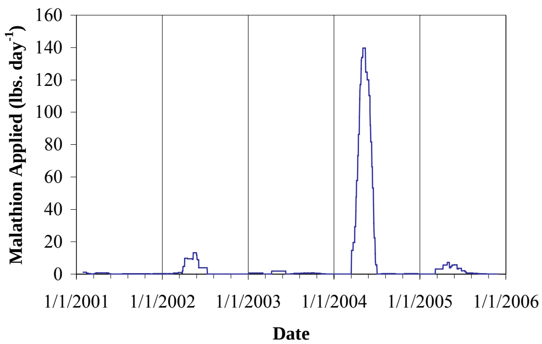
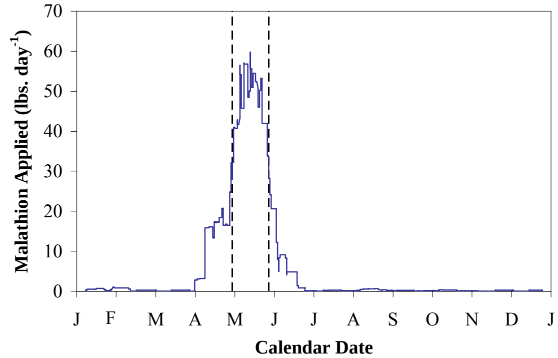


Figure 9. Continued.

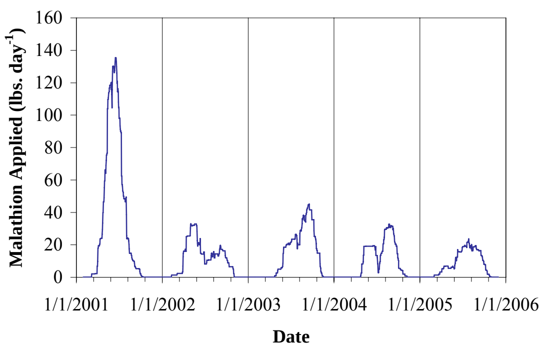
21. Papaya – *No data in CaPUR*

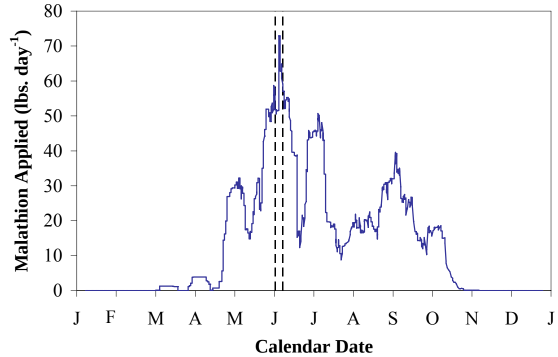
22. Garlic and Leek



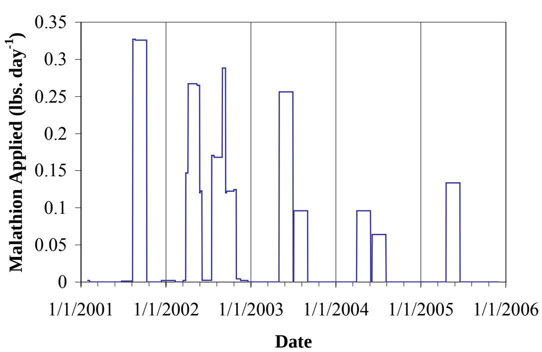


23. Grapes





26. Brussel Sprouts and Dandelion



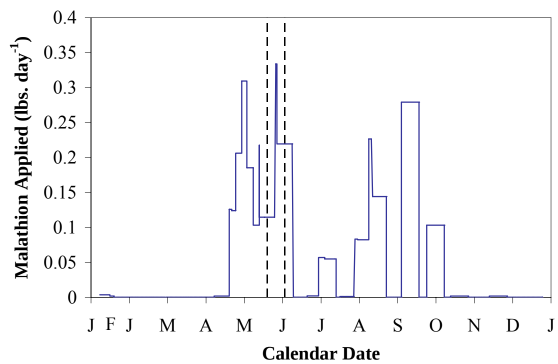
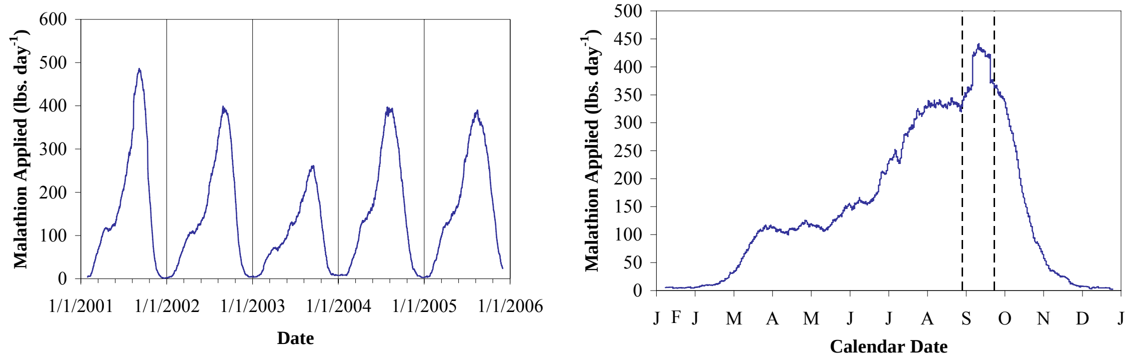
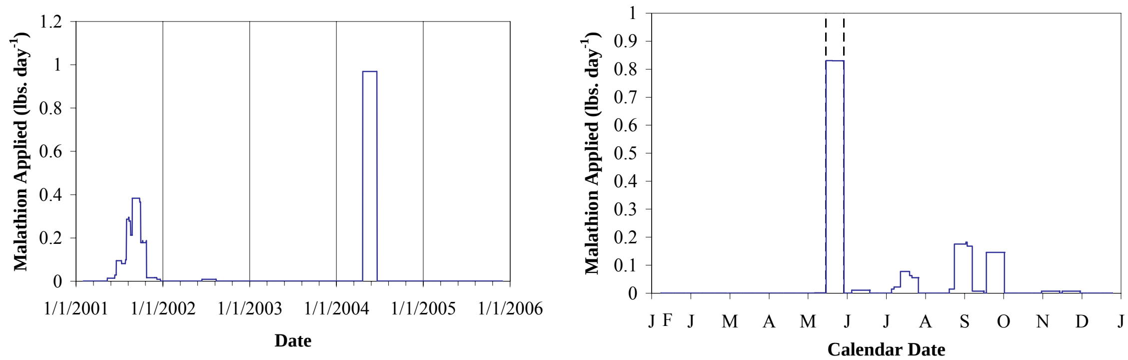


Figure 9. Continued.

27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach



28. Peppermint



29. Eggplant

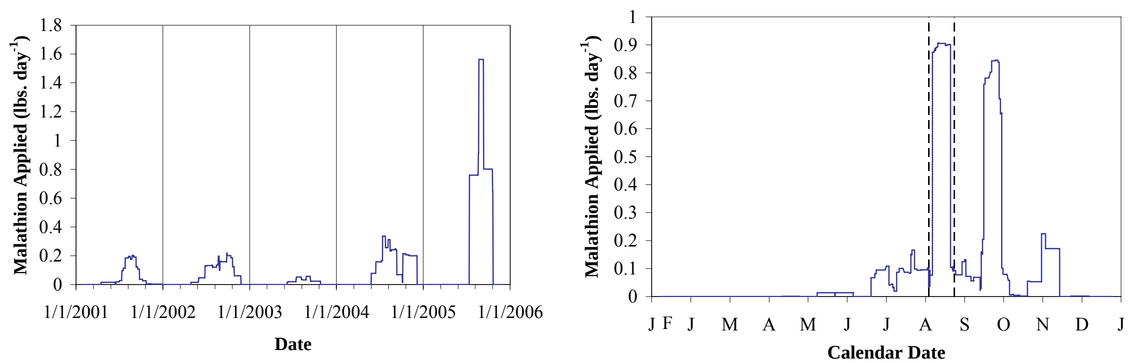
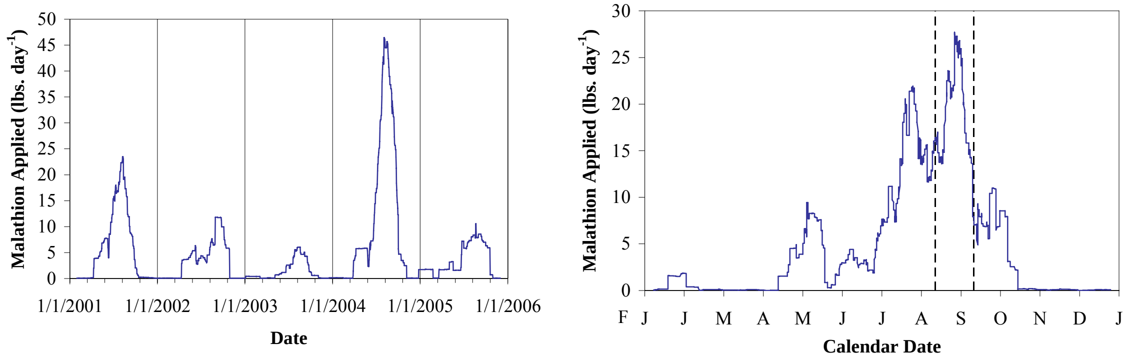
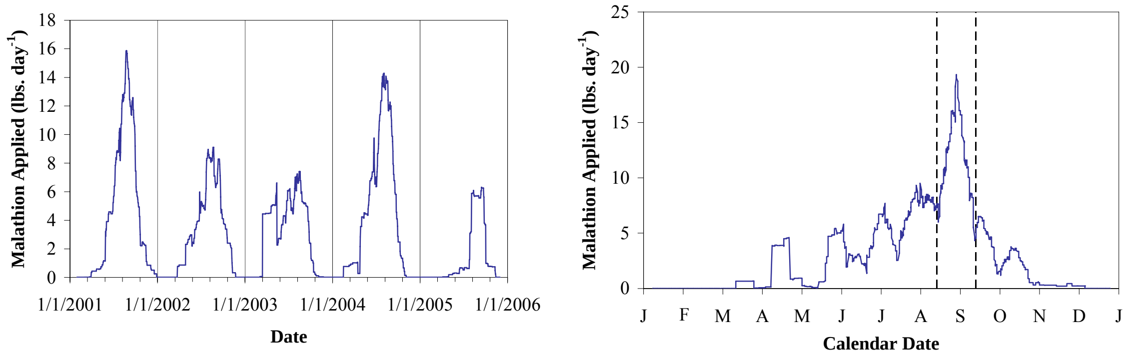


Figure 9. Continued.

30. Pumpkin



31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)



32. Onion (Unspecified and Green), Radish, and Shallot

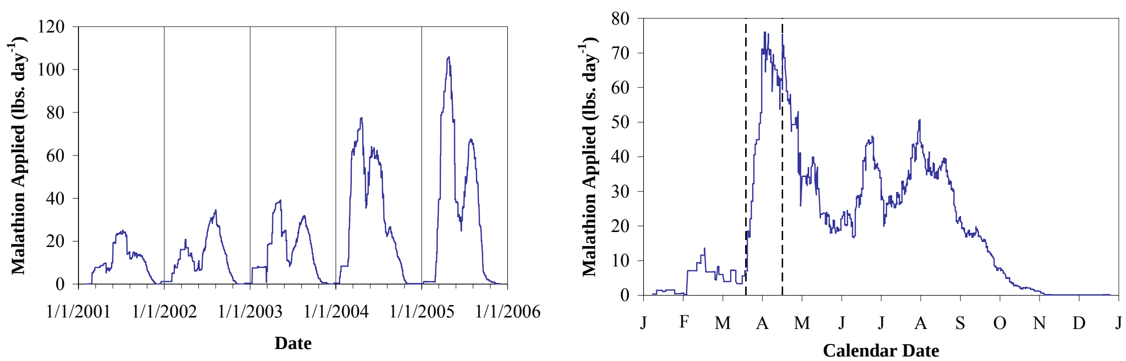
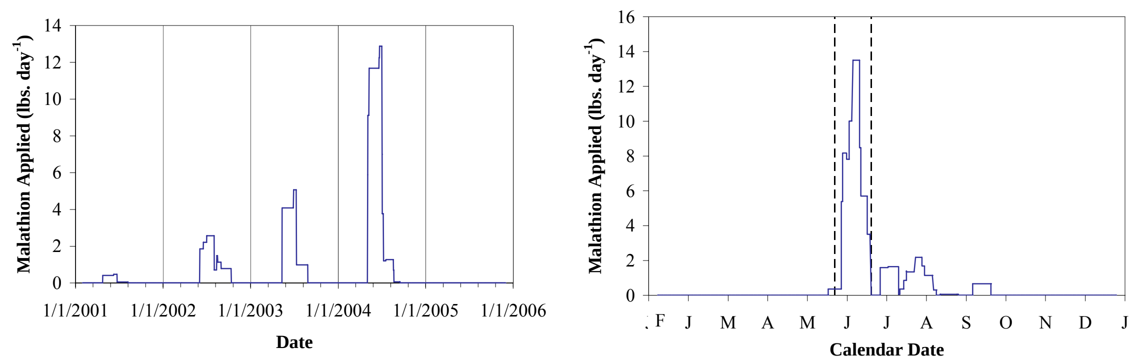
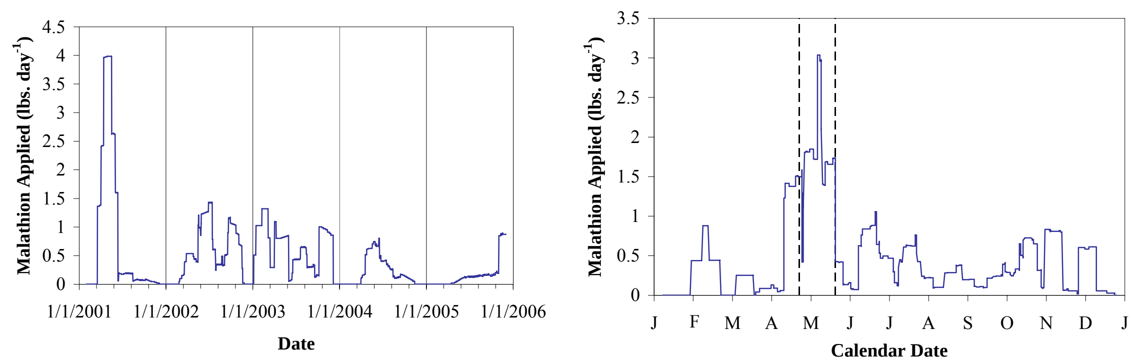


Figure 9. Continued.

33. Potato - White/Irish



34. Turnip



35. Parsnip and Rutabaga

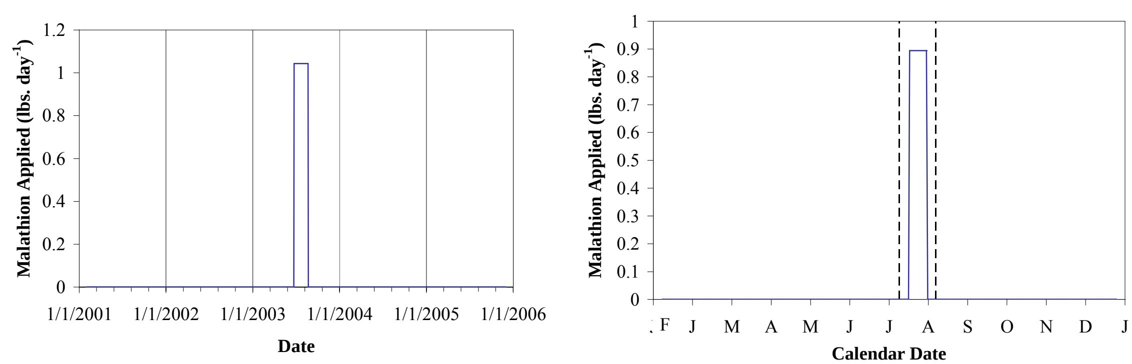
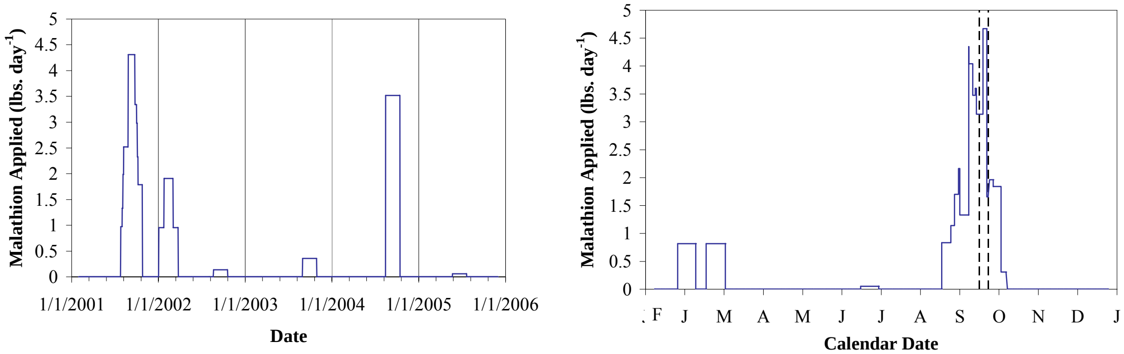
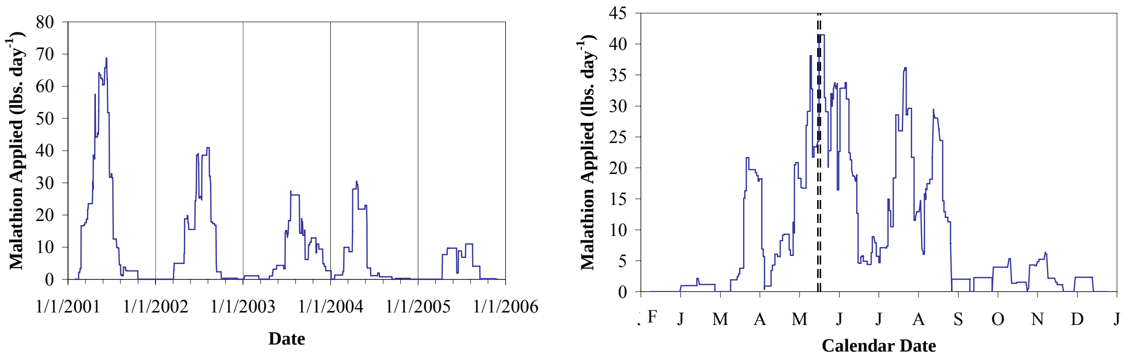


Figure 9. Continued.

36. Sweet Potato



37. Bermudagrass, Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy



40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)

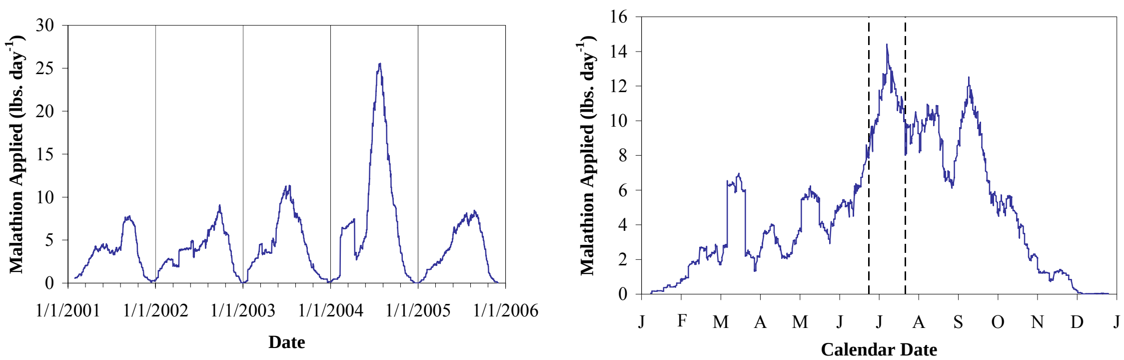


Figure 9. Continued.

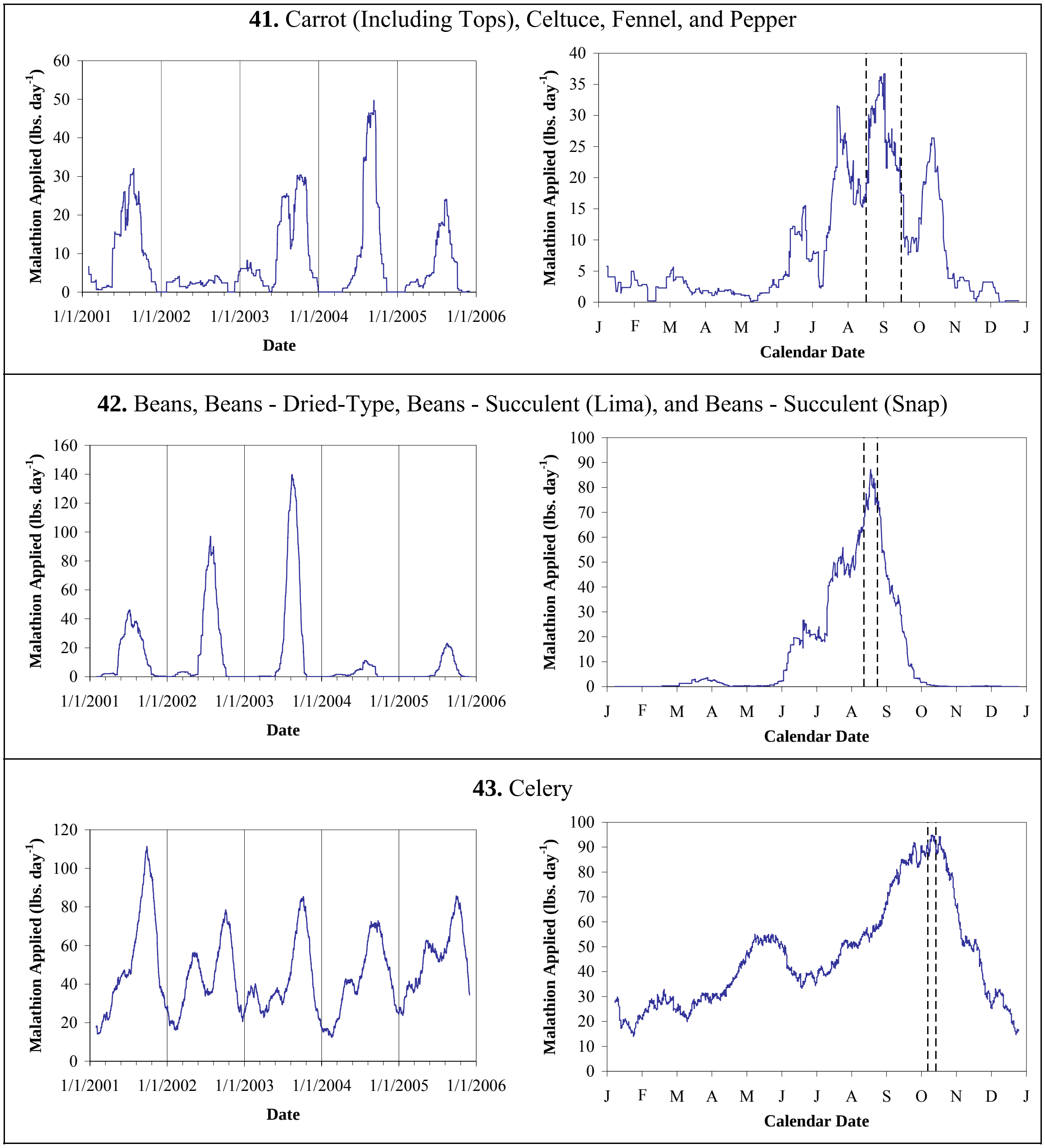
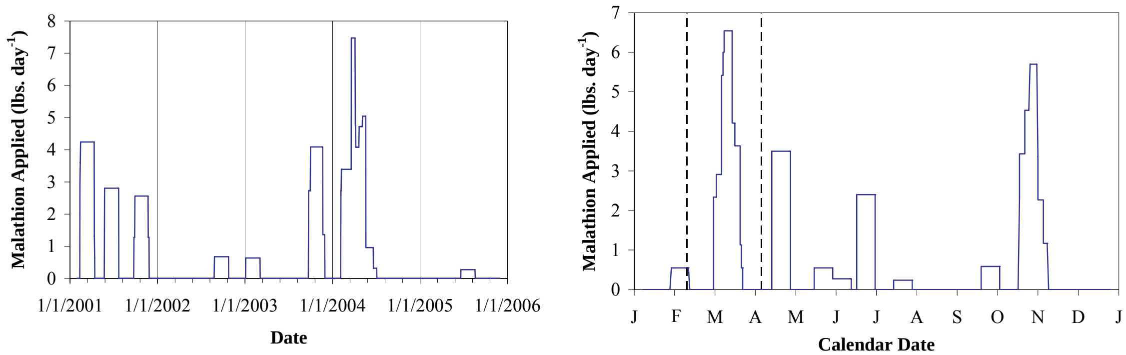


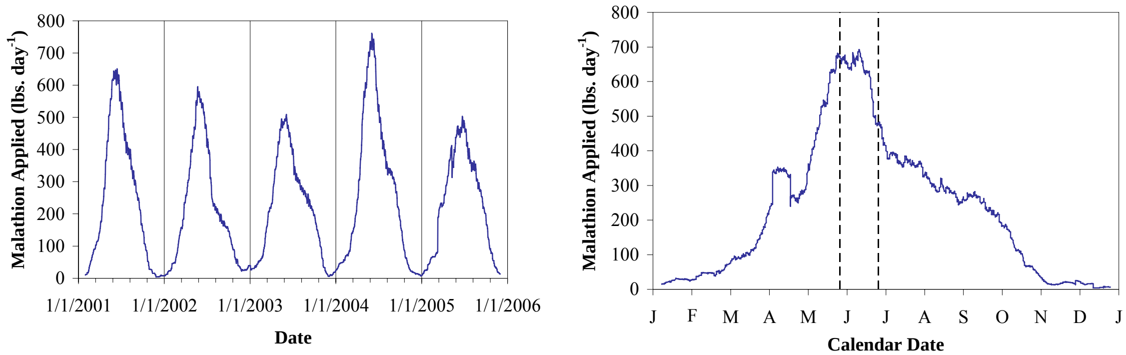
Figure 9. Continued.

44. Asparagus and Safflower (Unspecified)



45. Anise – *No data in CaPUR*

46. Strawberry



47. Sugar Beet

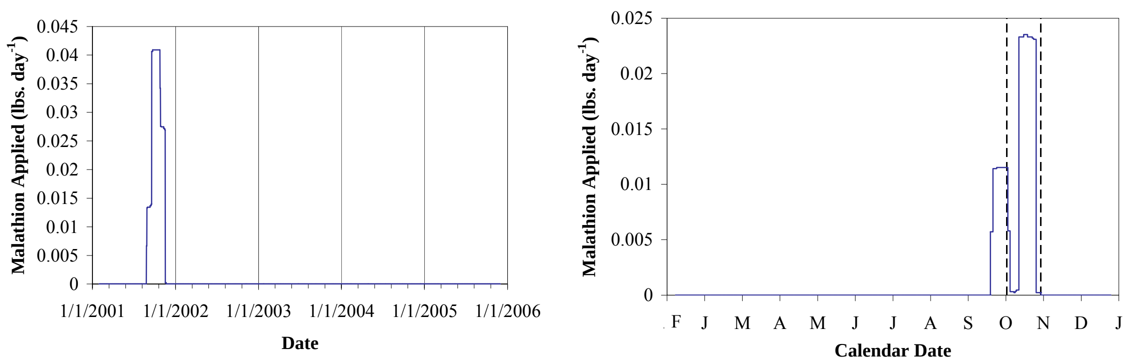
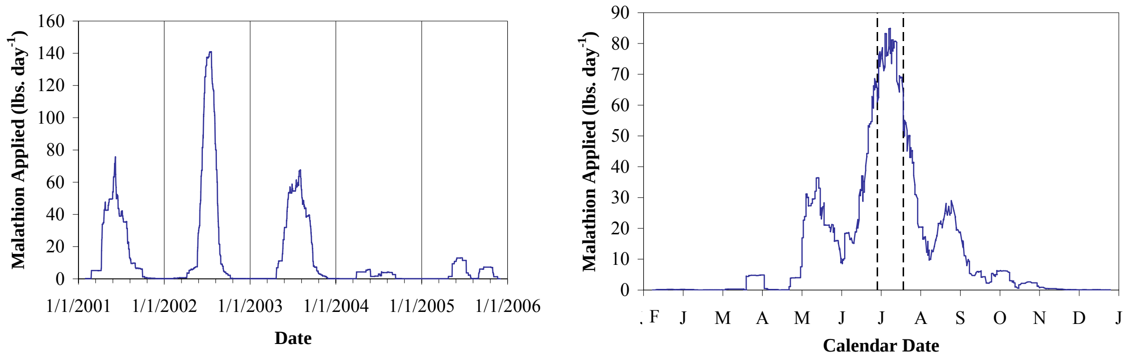
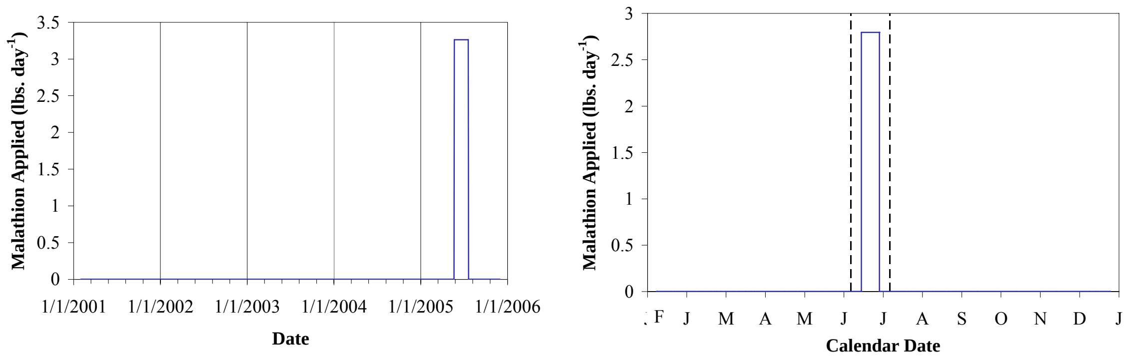


Figure 9. Continued.

48. Tomato



49. Okra



51. Sorghum

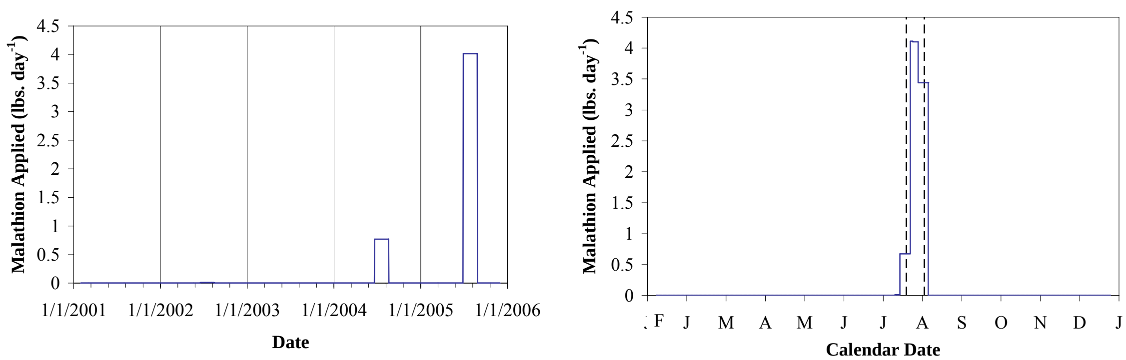
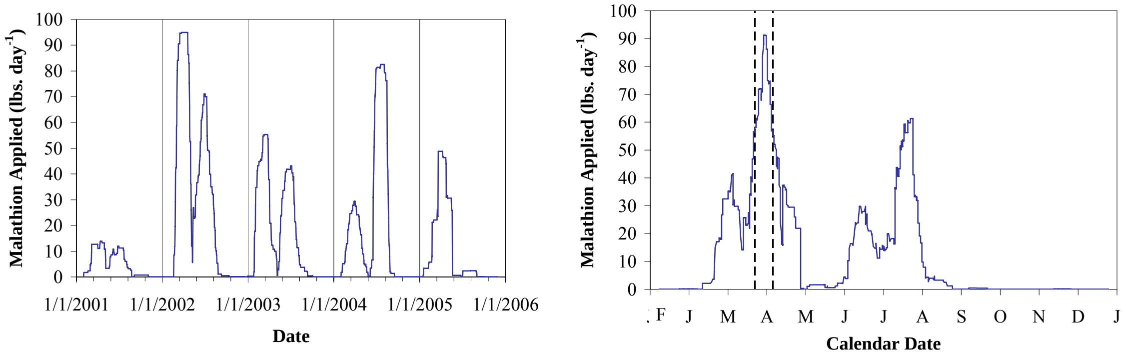


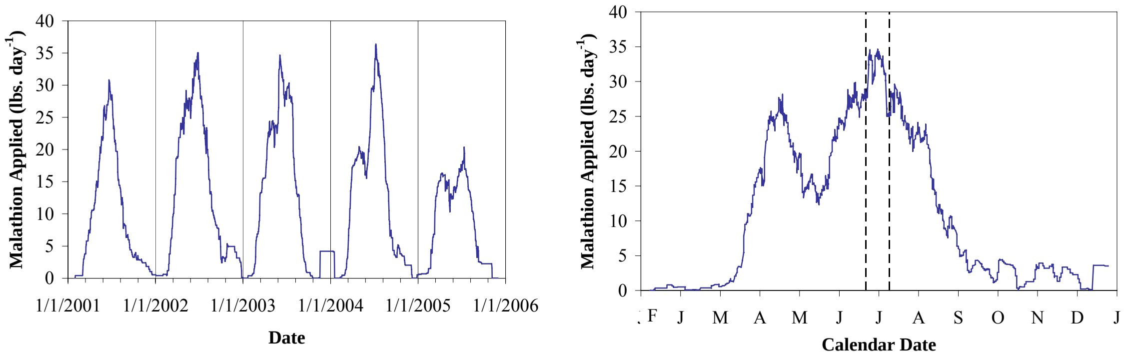
Figure 9. Continued.

52. Barley, Cereal Grains, Oats, Rye, and Wheat

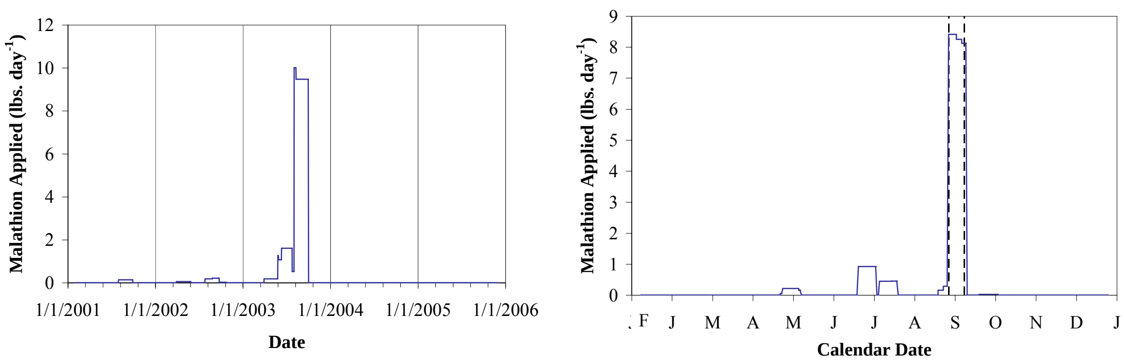


53. Gooseberry – *No data in CaPUR*

54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)



55. Blueberry



56. Caneberries and Currant – *No data in CaPUR*

57. Passion Fruit (Granadilla)– *No data in CaPUR*

Figure 9. Continued.

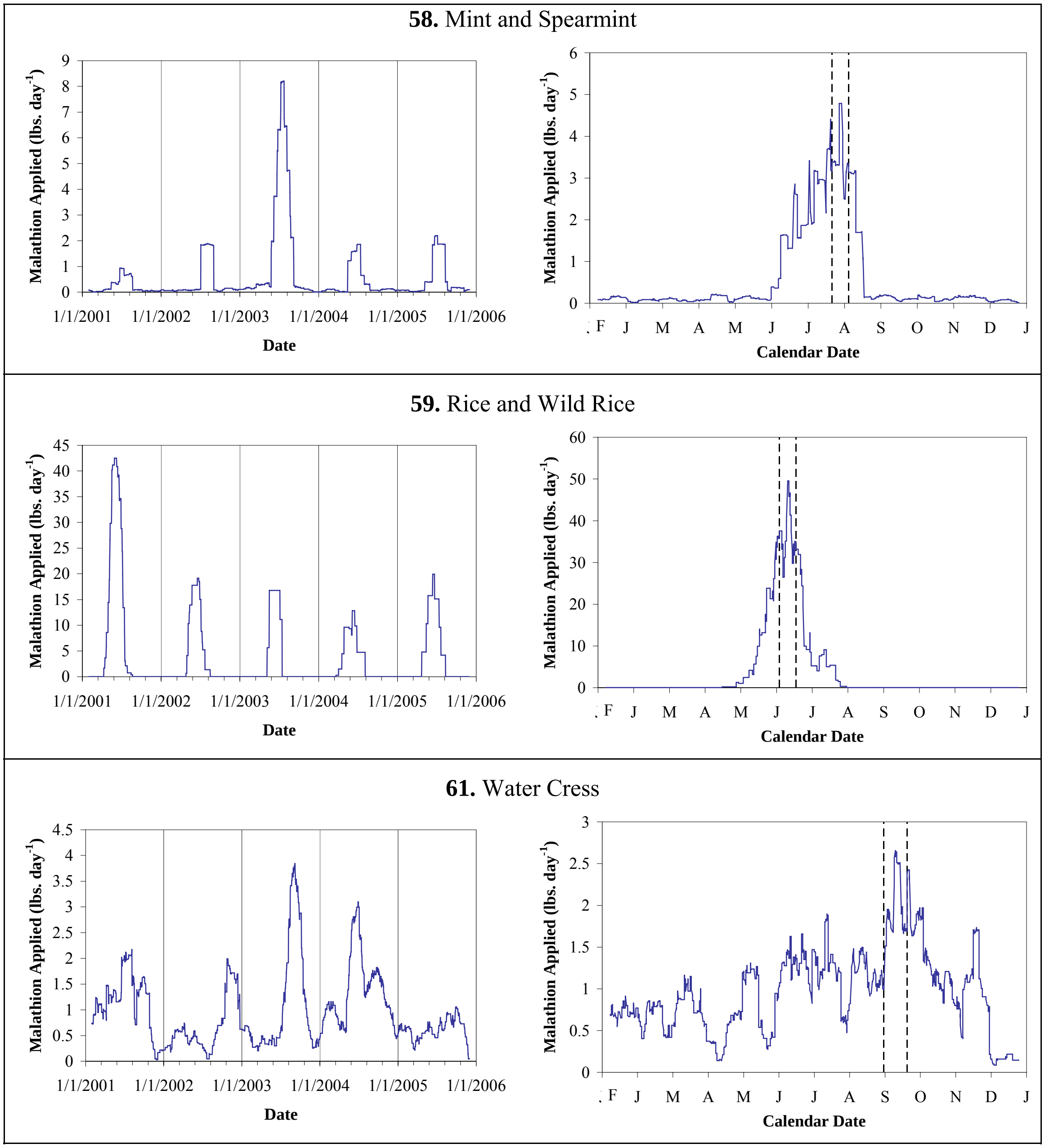
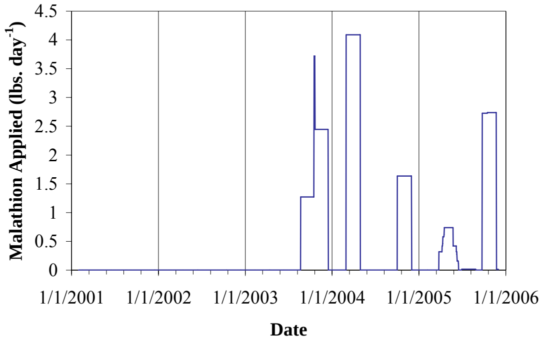
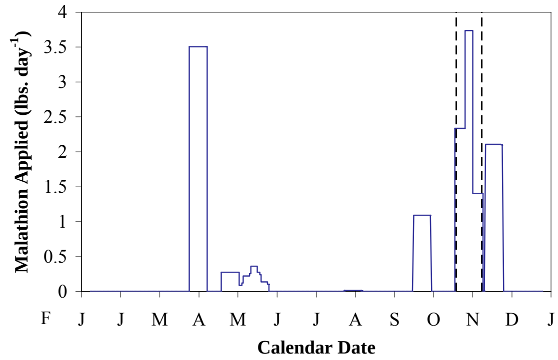


Figure 9. Continued.

Non-agricultural Uses

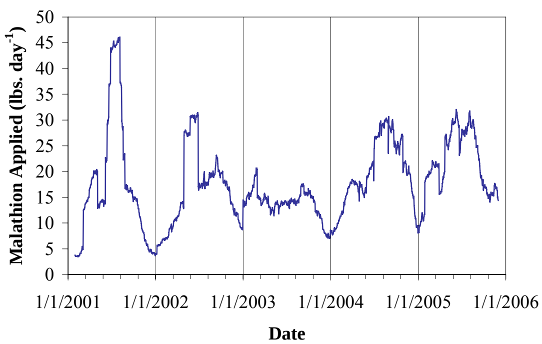
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)

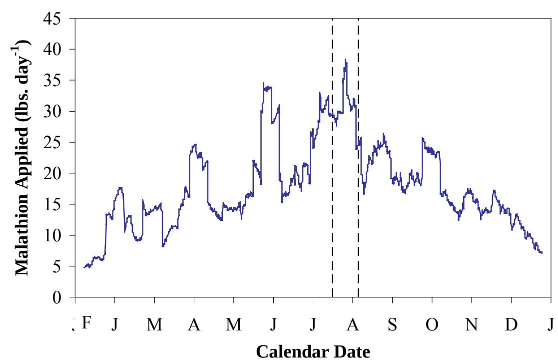




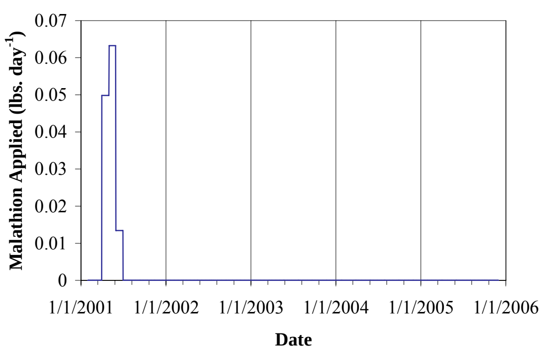
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water – *No data in CaPUR*

Nursery. Outdoor Nursery





Public Health. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)



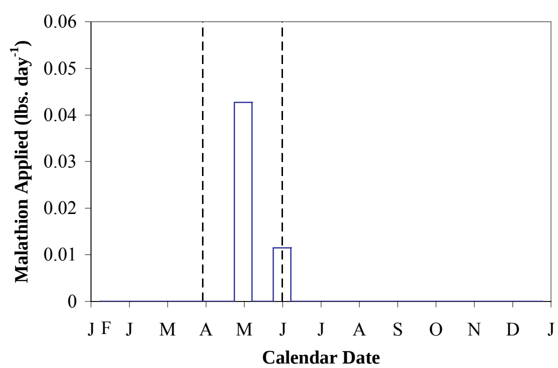


Figure 9. Continued.

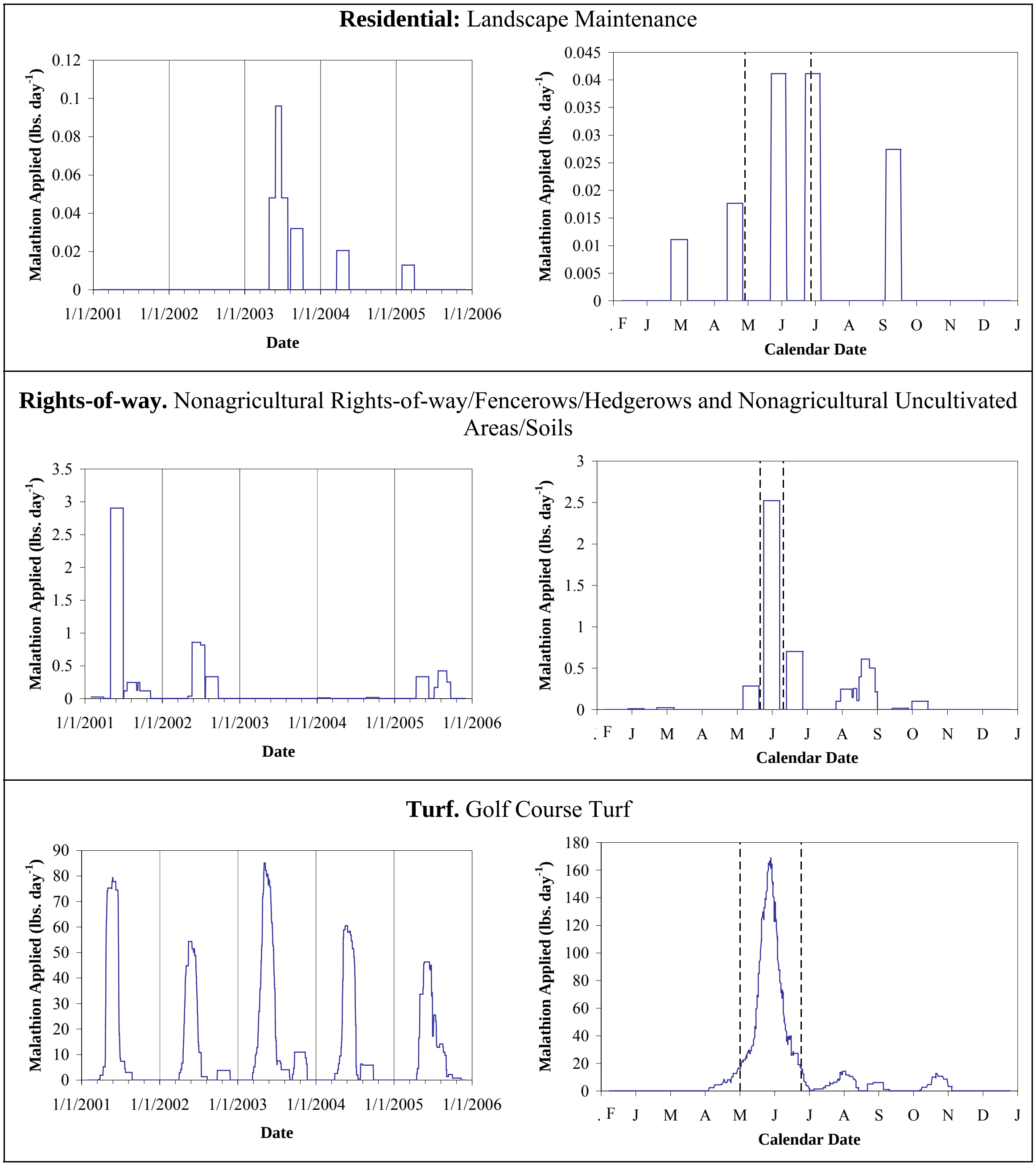


Figure 9. Continued.

3.2 Aquatic Exposure Assessment

The aquatic exposure assessment estimates the environmental concentrations of malathion and maloxon to which aquatic organisms are expected to be exposed. The estimated exposure concentrations will be used in subsequent sections to estimate the effects of malathion exposure on CRLF (direct effects) and on the CRLF habitat and prey (indirect effects). The linked models of PRZM (USEPA 1997a) and EXAMS (USEPA 1997b) are used to estimate aquatic malathion and maloxon concentrations.

Additionally, measured surface water, air, and spray drift monitoring data are presented and compared to the PRZM/EXAMS estimates. Because the risk assessment is intended to be protective of the CRLF, the PRZM/EXAMS estimates are based on conservative (protective) assumptions and, therefore, should be higher than measured concentrations, but not so high as to be unrealistic.

3.2.1 Aquatic Exposure Modeling

Typically, the Agency conducts modeling using scenarios intended to represent use sites in areas that are highly vulnerable to either runoff, erosion, or spray drift. Runoff estimates predicted by the PRZM model are linked to the Exposure Analysis Modeling System (EXAMS). For ecological risk assessment, the Agency relies on a standard water body to receive the edge-of-field runoff estimates. The standard water body is of fixed geometry and includes the processes of degradation and sorption expected to occur in ponds, canals, and low order streams (*e.g.*, first and second order streams). The water body is static (no outflow). The CLRF inhabits a range of water bodies, but generally prefers perennial or near perennial waters in order to complete its lifecycle. Generally it inhabits watersheds and drainages of 4^{th} order or lower streams.

3.2.1.1 PRZM/EXAMS Inputs

Chemical specific input parameters for PRZM and EXAMS are summarized in Table 7, respectively. Certain assumptions were made for chemical dissipation parameters included in PRZM 3.1:

1. The aerobic soil-metabolism half-life of 3 days (see following discussion) was used for the adsorbed and dissolved half-life throughout the soil column. Subsoil layers were assumed not to be anaerobic, as the deepest soil column simulated was only 150 cm deep.
2. A foliar decay rate of 0.126 d^{-1} was used based on the 90% upper confidence limit of 37 foliar half-lives reported in Willis and McDowell (1987).
3. Volatilization from the soil or foliage was not simulated (set to zero). Registrant submitted data suggest that volatilization is not an important route of dissipation.
4. Dissipation through plant uptake was not simulated.
5. Foliar wash-off of 0.5 cm^{-1} was simulated, although data exist showing complete wash-off of organophosphate pesticides with the first 0.1 cm of rainfall.
6. An application efficiency of 95% was assumed for all application methods. Drift from aerial applications was assumed to be 5% of the applied mass of malathion, and that from non-aerial applications was assumed to be 1% of the applied mass.

The aerobic soil half-life for malathion chosen for modeling purposes was 3 days. This value is consistent with that used for USDA modeling in for malathion in the boll weevil eradication program. Degradation rates in soils vary greatly from the registrant supported half-life of 0.2 days to 11 days in rangeland soil with low organic content.[12] Open literature values are mostly greater than those observed in the acceptable submitted aerobic soil metabolism study. However, because the conditions and parameters controlled in the different open literature studies vary greatly it is not possible to calculate an upper 90th percentile limit of the values. In this instance, multiplying the registrant's submitted half-life value of 0.2 days by three to estimate the 90th percentile upper confidence limit did not produce a conservative value relative to published literature (Table 4). Using a single half-life value for modeling multiple scenarios is clearly a simplification in this instance but it is necessary to choose a value that is a conservative estimate of malathion degradation in agricultural settings used in modeling. The 3 day half-life chosen is not the highest available value published but conditions favoring very long persistence (*i.e.,* very low moisture levels and microbial counts) are not expected to commonly occur in agricultural settings.

PRZM and EXAMS require that degradation half lives be converted into rate constants. The aerobic soil metabolism half-life of 3 days (as explained above) was converted to a daily rate constant for PRZM 3.1 by the equation $Ln(2)/(T_{1/2})$. The aerobic aquatic (input variable KBACW), anaerobic aquatic (KABCS), and photolysis (KDP) half-lives for EXAMS were converted to hourly rate constants using the formula $Ln(2)/(T_{1/2} \times 24)$. Hydrolysis half-lives at pH 7(KNH) and pH9 (KBH) were converted to rate constants by solving two simultaneous equations with the stable pH5 (KAH) constant set to zero.

[12] Buckman , H.O. and Brady, N.C., 1969. The Nature and Properties of Soils. Macmillian Company, Collier-Macmillian Limited, London as referrenced in USDA/APHIS National Boll Weevil Cooperative Control Program. Final Environmental Impact Statement Volume 1, 1991.

Table 7. PRZM/EXAMS input parameters for malathion and maloxon.

Input Parameter	Malathion	Maloxon
PRZM Parameters		
Foliar Volatilization (PLVKRT)	0 d^{-1}	0 d^{-1}
Foliar Decay Rate (PLDKRT)	0.126 d^{-1}	0.126 d^{-1}
Foliar Wash-off Extraction Coefficient (FEXTRC)	0.5 cm^{-1}	0.5 cm^{-1}
Plant Uptake Fraction (UPTKF)	0	0
Partition Coefficient (Koc) for all crops	151 L kg^{-1}	46 L kg^{-1}
Dissolved Phase Decay Rate: All Horizons (DWRATE)	0.231 d^{-1}	0.1304 d^{-1}
Adsorbed Phase Decay Rate: All Horizons (DSRATE)	0.231 d^{-1}	0.1304 d^{-1}
Vapor Phase Decay Rate (DGRATE) (all horizons)	0 d^{-1}	0 d^{-1}
EXAMS Parameters		
Aerobic Aqueous Metabolism Constant (KBACW)	8.82×10^{-3} h^{-1}	8.82×10^{-3} h^{-1}
Sediment Metabolism Constant (KBACS)	3.78×10^{-3} h^{-1}	3.78×10^{-3} h^{-1}
Acid Hydrolysis Rate Constant (KAH)	0 h^{-1}	0 h^{-1}
Neutral Hydrolysis Rate Constant (KNH)	4.10×10^{-3} h^{-1}	4.10×10^{-3} h^{-1}
Alkaline Hydrolysis Rate Constant (KBH)	5.46×10^{3} h^{-1}	5.46×10^{3} h^{-1}
Photolysis Rate Constant (KDP)	2.95×10^{-4} h^{-1}	2.95×10^{-4} h^{-1}
Partition Coefficient (KOC) for all modeled crops	151	46
Molecular Mass (MWT)	330 g ·mol^{-1}	314.29 g ·mol^{-1}
Solubility (SOL)	145 ppm	145 ppm
Henry's Law Constant (HENRY)	0	0
Q10 For The water Column (QTBAW)	2	2
Q10 For Sediment (QTBAS)	2	2

3.2.1.2 PRZM Scenarios

Although the labels for malathion typically do not restrict malathion applications geographically within the CRLF's range, different malathion uses can be expected to occur in different regions of California. To incorporate the effects of local variation in soil properties, meteorology, etc., the scenarios evaluated are based on specific PRZM scenarios and meteorological station data appropriate to each crop/site. Table 8 summarizes the application rates and timing and PRZM scenario name and location.

Table 8. Characteristics (application rates, number of applications and timing, PRZM scenario name and meteorological station) of the PRZM/EXAMS scenarios used to evaluate California Red-legged Frog (CRLF) exposure to malathion.

Scenario Group. Label Crop/Site	**Maximum Application Rates[1] (Lbs. ai/A)**	**Applications per Crop Cycle (Minimum Days before Re-treatment)**	**2001 - 2005 Peak Application Date (First and Last Application Dates)**	**PRZM Scenario Name**	**PRZM Scenario Meteorological Station**
Agricultural Uses					
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	2 (7)	3/15 (3/11 - 3/18)	CA alfalfa OP	Fresno, CA (W93193)
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	7 (7)	8/25 (8/4 - 9/17)	CA almond STD	Sacramento, CA (W23232)
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	3 (6)	8/25 (8/19 - 8/31)	CA almond STD	Sacramento, CA (W23232)
4. Chestnut	Air: 5 Other: 5	4 (7)	8/25 (8/15 - 9/4)	CA almond STD	Sacramento, CA (W23232)
5. Almond	Air: 1.25 Other: 4	3 (6)	3/21 (3/15 - 3/27)	CA almond STD	Sacramento, CA (W23232)
6. Date	Air: 1 Other: 2	3 (14)	8/28 (8/14 - 9/11)	CA almond STD	Sacramento, CA (W23232)
7. Filbert (Hazelnut)	Air: .625 Other: .625	3 (6)	8/25 (8/19 - 8/31)	CA almond STD	Sacramento, CA (W23232)
8. Avocado	Air: 9 Other: 9	2 (6)	7/14 (7/11 - 7/17)	CA avocado RLF	San Diego County (W23188)
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	3 (6)	3/23 (3/17 - 3/29)	CA citrus STD	Bakersfield, CA (W23155)
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	6 (7)	7/17 (6/29 - 8/3)	CA cole crop RLF	Santa Maria (W23234)
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	3 (2)	8/14 (8/12 - 8/16)	CA corn OP	Sacramento, CA (W23232)
12. Cotton	Air: 4 Other: 4	25 (3)	6/27 (5/22 - 8/2)	CA cotton STD	Bakersfield, CA (W23155)

Scenario Group. Label Crop/Site	**Maximum Application Rates[1] (Lbs. ai/A)**	**Applications per Crop Cycle (Minimum Days before Re-treatment)**	**2001 - 2005 Peak Application Date (First and Last Application Dates)**	**PRZM Scenario Name**	**PRZM Scenario Meteorological Station**
15. Apricot	Air: 10 Other: 10	4 (6)	6/5 (5/27 - 6/14)	CA fruit STD	Fresno, CA (W93193)
16. Nectarine and Peach	Air: 9 Other: 9	4 (6)	8/10 (8/1 - 8/19)	CA fruit STD	Fresno, CA (W93193)
17. Cherry	Air: 8 Other: 8	6 (6)	5/31 (5/16 - 6/15)	CA fruit STD	Fresno, CA (W93193)
18. Fig	Air: 2.5 Other: 2.5	3 (5)	7/23 (7/18 - 7/28)	CA fruit STD	Fresno, CA (W93193)
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	10 (6)	7/27 (6/30 - 8/23)	CA fruit STD	Fresno, CA (W93193)
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	12 (6)	5/25 (4/22 - 6/27)	CA fruit STD	Fresno, CA (W93193)
21. Papaya	Air: .175 Other: .175	12 (6)	5/25 (4/22 - 6/27)	CA fruit STD	Fresno, CA (W93193)
22. Garlic and Leek	Air: 2 Other: 2	5 (7)	5/14 (4/30 - 5/28)	CA garlic RLF	Fresno, CA (W93193)
23. Grapes	Air: 2.75 Other: 27.47	2 (6)	6/5 (6/2 - 6/8)	CA grapes STD	Fresno, CA (W93193)
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	3 (7)	5/27 (5/20 - 6/3)	CA lettuce STD	Santa Maria, CA (W23273)
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	6 (5)	9/11 (8/29 - 9/23)	CA lettuce STD	Santa Maria, CA (W23273)
28. Peppermint	Air: 1 Other: 1	3 (7)	5/23 (5/16 - 5/30)	CA lettuce STD	Santa Maria, CA (W23273)
29. Eggplant	Air: 3.5 Other: 3.5	5 (5)	8/14 (8/4 - 8/24)	CA tomato STD	Fresno, California (W93193).
30. Pumpkin	Air: 2 Other: 2	6 (6)	8/27 (8/12 - 9/11)	CA melons RLF	Fresno County, (W 93193)

Scenario Group. Label Crop/Site	**Maximum Application Rates[1] (Lbs. ai/A)**	**Applications per Crop Cycle (Minimum Days before Re-treatment)**	**2001 - 2005 Peak Application Date (First and Last Application Dates)**	**PRZM Scenario Name**	**PRZM Scenario Meteorological Station**
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	6 (6)	8/29 (8/14 - 9/13)	CA melons RLF	Fresno County, (W 93193)
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	5 (7)	4/3 (3/20 - 4/17)	CA onion STD	Bakersfield, CA (W23155)
33. Potato - White/Irish	Air: 3 Other: 3	5 (7)	6/6 (5/23 - 6/20)	CA potato RLF	Bakersfield, CA (W23155)
34. Turnip	Air: 2.5 Other: 2.5	5 (7)	5/7 (4/23 - 5/21)	CA potato RLF	Bakersfield, CA (W23155)
35. Parsnip and Rutabaga	Air: 2 Other: 2	5 (7)	7/24 (7/10 - 8/7)	CA potato RLF	Bakersfield, CA (W23155)
36. Sweet Potato	Air: 1.875 Other: 1.875	2 (7)	9/20 (9/16 - 9/23)	CA potato RLF	Bakersfield, CA (W23155)
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	3 (1)	5/17 (5/16 - 5/18)	CA rangeland hay RLF	Sacramento, CA (W23232)
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	5 (7)	7/8 (6/24 - 7/22)	CA row crop RLF	Monterey County, California (Santa Maria) (W23234)
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	7 (5)	9/1 (8/17 - 9/16)	CA row crop RLF	Monterey County, California (Santa Maria) (W23234)
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	3 (6)	8/18 (8/12 - 8/24)	CA row crop RLF	Monterey County, California (Santa Maria) (W23234)
43. Celery	Air: 1.5 Other: 1.5	2 (7)	10/11 (10/7 - 10/14)	CA row crop RLF	Monterey County, California (Santa Maria) (W23234)
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	9 (7)	3/9 (2/10 - 4/6)	CA row crop RLF	Monterey County, California (Santa Maria) (W23234)

Scenario Group. Label Crop/Site	**Maximum Application Rates[1] (Lbs. ai/A)**	**Applications per Crop Cycle (Minimum Days before Re-treatment)**	**2001 - 2005 Peak Application Date (First and Last Application Dates)**	**PRZM Scenario Name**	**PRZM Scenario Meteorological Station**
45. Anise	Air: .9375 Other: .9375	7 (7)	9/1 (8/10 - 9/23)	CA row crop RLF	Monterey County, California (Santa Maria) (W23234)
46. Strawberry	Air: 2 Other: 2	6 (6)	6/11 (5/27 - 6/26)	CA strawberry (non plastic) RLF	Santa Maria, CA (W 23273).
47. Sugar Beet	Air: 1.875 Other: 1.875	5 (7)	10/16 (10/2 - 10/30)	CA sugarbeet OP	Fresno, California (W93193).
48. Tomato	Air: 3.5 Other: 3.5	5 (5)	7/9 (6/29 - 7/19)	CA tomato STD	Fresno, California (W93193).
49. Okra	Air: 1.5 Other: 1.5	6 (6)	6/22 (6/7 - 7/7)	CA tomato STD	Fresno, California (W93193).
51. Sorghum	Air: 1.5 Other: 1.5	3 (7)	7/27 (7/20 - 8/3)	CA wheat RLF	Fresno, CA (W93193)
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	3 (7)	3/30 (3/23 - 4/6)	CA wheat RLF	Fresno, CA (W93193)
53. Gooseberry	Air: 16 Other: 16	4 (6)	7/1 (6/22 - 7/10)	CA wine grapes RLF	San Francisco, CA (W23234)
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	4 (6)	7/1 (6/22 - 7/10)	CA wine grapes RLF	San Francisco, CA (W23234)
55. Blueberry	Air: 2.5 Other: 2.5	4 (4)	9/2 (8/27 - 9/8)	CA wine grapes RLF	San Francisco, CA (W23234)
56. Caneberries and Currant	Air: 2 Other: 2	4 (6)	7/1 (6/22 - 7/10)	CA wine grapes RLF	San Francisco, CA (W23234)
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	8 (6)	7/1 (6/8 - 7/24)	CA wine grapes RLF	San Francisco, CA (W23234)
58. Mint and Spearmint	Air: 1 Other: 1	3 (7)	7/29 (7/22 - 8/5)	OR mint STD	Salem, OR (W24232)
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	3 (7)	6/11 (6/4 - 6/18)	Rice Guidance	NA
61. Water Cress	Air: 2 Other: 2	5 (5)	9/10 (8/31 - 9/20)	Rice Guidance	NA

Scenario Group. Label Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Applications per Crop Cycle (Minimum Days before Re-treatment)	2001 - 2005 Peak Application Date (First and Last Application Dates)	PRZM Scenario Name	PRZM Scenario Meteorological Station
Non-agricultural Uses					
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	3 (10)	10/29 (10/19 - 11/8)	CA forestry RLF	Arcata/Eureka, CA (W24283)
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	5 (10)	Not needed for scenarios based on rice guidance.	Rice Guidance	NA
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	5 (5)	7/27 (7/17 - 8/6)	CA Nursery	San Diego, CA (W23188)
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	10 (7)	5/1 (3/30 - 6/1)	CA impervious RLF	San Francisco, CA (W23234)
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	10 (7)	5/29 (4/29 - 6/28)	CA residential RLF	San Francisco, CA (W23234)
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	3 (10)	6/1 (5/22 - 6/11)	CA right of way RLF	Santa Maria, CA (W 23273).
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	6 (10)	5/23 (4/28 - 6/17)	CA turf RLF	San Francisco, CA (W23234)

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

3.2.1.3 Aquatic Estimated Environmental Concentrations

Aquatic EECS were estimated using PRZM/EXAMS except for scenarios involving direct application to water. Two EECs are given for each of the scenario groups listed in column 1 of Table 9. The first, labeled “air”, (column 2) is for scenarios based on malathion applications made using aerial and air-blast methods, which are modeled with an assumption of 5% spray drift according to EFED policy. The second, labeled “other”, is for scenarios based on malathion applications made using methods other than aerial and air-blast methods, which are modeled with an assumption of 1% spray drift according to EFED policy.

For each scenario (*e.g.*, the air scenario from the almond scenario group), 3 EECs are calculated. Peak EECs are the 90th percentile concentration of the highest annual concentrations estimated over the time period simulated by each PRZM scenario (typically, 25 to 30 years and based on the length of meteorological record available for the locality simulated). The 21-day EECs are the 90th percentile of the annual maximum 21-day average concentrations estimated over the time period simulated by each PRZM scenario. Similarly, 60-day EECs are similar to 21-day EECs but over a 60-day averaging period.

Within most scenario groups, air EECs will be higher due to the higher spray drift contribution if the application rates are the same for air and other application methods. For some agricultural scenario groups (5, 6, 19, 20, and 23), however, the application rates are higher for other application methods than air application methods. For these scenario groups, whether the air or other scenarios are higher depends on whether the additional EEC contribution from the higher other application rate is greater than the EEC contribution from the higher drift fraction. Only 1 scenario group, public health has a lower other application rate than the air application rate, which produces much lower other EECs than air EECs.

Further examination of the malathion EECs indicated that many of the EECs were almost solely due to the spray drift contribution. Because this observation has ramifications for the interpretation of the risk assessment, the percentage of the malathion EEC due to drift was estimated by running PRIZM EXAMS with the appropriate spray drift fraction and without the spray drift contribution (spray drift fraction set to 0%) for each scenario. Percent spray drift contribution was calculated as the difference between the with and without spray drift EECs divided by the with EEC times 100 (to get a percentage). Because the with and without spray drift EECs may occur at different times, this calculation produces a minimum estimate of percentage drift contribution. (The calculation would be exact only if the peak, 21-day, and 60-day EECs occurred at the same time for both the with and without spray drift EECs.)

Table 9. PRZM/EXAMS estimated environmental concentrations (EECs) for malathion (estimate includes drift component) and maloxon (drift calculated separately). Maloxon application rate is assumed to be 10.7% of malathion application rate. Maloxon as an impurity in drift is assumed to be 0.1% of malathion in drift.

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Estimated Environmental Concentrations (EECs)								
		Malathion EEC (µg/L) (% Drift Contribution to EEC)			Maloxon EEC (µg/L)					
					Degradate Fraction[2]			Impurity Fraction[3]		
		Peak	21-day	60-day	Peak	21-day	60-day	Peak	21-day	60-day
Agricultural Uses										
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	9.6 (57) 5.3 (21)	3.7 (71) 1.5 (32)	1.4 (72) .58 (34)	0.81	0.20	0.076	<0.001 <.001	<0.001 <.001	<0.001 <.001
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	52 (87) 13 (46)	23 (95) 5.5 (78)	18 (98) 3.8 (89)	1.3	.22	.076	.004 <.001	.001 <.001	<.001 <.001
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	43 (100) 8.6 (98)	18 (100) 3.6 (99)	6.5 (100) 1.3 (99)	.060	.014	.005	.004 <.001	<.001 <.001	<.001 <.001
4. Chestnut	Air: 5 Other: 5	16 (99) 3.3 (97)	7.3 (100) 1.5 (99)	3.5 (100) .70 (99)	.044	.011	.004	.001 <.001	<.001 <.001	<.001 <.001
5. Almond	Air: 1.25 Other: 4	7.4 (51) 13 (14)	3.4 (68) 5 (30)	1.3 (68) 1.9 (30)	.50 1.6	.16 .53	.062 .20	<.001 <.001	<.001 <.001	<.001 <.001
6. Date	Air: 1 Other: 2	2.9 (99) 1.1 (94)	.94 (99) .38 (97)	.52 (100) .21 (98)	.014 .027	.003 .007	.001 .002	<.001 <.001	<.001 <.001	<.001 <.001
7. Filbert (Hazelnut)	Air: .625 Other: .625	2.1 (100) .43 (98)	.88 (100) .18 (99)	.32 (100) .066 (99)	.003	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
8. Avocado	Air: 9 Other: 9	31 (100) 6.1 (100)	9.3 (100) 1.9 (100)	3.3 (100) .66 (100)	.003	<.001	<.001	.003 <.001	<.001 <.001	<.001 <.001
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	97 (98) 20 (90)	45 (99) 9.1 (95)	17 (99) 3.5 (95)	.24	.056	.020	.007 .001	.002 <.001	<.001 <.001
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	8.9 (100) 1.8 (100)	4.5 (100) .91 (100)	3.2 (100) .63 (100)	.005	.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Estimated Environmental Concentrations (EECs)								
		Malathion EEC (µg/L) (% Drift Contribution to EEC)			Maloxon EEC (µg/L)					
					Degradate Fraction[2]			Impurity Fraction[3]		
		Peak	21-day	60-day	Peak	21-day	60-day	Peak	21-day	60-day
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	7.9 (100) 1.6 (99)	2.1 (100) .43 (99)	.76 (100) .15 (99)	.024	.006	.002	<.001 <.001	<.001 <.001	<.001 <.001
12. Cotton	Air: 4 Other: 4	20 (74) 5.2 (0)	13 (95) 2.5 (75)	12 (98) 2.3 (91)	.97	.12	.041	.001 <.001	<.001 <.001	<.001 <.001
15. Apricot	Air: 10 Other: 10	34 (100) 6.8 (100)	16 (100) 3.3 (100)	6.5 (100) 1.3 (100)	<.001	<.001	<.001	.003 <.001	<.001 <.001	<.001 <.001
16. Nectarine and Peach	Air: 9 Other: 9	29 (100) 5.9 (100)	13 (100) 2.6 (100)	5.2 (100) 1 (100)	.010	.002	<.001	.003 <.001	<.001 <.001	<.001 <.001
17. Cherry	Air: 8 Other: 8	29 (100) 5.8 (100)	15 (100) 2.9 (100)	8.1 (100) 1.6 (100)	<.001	<.001	<.001	.002 <.001	<.001 <.001	<.001 <.001
18. Fig	Air: 2.5 Other: 2.5	8.5 (100) 1.7 (100)	2.9 (100) .58 (100)	1 (100) .21 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	4.1 (100) .98 (100)	1.9 (100) .46 (100)	1.7 (100) .41 (100)	.003 .003	<.001 <.001	<.001 <.001	<.001 <.001	<.001 <.001	<.001 <.001
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	2.8 (99) .56 (95)	1.5 (100) .31 (98)	1.3 (100) .27 (99)	.004 .009	<.001 .002	<.001 <.001	<.001 <.001	<.001 <.001	<.001 <.001
21. Papaya	Air: .175 Other: .175	.65 (99) .13 (95)	.36 (100) .072 (98)	.31 (100) .063 (99)	.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
22. Garlic and Leek	Air: 2 Other: 2	9.9 (50) 5.9 (16)	3.6 (78) 1.4 (41)	2 (85) .61 (53)	.70	.12	.041	<.001 <.001	<.001 <.001	<.001 <.001
23. Grapes	Air: 2.75 Other: 27.47	9 (100) 18 (100)	2.5 (100) 4.9 (100)	.87 (100) 1.7 (100)	<.001 <.001	<.001 <.001	<.001 <.001	<.001 .002	<.001 <.001	<.001 <.001
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	9.1 (100) 1.8 (100)	4.4 (100) .89 (100)	1.7 (100) .34 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	20 (33) 14 (9)	6.8 (58) 3.3 (15)	3.5 (72) 1.5 (33)	3.5	.75	.27	<.001 <.001	<.001 <.001	<.001 <.001

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Estimated Environmental Concentrations (EECs)								
		Malathion EEC (µg/L) (% Drift Contribution to EEC)			Maloxon EEC (µg/L)					
					Degradate Fraction[2]			Impurity Fraction[3]		
		Peak	21-day	60-day	Peak	21-day	60-day	Peak	21-day	60-day
28. Peppermint	Air: 1 Other: 1	3.6 (100) .73 (100)	1.8 (100) .36 (100)	.68 (100) .14 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
29. Eggplant	Air: 3.5 Other: 3.5	12 (94) 2.5 (70)	5.9 (98) 1.2 (88)	2.6 (98) .61 (91)	.31	.061	.023	.001 <.001	<.001 <.001	<.001 <.001
30. Pumpkin	Air: 2 Other: 2	6.9 (87) 1.4 (35)	3.2 (96) .65 (78)	1.8 (97) .39 (87)	.22	.037	.013	<.001 <.001	<.001 <.001	<.001 <.001
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	6.5 (87) 1.7 (48)	3.2 (95) .66 (77)	1.8 (96) .4 (81)	.26	.042	.016	<.001 <.001	<.001 <.001	<.001 <.001
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	7.9 (75) 3.2 (39)	4 (90) 1.1 (64)	2.3 (94) .55 (75)	.36	.072	.026	<.001 <.001	<.001 <.001	<.001 <.001
33. Potato - White/Irish	Air: 3 Other: 3	9.8 (100) 2 (100)	4.1 (100) .82 (100)	2.4 (100) .48 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
34. Turnip	Air: 2.5 Other: 2.5	8.5 (100) 1.7 (100)	4 (100) .79 (100)	2.3 (100) .46 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
35. Parsnip and Rutabaga	Air: 2 Other: 2	6.1 (100) 1.2 (100)	2.3 (100) .45 (100)	1.3 (100) .26 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
36. Sweet Potato	Air: 1.875 Other: 1.875	5.9 (94) 1.2 (72)	1.7 (97) .36 (86)	.61 (97) .13 (87)	.023	.004	.001	<.001 <.001	<.001 <.001	<.001 <.001
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	8.5 (100) 1.7 (100)	2.2 (100) .45 (100)	.77 (100) .16 (100)	.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	8.9 (100) 1.8 (100)	4.5 (100) .91 (100)	2.7 (100) .53 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	8.3 (99) 1.7 (96)	5 (100) 1 (99)	2.9 (100) .58 (99)	.065	.015	.005	<.001 <.001	<.001 <.001	<.001 <.001

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Estimated Environmental Concentrations (EECs)								
		Malathion EEC (µg/L) (% Drift Contribution to EEC)			Maloxon EEC (µg/L)					
					Degradate Fraction[2]			Impurity Fraction[3]		
		Peak	21-day	60-day	Peak	21-day	60-day	Peak	21-day	60-day
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	6.5 (100) 1.3 (100)	3 (100) .59 (100)	1.1 (100) .22 (100)	.002	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
43. Celery	Air: 1.5 Other: 1.5	9.5 (42) 6.3 (13)	2.8 (59) 1.4 (20)	1 (60) .53 (23)	.88	.19	.066	<.001 <.001	<.001 <.001	<.001 <.001
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	9 (29) 6.9 (8)	4.2 (60) 2.2 (21)	3.2 (78) 1.2 (41)	1.0	.28	.12	<.001 <.001	<.001 <.001	<.001 <.001
45. Anise	Air: .9375 Other: .9375	3.3 (98) .67 (89)	1.7 (99) .34 (95)	1.4 (100) .27 (98)	.047	.011	.004	<.001 <.001	<.001 <.001	<.001 <.001
46. Strawberry	Air: 2 Other: 2	7.8 (100) 1.6 (100)	4.6 (100) .92 (100)	2.7 (100) .53 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
47. Sugar Beet	Air: 1.875 Other: 1.875	10 (65) 4.8 (26)	3.9 (79) 1.3 (36)	2.3 (87) .69 (57)	.82	.17	.062	<.001 <.001	<.001 <.001	<.001 <.001
48. Tomato	Air: 3.5 Other: 3.5	12 (100) 2.4 (100)	5.7 (100) 1.1 (100)	2.4 (100) .48 (100)	.003	<.001	<.001	.001 <.001	<.001 <.001	<.001 <.001
49. Okra	Air: 1.5 Other: 1.5	5.1 (100) 1 (99)	2.5 (100) .5 (100)	1.3 (100) .27 (100)	.002	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
51. Sorghum	Air: 1.5 Other: 1.5	4.6 (100) .93 (100)	1.7 (100) .35 (100)	.63 (100) .13 (100)	.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	12 (30) 8.7 (8)	4.4 (43) 2.9 (12)	1.8 (48) 1.1 (16)	.98	.33	.12	<.001 <.001	<.001 <.001	<.001 <.001
53. Gooseberry	Air: 16 Other: 16	61 (100) 12 (100)	32 (100) 6.4 (100)	14 (100) 2.7 (100)	<.001	<.001	<.001	.005 <.001	.001 <.001	<.001 <.001
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	15 (100) 3 (100)	8 (100) 1.6 (100)	3.4 (100) .68 (100)	<.001	<.001	<.001	.001 <.001	<.001 <.001	<.001 <.001
55. Blueberry	Air: 2.5 Other: 2.5	11 (100) 2.3 (99)	5.6 (100) 1.1 (100)	2.1 (100) .42 (100)	.024	.006	.002	<.001 <.001	<.001 <.001	<.001 <.001
56. Caneberries and Currant	Air: 2 Other: 2	7.6 (100) 1.5 (100)	4 (100) .8 (100)	1.7 (100) .34 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Estimated Environmental Concentrations (EECs)								
		Malathion EEC (µg/L) (% Drift Contribution to EEC)			Maloxon EEC (µg/L)					
					Degradate Fraction[2]			Impurity Fraction[3]		
		Peak	21-day	60-day	Peak	21-day	60-day	Peak	21-day	60-day
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	2.9 (100) .58 (100)	1.7 (100) .33 (100)	1.3 (100) .25 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
58. Mint and Spearmint	Air: 1 Other: 1	3.4 (99) .68 (97)	1.5 (100) .3 (98)	.57 (100) .12 (99)	.021	.005	.002	<.001 <.001	<.001 <.001	<.001 <.001
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	1404 (N.A.)	313 (N.A.)	110 (N.A.)	.15	.034	.012	N.A.	N.A.	N.A.
61. Water Cress	Air: 2 Other: 2	1797 (N.A.)	401 (N.A.)	141 (N.A.)	.19	.043	.015	N.A.	N.A.	N.A.
Non-agricultural Uses										
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	56 (14) 50 (4)	15 (19) 12 (4)	6.5 (34) 4.7 (9)	6.2	1.5	.55	<.001 <.001	<.001 <.001	<.001 <.001
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	539 (N.A.)	120 (N.A.)	42 (N.A.)	.058	.013	.005	N.A.	N.A.	N.A.
Nursery. Outdoor Nursery	Air: 2.25[4] Other: 2.25[4]	8.7 (99) 1.7 (94)	4.6 (100) .92 (98)	2 (100) .4 (98)	.021	.003	.001	<.001 <.001	<.001 <.001	<.001 <.001
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	15 (14) 3 (3)	7.3 (17) 1.4 (4)	3.7 (33) .61 (9)	3.4 .75	1.6 .34	.67 .15	<.001 <.001	<.001 <.001	<.001 <.001

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Estimated Environmental Concentrations (EECs)								
		Malathion EEC (µg/L) (% Drift Contribution to EEC)			Maloxon EEC (µg/L)					
					Degradate Fraction[2]			Impurity Fraction[3]		
		Peak	21-day	60-day	Peak	21-day	60-day	Peak	21-day	60-day
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[5]	.18 (98)	.098 (99)	.096 (100)	.001	<.001	<.001	<.001	<.001	<.001
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	3 (100) .59 (100)	1.2 (100) .25 (100)	.62 (100) .12 (100)	<.001	<.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	4 (100) .8 (98)	1.8 (100) .36 (99)	1.6 (100) .33 (100)	.005	.001	<.001	<.001 <.001	<.001 <.001	<.001 <.001

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.

[2] Maloxon application rate is assumed to be 10.7% of malathion application rate.

[3] Maloxon as an impurity in drift is assumed to be 0.1% of malathion in drift.

[4] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).

[5] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

Malathion EECs for direct application to water scenario groups (59-rice and wild rice, 60-water cress, and mosquito control) were calculated using the methods documented in EFED's Rice Guidance document. Because the application rates for air and other application methods are the same for these scenarios and spray drift is not a factor in direct applications, only 1 set of peak, 21-day, and 60-day EECs are given for these scenario groups (*i.e.*, both air and other scenarios generate the same numbers).

EECs are difficult to calculate using PRZM/EXAMS for maloxon. Because maloxon is both an impurity of malathion (estimated as 1% of malathion applied) as well as a degradate (10.7% of malathion applied), both the impurity and degradate fractions should contribute to maloxon EECs through runoff and groundwater pathways, but only the impurity should contribute through the spray drift pathway. If maloxon is modeled as being directly applied at 10.7% of malathion, the spray drift fraction for the impurity needs to be 4.7×10^{-3} to simulate 1% impurity in a spray drift fraction of 5% (0.01 x 0.05 / 0.107) or 9.3×10^{-3} to simulate the 1% spray drift fraction (0.01 x 0.01 / 0.107). Because PRZM/EXAMS is not designed to accept such small spray drift fractions (there are not enough digits allocated in the PRZM input files to allow representation of such small numbers in either decimal or scientific notation), the impurity and degradate fractions of the maloxon EECs had to be estimated separately.

To model the degradate in PRZM/EXAMS, maloxon was applied at 10.7% of the malathion application rate with a spray drift fraction of 0% (no spray drift). Because spray drift assumptions do not apply to the degradate fraction, only 1 set of peak, 21-day, and 60-day EECs are given per scenario group (*i.e.*, both air and other scenarios generate the same numbers) except in those cases where the air and other application rates differ.

To model the impurity in PRZM/EXAMS, maloxon was applied at 1% of the malathion application rate with a 5 or 1% spray drift fraction for air (aerial and air-blast application methods) or other (other application methods), respectively.

3.2.2 Effect of Application Timing on Aquatic EECs

The application date can have a major impact on the aquatic EECs produced. This is because the application time period (the simulated first through last application dates) may cover only a small portion of the time period over which malathion is applied in California (Figure 9) or can be legally applied (*e.g.*, year-round for labels that do not have temporal restrictions). Malathion is applied in every month of the year (Figure 2). Because rain is more frequent in the winter for many of the scenarios while the peak malathion applications tend to occur in the summer, many of the scenarios will generate a much lower runoff contribution to EEC than would happen during other earlier or later times of the year when malathion is being applied to that use.

Figure 10 shows the affect of application date on malathion EECs produced by PRZM/EXAMS for the alfalfa scenario. During the summer months, the EECs are due almost solely to spray drift. During the winter months, when runoff and groundwater contributions occur, the EECs are much higher. Because the drift assumptions do not vary over time, the summer months without the contribution of runoff and groundwater contributions produce the lowest EECs.

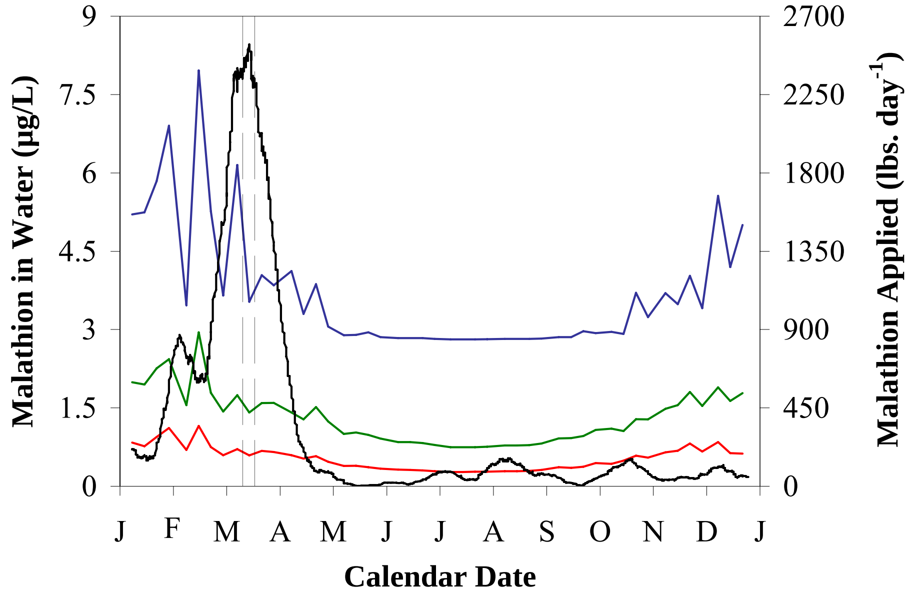


Figure 10. Variation in peak (blue) and maximum average 21-day (green) and 60-day (red) PRZM/EXAM estimated environmental concentrations (EECs) for malathion across a range of application dates. For comparison, a moving average of the CaDPR daily application malathion applied to alfalfa (solid black line) and the first and last application dates used in the PRZM model are shown (vertical dashed lines).

For most uses, the peak malathion application time is during the summer when EECs will be lowest. Similar to alfalfa (Figure 10), however, applications of malathion often occur outside of this peak application period. If these off-peak applications occur when runoff and groundwater are more likely to occur, the EECs generated for the peak application period may understate the EECs from off-peak applications and therefore, understate the risk to the CRLF from malathion use.

3.2.3 Surface Water Monitoring Data

Surface water monitoring data are presented from four monitoring programs. Two programs, California Department of Pesticide Regulation (CaDPR) and U.S. Geological Survey's National Water Quality Assessment (NAWQA), analyzed surface water samples for malathion in California, but were not targeted to malathion applications (non-targeted). Non-targeted monitoring programs are not designed to sample specifically in the vicinity of malathion applications and sampling is not timed to coincide specifically with malathion applications. These programs provide information about typical or average malathion concentrations and the general distribution of concentrations over the region, time period, and population of sites sampled. The PRZM/EXAMS EECs should, in general, be higher than these values with only the upper end of the distribution of non-targeted malathion concentration values approaching the PRZM/EXAMS EECs.

The other two USDA programs, the Boll Weevil Eradication Program (BWEP) and the Mediterranean fruit fly (medfly) control effort, are specifically designed to research the effects of malathion applications (targeted monitoring). Because targeted monitoring specifically samples water bodies expected to be most impacted by the malathion application being monitored, the after application samples should produce environmental concentrations that are much closer to corresponding PRZM/EXAMS EECs.

The ranges of the PRZM/EXAMS EECs and non-targeted and targeted monitoring data are compared in Section 3.2.5.

3.2.3.1 Non-targeted Monitoring

An evaluation of the surface water monitoring data was conducted to assess the occurrence of malathion and maloxon in California. Surface water data were obtained from the California Department of Pesticide Regulation (http://www.cdpr.ca.gov/docs/sw/surfdata.htm) and U.S. Geological Survey's National Water Quality Assessment (NAWQA) data warehouse (http://water.usgs.gov/nawqa/data.html). Maximum site concentrations are calculated from these data sets for comparison with PRZM/EXAMS EECs. Because these surface water sampling programs are not targeted to malathion use areas and were not collected at sites similar to the standard EXAMS pond (which is designed to present a high EEC scenario), these sampling programs are not expected to produce concentrations as high as the PRZM/EXAMS EECs. However, any agreement/disagreement can aid in characterizing the uncertainty of the PRZM/EXAMS malathion EECs.

Frequency distributions of maximum site malathion concentrations are shown in Figure 11. At many sites, all samples collected were below the level of quantitation ("< LOQ" - gray left-most bars in each graph of Figure 11). The maximum reported concentration of malathion in the CaDPR data set is 6 μg/L from the Colusa Basin Drain #5 in Colusa County, CA, and 1.35 μg/L from Warm Creek Near San Bernardino (site 11060400) in San Bernardino, CA, for the USGS NAWQA data set. However, the interpretation of these data sets is complicated because the LOQ varied between samples and over time. The maximum LOQs were 1 and 0.15 μg/L for the CaDPR and NAWQA data sets, respectively. Therefore, additional sites may have had actual concentrations approaching these LOQs in the samples that were collected that are listed as < LOQ. A total of 9 (CaDPR and NAWQA) sites had measured maximum concentrations in excess of 1 μg/L (the highest LOQ).

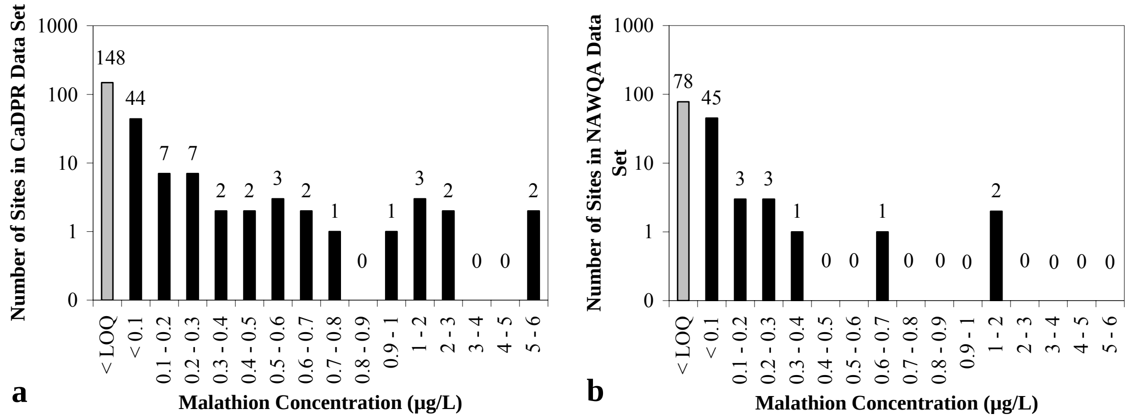


Figure 11. Frequency distributions of (a) maximum site malathion concentrations for California Department of Pesticide Regulation (CaDPR) and (b) U.S. Geological Survey's National Water Quality Assessment (NAWQA) data sets.

The only maloxon concentration measured above the detection limit in either the CaDPR or NAWQA data sets is 0.06 μg/L from the Alamo River at All American Canal in Imperial County, CA (from the CaDPR data set). The detection limits for maloxon varied from 0.05 to 0.2 μg/L for the CaDPR data set and from 0.008 to 0.09 μg/L for the NAWQA data set.

3.2.3.2 Targeted Monitoring

<u>Boll Weevil Eradication Program:</u> Malathion is water soluble and therefore has the potential to be dissolved in rain water and transported in runoff water from application sites. The Boll Weevil Eradication Program (BWEP) has monitored malathion in runoff, standing (ponded), and moving surface water.

Malathion in runoff: Levels of malathion in runoff water have been examined mostly using automatic runoff sampling equipment which consist of collection bottles with funnels recessed in the ground at sites where runoff is expected. The amount of malathion in runoff is expected to be affected by numerous variables including the soil type, half-life on the particular soil, the amount of time between application and precipitation, the amount of precipitation, and vegetation. Table 9 shows runoff monitoring data from five treated cotton fields in the Boll Weevil program close to bodies of water. Sampling was performed close to the field (10-25 feet) and closer to the water (40-135 feet from the field). In most cases, malathion concentrations were lower when the interval between application and rainfall was longer and/or distance from the field was farther. These observations are expected since increasing the time interval since application allows for more degradation to occur and longer runoff travel distances allow malathion to penetrate soil and adsorb to soil particles before reaching surface water.

Table 10. Field monitored runoff [a] from the Cotton Boll Weevil Control Program.

Field Number	Time from Application to Rain (Days)	Field Runoff Malathion Concentration (μg/L)	
		Closer to Field (Distance in Feet)	Farther from Field (Distance in Feet)
1806-502	1	9.3 (20')	1.9 (110')
	3	7.5 (20')	3.5 (110')
	6	>0.3 (20')	>0.3 (110')
1806-504	1	70 (20')	33 (40')
	6	0.48 (20')	nd (40')
2025-187	2	0.42 (10')	0.53 (70')
2027-468	1	63 (15')	nd (135')
	5	nd (15')	-
2100-200	18	4.2 (25')	3.8 (50')
502	3	1.1 (20')	nd (110')
	7	0.5 (20')	nd (110')
504	1	10.9 (20')	nd (40')
	3	41.8 (20')	15.6 (40')
	7	146 (20')	93.5 (40')
7806	?	0.9 (0')	0.5 (45')
	6	1.7 (0')	1.1 (45')
	14	<0.3 (0')	0.3 (45')
325	2	8.54 (15')	0.82 (60')
	9	35.8 (15')	16.2 (60')

[a] Malathion levels were measured in runoff water from cotton fields after rain events. Two sets of measurements were made, one closer to the field and one farther from the field. Adapted from *Environmental Monitoring Report: 1997 Southeast Boll Weevil Eradication Program Sensitive Sites* (USDA 1997a) and *Environmental Monitoring Report: 1996 Southeast Boll Weevil Eradication Program* (USDA 1996)
nd = none detected.
- = not sampled.

Spray drift contributions to standing water bodies: In monitoring projects the stability of malathion in still water has been examined. A half-acre pond surrounded by cotton fields with a 25 foot buffer was monitored for malathion (USDA 1993). Pesticide drift was determined to be the most important mechanism of contamination of the pond. Residue levels in the pond were lower before treatment (<0.1-0.44 μg/L) and higher immediately after malathion application (<0.33-91.4 μg/L). In most cases malathion in the pond degraded to <0.33 μg/L within 7 days. Runoff was only a minor contributor of residue to the pond but only two rainfalls occurred during the sampling period. The malathion in the runoff samples collected were 9.75 and 76.3 μg/L one day after the first and last treatments, respectively. Other natural bodies of water within treatment areas, but not intentionally receiving direct spray, showed no detectable levels of malathion 3-27 days after applications ceased (USDA 1995).

Spray drift contributions to moving water bodies: The Boll Weevil Eradication Program also assessed spray drift contributions to moving water bodies (Tables 10, 11, and 12). Wide buffer strips (125-700 feet) with high vegetation appeared to reduce malathion drift to sensitive areas to levels below detection while narrower and lower buffer afforded less protection (Table 12). With aerial applications, 8 of 19 applications lead to higher aquatic malathion concentrations, whereas only 1 of 10 ground applications resulted in higher malathion levels. (Aerial applications are more prone to drift than ground applications.) Although increased malathion levels in the streams, rivers, and canals examined after nearby treatments decreased rapidly, decreases are likely due primarily to the movement of contaminated water downstream.

Table 11. Southeast Boll Weevil Eradication Program monitoring data of spray drift to adjacent moving water (USDA 1993)[a].

Site: Comments	**Application (Aerial / Ground)**	**Treatment Number (Days since Last Treatment)**	**Downstream Malathion Concentration**	
			µg/kg (Minutes Before Treatment)	**µg/kg (Minutes After Treatment)**
McCall's Creek: The creek was separated from the field (13.3 acre) by a continuous 600-700' buffer of 30-60' trees.	Aerial	1 (?)	nd	nd
	Aerial	2 (8)	nd	nd
	Aerial	3 (6)	nd	nd
	Aerial	4 (7)	nd	nd
	Aerial	5 (7)	16.1 (60)	nd
North River: The field (8.3 acre) is separated from the river by a continuous buffer of mature hardwoods and moderately dense understory approximately 125' deep.	Ground	1 (?)	-	nd
	Ground	2 (5)	nd	nd
	Ground	3 (7)	nd	nd
	Ground	4 (6)	<0.33 (45)	<0.33 (45)
	Ground	5 (6)	<0.33 (0)	<0.33 (0-120)
	Aerial	6 (10)	1.54 (45)	1.44 (60)
	Aerial	7 (6)	<0.33 (0)	<0.33 (0-120)
	Aerial	8 (7)	1.77 (60)	1.46 (0)
	Aerial	9 (10)	0.42 (45)	0.55 (45)
Pursley Creek: The field (95.3 acre) was separated from the creek by 100' of mature hardwoods with a dense understory.	Aerial	1 (?)	nd	3.54 (135)
	Aerial	2 (7)	nd	0.39 (120)
	Aerial	3 (7)	nd	1.03 (30)
	Aerial	4 (7)	nd	<0.33 (75-120)
	Aerial	5 (7)	6.63 (30)	3.80 (120)
	Aerial	6 (6)	nd	3.35 (150)
Stewart Creek: The field (19.2 acre) was separated from the creek by a 25' buffer of low -lying kudzu vegetation.	Ground	1 (?)	nd	nd
	Ground	2 (8)	<0.33 (60)	nd
	Aerial	3 (7)	nd	7.69 (60)
	Aerial	4 (5)	nd	3.16 (75)
	Ground	5 (7)	0.52	<0.33 (0-240)
	Ground	6 (4)	0.51	10.89 (15)
	Ground	7 (5)	<0.33	<0.33 (15, 105, 135-250)
	Aerial	8 (6)	1.01	4.52 (60)
	Aerial	9 (12)	<0.33	3.49 (105)

[a] Malathion levels in moving water adjacent to cotton fields were measured before and after treatment. Measurements were made downstream from the field every 15 minutes from one hour before until 2-3.25 hours after application. Application was made when wind was not blowing directly over the water.

Table 12. Texas Lower Rio Grande Valley Boll Weevil Eradication Program monitoring data of spray drift to adjacent moving water (USDA 1995a)[a].

			Downstream Malathion Concentration	
Site/Comments	Aerial/ Ground	Treat-ment #	μg/kg (Minutes Before Treatment)	μg/kg (Minutes After Treatment)
#204060311/ Canal 200' from treated field.	?	1	0.324 (15)	0.297 (15)
	?	2	4.89 (15)	7.26 (30)
#2144070704 Canal 40' from treated field	?	1	6.38 (30)	11.4 (0)
	?	2	2.27 (45)	1.87 (0)
#212080704/ Canal 150' from treated field	?	1	4.81 (45)	4.15 (30,120)
	?	2	2.4 (30)	4.37 (120)
	?	3	5.92 (45)	4.21 (0)

[a] Malathion levels in moving water adjacent to cotton fields were measured before and after treatment. Measurements were made downstream from the field every 15 minutes from one hour before until 2-3.25 hours after application. Application was made when wind was not blowing directly over the water.

Table 13. Southern Rolling Plains Boll Weevil Eradication Program monitoring data of spray drift to adjacent moving water (USDA 1994-5)[a].

			Peak Downstream Malathion Concentration	
Site/Comments	Method of Application	Treat-ment #	μg/kg (Minutes Before Treatment)	μg/kg (Minutes After Treatment)
Concho County Stream (10303-1408) Samples collected 0.25 miles downstream	Hi-Boy	1	0.849 (15)	6.95 (105)
	Mist blower	2	0.695 (45)	86.9 (225)
	Mist blower	3	0.273 (45)	0.503 (210)
Concho River (10708-2707) Samples collected 0.25 miles downstream	Mist blower	1	0.676 (15)	0.813 (0)
	Mist blower	2	0.871 (60)	0.589 (150)
	Mist blower	3	2.24 (60)	7.45 (15)

[a] Malathion levels in moving water adjacent to cotton fields were measured before and after treatment. Measurements were made downstream from the field every 15 minutes from one hour before until 2 - 3.25 hours after application. Application was made when wind was not blowing directly over the water.

Monitoring data suggests that urban malathion use poses the highest risk of contaminating surface water. However, use data are not available to correlate with monitoring data to determine which particular uses have the greatest impact. Total usage and use rates in specific cities are also unavailable. Targeted urban monitoring and preliminary fate experiments suggest however that malathion contacting anthropogenic surfaces is likely to convert to the oxon and has a high runoff potential.

Mediterranean fruit fly (medfly) control effort: Malathion concentrations in water in and around urban medfly treatment areas in California and Florida have been measured. Although a risk assessment of malathion use for medfly control is not included in this document (these generally fall under section 18 local need uses), the monitoring studies associated with this use provide information on malathion fate and transport in residential settings. In urban areas not involved in medfly control measures, malathion can be found in runoff water at higher levels than agricultural areas. A monitoring report by United States Geological Survey showed that higher residues are found in urban areas. In this analysis of 11 urban streams (604 samples) and 37 agricultural streams (1530 samples) malathion concentrations were higher in the urban tributaries.

It is likely that proposed residential uses will result in aquatic contamination. Residential malathion uses include outdoor home and garden, public park, and commercial use as well as residential mosquito control. Home use formulations may be applied as a "... spray to lower foundation of house, patios and garbage cans ... along fences; to firewood piles; and other infested areas" (Ortho Malathion 50 Plus Insect Spray label). Malathion on the surfaces described on the this label is likely to persist longer and be more available for runoff than malathion on soil. Fyfanon ULV formulation is applied at 0.2 - 0.23 lbs/A aerially at 150 mph over residential areas for mosquito control. In addition to covering anthropogenic surfaces it is likely that moderate sized bodies of water receive direct spray during normal aerial mosquito control use. In medfly treatments, malathion is mixed with a bait mixture and applied aerially at nearly the same rate as in mosquito control but with large buffers (up to 200 feet). Medfly applications in residential areas provide useful information on the fate and transport of malathion in these settings, but it is very likely that the smaller particles produced from the ULV formulation used in mosquito control results in more drift than the baited mixture for medfly. Thus, medfly monitoring data of drift will be expected to underestimate drift from ULV mosquito use.

In medfly control efforts larger bodies of water are "flagged" to avoid direct malathion treatment. Thus, contaminated water bodies presumably received insecticide residues by drift and runoff. On average, reservoirs in the treatment area which were flagged to avoid direct spray contained 0.16 µg/L before treatments and 2.59 µg/L immediately after treatment (Table 14). All waters in and around the treatment area, whether protected or not, showed increased malathion levels immediately after treatment. In general, applications were performed approximately weekly with no noted aggregate accumulation of malathion in water.

Rainwater runoff in California medfly treatment area contributed greatly to malathion levels in a stream passing through the treatment area. After precipitation, inflow into the treatment area contained less than 1 µg/L while downstream water contained up to 203 µg/L malathion. Maxima in 1990 and 1981 were 44.1 and 583 µg/L (CaEPA1996).

Table 14. Malathion levels in bodies of water in relation to medfly control spraying[a].

Site	Treat-ment No.	Days since Last Spray	Malathion (μg/L)			Maloxon (μg/L)		
			No. of Samples	Before (Std. Err.)	After (Std. Err.)	No. of Samples	Before (Std. Err.)	After (Std. Err.)
Unprotected[1] natural waters	1	*	14	*	4.94 (2.71)	*	*	*
	2	9	6-16	0.20 (0.05)	18.66 (5.81)	1	*	18.0 (*)
	3	11	13-15	1.50 (1.17)	9.78 (2.47)	*	*	*
	4	7	14-15	.48 (.13)	95.4 (53.2)	1-2	0.64 (*)	1.9 (0.20)
	5	7	13-14	.66 (.12)	4.97 (1.05)	4-5	.19 (0.046)	.63 (.17)
	6	7	11-12	.57 (.20)	23.4 (11.6)	1-4	.90 (*)	.35 (.10)
Average	**-**	**8.2**	**-**	**.68 (.33)**	**26.19 (12.8)**	**-**	**-**	**-**
Protected[2] natural waters	1	*	20	.091 (.058)	.33 (.078)	*	*	*
	2	9	20	.12 (.07)	.56 (.10)	*	*	*
	3	11	19-20	.056 (.028)	.90 (.15)	*	*	*
	4	7	14-15	.12 (.07)	1.25 (.22)	*	*	*
	5	7	20-22	.040 (.019)	2.10 (.41)	1	*	.40 (*)
	6	7	15-19	.053 (.040)	.39 (.089)	2	*	.45 (.25)
Average	**-**	**8.2**	**-**	**.080 (.048)**	**.92 (.17)**	**-**	**-**	**-**
Flagged reservoirs	2	9	2	.18 (.03)	.75 (.65)	1	*	2.7 (*)
	3	11	2	*	.50 (.10)	*	*	*
	4	7	19-20	.033 (.024)	8.39 (3.81)	2	*	.92 (.29)
	5	7	10-12	.51 (.30)	1.90 (.94)	*	*	*
	6	7	8	.075 (.062)	1.42 (.41)	1	.1 (*)	.83 (*)
Average	**-**	**8.2**	**-**	**.16 (.083)**	**2.59 (1.18)**	**-**	**-**	**-**
Reservoirs outside treatment area	2	9	2	.05 (.05)	.34 (.07)	*	*	*
	3	11	2-4	.10 (.10)	1.0 (.55)	*	*	*
	4	7	10	.03 (.03)	.30 (.16)	*	*	*
	5	7	10	.036 (.024)	.14 (.058)	1	1.3 (*)	*
	6	7	8-10	.18 (.074)	.21 (.087)	*	*	*
Average	**-**	**8.2**	**-**	**.079 (.056)**	**.40 (.19)**	**-**	**-**	**-**

[a] Malathion was measured immediately before and after spraying a bait formulation at ~0.17 lbs ai/A from an altitude of 300 feet. This data was adapted from A Characterization of Sequential Aerial Malathion Applications in the Santa Clara Valley of California (CaEPA 1981).
[1] Unflagged and within the treatment area.
[2] Flagged to avoid treatment or outside the treatment area.
* No data.

Table 15. Malathion level in 29 ponds in Florida exposed to direct (unprotected aquatic sites) or indirect (protected aquatic sites) malathion spray in medfly control[a].

site	Before Application			After Application		
	Number of Samples	Average (µg/L)	St. Dev. (µg/L)	Number of Samples	Average (µg/L)	St. Dev. (µg/L)
Unprotected Aquatic Sites						
Fairgrounds	8	0.06	0.07	9	1.20	1.54
Palm river	9	0.78	0.72	7	3.97	3.24
Ragen Park	6	14.12	14.17	7	35.75	27.50
University Square Mall	7	0.04	0.07	7	3.77	3.67
Pond Lake	6	4.11	4.35	10	9.25	11.78
Bloomingdale Area	9	0.81	0.71	9	6.12	7.22
Carrolwood	7	1.05	2.01	6	4.77	3.75
Town and Country	6	1.10	1.15	5	6.88	3.07
McDill Site	5	0.12	0.06	4	5.20	2.33
Brandon Town Center	5	3.50	1.86	8	65.71	149.18
Lowry Zoo	7	0.14	0.22	6	1.55	1.86
Sun 'n Fun	8	0.09	0.07	10	7.28	15.48
Hamilton Creek	6	0.61	0.41	7	10.74	19.51
Eagle Lake	7	1.60	2.29	7	13.99	10.39
Protected Aquatic Sites						
Moore's lake	10	0.36	0.78	10	0.76	1.66
Lake Weeks	12	0.69	0.67	11	4.85	4.08
Lake Valrico	12	0.03	0.06	11	2.84	6.71
Lake Kathy	12	0.43	0.91	11	5.91	9.15
Lake Walden	6	0.21	0.14	6	2.21	2.37
Alafia River	6	0.13	0.17	6	1.93	4.06
Hillsborough River	8	0.35	0.39	8	5.02	9.13
Platt Lake	2	0.08	0.08	2	0.85	0.15
Lake Magdalene	2	0.08	0.08	2	0.80	0.20
Lake Carroll	2	0.31	0.16	2	1.65	0.55
Crystal Lake	9	0.02	0.05	9	0.46	0.74
Lake Horney	10	0.03	0.06	9	3.47	3.86
Banana Lake	7	0.21	0.33	7	2.48	3.97
Crews Lake	7	0.23	0.19	7	0.82	0.96

[a] Samples were collected within 18 hours of approximately weekly treatments of 0.15 lbs/A. Unprotected bodies of water were ~0.1 miles in length and may have received runoff from surrounding watersheds. Protected waters were rivers or larger lakes. Statistically, values below the detection limit (0.1 µg/L) were treated as 0 µg/L and values below limit of quantitation (0.3 µg/L) were treated as 0.15 µg/L. The data was adapted from the Environmental Monitoring Report: Cooperative Medfly Project Florida (USDA 1997b).

Residential settings are expected to be composed of numerous surfaces which may be physically and biologically impervious to malathion. The relative quantities and effects of adsorption and degradation on concrete, roofing, metal, and plastics is unknown in the residential settings where malathion may be sprayed for medfly and mosquito control. Monitoring results suggest that the residential surfaces increase availability of malathion for runoff probably due to lack of microbial activity which decreases metabolism, less water content which decreases hydrolysis, and little adsorption. Although the application rate for mosquito control is low relative to agricultural use (0.20 - 0.6 lbs/A for aerial mosquito control versus 0.175 – 27.47 lbs/A for agricultural pest control), application over wide areas may be concentrated in storm drain systems along with malathion from home and garden and commercial site use.

The concentration factor appears to be greater in residential settings when comparing residential and agricultural runoff. This is consistent with the results of several USGS and USDA monitoring studies. Preliminary monitoring results for malathion in surface water (USGS 1997) show malathion was detected above 0.01 µg/L with a 2.61% frequency in agricultural streams while in urban streams the frequency was 20.86%. The USDA monitoring studies for boll weevil control show an average runoff concentration of 15.5 µg/L (Table 11) while average downstream creek concentrations in the urban Santa Clara Valley of central California were 177 µg/L during 1981 malathion spraying for medfly.

The highest levels of aquatic maloxon found in a search of available data were a result of medfly control efforts in California (CaDFG 1982). The following table is derived from the monitoring study during the malathion spraying in the Santa Clara Valley. Samples were taken 2 - 3.5 hours after the first rainfall 6 days after the last application. These runoff concentrations are much higher than agricultural runoff levels.

Table 16. Malathion and maloxon concentrations in creeks after malathion applications in the Santa Clara Valley.

Sampling Location		Average Concentration (Std. Dev.)	
		Malathion (µg/L)	Maloxon (µg/L)
Adobe Creek	50' Upstream	449 (17.7)	164 (33.2)
	Drain	583 (40.3)	328 (18.4)
	100' Downstream	361 (20.5)	169 (-)
Stevens Creek	50' Upstream	159 (-)	68.0 (-)
	Drain	434 (73.5)	147 (4.2)
	150' Downstream	156 (23.3)	68.0 (-)
Guadalupe Creek, Site 1	50' Upstream	1.9 (0.2)	0.8 (0.3)
	Drain	142 (-)	147 (4.2)
	150' Downstream	23.5 (2.1)	22.0 (-)
Guadalupe Creek, Site 2	50' Upstream	137 (25.4)	212 (9.2)
	Drain	188 (12.0)	250 (8.5)
	150' Downstream	169 (6.4)	231 (8.5)

Fate data for malathion clearly show that its major routes of degradation are through aerobic microbial metabolism and hydrolysis. Both of these routes are expected to be lower on inert, dry surfaces; thus malathion persistence would be expected to be increased. Malathion persistence on steel plates is extended relative to soil with only 15% lost in two days (CaEPA 1996) compared to several soils on which 50% can be degraded in 8 hours. Slowed malathion hydrolysis and metabolism is likely to result in increased maloxon levels via abiotic oxidation. On the steel plate study mentioned previously, maloxon accounted for 5% of the degradates, significantly higher than the maximum of 1.8% on soil reported by the registrant.

3.2.4 Air Monitoring

An evaluation of air monitoring data was conducted to assess the occurrence of malathion and maloxon. Air monitoring data were obtained from the California Department of Pesticide Regulation (Segawa, *et al*, 2003 and Kollman 2002). A review of the air monitoring data indicates that malathion was detected in trace quantities in an air monitoring study in Lompoc City, Santa Barabara County (Segawa, *et al,* 2003). Air concentrations of malathion were 7.6 ng/m^3 for the highest one day average, 1.01 ng/m^3 for the highest 3 day average, 0.54 ng/m^3 for the highest 18 day average concentration. Air concentrations of malathion were not reported in the California Pesticide Air Monitoring Results: 1986-2000 (Kollman 2002). Additionally, air monitoring data for the malathion degradation products was not found.

The potential impact of malathion air concentrations on surface water quality was assessed for the standard water body. Air concentrations above the pond are assumed to be the maximum reported air concentration in CA (7.6 ng/m^3). The potential contribution of volatile malathion was evaluated assuming different air volumes above the pond. Mass loading of malathion was calculated assuming a complete rainwater "wash-out" from the air space above the pond. Malathion water concentrations from atmospheric deposition of volatile malathion are not expected to exceed 0.27 µg/L. Using similar assumptions, maloxon water concentrations from atmospheric deposition of volatile maloxon are not expected to exceed 0.078 µg/L.

3.2.5 Aquatic Exposure Summary

PRZM/EXAMS EECs represent the total contribution of spray drift, runoff, and groundwater flow paths. Because the application date for many of the scenarios is in the summer when there is little runoff and groundwater contribution, many scenarios' EECs are dominated by spray drift contributions. Table 9 provides estimates of the percentage of the EEC contributed by drift for each use. Figure 12 compares these estimates of drift contribution to EECs to the PRZM/EXAMS EECs produced for each use. These graphs show little relation between percentage contribution from drift and total EEC (combined contribution of drift, runoff, and erosion) even within PRZM/EXAMS scenarios from similar locations (as indicated by the location from which meteorological data was collected in Figure 12b).

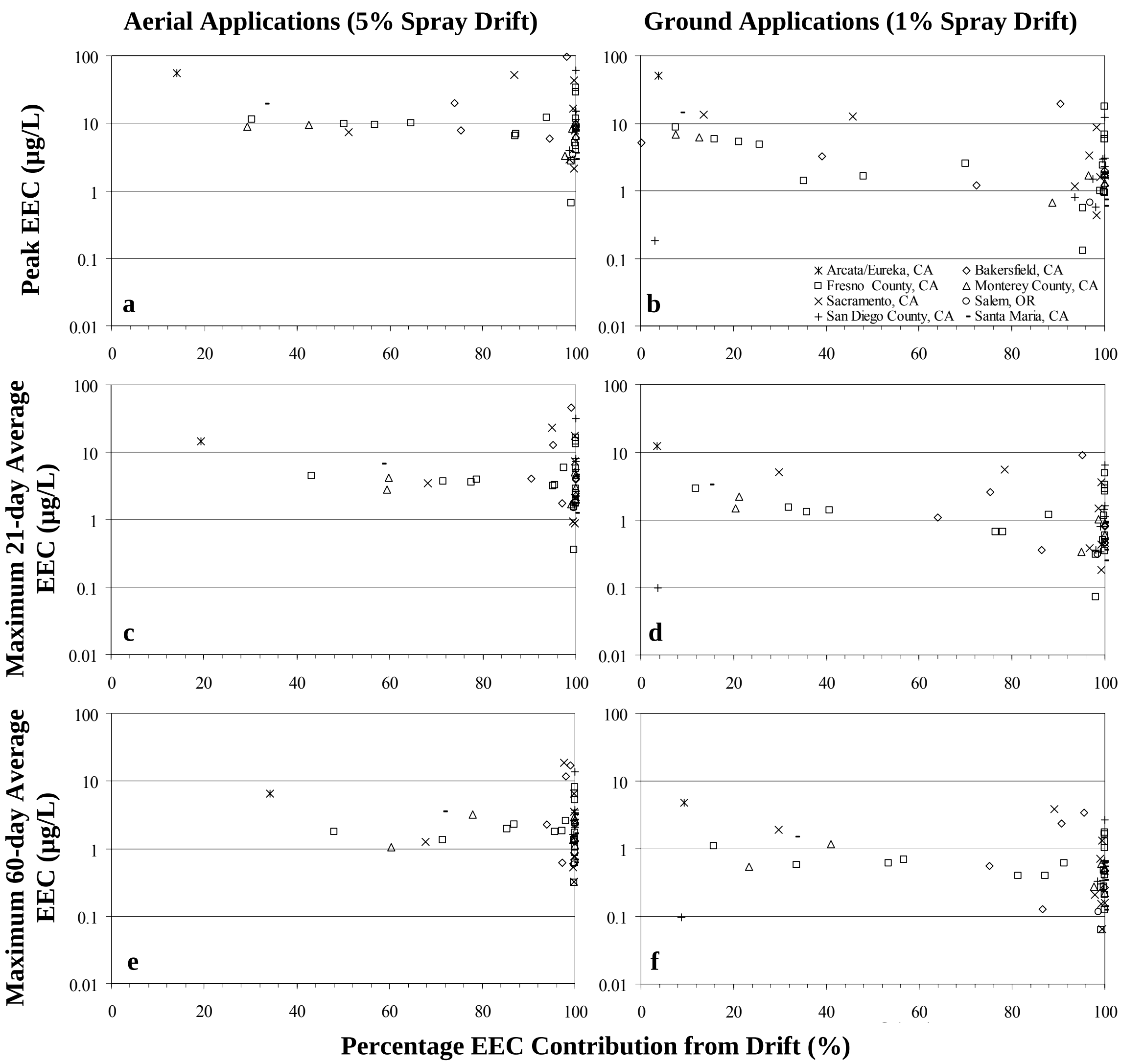


Figure 12. Comparison of PRZM/EXAMS estimated environmental concentrations (EECs) to the percentage of EEC contributed from drift shows that many high aquatic EECs are largely, or almost solely, attributable to drift alone (drift contribution for individual scenarios is listed in Table 9).

Figure 12 shows that some of the highest EECs are almost solely due to drift. Because drift is a relatively uncomplicated exposure pathway compared to runoff and groundwater pathways, there is correspondingly less uncertainty associated with the drift component of the PRZM/EXAMS EECs.

The range of peak and maximum average 21-day and 60-day malathion EECs generated by PRZM/EXAMS overlaps with, or is exceeded by, several of the previously-discussed surface water monitoring data sets (Figure 13). As expected, the non-targeted (CaDPR and USGS) data sets are lower, in general, than the PRZM/EXAMS EECs, but do show considerable overlap in concentration ranges. Monitoring from the Boll Weevil Eradication Program (a targeted monitoring program) shows concentration ranges that, in general, equal or exceed the PRZM/EXAMS EECs for concentrations measured in runoff, standing water (ponds), and in one study moving water. (The other 2 moving water studies found overlapping, but lower concentrations.) Monitoring from efforts to control the Mediterranean fruit fly (another targeted monitoring program) shows concentration ranges that are also, in general, equal to or exceed the PRZM/EXAMS EECs for concentrations measured in unprotected waters (waters located within the aerial treatment area). Protected waters from the medfly studies show lower concentrations than unprotected waters, but concentrations that partially overlap the PRZM/EXAMS EECs.

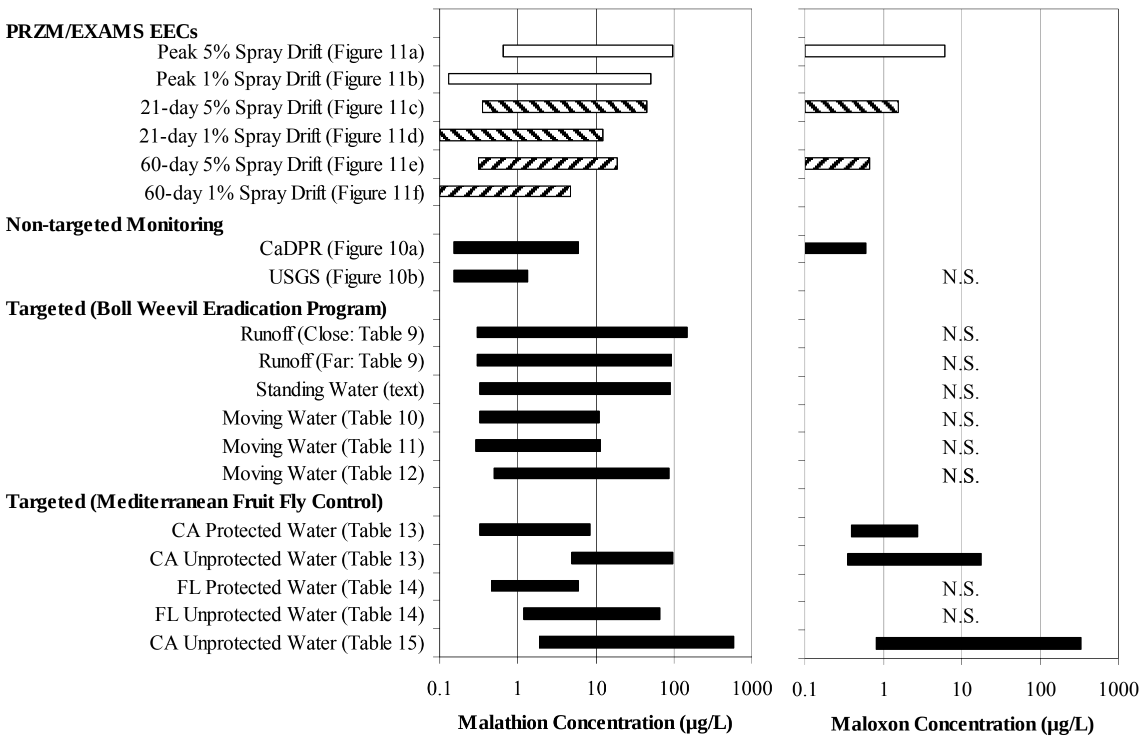


Figure 13. Comparison of PRZM/EXAMS estimated environmental concentrations (EECs) for malathion and maloxon to non-targeted monitoring and targeted monitoring in agricultural (Boll Weevil Control Program) and urban (Mediterrarainian fruit fly control) settings. (N.S. = not sampled.)

(Aquatic uses in which malathion is intentionally applied directly to water - rice and wild rice, water cress, and mosquito control - are not included in Figure 13. These uses, because of the direct application to water, generate the highest EECs ranging from 540 to 1800 µg/L.)

For maloxon, there is less data, but the PRZM/EXAMS EECs appear to be even lower relative to the available targeted monitoring data. Again, the non-targeted monitoring data are lower with only 1 sample having a measured concentration above the detection limit.

This comparison between the PRZM/EXAMS EECs and the available surface water data indicates the aquatic exposure assessment is not conservative (does not produce higher EECs than are documented to occur in the environment that would produce a risk assessment that is protective of the CRLF). Though there are many potential explanations, 2 explanations merit further exploration:

- *Malathion persistence may be under-estimated.* One of the major routes of malathion dissipation is hydrolysis. Under acidic conditions, malathion is expected to be much more persistent. Often in environmental modeling, average conditions are used to represent what is, in reality, a distribution of conditions. The PRZM/EXAMS EECs are based on hydrolysis under neutral conditions. If the actual environmental conditions are composed of a mosaic of micro-environments having a distribution of pHs centered on a neutral pH, the PRZM/EXAMS EECs would not account for the malathion and maloxon that persist for extended periods in the more acidic micro-environments.
- *EFED's spray drift assumptions may be under-estimated.* An assessment of drift from malathion use was conducted for the Boll Weevil Eradication Program by measuring off-target drift adjacent to aerial ULV malathion applications (Pennsylvania State University 1993). Maximum and average spray drift fractions were much higher than EFED's assumptions of 5% for aerial and air blast application methods and 1% for other application methods.

Because many of the high PRZM/EXAMS EECs are due almost completely to spray drift contribution, it is unlikely that the lack of conservatism is due to the PRZM/EXAMS parameters or inputs related to the runoff and groundwater flowpaths.

3.3 Terrestrial Exposure Assessment

Similar to the aquatic exposure assessment, the terrestrial exposure assessment estimates the environmental concentrations of malathion and maloxon to which terrestrial organisms are expected to be exposed. The estimated exposure concentrations will be used in subsequent sections to assess effects of terrestrial malathion exposure directly to CRLF and indirectly to CRLF through habitat and prey. The TerrPlant model is used to estimate terrestrial malathion and maloxon concentrations.

Again because the risk assessment is intended to be protective of the CRLF, the terrestrial exposure estimates are based on conservative (protective) assumptions and, therefore, should be higher than measured concentrations, but not unrealistically so.

3.3.1 Terrestrial Wildlife Exposure Modeling

EFED estimates exposure of birds and mammals to pesticides (Table 17) using the Terrestrial Exposure Model (T-REX). (Small birds and mammals are prey items of the CRLF. Therefore anything that directly impacts the population levels of CRLF prey items represents a potential indirect effect on the survival of the CRLF.) T-REX uses the Kenaga nomagram, as modified by Fletcher *et al.* (1994) to determine pesticide residue concentrations on several categories of food items, then calculates the potential dose an organism might receive from ingesting contaminated items using allometric equations. Dose estimates are based on an upper bound dose and the assumptions that the organism exclusively eats one type of food item and forages only in the treated and/or overspray areas. Dose based estimates for individual exposure scenarios vary from 3.97 to 11,548 mg/kg-bw for small birds and 0.74 to 9667 mg/kg-bw for small mammals.

Table 17. Dietary- and dose-based estimated environmental concentrations (EECs) for small birds and Mammals. Small birds (approximately 20 g) and small mammals (approximately 15 g) are prey items of the California Red-legged Frog.

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based EECs (mg/kg of Food Item)				Dose-based EECs (mg/kg-bw) for: 20 g Bird / 15 g Mammal				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
Agricultural Uses										
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	679	311	382	42.4	773 / 647	354 / 297	435 / 364	48.3 / 40.4	N.A. / 8.99
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	6129	2809	3448	383	6981 / 5844	3199 / 2678	3927 / 3287	436 / 365	N.A. / 81.2
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	5070	2324	2852	317	5774 / 4833	2646 / 2215	3248 / 2719	361 / 302	N.A. / 67.1
4. Chestnut	Air: 5 Other: 5	1987	911	1118	124	2263 / 1895	1037 / 868	1273 / 1066	141 / 118	N.A. / 26.3
5. Almond	Air: 1.25 Other: 4	507 1622	232 744	285 913	31.7 101	577 / 483 1848 / 1547	265 / 222 847 / 709	325 / 272 1039 / 870	36.1 / 30.2 115 / 96.7	N.A. / 6.71 N.A. / 21.5
6. Date	Air: 1 Other: 2	380 576	174 264	214 324	23.8 36	433 / 363 656 / 549	199 / 166 301 / 252	244 / 204 369 / 309	27.1 / 22.7 41 / 34.3	N.A. / 5.04 N.A. / 7.63
7. Filbert (Hazelnut)	Air: 0.625 Other: 0.625	253	116	143	15.8	289 / 242	132 / 111	162 / 136	18 / 15.1	N.A. / 3.36
8. Avocado	Air: 9 Other: 9	3174	1455	1785	198	3615 / 3026	1657 / 1387	2033 / 1702	226 / 189	N.A. / 42
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	10,139	4647	5703	634	11,548 / 9667	5293 / 4431	6495 / 5438	722 / 604	N.A. / 134
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower,	Air: 2.5 Other: 2.5	1019	467	573	63.7	1160 / 971	532 / 445	653 / 546	72.5 / 60.7	N.A. / 13.5

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based EECs (mg/kg of Food Item)				Dose-based EECs (mg/kg-bw) for: 20 g Bird / 15 g Mammal				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)										
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	857	393	482	53.6	976 / 817	447 / 375	549 / 460	61 / 51.1	N.A. / 11.4
12. Cotton	Air: 4 Other: 4	3049	1397	1715	191	3473 / 2907	1592 / 1332	1953 / 1635	217 / 182	N.A. / 40.4
15. Apricot	Air: 10 Other: 10	4304	1973	2421	269	4902 / 4104	2247 / 1881	2757 / 2308	306 / 256	N.A. / 57
16. Nectarine and Peach	Air: 9 Other: 9	3874	1775	2179	242	4412 / 3693	2022 / 1693	2482 / 2077	276 / 231	N.A. / 51.3
17. Cherry	Air: 8 Other: 8	3580	1641	2014	224	4078 / 3413	1869 / 1565	2294 / 1920	255 / 213	N.A. / 47.4
18. Fig	Air: 2.5 Other: 2.5	1090	499	613	68.1	1241 / 1039	569 / 476	698 / 584	77.6 / 64.9	N.A. / 14.4
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	565 678	259 311	318 381	35.3 42.4	644 / 539 772 / 647	295 / 247 354 / 296	362 / 303 434 / 364	40.2 / 33.7 48.3 / 40.4	N.A. / 7.48 N.A. / 8.98
20. Guava, Mango, Plum, and Prune	Air: 0.75 Other: 1.5	339 678	155 311	191 382	21.2 42.4	386 / 323 773 / 647	177 / 148 354 / 296	217 / 182 435 / 364	24.1 / 20.2 48.3 / 40.4	N.A. / 4.49 N.A. / 8.98
21. Papaya	Air: 0.175 Other: 0.175	79.2	36.3	44.5	4.95	90.2 / 75.5	41.3 / 34.6	50.7 / 42.5	5.63 / 4.72	N.A. / 1.05
22. Garlic and Leek	Air: 2 Other: 2	809	371	455	50.6	921 / 771	422 / 354	518 / 434	57.6 / 48.2	N.A. / 10.7
23. Grapes	Air: 2.75 Other: 27.47	970 9688	445 4440	546 5449	60.6 605	1105 / 925 11,034 / 9237	506 / 424 5057 / 4233	621 / 520 6206 / 5196	69 / 57.8 690 / 577	N.A. / 12.8 N.A. / 128

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based EECs (mg/kg of Food Item)				Dose-based EECs (mg/kg-bw) for: 20 g Bird / 15 g Mammal				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	951	436	535	59.4	1083 / 907	496 / 416	609 / 510	67.7 / 56.7	N.A. / 12.6
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	1003	460	564	62.7	1143 / 957	524 / 438	643 / 538	71.4 / 59.8	N.A. / 13.3
28. Peppermint	Air: 1 Other: 1	476	218	267	29.7	542 / 453	248 / 208	305 / 255	33.9 / 28.3	N.A. / 6.3
29. Eggplant	Air: 3.5 Other: 3.5	1720	788	967	107	1959 / 1640	898 / 752	1102 / 922	122 / 102	N.A. / 22.8
30. Pumpkin	Air: 2 Other: 2	895	410	503	55.9	1019 / 853	467 / 391	573 / 480	63.7 / 53.3	N.A. / 11.9
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew /Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	839	385	472	52.4	956 / 800	438 / 367	538 / 450	59.7 / 50	N.A. / 11.1
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	809	371	455	50.6	921 / 771	422 / 354	518 / 434	57.6 / 48.2	N.A. / 10.7
33. Potato - White/Irish	Air: 3 Other: 3	1213	556	683	75.8	1382 / 1157	633 / 530	777 / 651	86.4 / 72.3	N.A. / 16.1
34. Turnip	Air: 2.5 Other: 2.5	1011	463	569	63.2	1152 / 964	528 / 442	648 / 542	72 / 60.3	N.A. / 13.4

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based EECs (mg/kg of Food Item)				Dose-based EECs (mg/kg-bw) for: 20 g Bird / 15 g Mammal				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
35. Parsnip and Rutabaga	Air: 2 Other: 2	809	371	455	50.6	921 / 771	422 / 354	518 / 434	57.6 / 48.2	N.A. / 10.7
36. Sweet Potato	Air: 1.875 Other: 1.875	636	292	358	39.8	725 / 607	332 / 278	408 / 341	45.3 / 37.9	N.A. / 8.43
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	798	366	449	49.9	908 / 760	416 / 349	511 / 428	56.8 / 47.5	N.A. / 10.6
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	1011	463	569	63.2	1152 / 964	528 / 442	648 / 542	72 / 60.3	N.A. / 13.4
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	1014	465	571	63.4	1155 / 967	529 / 443	650 / 544	72.2 / 60.4	N.A. / 13.4
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	710	325	399	44.4	808 / 677	370 / 310	455 / 381	50.5 / 42.3	N.A. / 9.4
43. Celery	Air: 1.5 Other: 1.5	509	233	286	31.8	580 / 485	266 / 222	326 / 273	36.2 / 30.3	N.A. / 6.74
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	512	235	288	32	583 / 488	267 / 224	328 / 274	36.4 / 30.5	N.A. / 6.78
45. Anise	Air: 0.9375 Other: 0.9375	383	176	215	23.9	436 / 365	200 / 167	245 / 205	27.3 / 22.8	N.A. / 5.07
46. Strawberry	Air: 2 Other: 2	895	410	503	55.9	1019 / 853	467 / 391	573 / 480	63.7 / 53.3	N.A. / 11.9
47. Sugar Beet	Air: 1.875 Other: 1.875	758	348	427	47.4	864 / 723	396 / 331	486 / 407	54 / 45.2	N.A. / 10
48. Tomato	Air: 3.5	1720	788	967	107	1959 / 1640	898 / 752	1102 / 922	122 / 102	N.A. / 22.8

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based EECs (mg/kg of Food Item)				Dose-based EECs (mg/kg-bw) for: 20 g Bird / 15 g Mammal				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
	Other: 3.5									
49. Okra	Air: 1.5 Other: 1.5	671	308	378	42	765 / 640	350 / 293	430 / 360	47.8 / 40	N.A. / 8.89
51. Sorghum	Air: 1.5 Other: 1.5	571	262	321	35.7	650 / 544	298 / 249	366 / 306	40.6 / 34	N.A. / 7.56
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	476	218	267	29.7	542 / 453	248 / 208	305 / 255	33.9 / 28.3	N.A. / 6.3
53. Gooseberry	Air: 16 Other: 16	6886	3156	3874	430	7843 / 6566	3595 / 3009	4412 / 3693	490 / 410	N.A. / 91.2
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	1722	789	968	108	1961 / 1641	899 / 752	1103 / 923	123 / 103	N.A. / 22.8
55. Blueberry	Air: 2.5 Other: 2.5	1314	602	739	82.1	1496 / 1252	686 / 574	842 / 704	93.5 / 78.3	N.A. / 17.4
56. Caneberries and Currant	Air: 2 Other: 2	861	395	484	53.8	980 / 821	449 / 376	551 / 462	61.3 / 51.3	N.A. / 11.4
57. Passion Fruit (Granadilla)	Air: 0.75 Other: 0.75	338	155	190	21.2	385 / 323	177 / 148	217 / 182	24.1 / 20.2	N.A. / 4.48
58. Mint and Spearmint	Air: 1 Other: 1	476	218	267	29.7	542 / 453	248 / 208	305 / 255	33.9 / 28.3	N.A. / 6.3
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	594	272	334	37.2	677 / 567	310 / 260	381 / 319	42.3 / 35.4	N.A. / 7.87
61. Water Cress	Air: 2 Other: 2	983	450	553	61.4	1119 / 937	513 / 429	630 / 527	70 / 58.6	N.A. / 13
Non-agricultural Uses										
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	1048	480	589	65.5	1193 / 999	547 / 458	671 / 562	74.6 / 62.4	N.A. / 13.9

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based EECs (mg/kg of Food Item)				Dose-based EECs (mg/kg-bw) for: 20 g Bird / 15 g Mammal				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: 0.6 Other: 0.6	201	92	113	12.5	228 / 191	105 / 87.7	129 / 108	14.3 / 12	N.A. / 2.66
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	1106	507	622	69.1	1260 / 1055	577 / 483	709 / 593	78.7 / 65.9	N.A. / 14.6
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: 0.6119 Other: 0.1361	251 55.7	115 25.5	141 31.3	15.7 3.48	285 / 239 63.5 / 53.1	131 / 109 29.1 / 24.3	160 / 134 35.7 / 29.9	17.8 / 14.9 3.97 / 3.32	N.A. / 3.32 N.A. / 0.74
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: 0.25[3]	103	47.3	58	6.45	118 / 98.4	53.9 / 45.1	66.1 / 55.3	7.34 / 6.15	N.A. / 1.37

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based EECs (mg/kg of Food Item)				Dose-based EECs (mg/kg-bw) for: 20 g Bird / 15 g Mammal				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: 0.9281 Other: 0.9281	304	139	171	19	346 / 290	159 / 133	195 / 163	21.6 / 18.1	N.A. / 4.02
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	419	192	235	26.2	477 / 399	218 / 183	268 / 224	29.8 / 24.9	N.A. / 5.54

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3]Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

EFED uses the T-Herps model to estimate the direct terrestrial effects to CRLF from ingestion of chemical residues with food/prey items. Because the dose experienced by a CRLF varies with its size, dose is estimated for a range of CRLF sizes: small (1.4 g), medium (37 g), and large (238 g) CRLF (Table 18). Because small frogs are modeled to have a higher metabolic rate than large CRLF, smaller frogs are estimated to receive a higher dose than larger frogs when ingesting the same type of food item. However, it is also assumed that small frogs are incapable of ingesting small herbivore mammals, small insectivore mammals, and small terrestrial phase amphibians (note the "N.A." at the small frog location within the last three columns of Table 18).

Because it is the small herbivore mammal food item that is estimated to have the highest concentration and only the medium and large CRLF ingest this food item, it is the medium CRLF (with their higher metabolic rate than the large CRLF) that receive the highest doses. Dose based estimates for individual exposure scenarios vary from 0.99 to 394 mg/kg-bw for small frogs, 0.042 to 6320 mg/kg-bw for medium frogs, and 0.027 to 983 mg/kg-bw for large frogs.

Table 18. Assessment of direct effects on California Red-legged Frog (CRLF) using dose-based estimated environmental concentrations (EECs) of malathion based on the T-Herps model for small (1.4 g), medium (37 g), and large (238 g) CRLF.

Scenario Group. Crop/Site	**Maximum Application Rates[1] (Lbs. ai/A)**	**Dose-based EECs (mg/kg-bw) for Small, Medium, and Large CRLF (Small / Medium / Large)**				
		Broadleaf Plants/Small Insects	**Fruit/ Pods/ Seeds/Large Insects**	**Small Herbivore Mammals**	**Small Insectivore Mammals**	**Small Terrestrial Phase Amphibian**
Agricultural Uses						
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	14.8 / 14.6 / 9.55	1.65 / 1.62 / 1.06	N.A. / 423 / 65.8	N.A. / 26.4 / 4.11	N.A. / .51 / .33
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	134 / 132 / 86.3	14.9 / 14.6 / 9.59	N.A. / 3821 / 594	N.A. / 239 / 37.1	N.A. / 4.57 / 2.99
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	111 / 109 / 71.4	12.3 / 12.1 / 7.93	N.A. / 3160 / 491	N.A. / 197 / 30.7	N.A. / 3.78 / 2.48
4. Chestnut	Air: 5 Other: 5	43.4 / 42.7 / 28.0	4.83 / 4.74 / 3.11	N.A. / 1239 / 193	N.A. / 77.4 / 12.0	N.A. / 1.48 / .97
5. Almond	Air: 1.25 Other: 4	11.1 / 10.9 / 7.14 35.5 / 34.8 / 22.8	1.23 / 1.21 / .79 3.94 / 3.87 / 2.54	N.A. / 316 / 49.1 N.A. / 1011 / 157	N.A. / 19.7 / 3.07 N.A. / 63.2 / 9.83	N.A. / .38 / .25 N.A. / 1.21 / .79
6. Date	Air: 1 Other: 2	6.30 / 6.19 / 4.06 12.6 / 12.4 / 8.11	.70 / .69 / .45 1.40 / 1.38 / .90	N.A. / 180 / 27.9 N.A. / 359 / 55.8	N.A. / 11.2 / 1.75 N.A. / 22.5 / 3.49	N.A. / .21 / .14 N.A. / .43 / .28
7. Filbert (Hazelnut)	Air: .625 Other: .625	5.54 / 5.44 / 3.57	.62 / .60 / .40	N.A. / 158 / 24.6	N.A. / 9.87 / 1.54	N.A. / .19 / .12
8. Avocado	Air: 9 Other: 9	69.4 / 68.2 / 44.7	7.71 / 7.57 / 4.96	N.A. / 1978 / 308	N.A. / 124 / 19.2	N.A. / 2.37 / 1.55
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	222 / 218 / 143	24.6 / 24.2 / 15.9	N.A. / 6320 / 983	N.A. / 395 / 61.4	N.A. / 7.56 / 4.95
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	22.3 / 21.9 / 14.3	2.47 / 2.43 / 1.59	N.A. / 635 / 98.7	N.A. / 39.7 / 6.17	N.A. / .76 / .50
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	18.7 / 18.4 / 12.1	2.08 / 2.05 / 1.34	N.A. / 534 / 83.1	N.A. / 33.4 / 5.19	N.A. / .64 / .42

Scenario Group. Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based EECs (mg/kg-bw) for Small, Medium, and Large CRLF (Small / Medium / Large)				
		Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
12. Cotton	Air: 4 Other: 4	66.6 / 65.5 / 42.9	7.40 / 7.28 / 4.77	N.A. / 1901 / 295	N.A. / 119 / 18.5	N.A. / 2.27 / 1.49
15. Apricot	Air: 10 Other: 10	94.1 / 92.4 / 60.6	10.5 / 10.3 / 6.73	N.A. / 2683 / 417	N.A. / 168 / 26.1	N.A. / 3.21 / 2.10
16. Nectarine and Peach	Air: 9 Other: 9	84.7 / 83.2 / 54.5	9.41 / 9.24 / 6.06	N.A. / 2415 / 375	N.A. / 151 / 23.5	N.A. / 2.89 / 1.89
17. Cherry	Air: 8 Other: 8	78.2 / 76.9 / 50.4	8.69 / 8.54 / 5.6	N.A. / 2232 / 347	N.A. / 139 / 21.7	N.A. / 2.67 / 1.75
18. Fig	Air: 2.5 Other: 2.5	23.8 / 23.4 / 15.3	2.65 / 2.60 / 1.70	N.A. / 679 / 106	N.A. / 42.5 / 6.60	N.A. / .81 / .53
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	12.4 / 12.1 / 7.96 14.8 / 14.6 / 9.55	1.37 / 1.35 / .88 1.65 / 1.62 / 1.06	N.A. / 352 / 54.8 N.A. / 423 / 65.7	N.A. / 22.0 / 3.42 N.A. / 26.4 / 4.11	N.A. / .42 / .28 N.A. / .51 / .33
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	7.41 / 7.29 / 4.78 14.8 / 14.6 / 9.55	.82 / .81 / .53 1.65 / 1.62 / 1.06	N.A. / 211 / 32.9 N.A. / 423 / 65.7	N.A. / 13.2 / 2.05 N.A. / 26.4 / 4.11	N.A. / .25 / .17 N.A. / .51 / .33
21. Papaya	Air: .175 Other: .175	1.73 / 1.70 / 1.11	.19 / .19 / .12	N.A. / 49.3 / 7.67	N.A. / 3.08 / .48	N.A. / .06 / .04
22. Garlic and Leek	Air: 2 Other: 2	17.7 / 17.4 / 11.4	1.96 / 1.93 / 1.27	N.A. / 504 / 78.4	N.A. / 31.5 / 4.90	N.A. / .60 / .40
23. Grapes	Air: 2.75 Other: 27.47	21.2 / 20.8 / 13.7 212 / 208 / 136	2.36 / 2.31 / 1.52 23.5 / 23.1 / 15.2	N.A. / 605 / 94.0 N.A. / 6039 / 939	N.A. / 37.8 / 5.87 N.A. / 377 / 58.7	N.A. / .72 / .47 N.A. / 7.22 / 4.73
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	20.8 / 20.4 / 13.4	2.31 / 2.27 / 1.49	N.A. / 593 / 92.2	N.A. / 37.1 / 5.76	N.A. / .71 / .46
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	21.9 / 21.6 / 14.1	2.44 / 2.39 / 1.57	N.A. / 625 / 97.2	N.A. / 39.1 / 6.08	N.A. / .75 / .49
28. Peppermint	Air: 1 Other: 1	8.31 / 8.17 / 5.36	.92 / .91 / .60	N.A. / 237 / 36.9	N.A. / 14.8 / 2.3	N.A. / .28 / .19
29. Eggplant	Air: 3.5 Other: 3.5	37.6 / 36.9 / 24.2	4.18 / 4.1 / 2.69	N.A. / 1072 / 167	N.A. / 67 / 10.4	N.A. / 1.28 / .84

Scenario Group. Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based EECs (mg/kg-bw) for Small, Medium, and Large CRLF (Small / Medium / Large)				
		Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
30. Pumpkin	Air: 2 Other: 2	19.6 / 19.2 / 12.6	2.17 / 2.14 / 1.4	N.A. / 558 / 86.7	N.A. / 34.9 / 5.42	N.A. / .67 / .44
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	18.3 / 18 / 11.8	2.04 / 2 / 1.31	N.A. / 523 / 81.3	N.A. / 32.7 / 5.08	N.A. / .63 / .41
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	17.7 / 17.4 / 11.4	1.96 / 1.93 / 1.27	N.A. / 504 / 78.4	N.A. / 31.5 / 4.90	N.A. / .60 / .40
33. Potato - White/Irish	Air: 3 Other: 3	26.5 / 26.1 / 17.1	2.95 / 2.90 / 1.90	N.A. / 756 / 118	N.A. / 47.3 / 7.35	N.A. / .90 / .59
34. Turnip	Air: 2.5 Other: 2.5	22.1 / 21.7 / 14.2	2.46 / 2.41 / 1.58	N.A. / 630 / 98.0	N.A. / 39.4 / 6.12	N.A. / .75 / .49
35. Parsnip and Rutabaga	Air: 2 Other: 2	17.7 / 17.4 / 11.4	1.96 / 1.93 / 1.27	N.A. / 504 / 78.4	N.A. / 31.5 / 4.90	N.A. / .60 / .40
36. Sweet Potato	Air: 1.875 Other: 1.875	13.9 / 13.7 / 8.96	1.54 / 1.52 / 1.00	N.A. / 397 / 61.7	N.A. / 24.8 / 3.85	N.A. / .47 / .31
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	17.4 / 17.1 / 11.2	1.94 / 1.90 / 1.25	N.A. / 497 / 77.3	N.A. / 31.1 / 4.83	N.A. / .59 / .39
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	22.1 / 21.7 / 14.2	2.46 / 2.41 / 1.58	N.A. / 630 / 98.0	N.A. / 39.4 / 6.12	N.A. / .75 / .49
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	22.2 / 21.8 / 14.3	2.46 / 2.42 / 1.59	N.A. / 632 / 98.3	N.A. / 39.5 / 6.14	N.A. / .76 / .50
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	15.5 / 15.2 / 9.99	1.72 / 1.69 / 1.11	N.A. / 442 / 68.8	N.A. / 27.6 / 4.30	N.A. / .53 / .35
43. Celery	Air: 1.5 Other: 1.5	11.1 / 10.9 / 7.16	1.24 / 1.21 / .80	N.A. / 317 / 49.3	N.A. / 19.8 / 3.08	N.A. / .38 / .25
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	11.2 / 11.0 / 7.20	1.24 / 1.22 / .80	N.A. / 319 / 49.6	N.A. / 19.9 / 3.1	N.A. / .38 / .25

Scenario Group. Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based EECs (mg/kg-bw) for Small, Medium, and Large CRLF (Small / Medium / Large)				
		Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
45. Anise	Air: .9375 Other: .9375	8.37 / 8.23 / 5.39	.93 / .91 / .60	N.A. / 239 / 37.1	N.A. / 14.9 / 2.32	N.A. / .29 / .19
46. Strawberry	Air: 2 Other: 2	19.6 / 19.2 / 12.6	2.17 / 2.14 / 1.40	N.A. / 558 / 86.7	N.A. / 34.9 / 5.42	N.A. / .67 / .44
47. Sugar Beet	Air: 1.875 Other: 1.875	16.6 / 16.3 / 10.7	1.84 / 1.81 / 1.19	N.A. / 473 / 73.5	N.A. / 29.5 / 4.59	N.A. / .57 / .37
48. Tomato	Air: 3.5 Other: 3.5	37.6 / 36.9 / 24.2	4.18 / 4.10 / 2.69	N.A. / 1072 / 167	N.A. / 67.0 / 10.4	N.A. / 1.28 / .84
49. Okra	Air: 1.5 Other: 1.5	14.7 / 14.4 / 9.45	1.63 / 1.60 / 1.05	N.A. / 418 / 65.1	N.A. / 26.2 / 4.07	N.A. / .50 / .33
51. Sorghum	Air: 1.5 Other: 1.5	12.5 / 12.3 / 8.03	1.39 / 1.36 / .89	N.A. / 356 / 55.3	N.A. / 22.2 / 3.46	N.A. / .43 / .28
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	10.4 / 10.2 / 6.69	1.15 / 1.13 / .74	N.A. / 296 / 46.1	N.A. / 18.5 / 2.88	N.A. / .35 / .23
53. Gooseberry	Air: 16 Other: 16	150 / 148 / 96.9	16.7 / 16.4 / 10.8	N.A. / 4292 / 667	N.A. / 268 / 41.7	N.A. / 5.13 / 3.36
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	37.6 / 37.0 / 24.2	4.18 / 4.11 / 2.69	N.A. / 1073 / 167	N.A. / 67.1 / 10.4	N.A. / 1.28 / .84
55. Blueberry	Air: 2.5 Other: 2.5	28.7 / 28.2 / 18.5	3.19 / 3.13 / 2.05	N.A. / 819 / 127	N.A. / 51.2 / 7.96	N.A. / .98 / .64
56. Caneberries and Currant	Air: 2 Other: 2	18.8 / 18.5 / 12.1	2.09 / 2.05 / 1.35	N.A. / 537 / 83.4	N.A. / 33.5 / 5.21	N.A. / .64 / .42
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	7.40 / 7.27 / 4.76	.82 / .81 / .53	N.A. / 211 / 32.8	N.A. / 13.2 / 2.05	N.A. / .25 / .17
58. Mint and Spearmint	Air: 1 Other: 1	8.31 / 8.17 / 5.36	.92 / .91 / .60	N.A. / 237 / 36.9	N.A. / 14.8 / 2.30	N.A. / .28 / .19
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	13.0 / 12.8 / 8.37	1.44 / 1.42 / .93	N.A. / 371 / 57.6	N.A. / 23.2 / 3.60	N.A. / .44 / .29
61. Water Cress	Air: 2 Other: 2	21.5 / 21.1 / 13.8	2.39 / 2.35 / 1.54	N.A. / 613 / 95.2	N.A. / 38.3 / 5.95	N.A. / .73 / .48

Scenario Group. Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based EECs (mg/kg-bw) for Small, Medium, and Large CRLF (Small / Medium / Large)				
		Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
Non-agricultural Uses						
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	22.9 / 22.5 / 14.7	2.54 / 2.50 / 1.64	N.A. / 653 / 102	N.A. / 40.8 / 6.34	N.A. / .78 / .51
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	4.38 / 4.31 / 2.82	.49 / .48 / .31	N.A. / 125 / 19.4	N.A. / 7.82 / 1.22	N.A. / .15 / .10
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	24.2 / 23.8 / 15.6	2.69 / 2.64 / 1.73	N.A. / 689 / 107	N.A. / 43.1 / 6.70	N.A. / .82 / .54
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	5.47 / 5.38 / 3.53 1.22 / 1.20 / .78	.61 / .60 / .39 .14 / .13 / .09	N.A. / 156 / 24.3 N.A. / 34.7 / 5.40	N.A. / 9.76 / 1.52 N.A. / 2.17 / .34	N.A. / .19 / .12 N.A. / .04 / .03
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	2.25 / 2.22 / 1.45	.25 / .25 / .16	N.A. / 64.3 / 10	N.A. / 4.02 / .62	N.A. / .08 / .05
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	6.64 / 6.53 / 4.28	.74 / .73 / .48	N.A. / 189 / 29.4	N.A. / 11.8 / 1.84	N.A. / .23 / .15
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	9.15 / 8.99 / 5.89	1.02 / 1.00 / .65	N.A. / 261 / 40.6	N.A. / 16.3 / 2.53	N.A. / .31 / .20

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.

[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).

[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

3.3.2 Terrestrial Plant Exposure Modeling

Malathion (and consequently, its degradates) is directly applied to wide variety of terrestrial plant crops without apparently affecting these plants negatively. Therefore, it seems unlikely that other terrestrial plants would be negatively impacted through non-target or incidental exposure.

As a check on this assumption, the highest application rate assuming direct application and no dissipation effects was compared to the lowest affect level found for terrestrial plants (30 kg/cm^2). Converting the highest application rate of 27.47 lbs. ai/A (the “other” use application rate for grapes, scenario 23) to comparable units (kg/cm^2) produces:

$$\frac{27.47\text{lbs./A} \times 1.12\frac{\text{kg/ha}}{\text{lbs./A}} \times 10^6\,\text{mg/kg}}{10000\text{m}^2\text{/ha} \times 10000\text{cm}^2 / m^2} = 0.31\text{mg/cm}^2$$

Because the maximum exposure (0.31 mg/cm^2) is much less than the lowest adverse effect concentration, the assumption that malathion and its degradates are unlikely to harm CRLF through an indirect effect on terrestrial plants seems justified. Therefore, there will be no further analysis of exposure of terrestrial plants.

4. Effects Assessment

This effects assessment identifies assessment endpoints that can be used to judge whether the EECs developed in the exposure assessment (Section 3) for malathion and maloxon would be likely to cause adverse effects to the CRLF and/or its habitat. Assessment endpoints are expressed in concentration units measured over a time period and, therefore, can be compared directly to EECs. Acute assessment endpoints are concentrations that cause an adverse affect over a brief duration of exposure. Conversely, chronic assessment endpoints are concentrations that cause an adverse affect over a longer duration of exposure. These assessment endpoints will be compared to the peak EECs (acute endpoints) and maximum average 21-day and 60-day EECs (chronic endpoints) in the risk characterization section (Section 5) of this risk assessment.

As previously discussed in Section 2.7, selected assessment endpoints for the CRLF include assessment of direct toxic effects on the survival, reproduction, and growth of the frog itself, as well as indirect effects, such as reduction of the prey base and/or modification of its habitat (Table 5). Taxa selected as measurement endpoints include freshwater fish and amphibians as a prey item and also as a surrogate for aquatic phase CRLF; freshwater aquatic invertebrates (prey item); birds as surrogates for terrestrial phase CRLF and other amphibians (prey item); small mammals (prey item); terrestrial invertebrates (prey item); aquatic plants, and terrestrial plants (Table 5). Toxicity data for freshwater fish and birds are also used as surrogate data for aquatic-phase and terrestrial-phase amphibians (USEPA 2004).

Information on the toxicity of malathion and its impurity/degradate, maloxon, to selected taxa is characterized based on registrant-submitted studies and a comprehensive review of the open literature on malathion and maloxon. Values used for each measurement endpoint identified in Table 5 are selected from this data. Currently, no FIFRA data requirements exist for aquatic-phase or terrestrial-phase frogs and are therefore not part of typical registrant submitted data packages. However, some aquatic-phase frog survival data for malathion are available from open literature (Table 19); these data were reviewed for use in the risk determination.

4.1 Evaluation of Aquatic Ecotoxicity Studies

Toxicity measurement endpoints are selected from data 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) (USEPA 2004). Open literature data presented in this assessment were obtained from a search of the ECOTOX database (June 2007). Additional information is provided in Appendix B.

In order to be included in the ECOTOX database, papers must meet the following minimum criteria:

1. The toxic effects are related to single chemical exposure;
2. The toxic effects are on an aquatic or terrestrial plant or animal species;
3. There is a biological effect on live, whole organisms;

4. A concurrent environmental chemical concentration/dose or application rate is reported; and
5. There is an explicit duration of exposure.

Data that pass the ECOTOX screen are further evaluated for use in the assessment 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, matching measurement endpoints listed in Table 5, that are more conservative than the registrant-submitted data and are found to be scientifically sound based on a review of the paper are used quantitatively. In addition, effects data for taxa that are directly relevant to the California Red-Legged Frog (*i.e.*, aquatic-phase and terrestrial-phase amphibian data) were also considered over the use of surrogate taxa effects data, if available. The degree to which open literature data are used quantitatively or qualitatively is dependent on whether the information is scientifically sound and whether it is quantitatively linked to the assessment endpoints (*e.g.*, maintenance of California Red-Legged Frog survival, reproduction, and growth) identified in Section 2.7 (Table 5). For example, endpoints such as behavior modifications are likely to be qualitatively evaluated, because quantitative relationships between degree and type of behavior modifications and reduction in species survival, reproduction, and/or growth are usually not available.

4.1.1 Acute Toxicity to Fish and Larval Stage Amphibians

Available laboratory acute toxicity data for freshwater fish and larval amphibians are summarized in Table 19[13]. The data suggest that sensitivity to malathion is highly varied ranging from 4 µg/L to 45,000 µg/L for fish and from 0.59 µg/L to 19,200 µg/L for larval amphibians. In addition to the fish and larval amphibian studies listed above, there is an immersion study involving leopard frogs (*Rana pipiens*). Adult frogs were immersed in malathion (100% purity) treated water for 15 days. The LD_{50} for this study was 150,000 µg/L (ECOTOX ref. 50823). Sublethal effects beyond the reproduction endpoints commonly measured in chronic fish studies include growth, hematological, immune function, acetyl cholinesterase inhibition, and protein and lipid metabolism disruptions. In general, observations of these sublethal effects occurred at malathion concentrations above selected acute and chronic endpoints for risk assessment.

[13] Most of the tables in Section 4 of this assessment have formats similar to Table 19. The column labeled "% ai" is the percentage of active ingredient (ai) to which the test organisms were exposed. The LC_{50} is the concentration (extrapolated from the study data) at which 50% of the test organisms would die under the conditions of the experiment. This list contains those endpoints available from submitted registrant data as well as data available from the ECOTOX database. The registrant submitted data are referenced by unique MRID (Master Record Identification) numbers that are assigned to studies submitted to U.S. EPA. The ECOTOX data base listings are taken from those studies deemed acceptable for ECOTOX inclusion as well as passing OPP data quality criteria. Studies are classified as core, supplemental, or unacceptable depending on the study's suitability for developing an assessment endpoint. Core studies meet all of the suitability criteria that OPP requires. Supplemental (Supl.) studies have minor deficiencies, but are deemed useful for assessment endpoint identification. Unacceptable studies have deficiencies that preclude their use and, therefore, are not included in the following tables. All studies evaluated, including unacceptable studies, have full citations listed in Appendix B.

Table 19. Freshwater fish and amphibian acute toxicity studies (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP).

Species Tested	% ai	LC_{50} and Confidence Limits (where available) in µg/L	Reference MRID or ECOTOX	Classification
Freshwater Fish Effects				
Bluegill sunfish	95	96 Hr LC_{50}=20 (16-25)	40098001	Core
Bluegill sunfish	95	96 Hr LC_{50}=30 (10-88)	40098001	Core
Bluegill sunfish	99	96 Hr LC_{50}=336.6	ECOTOX ref. 77525	Supl.
Red-ear sunfish	95	95 Hr LC_{50}=62 (58-67)	40098001	Core
Rainbow trout	**95**	**96 Hr LC_{50}=4* (2-7)**	**40098001**	**Core**
Rainbow trout	95	96 Hr LC_{50}=160	ECOTOX ref. 12182	Supl.
Yellow perch	95	96 Hr LC_{50}=263 (205-338)	40098001	Core
Largemouth bass	95	96 Hr LC_{50}=250 (229-310)	40098001	Core
Carp	95	96 Hr LC_{50}=6590 (4920-8820)	40098001	Supl.
Carp	--	96 Hr LC_{50}=710	ECOTOX ref. 6999	Supl.
Carp	--	96 Hr LC_{50}=3150	ECOTOX ref. 69277	Supl.
Carp	95	96 Hr LC_{50}=23180	ECOTOX ref. 14861	Supl.
Carp	57	96 Hr LC_{50}=9462	ECOTOX ref. 89874	Supl.
Fathead minnow	95	96 Hr LC_{50}=8650 (6450-11500)	40098001	Core
Fathead minnow	--	96 Hr LC_{50}= 12500	ECOTOX ref. 2155	Supl.
Fathead minnow	--	96 Hr LC_{50}= 14100	ECOTOX ref. 12859	Supl.
Channel catfish	95	96 Hr LC_{50}=7620 (5820-9970)	40098001	Core
Coho salmon	95	96 Hr LC_{50} 170 (160-180)	40098001	Core
Cutthroat trout	95	96 Hr LC_{50}=174 (112-269)	40098001	Core
Brown trout	95	96 Hr LC_{50}=101 (84-115)	40098001	Core
Lake trout	95	96 Hr LC_{50}=76 (47-123)	40098001	Core
Black bullhead catfish	95	96 Hr LC_{50}=11700 (9600-14100)	40098001	Core
Green sunfish	95	96 Hr LC_{50}=1460 (900-2340)	40098001	Core
Walleye	95	96 Hr LC_{50}=64 (59-70)	40098001	Core

Species Tested	% ai	LC_{50} and Confidence Limits (where available) in µg/L	Reference MRID or ECOTOX	Classification
Tilapia	95	96 Hr LC_{50}=2000	40098001	Core
Java tilapia	--	96 Hr LC_{50}=5880	ECOTOX ref. 166	Supl.
Mozambique tilapia	--	96 Hr LC_{50}=290.1	ECOTOX ref. 11603	Supl.
Nile tilapia	80	96 Hr LC_{50}=140	ECOTOX ref. 3296	Supl.
Nile tilapia	98	96 Hr LC_{50}= 2200	ECOTOX ref. 20087	Supl.
Nile tilapia	57	96 Hr LC_{50}= 1128.6	ECOTOX ref. 89874	Supl.
Goldfish	95	96 Hr LC_{50}=10700 (8340-13800)	40098001	Core
Goldfish	NR	96 Hr LC_{50}=2610	ECOTOX ref. 563	Supl.
Goldfish	95	96 Hr LC_{50}=8490	ECOTOX ref. 13456	Supl.
Medaka	50	96 Hr LC_{50}=2800	ECOTOX ref. 8977	Supl.
Medaka	99.1	96 Hr LC_{50}= 9700	ECOTOX ref. 89099	Supl.
Killifish	--	24 Hr LC_{50}=28900	ECOTOX ref. 20487	Supl.
Pale chub	50	96 Hr LC_{50}=9700	ECOTOX ref. 8977	Supl.
Western mosquitofish	--	24 Hr LC_{50}=150	ECOTOX ref. 184	Supl.
Western mosquitofish	--	96 Hr LC_{50}=200	ECOTOX ref. 5806	Supl.
Western mosquitofish	--	96 Hr LC_{50}=300	ECOTOX ref. 20475	Supl.
Chinook salmon	--	96 Hr LC_{50}=23	ECOTOX ref. 522	Supl.
Chinook salmon	--	96 Hr LC_{50}=120	ECOTOX ref. 2159	Supl.
Two spot barb	--	96 Hr LC_{50}=1650	ECOTOX ref. 765	Supl.
Two spot barb	--	96 Hr LC_{50}=3700	ECOTOX ref. 6722	Supl.
Two spot barb	--	96 Hr LC_{50}=3200	ECOTOX ref. 9276	Supl.
Flagfish	--	96 Hr LC_{50}= 349	ECOTOX ref. 995	Supl.
Flagfish	--	48 Hr LC_{50}= 280	ECOTOX ref. 10687	Supl.
Asiatic knifefish	--	96 Hr LC_{50}= 77	ECOTOX ref. 4022	Supl.
Indian catfish	--	96 Hr LC_{50}= 45000	ECOTOX ref. 5064	Supl.
Indian catfish	100	96 Hr LC_{50}= 15000	ECOTOX ref. 7375	Supl.

Species Tested	% ai	LC_{50} and Confidence Limits (where available) in µg/L	Reference MRID or ECOTOX	Classification
Indian catfish	--	96 Hr LC_{50}= 15000	ECOTOX ref. 15179	Supl.
Indian catfish	--	96 Hr LC_{50}= 8500	ECOTOX ref. 17539	Supl.
Smooth-breasted snakefish	--	96 Hr LC_{50}= 6995	ECOTOX ref.5736	Supl.
Cyprinion watsoni no common name	57	24 Hr LC_{50}= 7930	ECOTOX ref.6638	Supl.
Hawk fish	--	96 Hr LC_{50}= 2250	ECOTOX ref. 9277	Supl.
Hawk fish	--	96 Hr LC_{50}= 5397	ECOTOX ref. 12910	Supl.
Hawk fish	50	96 Hr LC_{50}= 9360	ECOTOX ref. 14166	Supl.
Catla	--	72 Hr LC_{50}= 2350	ECOTOX ref. 9277	Supl.
Rohu	--	96 Hr LC_{50}= 4980	ECOTOX ref. 9277	Supl.
Slender rasbora	--	96 Hr LC_{50}= 6000	ECOTOX ref. 10764	Supl.
Tic tac toe barb	--	96 Hr LC_{50}= 4000	ECOTOX ref. 10764	Supl.
Striped bass (freshwater)	--	96 Hr LC_{50}= 24.5	ECOTOX ref. 11334	Supl.
Striped bass (freshwater)	--	96 Hr LC_{50}= 12	ECOTOX ref. 15472	Supl.
Snakehead catfish	--	96 Hr LC_{50}= 3890	ECOTOX ref. 11988	Supl.
Snakehead catfish	100	96 Hr LC_{50}= 894	ECOTOX ref. 14166	Supl.
Snakehead catfish	--	96 Hr LC_{50}= 874	ECOTOX ref. 14166	Supl.
Snakehead catfish	--	96 Hr LC_{50}= 6610	ECOTOX ref. 81095	Supl.
Zebra danio	--	96 Hr LC_{50}= 155	ECOTOX ref. 12047	Supl.
Bitterling	95	96 Hr LC_{50}= 4807	ECOTOX ref. 12047	Supl.
Bleak	95	96 Hr LC_{50}= 3591	ECOTOX ref. 12047	Supl.
Crimson-spotted rainbowfish	--	96 Hr LC_{50}= 2090	ECOTOX ref. 15030	Supl.
Atlantic salmon	98	96 Hr LC_{50}= 313.6	ECOTOX ref. 16946	Supl.
Loach	100	96 Hr LC_{50}= 13790	ECOTOX ref. 17207	Supl.
Giant gourami	99	96 Hr LC_{50}= 1480	ECOTOX ref. 74220	Supl.
Climbing perch	100	96 Hr LC_{50}= 16000	ECOTOX ref. 88437	Supl.

Species Tested	% ai	LC_{50} and Confidence Limits (where available) in µg/L	Reference MRID or ECOTOX	Classification
		Amphibian Effects		
Fowlers toad	technical	96 Hr LC_{50}=420 (90-980)	ECOTOX ref. 2891	Supl.
Chorus frog	technical	96 Hr LC_{50}=200 (90-270)	ECOTOX ref. 2891	Supl.
Indian bullfrog, six-fingered frog	**50**	**96 Hr LC_{50}=0.59* (0.43-0.78)**	**ECOTOX ref. 11521**	**Supl.**
Tiger frog, Indian bullfrog	100	148 Hr LC_{50}=170	ECOTOX ref. 61878	Supl.
Argentine toad	NR	96 Hr LC_{50}=19200 (N.R.)	ECOTOX ref. 3883	Supl.
Woodhouse toad	technical	96 Hr LC_{50}=420	ECOTOX ref 344	Supl.
Western chorus frog	technical	48 Hr LC_{50}=320	ECOTOX ref 2891	Supl.
Bog frog	--	48 Hr LC_{50}=2271	ECOTOX ref. 16056	Supl.
African clawed frog	>90	96 Hr LC_{50}= 9810	ECOTOX ref. 66506	Supl.
Yellow-legged frog	--	96 Hr LC_{50}= 2137	**	Supl.

*Endpoint used for quantitative assessment of risks.

** Sparling, D.W. and G. Fellers. 2006 Comparative toxicity of chlorpyrifos, diazinon, malathion and their oxon derivatives to larval *Rana boylii*. Environmental Pollution (Article in Press; available online at www.sciencedirect.com).

The lowest larval amphibian acute endpoint is 0.59 µg/L. The lowest fish acute toxicity value is 4 µg/L. These endpoints will be used for risk quotient calculation for direct effects on aquatic phases of the frog and effects on fish prey source, respectively.

4.1.2 Freshwater Fish and Amphibian: Chronic Exposure (Growth/Reproduction) Studies

Table 20 summarizes the available chronic exposure freshwater fish and other aquatic vertebrate studies. There are paired species acute and chronic reproduction (NOAEC) values for rainbow trout and flagfish. However, the NOAEC values established for rainbow trout is higher than the most sensitive rainbow trout acute value, invalidating the calculation of an acute to chronic ratio for this species as per OPP policy. For flagfish, the largest acute to chronic ratio is 40.6 (349/8.6 = 40.6). Applying this value to the lowest available freshwater fish acute toxicity value of 4 µg/L yields a chronic effects endpoint for freshwater fish of 0.098 µg/L for use in risk quotient calculations. **Applying the same ACR to the lowest acute aquatic phase amphibian endpoint of 0.59 µg/L yields a chronic amphibian effects endpoint of 0.014 µg/L for use in risk quotient calculations.**

Table 20. Freshwater fish and other aquatic vertebrate chronic exposure toxicity data (growth, survival, and reproduction endpoints) (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP).

Species	% ai	Duration (Days)	LOAEC (µg/L)	NOAEC (µg/L)	Reference MRID or ECOTOX	Category
Rainbow trout	94	97	44	21	41422401	Core
Flagfish	tech	110	11	8.6	Hermanutz, R., 1978*	Supl.
Fathead minnow	tech	158	350	N.D.	D234663	Supl.
Snakehead catfish	100	15	--	500	ECOTOX ref. 14673	Supl.
Medaka	99.8	14	798.4	199.6	ECOTOX ref. 59285	Supl.
Nile tilapia	100	168	500	--	ECOTOX ref. 92183	Supl.

* Hermanutz, R. 1978. Endrin and Malathion toxicity to Flagfish (*Jordanella floridae).* Arch. Of Environmental Contaminants and Toxicology 7:159-168, as cited in malathion RED.

4.1.3 Freshwater Fish: Sublethal Effects and Additional Open Literature Information

Table 21 presents available sublethal endpoints for freshwater fish and other aquatic vertebrates. EFED has no information for establishing quantitative relationships of these sublethal endpoints with the assessment endpoints, precluding the use of these endpoints in the calculation of RQ values. However, it is important to note that in all cases, none of the above NOAEC or LOAEC values falls below acute and chronic endpoints used to calculate RQ values in this risk assessment.

Table 21. Freshwater fish and other aquatic vertebrate sublethal effects (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP).

Species	% ai	Duration (Days)	Effect Type	LOAEC (µg/l)	NOAEC (µg/L)	Reference MRID or ECOTOX	Category
Zambezi barbel	98	5	growth, edema	1225	617.4	ECOTOX ref. 65919	Supl.
Zambezi barbel	98	5	growth	2450	1225	ECOTOX ref. 88998	Supl.
Mozambique tilapia	95	2	biochemical and enzymatic	2000	--	ECOTOX ref. 12190	Supl.
Mozambique tilapia	100	2	biochemical and cellular	2000	--	ECOTOX ref. 13476	Supl.
Mozambique tilapia	100	2	cellular	690	--	ECOTOX ref. 13920	Supl.
Goldfish	85	3	behavioral	1000	500	ECOTOX ref. 13456	Supl.
Channel catfish	100	20	acetyl cholinesterase inhibition	IC_{50}=1800	--	ECOTOX ref. 14034	Supl.

Species	% ai	Duration (Days)	Effect Type	LOAEC (µg/l)	NOAEC (µg/L)	Reference MRID or ECOTOX	Category
Channel catfish	56.1	30	humoral immune response	1750	500	ECOTOX ref. 89134	Supl.
Snake-head catfish	100	15	hematological	250	--	ECOTOX ref. 14673	Supl.
Snake-head catfish	100	15	In vitro lipid and protein synthesis markers	290	140	ECOTOX ref. 88911	Supl.
Walking catfish	100	30	cytochrome a activity	1000	--	ECOTOX ref. 15861	Supl.
Walking catfish	100	7	protein content	40	--	ECOTOX ref. 72761	Supl.
Walking catfish	100	120	acetyl cholinesterase inhibition	190	--	ECOTOX ref. 89006	Supl.
Walking catfish	100	4-16	thyroid function markers	3.5-7	--	ECOTOX ref. 89093	Supl.
Medaka	99.8	15	hematological and immunological	199.6	--	ECOTOX ref. 59285	Supl.
Gilthead seabream	100	7	chromosomal aberrations	--	6380	ECOTOX ref. 60863	Supl.
Carp	100	0.0417	acetyl cholinesterase inhibition	30,000	--	ECOTOX ref. 64529	Supl.
Carp	100	7	lipid metabolism biochemical markers	100	--	ECOTOX ref. 72824	Supl.
Rainbow trout	>98	1	behavioral	20	--	ECOTOX ref. 65887	Supl.
Giant gourami	99	1	biochemical	1000	--	ECOTOX ref. 74220	Supl.
Catla	50	15	protein metabolism markers	1000	--	ECOTOX ref. 82785	Supl.
Brook trout	95	10	cough response	6.9	--	ECOTOX ref. 86858	Supl.
Zebra danio	95	7	nucleotide hydrolysis markers	475	47.5	ECOTOX ref. 88999	Supl.

4.1.4 Freshwater Invertebrates: Acute Exposure Studies

Table 22 presents the available acute exposure toxicity studies for freshwater invertebrates. As for the case with fish and amphibians, malathion sensitivity is highly varied with acute endpoints ranging from 0.01 µg/L to 67,750 µg/L. **The lowest freshwater invertebrate acute exposure endpoint available from Table 22 is for an**

LC_{50} of 0.01 µg/L. This endpoint will be used to calculate freshwater invertebrate acute risk quotients.

Table 22. Freshwater invertebrate acute toxicity studies (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP).

Species Tested	% ai	Duration (Hours)	EC_{50} or LC_{50} in µg/L	Reference MRID or ECOTOX	Classification
Calanoid copepod, *Diaptomus sp.*	--	48	2	ECOTOX ref. 786	Supl.
Cyclopoid copepod, *Eucyclops sp.*	--	48	1	ECOTOX ref. 786	Supl.
Ostracod, *Cypria sp.*	--	48	2	ECOTOX ref. 786	Supl.
Ostracod, *Cypretta kawatai*	--	72	86	ECOTOX ref. 7796	Supl.
Daphnid *Simocephalus serrulatus*	95	48	0.69 (0.44-0.79)	40098001	Supl.
Water flea, *Daphnia magna*	95	48	1.0 (0.7-1.4)	40098001	Core
Water flea, *Daphnia magna*	57	48	2.2 (1.9-2.5)	41029701	Core
Water flea, *Daphnia magna*	--	24	0.098	ECOTOX ref. 5539	Supl.
Water flea, *Daphnia magna*	--	48	1.7	ECOTOX ref. 6449	Supl.
Water flea, *Daphnia magna*	--	24	2.35	ECOTOX ref. 20475	Supl.
Water flea, *Alonella sp.*	--	48	2	ECOTOX ref. 786	Supl.
Water flea, *Daphnia pulex*	95	48	1.8 (1.4-2.4)	40098001	Core
Water flea, *Daphnia carinata*	--	48	100	ECOTOX ref. 5194	Supl.
Water flea, *moina macrocopa*	**--**	**132**	**0.01***	**ECOTOX ref. 16371**	**Supl.**
Scud, *Gammarus fasciatus*	95	96	0.5 (N.R.)	40098001	Core
Scud, *Gammarus fasciatus*	--	48	Two assays 2and 0.5	ECOTOX ref. 887	Supl.
Scud, *Gammarus lacustris*	tech	48	1.8 (1.3-2.4)	05009242	Core
Scud, *Gammarus lacustris*	--	96	1.62	ECOTOX ref. 528	Supl.
Glass shrimp, *Palaemonetes kadiakensis*	95	96	12 (N.R.)	40098001	Supl.
Glass shrimp, *Palaemonetes kadiakensis*	--	48	Two assays 25 and 100	ECOTOX ref. 887	Supl.
Shrimp, *Paratya compressa*	--	96	3.62	ECOTOX ref. 18945	Supl.
Seed Shrimp, *Cypridopsis vidua*	95	48	47 (32-69)	40098001	Core
Prawn, *Macrobrachium lamarrei*	--	48	1261	ECOTOX ref. 11557	Supl.

Species Tested	% ai	Duration (Hours)	EC_{50} or LC_{50} in μg/L	Reference MRID or ECOTOX	Classification
Fairy shrimp, Streptocephalus sudanicus	100	48	67750	ECOTOX ref. 59962	Supl.
Crayfish,*Orconectes nais*	95	96	180 (140-230)	40098001	Supl.
Red swamp crayfish, *Procambrus clarkii*	--	96	1340	ECOTOX ref. 20475	Supl.
Crab, *Paratelphusa hydrodromus*	--	96	6000	ECOTOX ref. 13437	Supl.
Sowbug, *Asellus brevicaudus*	95	96	3000 (1500-8500)	40098001	Supl.
Dragonfly *Orthetrum albistylum*	--	48	730	ECOTOX ref.7119	Supl.
Dragonfly *Odonata*	50	24	220	ECOTOX ref.45081	Supl.
Stonefly, *Claasenia sabulosa*	95	49	2.8 (1.4-4.3)	40098001	Supl.
Stonefly, *Pteronarcella badia*	95	48	1.1 (0.78-1.5)	40098001	Supl.
Stonefly, *Isoperla* sp.	95	48	0.69 (0.2-2.4)	40098001	Supl.
Stonefly, *Hesperoperla pacifica*	--	96	7	ECOTOX ref. 528	Supl.
Stonefly, *Hesperoperla pacifica*	--	48	12	ECOTOX ref. 2667	Supl.
Stonefly, *Pteronarcys californicus*	--	96	50	ECOTOX ref. 528	Supl.
Stonefly, *Pteronarcys californicus*	--	48	180	ECOTOX ref. 2667	Supl.
Damselfly, *Lestes congener*	95	48	10 (6.5-15.0)	40098001	Supl.
Damselfly, *Lestes congener*	--	24	300	ECOTOX ref. 7775	Supl.
Damselfly, *Agriocnemis sp.*	50	24	300	ECOTOX ref. 45081	Supl.
Damselfly, *Ceriagrion sp.*	50	24	200	ECOTOX ref. 45081	Supl.
Caddisfly, *Hydropsyche sp.*	95	48	5.0 (2.9-8.6)	40098001	Supl.
Caddisfly, *Hydropsyche sp.*	--	24	12.3	ECOTOX ref. 2158	Supl.
Caddisfly, *Limnephalus sp.*	95	48	1.3 (0.77-2.0)	40098001	Supl.
Caddisfly, *Hydropsyche californica*	--	96	32	ECOTOX ref. 528	Supl.
Caddisfly, *Arctopsyche grandis*	--	96	22.5	ECOTOX ref. 528	Supl.
Mayfly, *Drunella grandis*	--	96	100	ECOTOX ref. 528	Supl.
Mayfly, *Hexagenia sp.*	--	24	631	ECOTOX ref. 2158	Supl.
Mayfly, *Cloeon sp*	--	24	5.5	ECOTOX ref. 20475	Supl.

Species Tested	% ai	Duration (Hours)	EC_{50} or LC_{50} in µg/L	Reference MRID or ECOTOX	Classification
Snipefly, *Atherix variegata*	95	48	385 (245-602)	40098001	Supl.
Midge, *Chironomidae*	--	24	37.63	ECOTOX ref. 7954	Supl.
Midge, *Chironomus sp.*	--	24	2.1	ECOTOX ref. 2899	Supl.
Midge, *Chironomus tentans*	--	24	2	ECOTOX ref. 6267	Supl.
Midge, *Chironomus tentans*	--	72	2500	ECOTOX ref. 7796	Supl.
Midge, *Chironomus tepperi*	--	24	8.4	ECOTOX ref. 13398	Supl.
Midge, *Dicrotendipes californicus*	--	24	80	ECOTOX ref. 3671	Supl.
Midge, *Cricotopus sp.*	--	24	30	ECOTOX ref. 3671	Supl
Midge, *Chironomus decorus*	--	24	70	ECOTOX ref. 3671	Supl
Midge, *Chironomus decorus*	--	24	32	ECOTOX ref. 5559	Supl
Midge, *Chironomus crassicaudatuss*	--	24	56	ECOTOX ref. 5559	Supl
Midge, *Chironomus riparius*	--	24	1.9	ECOTOX ref. 6830	Supl
Midge, *Chironomus riparius*	--	24	440	ECOTOX ref. 14897	Supl
Midge, *tanytarsus sp.*	--	24	32	ECOTOX ref. 5559	Supl
Midge, *Glyptotendipes paripes*	--	24	4	ECOTOX ref. 5559	Supl
Midge, *Goeldichironomus holoprasinus*	--	24	28	ECOTOX ref. 5559	Supl
Mosquito, *Anopheles freeborni*	--	24	79	ECOTOX ref. 3660	Supl.
Mosquito, *Anopheles albimanus*	--	24	350	ECOTOX ref. 11596	Supl.
Mosquito, *Anopheles stephensi*	--	24	180	ECOTOX ref. 11799	Supl.
Mosquito, *Anopheles stephensi*	100	24	633	ECOTOX ref. 59254	Supl.
Mosquito, *Anopheles gambiae*	--	24	51.8	ECOTOX ref. 11799	Supl.
Mosquito, *Anopheles quadrimaculatus*	--	48	1	ECOTOX ref. 56989	Supl.
Mosquito, *Toxorhynchites splendens*	--	48	49.8	ECOTOX ref. 4139	Supl.

Species Tested	% ai	Duration (Hours)	EC_{50} or LC_{50} in µg/L	Reference MRID or ECOTOX	Classification
Mosquito, *Toxorhynchites splendens*	100	24	220	ECOTOX ref. 59254	Supl.
Mosquito, *Aedes nigromaculis*	--	24	68	ECOTOX ref. 4431	Supl.
Mosquito, *Aedes trivittatus*	--	24	32.2	ECOTOX ref. 4896	Supl.
Mosquito, *Aedes aegypti*	--	24	92	ECOTOX ref. 11009	Supl.
Mosquito, *Aedes aegypti*	100	24	23.2	ECOTOX ref.59254	Supl.
Mosquito, *Aedes caspius*	--	24	2230	ECOTOX ref. 13544	Supl.
Mosquito, *Aedes albopictus*	--	24	379	ECOTOX ref. 16077	Supl.
Mosquito, *Aedes hendersoni*	--	24	66	ECOTOX ref. 19944	Supl.
Mosquito, *Aedes triseriatus*	--	24	43	ECOTOX ref. 19944	Supl.
Mosquito, *Culex pipiens*	--	24	42.6	ECOTOX ref. 4896	Supl.
Mosquito, *Culex pipiens*	35	72	50	ECOTOX ref. 4896	Supl.
Mosquito, *Culex pipiens*	30	48	24	ECOTOX ref. 4896	Supl.
Mosquito, *Culex pipiens*	--	24	42.1	ECOTOX ref.12072	Supl.
Mosquito, *Culex quinquefasciatus*	--	24	62.1	ECOTOX ref.12072	Supl.
Mosquito, *Culex quinquefasciatus*	100	24	62.1	ECOTOX ref.59254	Supl.
Mosquito, *Culex fatigans*	100	24	440	ECOTOX ref.61960	Supl.
Mosquito, *Culoseta longiareolata*	--	24	170	ECOTOX ref. 20475	Supl.
Beetle *Eretes sticticus*	--	48	430	ECOTOX ref. 5182	Supl.
Beetle, *Peltodytes sp.*	--	48	1500	ECOTOX ref. 7775	Supl.
Backswimmer, *Notonecta undulata*	--	48	110	ECOTOX ref. 7775	Supl.
Backswimmer, *Anisops sardeus*	100	48	42.2	ECOTOX ref. 59962	Supl.

*Endpoint used for quantitative assessment of risks.

4.1.5 Freshwater Invertebrates: Chronic Exposure Studies

Table 23 presents available chronic exposure effects endpoints for freshwater invertebrates. There are limited chronic effects studies and with limited opportunities to compare acute and chronic endpoints within species. **Because *Daphnia magna* is not the most sensitive species tested acutely, a chronic endpoint for risk quotient calculation was derived by applying the largest freshwater invertebrate acute to chronic ratio for the daphnid (LC_{50} 2.35/NOEC 0.006 = 392) to the most sensitive invertebrate acute endpoint to result in a chronic effects endpoint of 0.000026 µg/L (0.01/392 = 0.000026).**

Table 23. Freshwater invertebrate chronic exposure toxicity studies (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP).

Species Tested	% ai	Duration (Days)	NOEC/LOEC (µg/L)	Reference MRID or ECOTOX	Classification
Water flea, *Daphnia magna*	94	21	0.006 /0.1	41718401	Core
Water flea, *Daphnia magna*	--	21	0.15/not reported	ECOTOX ref. 6449	Supl.

4.1.6 Toxicity to Aquatic Plants

Table 24 summarizes available aquatic plant effects data from both registrant submitted and ECOTOX database holdings passing ECOTOX and OPP data quality criteria. **For unicellular aquatic plants the lowest pair of EC_{50} and NOEC is 2040 and 500 µg/L. For vascular plants, there is no established EC_{50}, but the NOEC is 24,065 µg/L. These values will be used for risk quotient calculation.**

Table 24. Aquatic plant toxicity studies (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP)

Species Tested	% ai	Duration (Days)	EC_{50}/NOEC or EC_5 (µg/L)	Reference MRID or ECOTOX	Classification
Blue-green algae *Anabaena flosaquae*	60	6	129,080/92,940	ECOTOX ref. 61937	Supl.
Blue-green algae *Nostoc calcicola*	100	6	No EC_{50}/200,000	ECOTOX ref. 61937	Supl.
Green algae *Scenedesmus obstusiusculus*	60	6	33,228/22,392	ECOTOX ref. 61937	Supl.
Green algae *dunaliella tertiolecta*	--	1	17,880/no NOEC	ECOTOX ref.66270	Supl.
Green algae *Pseudokirchneriella subcapitata*	**100**	**2**	**2040/500***	**ECOTOX ref. 85816**	**Supl.**
Large duckweed *Spirodela polyrhiza*	**96.26**	**7**	**No EC_{50}/24065***	**ECOTOX ref. 9184**	**Supl.**

*Endpoint used for quantitative assessment of risks.

4.2 Evaluation of Terrestrial Ecotoxicity Studies

4.2.1 Toxicity to Mammals

A variety of mammalian acute toxicity values are available from the Agency's Health Effects Division (HED) and form the basis for a wild mammal effects profile. In addition to the laboratory studies, data exist demonstrating malathion effects on small mammal populations in the field at an application rate of 2 lb/acre.

4.2.1.1 Acute and Chronic Mammalian Toxicity

Table 25 presents the available HED acute and reproduction endpoints used in the risk assessment. **The rat LD_{50} of 3400 will serve as the acute mammalian effects endpoint for risk quotient calculations. The rat 240 mg/kg/day reproduction effect for reduced pup survival will be used to calculate chronic mammalian risk quotients.**

Table 25. Mammalian acute oral and chronic dietary toxicity studies.

Species	%ai	LD_{50} (mg/Kg)	Study ID	NOEL (parameter)	Study ID and Author	Category
Mice	--	--	--	500 mg/kg-diet (growth -2 yr. chronic study)	Reference Doc#000389 N.C.I.,1979	N.R.
Rat (Wistar albino)	57% EL	1763	Doc # 000317	ataxia, tremors, salivation, diarrhea observed	Reference Doc#000317 Doc# 000389	Supl.
Rat	Tech	3400*	Doc # 057701 MRID 00159876	1000 mg/kg-diet (growth) 32 day ChE reduction at 100 mg/kg-diet 240 mg/kg/day reduced pup survival and BW	Reference Doc#000389 Karlow and Martin , 1965	N.R.

* Endpoint selected with consultation with the health Effects Division (August 2007).

4.2.1.2 Mammalian Field Studies

Giles and Robert (1970, as cited in the RED), investigated aerial application of malathion to Ohio watersheds with one treated and the other untreated. Malathion was radio tagged with Sulfur 35 radio nuclide. Application rate was 2 lbs/acre and 4 applications were made. Species of small mammals (white-footed mice and chipmunks) showed significant population reductions on treatment areas as compared with controls. Larger mammals and interestingly, shrews which are often sensitive due to high metabolism, were not observed to have been affected. Population reductions were not observed to be related to acute adult mortality, but rather to reduced reproductive success or possibly effects on survival of young. While this study does not provide endpoints for direct incorporation into risk quotient calculations, it affirms that utilization of reproduction endpoints in the chronic risk quotient calculations is meaningful in the context of evaluating potential effects on mammalian populations. Also importantly the field study establishes that small mammals, like those of a size potentially consumed by the listed frog, are likely to be sensitive organisms.

4.2.2 Toxicity to Birds

Effects data for birds span acute and reproduction studies in a variety of species and also includes studies of malathion effects on avian embryo development enzyme activities and liver function. Some of the developmental and sublethal effects studies involved exposure routes not applicable to field situations or not represented by existing exposure estimation methods in Agency risk assessment precluding quantitative use in the risk assessment process. When exposure routes were comparable to other lab studies and risk assessment exposure estimation methods, the sublethal endpoints were adequately addressed by the selection of acute and reproduction endpoints. Available field study data demonstrate that malathion produces varying responses in birds under field application scenarios and seem to indicate that reliance of acute and reproduction laboratory studies may be conservative for assessing avian risk with this pesticide.

4.2.2.1 Acute and Subacute Avian Toxicity

Results of avian oral acute tests with malathion are tabulated in Table 26. **The most sensitive species tested was the ring-necked pheasant, and this endpoint will be used for any quantitative risk estimations.**

Table 26. Avian acute oral toxicity studies (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP).

Species	% ai	LD_{50} (mg/kg-bw) (CL's, when available)	MRID or ECOTOX	Classification
Mallard duck	95	14D LD_{50}=1485 (1020-2150)	00160000	Core
Ring-necked pheasant	**95**	**14D LD_{50}=167* (120-231)**	**00160000**	**Supl.**
Horned lark	95	14D LD_{50}=403 (247-658)	00160000	Supl.
Sharp tailed grouse	tech	LD_{50} =220 (171-240)	Crabtree, D.G., 1965, Denver Wildlife Res. Center, USFWS as cited in RED	Supl.
Bantam chicken	97.7	LD_{50} = 524.8	ECOTOX ref. 36916	Supl.

*Endpoint used for quantitative assessment of risks.

Results of subacute dietary tests with malathion conducted by USFWS laboratories are tabulated in Table 27. **The lowest subacute dietary LC_{50} is 2128 mg/kg-diet.**

Table 27. Avian Subacute Dietary Toxicity Studies (Sourced from OPP data and ECOTOX Studies Meeting Minimum Quality for Database and OPP).

Species	% ai	LC_{50} (mg/kg-diet) (CL's, when available)	MRID or ECOTOOX	Classification
Ring-necked pheasant	95	8D LC_{50}=2639 (2220-3098)	00022923	Core
Bobwhite quail	95	8D LC_{50}=3497 (2959-4011)	00022923	Core

Species	% ai	LC_{50} (mg/kg-diet) (CL's, when available)	MRID or ECOTOOX	Classification
Japanese quail	95	8D LC_{50}=2962 (2453-3656)	00022923	Supl.
Japanese quail	**100**	**8D LC_{50}=2128***	**ECOTOX ref. 35214**	**Supl.**
Japanese quail	95	8D LC_{50}=2968	ECOTOX ref. 50181	Supl.
Mallard duck	95	8D LC_{50}>5000	00022923	Core

*Endpoint used for quantitative assessment of risks.

4.2.2.2 Chronic Avian Toxicity

Available avian reproduction laboratory study results are tabulated in Table 28. Chronic exposure to malathion in diets produced moderate toxicity to terrestrial avian species and low toxicity to waterfowl species tested to date. At food exposure concentrations of 350 mg/kg-diet, 4 of 15 female bobwhite quail exposed to malathion for 21 weeks displayed regressed ovaries and abnormally enlarged/flaccid gizzards. The same observation was made in females at the 1200 mg/kg-diet level. A reduction in numbers of eggs hatched from eggs set was observed at 350 mg/kg-diet. Reduced egg production, viability of eggs, and embryo survival as well as an increase in the number of cracked eggs (a possible indication of the weakening of the shell structure) was observed at 1200 mg/kg-diet. Effects to adults at 1200 mg/kg-diet included weight loss, reduced feed consumption, some mortality, and clinical signs of toxicity.

Table 28. Avian reproduction studies (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP).

Species	% ai	LOAEL mg/kg-diet Effected Parameters	NOAEL mg/kg-diet	MRID	Classification
Bobwhite quail	**96.4**	**21WK LOEL=350 -regressed ovaries and reduced egg hatch** **At 1200 - reduced shell thickness, # eggs laid , egg viability**	**110***	**43501501**	**Core**
Mallard duck	94.0	20WK LOEL =2400 Growth and viability	1200	42782101	Core
Bantam chicken	95	252 day LOEL 475 Chick growth, weight gain No LOEL established for egg production	237.5 475	ECOTOX ref. 37706	Supl.
Bantam chicken	100	56 day LOEL not determined for growth, weight, or egg production	100	ECOTOX ref. 38417	Supl.

*Endpoint used for quantitative assessment of risks.

Available data from the ECOTOX database include additional reproduction effects information for the bantam chicken (domesticated chicken). The lowest NOAEL for reproduction effects and chick growth in one study is 100 mg/kg-diet, the highest exposure level tested. An additional study with the same species and malathion at similar purity provided both a NOAEL and LOAEL for growth (475 mg/kg-diet and 237.5 mg/kg-diet) and a NOAEL for egg production (475 mg/kg-diet). When taken together, these studies suggest that effects on growth and egg production for this species are not expected until exposure levels reach or exceed 475 mg/kg-diet in the bantam chicken. This in turn suggests that the 100 mg/kg-diet NOEL is more an artifact of dose selection than a true threshold for effects in the species.

The data described above indicate that a reproduction threshold dietary exposure of 110 mg/kg-diet represents the lowest effect threshold for use in quantitative risk estimation.

4.2.2.3 Avian Development and Embryonic Effects Studies

In a University of Ottawa study 0.1 ml of solution injected into leghorn chicken eggs proved lethal to 50% of the embryos after 7 days (dependent on age). Four to five-day old embryos were most susceptible. Abnormalities included lack of feathers, smaller size, and beak, plumage, and hind limb defects (Greenburg, J. and. N. Latham, 1968, as cited in RED). In other studies where malathion was injected into eggs at 50 mg/egg, chicks showed shortening of legs and bleaching of feathers (Marliac and Mutchler 1963, as cited in RED). For hen eggs injected with 25, 100, 200, 300, 400, and 500 mg/kg of malathion dissolved in acetone, hatchability was significantly reduced at higher levels with hatches of 85%, 87%, 62%, 71%, 42%, and 6%, respectively (Dunachie and Fletcher, 1969, as cited in RED). In an egg injection study with chick embryos (ECOTOX ref. 88908), maloxon caused reduced survival of embryos at a concentration of 30 micromoles, and those that did survive had severe abnormalities.

The effects of topical application of malathion (95% purity) to the eggs of mallard ducks is reported in ECOTOX reference 35250. No adverse effects of embryo growth were observed at exposures as high as a field equivalent exposure of 12.5 lb/acre (NOAEL). The LOAEL for this study was 14 lb/acre).

The significance of effects associated with egg injection or topical application studies cannot be reliably interpreted in the context of existing risk assessment exposure assumptions. The exposure route for these studies cannot be related quantitatively to existing exposure estimation methods which are either based on dietary concentrations or daily oral dose estimation.

4.2.2.4 Avian Sublethal Effects Studies

Starlings fed 160 mg/kg-diet of malathion for 12 weeks showed 30% decrease in AChE and 50% decrease in 1 acetate dehydrogenase activity (ECOTOX ref. 35129). It should be noted that dosages associated with this study are within the range of lethal effects endpoints from available studies described in sections above.

Japanese quail (*Coturnix japonica*) fed malathion at 100 mg/kg-diet for 2 months exhibited statistically significant increased in liver weights ($p<0.05$) and a significant decrease in liver lipid and vitamin A content ($p<0.001$) (ECOTOX ref. 35083). It should be noted that dosages associated with this study are within the range of lethal effects endpoints from available studies described in sections above and also very close to available reproduction endpoints in quail.

House Sparrows (*Passer domesticus*) were offered treated grain with 5% ai malathion dust. (Concentration 56.7g/56.8 kg of grain or approximately 100 mg/kg) to determine deterrent effect. Oral doses were administered at 1, 2, 5, and 10 mg/bird in acetone or approximately 50, 100, 250, and 500 mg/kg based on mean average weight. Sparrows showed 75% reduction in feeding on treated seed *vs*. untreated seed (4 g of treated seed consumed vs. 21 g of untreated seed on average). Orally dosed birds showed increased respiration, head droop, ejection of white fluid from mouth, and chronic and tonic convulsions at 5 mg/kg or more. Birds that did recover did so in about 1 hour. AChE inhibition was 83%, 75%, 50%, and 25% at 19 mg, 5 mg, 2 mg, and 1 mg per kg of body weight, respectively within 5 minutes of ingestion. The 1 and 2 mg/kg dosed birds recovered in 24 hours. Fifty-seven and 18% mortality was observed at 10 and 5 mg/kg feed residue concentrations, respectively (ECOTOX ref. 37921).

4.2.2.5 Avian Field Studies

The following discussions of avian field studies with malathion and birds are excerpted from the 2006 malathion RED. While these discussions do not in themselves establish endpoints for incorporation into risk quotient calculations, they do provide in-field lines of evidence that can be used to evaluate whether risk quotient-based interpretations of malathion risks to birds (and by extension risks to amphibians) are appropriate.

In a Montana study, 52 live-trapped sharptailed grouse were given oral doses of dieldrin, malathion, and lactose (controls) and released after tagging. They were subsequently observed by capture or radio tracking. The lethal dose of malathion was observed to occur between 200-240 mg/kg (note: this is consistent with lethal effects levels in laboratory studies described above). Reaction to malathion occurred within 72 hours - either death or full recovery. Sublethal signs included depression, slow reactions, blinking, head nodding, and eventual heart or respiratory failure. Radio tracked grouse displayed normal to severe reactions once released. Eight of twelve birds were recovered. Predators are suspected in the disappearance of unrecovered birds (in one case a bird moderately dosed with dieldrin was confirmed killed by a coyote). Grouse that were dosed carried transmitters up to 12 days after release. All confirmed predator kills had received what were considered sublethal doses of the test material. Other birds were discovered to have been attacked and injured. The radio transmitters did not hinder all birds as many were recovered in healthy condition. The sublethal effects of the malathion and dieldrin on survivability are suspected. All controls survived and successfully bred (MRID 113233).

An aerial application of malathion was made over Winnipeg in July 1983 as an ULV solution (95% malathion). Application rate was 210 ml/ha over the entire city to control mosquitoes. Forty one sparrows and thirty nine pigeons were collected within 2 weeks of spraying. Caged exposed sparrows were sacrificed and examined as well. Slight, but not statistically significant, differences were noted (6-12% variation) in AChE levels of post spray to prespray birds. Some reservation is expressed that study birds may all have been exposed to ground fogging applications prior to aerial application exposure (Kucera, 1987, as cited in the RED).

An experimental program to control melon flies on the Island of Bota (Northern Marianas Islands) provided the USFWS with an opportunity to monitor avian populations while subjected to exposure to malathion laced bait sprays (Cue-lure) that were aerially applied. Applications were made at 3 week intervals beginning in Oct. 1988 at up to 5 -30 g/hectare depending on bait type. Of the 10 native species counted, 5 increased in number and 5 decreased. The author was not certain if this was a normal annual fluctuation or one caused by pesticides. Populations of the white throated ground dove, the Philippine turtle dove, and possibly the bridled white eye were significantly lower in the following year. No acute mortality was reported. The other 20 native species were observed and populations appeared unaffected. Even insectivorous species did not appear to suffer population decreases (Engbring 1989, as cited in the RED).

During 1964-1968 boll weevil control programs on cotton, game and non-game bird populations near cotton fields were observed. Applications were aerial at 12 to 16 oz. (approx. 1.2 lb ai) of technical malathion per acre, with up to 7 applications made at 5-22 day intervals. No major differences in weight gain were noted between treated and control birds. No toxicant related mortality was noted after 3 applications of malathion. No dead birds were located adjacent to fields. However, sublethal indicators other than weight were not measured (Parsons and Davis 1971, as cited in the RED).

While these field effects studies are not quantitatively used as inputs to risk calculations, they do provide information on the potential for malathion to produce adverse effects in terrestrial vertebrates under actual field conditions.

4.2.3 Effects on Other Terrestrial Vertebrates Including Amphibians

In one reported study, oral ingestion of organophosphate pesticides and the resulting percent mortality was measured for Carolina anoles. For malathion, the acute LD_{50} was determined to be 2324 mg/kg (Hall and Clark, 1982, as cited in the RED). It should be noted that this acute oral endpoint is higher than the results for birds.

Topical application (1.1 mg/kg-bw) of malathion (96.5% purity) daily for 30 days to woodhouse toads (*Bufo woodhousei*) adversely affected frog growth, organ to bodyweight somatic growth index, and produced cholinesterase inhibition (ECOTOX ref. 89016 and 89577. No mortalities were observed at this exposure level. An exposure level of 11 mg/kg-bw with the same organism resulted in frog mortality. This exposure route is not assessed by the usual terrestrial vertebrate exposure modeling tools. Discussion of the implications of this study will be included in the risk discussion section (5) of this document.

Topical application of malathion (96.5% purity) to bullfrogs (*Rana catesbeiana*) and giant toads (*Bufo marinus*), produced lethality at a dose of 0.011 µg/animal (ECOTOX ref. 89001). This exposure route is not assessed by the usual terrestrial vertebrate exposure modeling tools. Discussion of the implications of this study will be included in the risk discussion section of this document.

Intramuscular injection (990 µg/kg) malathion (100% purity) in leopard frogs (*Rana pipiens*) affected humeral immune response (ECOTOX ref. 68828). There are no established methods for quantitatively relating immune response to assessment endpoints of survival, growth, or fecundity in frogs. In addition, the intramuscular exposure route does not represent an exposure route likely to occur in the field. Consequently, this study is not considered quantitatively or qualitatively in the effects determination.

Wild caught salamanders (*Plethodon glutinosus and P. cinerus*) were exposed to malathion via impregnated filter paper liners of their cages (ECOTOX ref. 40014). The organisms exhibited significant ($p<0.05$) cholinesterase inhibition relative to controls at application rates of 5.12 kg ai/ha and higher. Despite this cholinesterase depression, neither species exhibited behavioral deficits (predatory striking behavior and evasion of mechanical stimuli).

4.2.4 Toxicity to Terrestrial Insects and Other Invertebrates

Data for effects of malathion range from laboratory contact studies with pollinators and lepidopterans to studies of field effects of the pesticide on insect populations under field conditions. It is not surprising that application of an insecticide under field conditions produces population reductions in insects. While the available laboratory studies do provide background information to enhance the understanding of malathion toxicity to invertebrates, the potential widespread use of the insecticide and field studies demonstrating its insecticidal activity suggest that quantitative assessment of risks based on laboratory effects data and uncertain exposure models would be unnecessary to conclude that malathion produces invertebrate population reductions in treated areas.

4.2.4.1 Laboratory Studies

Results for registrant submitted and ECOTOX database non-target insect contact toxicity studies are tabulated in Table 29. Many of the studies listed in ECOTOX did not provide a quantitative estimate of the level of effect beyond a listing of near zero or near 100 percent. These studies have not been included in the following list as they do not provide endpoints useful for quantitative risk assessment. **The most sensitive contact LD_{50} value is for the alfalfa leaf cutter bee 0.000285 µg/animal.**

Table 29. Non-target insect acute contact toxicity studies (sourced from OPP data and ECOTOX studies meeting minimum quality for database and OPP).

Species	%ai	LD_{50} (µg ai/animal)	MRID	Classification
Honey bee *Apis mellifera*	Tech	48 HR LD_{50} =0.20	05001991	Acceptable
Honey bee *Apis mellifera*	Tech	96 HR LD_{50} =0.709	0001999	Acceptable
Honey bee *Apis mellifera*	Tech	N.R. LD_{50}= 0.27 (0.22-0.29)	05004151	Acceptable
Honey bee *Apis mellifera*	Tech	48 HR LD_{50} =0.38	05004003	Acceptable

Species	%ai	LD_{50} (µg ai/animal)	MRID	Classification
Alfalfa leafcutter bee *Megachile rotundata*	**57**	**96 hr LD_{50} = 0.000285 ***	**ECOTOX ref. 39126**	**Supl.**
Alkali bee *Nomia melanderi*	57	96 hr LD_{50} = 0.002052	ECOTOX ref. 39126	Supl.
Asiatic honey bee *Apis cerana*	100	72 hr LD_{50} = 0.46	ECOTOX ref. 58115	Supl.
Cabbage moth *Mamestra brassicae*	94	24 hr LD_{50} = 3.102	ECOTOX ref. 19582	Supl.

*Endpoint used for quantitative assessment of risks.

Martinez and Phenkowski (ECOTOX ref. 37837) reported immersion contact LC_{50} values (2 second immersion, 24 hour post exposure observation) for three insect species. The LC_{50} values for the potato leafhopper (*Empoasca fabae*), tarnished plant bug (*Lygus lineolaris*), and the predatory nabid (*Reduviolus americoferus*) were reported to be 41.32, 68.08, and 273.13 mg/l, respectively.

Panda and Sahu (ECOTOX ref. 52962) reported 96 hour LC_{50} values for the field earthworm (*Drawida willsi*) ranging from 15.1 to 18.8 mg/kg-soil. The same authors (ECOTOX ref. 89517) reported a reduction in the population of the same earthworm species relative to controls (measures at 60 days post application in laboratory colonies) at a malathion soil concentration of 2.2 mg/kg.

4.2.4.2 Field Observations of Effects to Non-Target Insects

There are a number of field efficacy experiments involving applications of malathion to control target insect pests. In addition, there are studies of malathion effects on field populations of beneficial insect pollinators and insect predators. The following discussion represents the results of such field studies extracted both from available ECOTOX references and from summaries of literature reported in the RED.

Malathion (57% formulation) applied in the field at 1.4 kg ai/ha produced reductions in alfalfa plant bugs (*Adelphocoris lineolatus*) relative to controls for up to 7 days post application (ECOTOX ref. 91092).

Field populations of the aphid (*Rhopalosiphum padi*) were suppressed at a malathion application rate of 1 lb ai/acre (ECOTOX ref. 89090).

Populations of the cotton aphid (*Aphis gossypii*) were not reduced relative to controls at a malathion treatment rate of 0.82 lb ai/acre in cotton (ECOTOX ref. 88773).

Field application of malathion at a rate of 20 kg ai/ha had no adverse effect on population abundance of gall flies (*Asphondylia sesami*, ECOTOX ref. 91627).

Malathion application in the field at a rate of 1.4 kg ai/ha produced population reductions in *Plagiognathus chrysanthemi* and *Lygus lineolaris* (ECOTOX ref. 91092) and the weevil (*Hypera postica*, ECOTOX ref. 88952), but no adverse effects on populations of the parasitoid wasps (*Aprostocetus bruchophagi* and *Mesopolobus bruchophagi*) or the trefoil seed chalcid (*Bruchophagus platypterus*, ECOTOX ref. 89230).

Rangeland application of malathion at a rate of 0.342 kg ai/ha reduced orthopteran population abundance relative to controls (ECOTOX ref. 52733).

During a six week period, baited sprays were applied with large droplet sizes (200-300 µm mean diameter). Malathion and maloxon were detected in water throughout the monitoring period. Rain runoff to storm drains produced concentrations up to 583 µg/L in existing streams. Since bait sprays did not attract honeybees, it was believed that they would be unaffected. However, non-targeted lacewings and dipterans were attracted (mainly scavenger flies) to the bait and killed (Oshima 1982, as cited in RED).

Significant impact on honeybees was observed in a study conducted near San Francisco using Mediterranean fruit fly/malathion bait sprays. Significant mortality was observed during 48 hours post-application. Cause was determined to be pesticide contaminated pollen (2.06 mg/kg (mean) and body residue levels of 0.9 - 5.3 mg/kg. Data from a Stockton study also showed increased mortality which was partially attributable to nearby application of Sevin (alfalfa fields), Kabbate, and sulfur dust (tomato fields). Reduced flight activity was observed at both exposed sites after pesticide applications. Other mortality may have occurred in the fields that was not measurable (Gary and Mussen 1984, as cited in RED).

In a University of California study, protein hydrosylate bait spray and malathion applications were monitored and effects to non-target beneficial insect predators common in urban trees were measured. Drop cloths were placed under trees and dead fallen insects were collected and identified. 17 species of aphids, numerous dipterids, butterfly (lepidopteran) larvae, spiders, cynipoidea, and hemiptera appeared to be heavily effected. Also, pscopterans were reduced (Dahlsten 1983, as cited in RED).

In a Washington University study, 6 colonies of honeybees were placed in a 125 acre alfalfa field 36 hours before aerial application. Two hives were covered with wet burlap during application and burlap was removed 24 and 48 hours post application. Two hives were left uncovered in the sprayed fields. Two other colonies were placed 2.25 miles from the application site and one of these was covered with burlap for 48 hours. Eight fluid oz of malathion ULV concentrate was applied per acre by aerial spray at 50 feet altitude in a 125 foot swath on Aug 14. Package bee cages (150-200 bees) were also placed in fields 2 and 7 hours after application for a 3 hour exposure period. Caged bees were also exposed to foliar residue samples at intervals following the application. Bee mortality was higher than normal for 4 days after application. Those covered with wet burlap suffered the highest mortality 1 day after the covers were removed. Bees caged on treated foliage also exhibited higher than normal mortality. Check (control) colonies showed between 500 and 838 dead bees at hive entrances. Treated hive mortalities ranged from 1298 (unprotected) to 2582 (entrance covered) honeybees. Bees which contacted treated foliage showed from 100% (2 hours-1 day post application) mortality to 14% mortality (4 day old residues) versus an average of 5% mortality for control bees.

Malathion residues on foliage ranged from 28.8 mg/kg at application to 0.4 mg/kg (14 days after application). Residues remained over 25 mg/kg for 4 days following application after which a rainfall event occurred. Grasshopper populations were greatly reduced from 12/sq. yd. to less than 1/sq yd. three days after treatment. Lygus bugs were also controlled for up to 3 weeks. Interestingly, the target organisms, Alfalfa weevils and larvae, were not totally controlled. Lady beetles populations were reduced for up to 3 weeks following applications (Johansen 1965, as cited in RED).

4.2.5 Toxicity to Plants

The risk assessment process relies predominantly on effects endpoints associated with seedling emergence, growth, and plant viability. There are no submitted registrant data for malathion and terrestrial plants. A review of the available ECOTOX data meeting OPP data quality criteria, did not show any effects on emergence, growth, and plant viability for any dicot plants species under any application conditions. For monocots, ECOTOX ref. 70355 reports statistically significant ($P<0.01$) reductions in corn root length in seedlings grown for 21-days in a pure quartz sand matrix treated with 30 mg/kg malathion. However, this root length reduction did not translate into any adverse effect in above ground growth of the plants or deficits in root or shoot dry weight. Given the extreme growing conditions in pure quartz sand and the lack of frank effects on plant growth this study was judged not to demonstrate biologically relevant effects of malathion to monocot plants that would be manifested under field conditions.

Another study of malathion exposure in monocots involved the soaking of onion bulbs in a 5 mg/L malathion solution (ECOTOX ref. 8571391). Under these conditions, onion root tip cells showed some alteration in mitotic index elative to untreated controls. This study involves a non-field pertinent exposure scenario and the cellular level effects are not readily related to assessment endpoints for terrestrial plants.

Immersion of wheat seeds in aqueous solutions of malathion resulted in reductions in seedling shoot length (ECOTOX ref. 2240256). The LOAEC for this effect was 100 mg/L and the NOAEC was 500 mg/L. Again, as in the onion study, immersion in an aqueous solution does not represent a field pertinent exposure scenario.

As a consequence of these findings, the risk assessment assumes that malathion will not produce adverse effects on plants at field relevant levels and conditions of exposure.

4.2.6 Terrestrial Wildlife Field Incidents

The Agency reviews and records all wildlife mortality incidents reported independently or under 6a2 provisions of FIFRA regarding use of pesticides or pesticide mixtures. These incidents are reported to the Agency by a variety of sources including registrants, private organizations and local, state, or federal agencies. A summary of all terrestrial incidents reviewed by the Agency following use of malathion products or mixtures is provided in Table 30.

Table 30. Incidence reports potentially attributable to malathion.

Location and Date	Incident	Description	Probability
Oregon, 1/1/85	I000130	5000 acres of alfalfa treated with malathion by USDA-extensive mortality of honeybees collecting nectar from blossoms reported	Probable
Florida, 1997 Medfly Program, Hillsborough County area	USDA Medfly Incident Report	Three incidents involving mortality of ducks were reported along with over 40 fish kills that were investigated. All occurred where malathion bait formulations were used near ponds. 6/22-10 to 14 Ducks killed-Seminole Hts.-baits used 6/14-Duck kill-NW Hillsborough sector-baits used 6/25-Duck kill-Rodrie pond-baits applied aerially	Possible- but unlikely. Only routes believed to offer logical exposure route- oral ingestion of baits or dermal exposure-residue concentration too low to =LD_{50}.

The incidents where duck mortality was reported in Florida medfly program investigations were determined to be more likely caused by some other toxicant. Though fish kills did occur in the ponds, actual residues were well under those which would be expected to cause oral toxicity in mallard duck (1485 mg/Kg). In the case of the June 14 fish kill, an oily substance was observed on the moribund ducks. Park service personnel had also sprayed herbicides near the pond (Glyphosate and Copper). Maximum malathion concentration on vegetation was only 3.0 mg/kg far below avian toxicity thresholds. The Agency would tend to agree with USDA that malathion was not the primary cause of death in the duck kill incidents

4.3 Maloxon Toxicity

One of the degradates of malathion under selected environmental conditions is the oxon of the molecule, maloxon. Limited toxicity data are available for selected taxonomic groups and are summarized in the following sections.

4.3.1 Aquatic Organism Toxicity for Maloxon

Table 31 presents available toxicity data for maloxon for aquatic organisms.

Table 31. Aquatic organism maloxon toxicity studies (sourced from ECOTOX studies meeting minimum quality for database and OPP).

Species Tested	% ai	Duration hours	EC_{50} or LC_{50} µg/L	Reference MRID or ECOTOX	Classification
African clawed frog *Xenopus laevis.*		96	900	ECOTOX ref. 66506	Supl.
Yellow-legged frog *Rana boylii*		96	23	*	Supl.
Medaka *Oryzias latipes*		48	200	ECOTOX ref. 18396	Supl.
Carp *Cyprinus carpio*		48	1600	ECOTOX ref. 86	Supl.

Species Tested	% ai	Duration hours	EC_{50} or LC_{50} µg/L	Reference MRID or ECOTOX	Classification
Perch *Perca fluviatilis*		48	150	ECOTOX ref. 86	Supl.
Roach *Rutilus rulitus*		48	1100	ECOTOX ref. 86	Supl.
Midge *Chironomus riparius*		24	5.4	ECOTOX ref. 86	Supl.

*Sparling, D.W. and G. Fellers. 2006 Comparative toxicity of chlorpyrifos, diazinon, malathion and their oxon derivatives to larval *Rana boylii*. Environmental Pollution (Article in Press; available online at www.sciencedirect.com).

4.3.2 Terrestrial Organism Toxicity for Maloxon

No acute or chronic maloxon toxicity data were available for terrestrial vertebrates.

4.3.3 Establishing Relationships between Malathion and Maloxon Toxicity

There are a limited number of situations where acute toxicity for malathion and maloxon have been determined for the same test species (Table 32). In most cases maloxon is observed to be more toxic than malathion. The strongest comparison of relative potencies within these species is with the larval yellow-legged frog tests, which were conducted in the same lab with the same stock organisms. Because this comparison has the highest degree of confidence and is the most conservative, the potency ratio of 92.9 malathion to maloxon was used to adjust other effects endpoints for malathion to maloxon potency equivalency.

Table 32. Within species comparisons of malathion and maloxon acute toxicity.

Species Tested	Malathion LC_{50} µg/L	Maloxon LC_{50} µg/L	Ratio of Malathion to Maloxon Toxicity
Carp *Cyprinus carpio*	6590 - 23180	1600	4.1 – 14.5
Medaka *Oryzias latipes*	9700	200	48.5
Yellow-legged frog *Rana boylii*	2137	23	92.9
Midge *Chironomus riparius*	1.9 - 440	5.4	0.35 – 81.5

The only exception to the application of the above relative potency adjustment factor was for plants, where the mechanism of action is not likely to be related to the anti-acetyl cholinesterase activity of the phosphate ester or thioester of maloxon or malathion. Therefore, in this case of plant toxicity prediction malathion and maloxon are assumed to be equipotent.

5. *Risk Characterization*

Risk characterization is the integration of the exposure and effects characterizations to determine the potential ecological risk from various malathion use scenarios within the action area and likelihood of direct and indirect effects on the CRLF. The risk characterization provides 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," "may affect, but not likely to adversely affect", or "likely to adversely affect") for the CRLF.

5.1 *Risk Estimation*

Risk is estimated by calculating the ratio of the EECs and the appropriate toxicity endpoint. This value is the risk quotient (RQ), which is then compared to pre-established levels of concern (LOC) for each category evaluated (Table 33). The RQ methodology, LOCs, and specific details of calculation are contained in Appendix G. The highest EECs and most sensitive endpoints are used to determine the screening level RQ. Using these two values theoretically results in a conservative estimate of risk.

Table 33. Levels of concern for terrestrial and aquatic organisms.

Taxa	Acute LOC	Chronic LOC
Avian[1] (terrestrial phase amphibians)	0.1	1
Mammalian[2]	0.1	1
Terrestrial plants[3]	1	N.A.
Aquatic Animals[4] (aquatic phase amphibians)	0.05	1
Insects[5]	0.05	1

Used in RQ calculations:
[1] LD_{50} and estimated NOEL
[2] LD_{50} and NOEC
[3] EC_{25}
[4] LC_{50}/EC_{50} and estimated and reproductive NOEC
[5] LD_{50} per EFED's CRLF Steering Committee

5.1.1 *Aquatic Phase Direct Effects*

Direct effects to the aquatic phase CRLF are assessed in Table 34 for both malathion and maloxon (drift calculated separately). RQs calculations are based on EECs from PRZM/EXAMS (application to land) and EFED Rice Guidance document methods (direct applications to water) and the appropriate assessment endpoints.

Table 34. Assessment of direct effects on the aquatic phase California Red-legged Frog (CRLF) from malathion (estimate includes drift component) and maloxon (drift calculated separately).

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Aquatic Phase CRLF Direct Effects					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
Agricultural Uses							
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	16$ 8.9$	96# 41#	128$	506#	0.094* .019	0.31 .063
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	88$ 22$	1320# 273#	198$	507#	.71$ .14*	2.3# .47
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	72$ 15$	462# 94#	9.5$	34#	.59$ .12*	2.0# .39
4. Chestnut	Air: 5 Other: 5	28$ 5.6$	248# 50#	7.0$	25#	.24* .047	.78 .16
5. Almond	Air: 1.25 Other: 4	12$ 23$	92# 134#	79$ 253$	413# 1320#	.059* .038	.20 .13
6. Date	Air: 1 Other: 2	4.9$ 1.9$	37# 15#	2.2$ 4.3$	7.6# 15#	.047 .019	.16 .063
7. Filbert (Hazelnut)	Air: .625 Other: .625	3.6$ .73$	23# 4.7#	.47*	1.7#	.029 .006	.098 .020
8. Avocado	Air: 9 Other: 9	52$ 10$	234# 47#	.52$	1.3#	.42* .085*	1.4# .28
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	165$ 33$	1207# 248#	38$	132#	1.2$ .24*	3.9# .78
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	15$ 3.0$	226# 45#	.84$	2.7#	.12* .024	.39 .078

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Aquatic Phase CRLF Direct Effects					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	13$ 2.7$	54# 11#	3.7$	13#	.071* .014	.23 .047
12. Cotton	Air: 4 Other: 4	34$ 8.9$	834# 167#	152$	269#	.19* .038	.63 .13
15. Apricot	Air: 10 Other: 10	58$ 12$	464# 93#	<.001	.002	.47* .094*	1.6# .31
16. Nectarine and Peach	Air: 9 Other: 9	50$ 9.9$	372# 74#	1.6$	3.7#	.42* .085*	1.4# .28
17. Cherry	Air: 8 Other: 8	49$ 9.8$	580# 116#	<.001	.002	.38* .075*	1.3# .25
18. Fig	Air: 2.5 Other: 2.5	14$ 2.9$	74# 15#	.041	.097	.12* .024	.39 .078
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	6.9$ 1.7$	123# 29#	.40* .48*	.97 1.2#	.059* .014	.20 .047
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	4.7$ .94$	96# 19#	.70$ 1.4$	2.2# 4.5#	.035 .014	.12 .047
21. Papaya	Air: .175 Other: .175	1.1$ .22*	22# 4.5#	.16*	.52	.008 .002	.027 .005
22. Garlic and Leek	Air: 2 Other: 2	17$ 9.9$	140# 44#	111$	272#	.094* .019	.31 .063
23. Grapes	Air: 2.75 Other: 27.47	15$ 30$	62# 125#	<.001 <.001	<.001 .002	.13* .26*	.43 .86
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	15$ 3.1$	121# 25#	.071*	.24	.12* .024	.39 .078
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	33$ 24$	251# 107#	547$	1764#	.094* .019	.31 .063

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Aquatic Phase CRLF Direct Effects					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
28. Peppermint	Air: 1 Other: 1	6.2$ 1.2$	49# 9.9#	.017	.056	.047 .009	.16 .031
29. Eggplant	Air: 3.5 Other: 3.5	21$ 4.3$	183# 43#	49$	149#	.17* .033	.55 .11
30. Pumpkin	Air: 2 Other: 2	12$ 2.4$	132# 28#	35$	87#	.094* .019	.31 .063
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	11$ 2.8$	126# 29#	41$	106#	.088* .018	.29 .059
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	13$ 5.4$	162# 39#	57$	169#	.094* .019	.31 .063
33. Potato - White/Irish	Air: 3 Other: 3	17$ 3.3$	171# 34#	.038	.068	.14* .028	.47 .094
34. Turnip	Air: 2.5 Other: 2.5	14$ 2.9$	164# 33#	<.001	.002	.12* .024	.39 .078
35. Parsnip and Rutabaga	Air: 2 Other: 2	10$ 2.1$	93# 19#	.072*	.19	.094* .019	.31 .063
36. Sweet Potato	Air: 1.875 Other: 1.875	10$ 2.0$	44# 9.2#	3.6$	8.5#	.088* .018	.29 .059
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	14$ 2.9$	55# 11#	.16*	.58	.059* .012	.20 .039
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	15$ 3$	189# 38#	.007	.024	.12* .024	.39 .078
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	14$ 2.8$	208# 42#	10$	35#	.094* .019	.31 .063

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Aquatic Phase CRLF Direct Effects					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	11$ 2.2$	79# 16#	.36*	1.2#	.083* .017	.27 .055
43. Celery	Air: 1.5 Other: 1.5	16$ 11$	74# 38#	139$	441#	.071* .014	.23 .047
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	15$ 12$	226# 84#	165$	765#	.059* .012	.20 .039
45. Anise	Air: .9375 Other: .9375	5.6$ 1.1$	97# 19#	7.4$	26#	.044 .009	.15 .029
46. Strawberry	Air: 2 Other: 2	13$ 2.6$	191# 38#	.11*	.32	.094* .019	.31 .063
47. Sugar Beet	Air: 1.875 Other: 1.875	17$ 8.1$	162# 49#	128$	409#	.088* .018	.29 .059
48. Tomato	Air: 3.5 Other: 3.5	20$ 4.0$	173# 35#	.48*	1.5#	.17* .033	.55 .11
49. Okra	Air: 1.5 Other: 1.5	8.6$ 1.7$	96# 19#	.37*	.89	.071* .014	.23 .047
51. Sorghum	Air: 1.5 Other: 1.5	7.8$ 1.6$	45# 8.9#	.21*	.51	.071* .014	.23 .047
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	20$ 15$	126# 77#	155$	822#	.059* .012	.20 .039
53. Gooseberry	Air: 16 Other: 16	103$ 21$	969# 194#	.010	.035	.75$ .15*	2.5# .50
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	26$ 5.1$	242# 48#	.002	.009	.19* .038	.63 .13
55. Blueberry	Air: 2.5 Other: 2.5	19$ 3.9$	150# 30#	3.7$	13#	.12* .024	.39 .078
56. Caneberries and Currant	Air: 2 Other: 2	13$ 2.6$	121# 24#	.001	.004	.094* .019	.31 .063

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Aquatic Phase CRLF Direct Effects					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	4.9$ .98$	91# 18#	.002	.006	.035 .007	.12 .023
58. Mint and Spearmint	Air: 1 Other: 1	5.7$ 1.1$	41# 8.2#	3.3$	11#	.047 .009	.16 .031
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	2380$ 2380$	7886# 7886#	24$	78#	.074* .015	.24 .049
61. Water Cress	Air: 2 Other: 2	3046$ 3046$	10,094# 10,094#	30$	100#	.094* .019	.31 .063
Non-agricultural Uses							
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	95$ 85$	466# 339#	971$	3628#	.15* .030	.50 .10
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	914$ 914$	3028# 3028#	9.1$	30#	.028 .006	.094 .019
Nursery. Outdoor Nursery	Air: 2.25[4] Other: 2.25[4]	15$ 2.9$	143# 29#	3.3$	8.1#	.11* .021	.35 .070
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	25$ 5.0$	267# 44#	534$ 119$	4425# 983#	.029 .001	.096 .004

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Aquatic Phase CRLF Direct Effects					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[5]	.31*	6.9#	.22*	.72	.002	.008
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	5.0$ 1.0$	45# 8.9#	.021	.067	.044 .009	.15 .029
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	6.8$ 1.4$	117# 23#	.71$	2.4#	.059* .012	.20 .039

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Maloxon application rate is assumed to be 10.7% of malathion application rate.
[3] Maloxon as an impurity in drift is assumed to be 0.1% of malathion in drift.
[4] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[5] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.
* Acute RQ ≥ 0.1 for listed species.
$ Acute RQ ≥ 0.5 for listed and non-listed species.
# Chronic RQ ≥ 1.0 for listed and non-listed species.

For malathion, the PRZM/EXAMS EECs includes the drift, runoff, and groundwater components. The assessment endpoints are 0.59 µg/L (acute) and 0.014 µg/L (chronic). Malathion acute RQs range from 1.1 to 160 for aerial and air-blast application methods to land (5% spray drift assumed), 0.22 to 85 for other applications to land (1% spray drift assumed), and 910 to 3000 for direct applications to water. Malathion chronic RQs range from 22 to 1320 for aerial and air-blast application methods to land (5% spray drift assumed), 4.5 to 340 for other applications to land (1% spray drift assumed), and 3000 to 10,000 for direct applications to water. All of the uses modeled with aerial and air-blast application methods to land and all of the uses with direct application to water exceed both the LOCs for listed (0.1) as well as non-listed (0.5) species. All of the uses modeled with other application methods to land exceed both the LOCs for listed (0.1) as well as non-listed (0.5) species, except residential (RQ = 0.31) and papaya (RQ = 0.22) uses, which only exceeded the LOC for listed species. Malathion EECs would need to be reduced by factors of 11 to 1600 for aerial and air-blast application methods to land, 2.2 to 850 for other applications to land, and 9100 to 30,000 for applications to water in order to not exceed the listed species LOC (0.05) for acute affects (the most sensitive assessment endpoint for direct aquatic phase effects).

For maloxon, the impurity fraction (based on maloxon as an impurity) had to be calculated separately from the degradate fraction in PRZM/EXAMS. (When calculated this way the peak and maximum 21-day and 60-day averages may occur at different times for the impurity fraction and degradate fraction EECs, therefore, the impurity and degradate EECs can not be validly added to estimate a total exposure.) The maloxon assessment endpoints are 0.0064 µg/L (acute) and 0.00015 µg/L (chronic). Maloxon acute RQs based on the degradate EECs range from 7×10^{-5} to 970 for application methods to land (spray drift assumptions do not apply). Maloxon acute RQs based on the impurity EECs range from 8×10^{-3} to 1.2 for aerial and air-blast application methods to land (5% spray drift assumed) and 1×10^{-3} to 0.26 for other applications to land (1% spray drift assumed). Maloxon chronic RQs based on the degradate EECs range from 2×10^{-4} to 4400 for application methods to land. Maloxon chronic RQs based on the impurity EECs range from 0.027 to 3.9 for aerial and air-blast application methods to land (5% spray drift assumed) and 4×10^{-3} to 0.86 for other applications to land (1% spray drift assumed). RQs for direct applications to water (spray drift assumptions do not apply) range from 9.1 to 30 (acute) and 30 to 100 (chronic).

Several maloxon EECs produce higher RQs than the respective malathion RQs. Because maloxon is both an impurity (assumed 1% of applied malathion) and a degradate (assumed 10.7% of applied malathion), uses that a have a large drift contribution to their total EECs tend to have higher malathion than maloxon RQs, while uses that a have a large runoff and groundwater contributions to their total EECs tend to have higher maloxon than malathion RQs. Seventeen of the uses modeled with aerial and air-blast application rates to land have higher *acute* maloxon RQs than their respective malathion RQs. Of the 6 uses that have an ‘other’ application rates to land that differ from the aerial and air-blast application rate, 4 uses have higher *acute* maloxon RQs than their respective malathion RQs. Eleven of the uses modeled with aerial and air-blast application rates to land have higher *chronic* maloxon RQs than their respective malathion RQs. Of the 6 uses that have an 'other' application rates to land that differ from the aerial and air-blast application rate, 3 uses had higher *chronic* maloxon RQs than their respective malathion RQs. None of the acute or chronic maloxon RQs based on the impurity EECs are greater than the respective malathion RQs.

5.1.2 Aquatic Phase Indirect Effects

Potentially, indirect effects on the aquatic phase of the CRLF include toxic effects on prey items including fish, invertebrates, and aquatic plants. Effects on aquatic plants may also indirectly affect aquatic phase amphibians through reductions in shelter/cover opportunities. Terrestrial plant effects may indirectly result in alterations in riparian habitat, which could limit sheltering opportunities as well as water quality. The following sections present the results of RQ evaluations for fish, aquatic invertebrate, aquatic plant, and terrestrial plant taxonomic groups.

5.1.2.1 Aquatic Phase Indirect Effects via Reduction in Food Items

Indirect effects to the aquatic phase CRLF from reduction in food items are assessed in Table 35 (fish) and 36 (invertebrates) for both malathion and maloxon (impurity calculated separately). RQs calculations are based on EECs from PRZM/EXAMS (application to land) and EFED Rice Guidance document methods (direct applications to water) and the appropriate assessment endpoints.

Freshwater Fish

For malathion, the PRZM/EXAMS EECs include the drift, runoff, groundwater components. For freshwater fish, the assessment endpoints are 4 µg/L (acute) and 0.098 µg/L (chronic). Malathion *acute* RQs range from 0.16 to 24 for aerial and air-blast application methods to land (5% spray drift assumed), 0.032 to 13 for other applications to land (1% spray drift assumed), and 130 to 450 for direct applications to water. Malathion *chronic* RQs range from 3.2 to 190 for aerial and air-blast application methods to land (5% spray drift assumed), 0.64 to 48 for other applications to land (1% spray drift assumed), and 430 to 1400 for direct applications to water. All of the uses modeled with aerial and air-blast application methods to land and all of the uses with direct application to water exceed both the LOCs for listed (0.1) as well as non-listed (0.5) species. All of the uses modeled with other application methods to land exceed both the LOCs for listed (0.1) as well as non-listed (0.5) species, except residential (RQ = 0.31) and papaya (RQ = 0.22) uses, which only exceeded the LOC for listed species. Malathion EECs would need to be reduced by factors of 11 to 1600 for aerial and air-blast application methods to land, 2.2 to 850 for other applications to land, and 9100 to 30,000 for applications to water in order to not exceed the listed species LOC for acute affects.

Table 35. Assessment of indirect effects on the aquatic phase California Red-legged Frog (CRLF) for malathion (estimate includes drift component) and maloxon (drift calculated separately) to freshwater fish.

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Fish					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
Agricultural Uses							
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	2.4$ 1.3$	14# 5.9#	19$	72#	0.014 .003	0.045 .009
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	13$ 3.2$	189# 39#	29$	72#	.10* .021	.33 .067
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	11$ 2.1$	66# 13#	1.4$	4.8#	.087* .017	.28 .056
4. Chestnut	Air: 5 Other: 5	4.1$ .83$	35# 7.2#	1.0$	3.5#	.035 .007	.11 .022
5. Almond	Air: 1.25 Other: 4	1.8$ 3.3$	13# 19#	12$ 37$	59# 189#	.009 .006	.028 .018
6. Date	Air: 1 Other: 2	.72$ .29*	5.3# 2.2#	.32* .64$	1.1# 2.2#	.007 .003	.022 .009
7. Filbert (Hazelnut)	Air: .625 Other: .625	.53$ .11*	3.3# .67	.070*	.24	.004 <.001	.014 .003
8. Avocado	Air: 9 Other: 9	7.6$ 1.5$	33# 6.7#	.077*	.18	.063* .013	.20 .04
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	24$ 4.9$	172# 35#	5.6$	19#	.17* .035	.56 .11

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Fish					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	2.2$ .44*	32# 6.5#	.12*	.38	.017 .003	.056 .011
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	2.0$ .40*	7.8# 1.6#	.55$	1.9#	.010 .002	.033 .007
12. Cotton	Air: 4 Other: 4	5.0$ 1.3$	119# 24#	22$	38#	.028 .006	.089 .018
15. Apricot	Air: 10 Other: 10	8.5$ 1.7$	66# 13#	<.001	<.001	.070* .014	.22 .045
16. Nectarine and Peach	Air: 9 Other: 9	7.3$ 1.5$	53# 11#	.23*	.54	.063* .013	.20 .040
17. Cherry	Air: 8 Other: 8	7.2$ 1.4$	83# 17#	<.001	<.001	.056* .011	.18 .036
18. Fig	Air: 2.5 Other: 2.5	2.1$ .42*	11# 2.1#	.006	.014	.017 .003	.056 .011
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	1.0$ .24*	18# 4.2#	.059* .071*	.14 .17	.009 .002	.028 .007
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	.70$ .14*	14# 2.7#	.10* .21*	.32 .64	.005 .002	.017 .007
21. Papaya	Air: .175 Other: .175	.16* .032	3.2# .64	.024	.075	.001 <.001	.004 <.001
22. Garlic and Leek	Air: 2 Other: 2	2.5$ 1.5$	20# 6.2#	16$	39#	.014 .003	.045 .009
23. Grapes	Air: 2.75 Other: 27.47	2.2$ 4.5$	8.9# 18#	<.001 <.001	<.001 <.001	.019 .038	.061 .12

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Fish					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	2.3$ .46*	17# 3.5#	.01	.034	.017 .003	.056 .011
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	4.9$ 3.6$	36# 15#	81$	252#	.014 .003	.045 .009
28. Peppermint	Air: 1 Other: 1	.91$ .18*	7.0# 1.4#	.002	.008	.007 .001	.022 .004
29. Eggplant	Air: 3.5 Other: 3.5	3.1$ .63$	26# 6.2#	7.2$	21#	.024 .005	.078 .016
30. Pumpkin	Air: 2 Other: 2	1.7$ .35*	19# 4.0#	5.1$	12#	.014 .003	.045 .009
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	1.6$ .41*	18# 4.1#	6.0$	15#	.013 .003	.042 .008
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	2.0$ .80$	23# 5.6#	8.4$	24#	.014 .003	.045 .009
33. Potato - White/Irish	Air: 3 Other: 3	2.4$ .49*	24# 4.9#	.006	.010	.021 .004	.067 .013
34. Turnip	Air: 2.5 Other: 2.5	2.1$ .43*	23# 4.7#	<.001	<.001	.017 .003	.056 .011
35. Parsnip and Rutabaga	Air: 2 Other: 2	1.5$ .31*	13# 2.7#	.011	.027	.014 .003	.045 .009
36. Sweet Potato	Air: 1.875 Other: 1.875	1.5$ .30*	6.2# 1.3#	.54$	1.2#	.013 .003	.042 .008

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Fish					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	2.1$ .43*	7.8# 1.6#	.024	.082	.009 .002	.028 .006
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	2.2$ .44*	27# 5.4#	.001	.003	.017 .003	.056 .011
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	2.1$ .42*	30# 6.0#	1.5$	5.0#	.014 .003	.045 .009
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	1.6$ .33*	11# 2.3#	.053*	.18	.012 .002	.039 .008
43. Celery	Air: 1.5 Other: 1.5	2.4$ 1.6$	11# 5.4#	21$	63#	.010 .002	.033 .007
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	2.3$ 1.7$	32# 12#	24$	109#	.009 .002	.028 .006
45. Anise	Air: .9375 Other: .9375	.83$ .17*	14# 2.8#	1.1$	3.7#	.007 .001	.021 .004
46. Strawberry	Air: 2 Other: 2	1.9$ .39*	27# 5.5#	.016	.046	.014 .003	.045 .009
47. Sugar Beet	Air: 1.875 Other: 1.875	2.5$ 1.2$	23# 7.0#	19$	58#	.013 .003	.042 .008
48. Tomato	Air: 3.5 Other: 3.5	3.0$ .60$	25# 4.9#	.071*	.21	.024 .005	.078 .016
49. Okra	Air: 1.5 Other: 1.5	1.3$ .25*	14# 2.8#	.055*	.13	.010 .002	.033 .007
51. Sorghum	Air: 1.5 Other: 1.5	1.2$ .23*	6.4# 1.3#	.031	.073	.010 .002	.033 .007
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	2.9$ 2.2$	18# 11#	23$	117#	.009 .002	.028 .006
53. Gooseberry	Air: 16 Other: 16	15$ 3.0$	138# 28#	.001	.005	.11* .022	.36 .071

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Fish					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	3.8$ .76$	35# 6.9#	<.001	.001	.028 .006	.089 .018
55. Blueberry	Air: 2.5 Other: 2.5	2.9$ .57$	21# 4.3#	.55$	1.9#	.017 .003	.056 .011
56. Caneberries and Currant	Air: 2 Other: 2	1.9$ .38*	17# 3.5#	<.001	<.001	.014 .003	.045 .009
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	.72$ .14*	13# 2.6#	<.001	<.001	.005 .001	.017 .003
58. Mint and Spearmint	Air: 1 Other: 1	.85$ .17*	5.9# 1.2#	.49*	1.5#	.007 .001	.022 .004
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	351$ 351$	1127# 1127#	3.5$	11#	.011 .002	.035 .007
61. Water Cress	Air: 2 Other: 2	449$ 449$	1442# 1442#	4.5$	14#	.014 .003	.045 .009
Non-agricultural Uses							
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	14$ 13$	67# 48#	143$	518#	.022 .004	.071 .014
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	135$ 135$	433# 433#	1.3$	4.3#	.004 <.001	.013 .003
Nursery. Outdoor Nursery	Air: 2.25[4] Other: 2.25[4]	2.2$ .43*	20# 4.1#	.49*	1.2#	.016 .003	.050 .010

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Fish					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day	Acute Peak	Chronic 60-day
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	3.7$ .74$	38# 6.3#	79$ 17$	632# 140#	.004 <.001	.014 <.001
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[5]	.046	.98	.032	.10	<.001	.001
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	.74$ .15*	6.4# 1.3#	.003	.010	.006 .001	.021 .004
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	1.0$ .20*	17# 3.3#	.11*	.34	.009 .002	.028 .006

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Maloxon application rate is assumed to be 10.7% of malathion application rate.
[3] Maloxon as an impurity in drift is assumed to be 0.1% of malathion in drift.
[4] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[5] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.
* Acute RQ ≥ 0.1 for listed species.
$ Acute RQ ≥ 0.5 for listed and non-listed species.
# Chronic RQ ≥ 1.0 for listed and non-listed species.

For maloxon, the impurity component had to be calculated separately from the degadate component in PRZM/EXAMS. The maloxon assessment endpoints for freshwater invertebrates are 0.043 µg/L (acute) and 1.1 x 10^{-3} µg/L (chronic). Maloxon *acute* RQs based on the degradate EECs range from 1.0 x 10^{-5} to 143 for application methods to land (spray drift assumptions do not apply). Maloxon *acute* RQs based on the impurity EECS range from 1.2 x 10^{-3} to 0.17 for aerial and air-blast application methods to land (5% spray drift assumed) and 1.9 x 10^{-4} to 0.038 for other applications to land (1% spray drift assumed). Maloxon *chronic* RQs based on the degradate EECS range from 2.5 x 10^{-5} to 632 for application methods to land. Maloxon *chronic* RQs based on the impurity EECS range from 3.9 x 10^{-3} to 0.56 for aerial and air-blast application methods to land (5% spray drift assumed) and 6.1 x 10^{-4} to 0.12 for other applications to land (1% spray drift assumed). RQs for direct applications to water (spray drift assumptions do not apply) range from 1.3 to 4.5 (acute) and 4.3 to 14.3 (chronic).

Maloxon EECs, for several uses, yield higher RQs than the respective malathion RQs. Seventeen of the uses modeled with aerial and air-blast application rates to land have higher *acute* maloxon RQs than their respective malathion RQs. Of the 6 uses that have an ‘other’ application rates to land that differ from the aerial and air-blast application rate, 4 uses have higher *acute* maloxon RQs than their respective malathion RQs. Eleven of the uses modeled with aerial and air-blast application rates to land have higher *chronic* maloxon RQs than their respective malathion RQs. Of the 6 uses that have an ‘other’ application rates to land that differ from the aerial and air-blast application rate, 3 uses had higher *chronic* maloxon RQs than their respective malathion RQs. None of the acute or chronic RQs based on the maloxon EECs from the impurity component alone are greater than the respective malathion RQs.

Freshwater Invertebrates

For malathion, the PRZM/EXAMS EECs includes the drift, runoff, and groundwater components. For freshwater invertebrates, the assessment endpoints are 0.01 µg/L (acute) and 2.6 x 10^{-5} µg/L (chronic). Malathion acute RQs range from 65 to 9700 for aerial and air-blast application methods to land (5% spray drift assumed), 13 to 5000 for other applications to land (1% spray drift assumed), and 54,000 to 180,000 for direct applications to water (Table 36). Malathion chronic RQs range from 14,000 to 1,700,000 for aerial and air-blast application methods to land (5% spray drift assumed), 2800 to 470,000 for other applications to land (1% spray drift assumed), and 4,600,000 to 15,000,000 for direct applications to water. All of the uses (aerial and air-blast application methods to land, other application methods to land, and direct application to water) exceed both the LOCs for listed (0.1) as well as non-listed (0.5) species. Malathion EECs would need to be reduced by factors of 14,000 to 1,700,000 for aerial and air-blast application methods to land, 2700 to 460,000 for other applications to land, and 4,600,000 to 15,000,000 for applications to water in order to not exceed the listed species LOC (1) for chronic affects (the most sensitive assessment endpoint for indirect aquatic phase effects).

Table 36. Assessment of indirect effects on the California Red-legged Frog (CRLF) based on effects of malathion (estimate includes drift component) and maloxon (drift calculated separately) to freshwater Invertebrates.

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Invertebrates					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day
Agricultural Uses							
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	957$ 525$	140,827# 59,069#	7530$	724,691#	5.6$ 1.1$	478# 96#
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	5189$ 1274$	901,577# 210,865#	11,660$	777,637#	42$ 8.3$	3583# 717#
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	4265$ 857$	673,308# 137,219#	558$	50,945#	35$ 7.0$	2986# 597#
4. Chestnut	Air: 5 Other: 5	1649$ 331$	281,854# 57,323#	411$	37,543#	14$ 2.8$	1194# 239#
5. Almond	Air: 1.25 Other: 4	735$ 1333$	132,673# 192,038#	4672$ 14,936$	588,557# 1,883,083#	3.5$ 2.2$	299# 191#
6. Date	Air: 1 Other: 2	287$ 115$	36,066# 14,494#	127$ 254$	11,612# 23,231#	2.8$ 1.1$	239# 96#
7. Filbert (Hazelnut)	Air: .625 Other: .625	213$ 43$	33,663# 6861#	28$	2546#	1.7$ .35*	149# 30#
8. Avocado	Air: 9 Other: 9	3057$ 611$	356,088# 71,223#	31$	1943#	25$ 5.0$	2150# 430#
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	9720$ 1952$	1,742,308# 351,650#	2249$	200,850#	70$ 14$	5972# 1194#
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	890$ 178$	174,442# 34,892#	50$	4039#	7.0$ 1.4$	597# 119#

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Invertebrates					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	795\$ 159\$	82,054# 16,414#	221\$	20,463#	4.2\$ .83\$	358# 72#
12. Cotton	Air: 4 Other: 4	1999\$ 522\$	487,654# 97,492#	8966\$	414,405#	11\$ 2.2\$	955# 191#
15. Apricot	Air: 10 Other: 10	3404\$ 681\$	627,308# 125,496#	.039	2.5#	28\$ 5.6\$	2389# 478#
16. Nectarine and Peach	Air: 9 Other: 9	2934\$ 587\$	508,654# 101,762#	93\$	5694#	25\$ 5.0\$	2150# 430#
17. Cherry	Air: 8 Other: 8	2884\$ 577\$	558,192# 111,696#	.037	2.4#	22\$ 4.5\$	1911# 382#
18. Fig	Air: 2.5 Other: 2.5	847\$ 169\$	112,254# 22,447#	2.4\$	148#	7.0\$ 1.4\$	597# 119#
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	408\$ 98\$	73,642# 17,671#	24\$ 28\$	1461# 1752#	3.5\$ .83\$	299# 72#
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	278\$ 56\$	59,069# 11,814#	41\$ 82\$	3429# 6859#	2.1\$ .83\$	179# 72#
21. Papaya	Air: .175 Other: .175	65\$ 13\$	13,785# 2757#	9.6\$	801#	.49* .097*	42# 8.4#
22. Garlic and Leek	Air: 2 Other: 2	987\$ 586\$	139,500# 52,619#	6543\$	418,250#	5.6\$ 1.1\$	478# 96#
23. Grapes	Air: 2.75 Other: 27.47	900\$ 1798\$	95,277# 190,327#	.004 .041	.27 2.7#	7.7\$ 15\$	657# 1312#
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	908\$ 183\$	167,985# 34,147#	4.2\$	358#	7.0\$ 1.4\$	597# 119#
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	1954\$ 1429\$	259,850# 127,150#	32,269\$	268,4024#	5.6\$ 1.1\$	478# 96#

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Invertebrates					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day
28. Peppermint	Air: 1 Other: 1	364$ 73$	67,588# 13,800#	.99$	85#	2.8$ .56$	239# 48#
29. Eggplant	Air: 3.5 Other: 3.5	1224$ 253$	227,846# 46,004#	2871$	216,382#	9.7$ 1.9$	836# 167#
30. Pumpkin	Air: 2 Other: 2	695$ 139$	124,996# 25,002#	2040$	132,561#	5.6$ 1.1$	478# 96#
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	655$ 166$	121,577# 25,500#	2391$	149,397#	5.2$ 1.0$	448# 90#
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	787$ 320$	155,081# 41,612#	3349$	258,587#	5.6$ 1.1$	478# 96#
33. Potato - White/Irish	Air: 3 Other: 3	978$ 195$	157,550# 31,514#	2.3$	104#	8.3$ 1.7$	717# 143#
34. Turnip	Air: 2.5 Other: 2.5	853$ 171$	152,115# 30,427#	.051*	2.4#	7.0$ 1.4$	597# 119#
35. Parsnip and Rutabaga	Air: 2 Other: 2	611$ 122$	87,158# 17,435#	4.2$	285#	5.6$ 1.1$	478# 96#
36. Sweet Potato	Air: 1.875 Other: 1.875	594$ 120$	66,458# 13,783#	215$	13,001#	5.2$ 1.0$	448# 90#
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	850$ 171$	83,827# 17,320#	9.6$	757#	3.5$ .70$	299# 60#
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	890$ 178$	174,315# 34,863#	.41*	36#	7.0$ 1.4$	597# 119#
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	834$ 167$	193,723# 38,731#	602$	53,426#	5.6$ 1.1$	478# 96#

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Invertebrates					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	653$ 130$	114,162# 22,833#	21$	1879#	4.9$ .97$	418# 84#
43. Celery	Air: 1.5 Other: 1.5	954$ 629$	109,042# 55,730#	8213$	669,302#	4.2$ .83$	358# 72#
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	900$ 688$	162,981# 83,231#	9735$	993,351#	3.5$ .70$	299# 60#
45. Anise	Air: .9375 Other: .9375	333$ 67$	64,992# 13,002#	437$	38,790#	2.6$ .52$	224# 45#
46. Strawberry	Air: 2 Other: 2	780$ 156$	176,877# 35,375#	6.2$	494#	5.6$ 1.1$	478# 96#
47. Sugar Beet	Air: 1.875 Other: 1.875	1001$ 478$	150,704# 49,719#	7574$	615,177#	5.2$ 1.0$	448# 90#
48. Tomato	Air: 3.5 Other: 3.5	1194$ 239$	220,123# 44,012#	28$	2139#	9.7$ 1.9$	836# 167#
49. Okra	Air: 1.5 Other: 1.5	507$ 101$	94,900# 19,043#	22$	1366#	4.2$ .83$	358# 72#
51. Sorghum	Air: 1.5 Other: 1.5	463$ 93$	66,412# 13,282#	12$	781#	4.2$ .83$	358# 72#
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	1152$ 869$	170,862# 110,385#	9143$	1,192,229#	3.5$ .70$	299# 60#
53. Gooseberry	Air: 16 Other: 16	6069$ 1214$	1,231,462# 246,327#	.58$	54#	45$ 8.9$	3822# 764#
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	1518$ 303$	307,900# 61,573#	.15*	13#	11$ 2.2$	955# 191#
55. Blueberry	Air: 2.5 Other: 2.5	1149$ 230$	216,154# 43,300#	218$	20,085#	7.0$ 1.4$	597# 119#
56. Caneberries and Currant	Air: 2 Other: 2	759$ 152$	153,950# 30,790#	.073*	6.7#	5.6$ 1.1$	478# 96#

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Invertebrates					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	288$ 58$	64,246# 12,857#	.10*	9.5#	2.1$ .42*	179# 36#
58. Mint and Spearmint	Air: 1 Other: 1	339$ 68$	58,331# 11,666#	194$	16,434#	2.8$ .56$	239# 48#
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	140,400$ 140,416$	12,050,824# 12,050,824#	1396$	119,789#	4.3$ .87$	373# 75#
61. Water Cress	Air: 2 Other: 2	179,700$ 179,732$	15,425,054# 15,425,054#	1787$	153,330#	5.6$ 1.1$	478# 96#
Non-agricultural Uses							
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	5584$ 5002$	558,462# 466,658#	57,274$	5,308,878#	8.9$ 1.8$	764# 153#
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	53,920$ 53,920$	4,627,516# 4,627,516#	536$	45,999#	1.7$ .33*	143# 29#
Nursery. Outdoor Nursery	Air: 2.25[4] Other: 2.25[4]	867$ 173$	175,435# 35,227#	196$	12,356#	6.3$ 1.3$	537# 107#
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	1494$ 296$	281,596# 54,431#	31,491$ 6994$	5,541,128# 1,230,067#	1.7$ .076*	146# 6.5#

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Risk Quotients (RQs) for Freshwater Invertebrates					
		Malathion		Maloxon			
				Degradate Fraction[2]		Impurity Fraction[3]	
		Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day	Acute Peak	Chronic 21-day
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[5]	18$	3755#	13$	1096#	.14*	12#
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	296$ 59$	47,569# 9517#	1.3$	102#	2.6$ .52$	222# 44#
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	402$ 80$	69,023# 13,805#	42$	3586#	3.5$ .70$	299# 60#

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Maloxon application rate is assumed to be 10.7% of malathion application rate.
[3] Maloxon as an impurity in drift is assumed to be 0.1% of malathion in drift.
[4] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[5] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.
* Acute RQ ≥ 0.1 for listed species.
$ Acute RQ ≥ 0.5 for listed and non-listed species.
# Chronic RQ ≥ 1.0 for listed and non-listed species.

For maloxon, the impurity component had to be calculated separately from the degradate component using PRZM/EXAMS. The maloxon assessment endpoints for freshwater invertebrates are 1.1 x 10^{-4} µg/L (acute) and 2.8 x 10^{-7} µg/L (chronic). Maloxon *acute* RQs based on the *degradate* EECs range from 4.1 x 10^{-3} to 57,000 for application methods to land (spray drift assumptions do not apply). Maloxon *acute* RQs based on the *impurity* EECs range from 0.49 to 70 for aerial and air-blast application methods to land (5% spray drift assumed) and 0.076 to 15 for other applications to land (1% spray drift assumed). Maloxon *chronic* RQs based on the *degradate* EECs range from 0.27 to 5,500,000 for application methods to land. Maloxon *chronic* RQs based on the *impurity* EECs range from 42 to 6000 for aerial and air-blast application methods to land (5% spray drift assumed) and 6.5 to 1300 for other applications to land (1% spray drift assumed). RQs for direct applications to water (spray drift assumptions do not apply) range from 540 to 1800 (acute) and 46,000 to 150,000 (chronic).

A number of maloxon EECs result in higher RQs than the respective malathion RQs. Seventeen of the uses modeled with aerial and air-blast application rates to land have higher *acute* maloxon RQs than their respective malathion RQs. Of the 6 uses that have an ‘other’ application rates to land that differ from the aerial and air-blast application rate, 4 uses have higher *acute* maloxon RQs than their respective malathion RQs. Eleven of the uses modeled with aerial and air-blast application rates to land have higher *chronic* maloxon RQs than their respective malathion RQs. Of the 6 uses that have an ‘other’ application rates to land that differ from the aerial and air-blast application rate, 3 uses had higher *chronic* maloxon RQs than their respective malathion RQs. None of the acute or chronic RQs based on the maloxon EECs from the drift component alone are greater than the respective malathion RQs.

5.1.2.2 Aquatic Phase Indirect Effects via Reduction in Habitat and/or Primary Productivity (Freshwater Aquatic Plants)

Risk estimates for aquatic plants with malathion are presented in Table 37. For unicellular aquatic plants non-listed and listed species effects levels are 2040 and 500 µg/L, respectively. For vascular plants, an effect endpoint of 24,065 µg/L was used as a conservative estimate for both listed and non-listed species evaluation. No RQ values exceed the non-listed species concern level and only two use scenarios, rice and watercress produced EECs that trigger listed species concerns and only for unicellular plants.

Table 37. Assessment of indirect effects to aquatic phase California Red-legged Frog (CRLF) based on acute risk to aquatic plants and the PRZM/EXAMS estimated environmental concentrations (EECs) of malathion.

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Acute RQs		
		Unicellular plants EC50	Unicellular plants NOEC	Vascular plants NOEC
Agricultural Uses				
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	0.005 .003	0.019 .011	<0.001 <.001
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	.025 .006	.10 .025	.002 <.001

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Acute RQs		
		Unicellular plants EC50	Unicellular plants NOEC	Vascular plants NOEC
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	.021 .004	.085 .017	.002 <.001
4. Chestnut	Air: 5 Other: 5	.008 .002	.033 .007	<.001 <.001
5. Almond	Air: 1.25 Other: 4	.004 .007	.015 .027	<.001 <.001
6. Date	Air: 1 Other: 2	.001 <.001	.006 .002	<.001 <.001
7. Filbert (Hazelnut)	Air: .625 Other: .625	.001 <.001	.004 <.001	<.001 <.001
8. Avocado	Air: 9 Other: 9	.015 .003	.061 .012	.001 <.001
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	.048 .010	.19 .039	.004 <.001
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	.004 <.001	.018 .004	<.001 <.001
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	.004 <.001	.016 .003	<.001 <.001
12. Cotton	Air: 4 Other: 4	.010 .003	.040 .010	<.001 <.001
15. Apricot	Air: 10 Other: 10	.017 .003	.068 .014	.001 <.001
16. Nectarine and Peach	Air: 9 Other: 9	.014 .003	.059 .012	.001 <.001
17. Cherry	Air: 8 Other: 8	.014 .003	.058 .012	.001 <.001
18. Fig	Air: 2.5 Other: 2.5	.004 <.001	.017 .003	<.001 <.001
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	.002 <.001	.008 .002	<.001 <.001
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	.001 <.001	.006 .001	<.001 <.001
21. Papaya	Air: .175 Other: .175	<.001 <.001	.001 <.001	<.001 <.001
22. Garlic and Leek	Air: 2 Other: 2	.005 .003	.020 .012	<.001 <.001
23. Grapes	Air: 2.75 Other: 27.47	.004 .009	.018 .036	<.001 <.001
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	.004 <.001	.018 .004	<.001 <.001
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	.010 .007	.039 .029	<.001 <.001

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Acute RQs		
		Unicellular plants EC50	Unicellular plants NOEC	Vascular plants NOEC
28. Peppermint	Air: 1 Other: 1	.002 <.001	.007 .001	<.001 <.001
29. Eggplant	Air: 3.5 Other: 3.5	.006 .001	.024 .005	<.001 <.001
30. Pumpkin	Air: 2 Other: 2	.003 <.001	.014 .003	<.001 <.001
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	.003 <.001	.013 .003	<.001 <.001
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	.004 .002	.016 .006	<.001 <.001
33. Potato - White/Irish	Air: 3 Other: 3	.005 <.001	.020 .004	<.001 <.001
34. Turnip	Air: 2.5 Other: 2.5	.004 <.001	.017 .003	<.001 <.001
35. Parsnip and Rutabaga	Air: 2 Other: 2	.003 <.001	.012 .002	<.001 <.001
36. Sweet Potato	Air: 1.875 Other: 1.875	.003 <.001	.012 .002	<.001 <.001
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	.004 <.001	.017 .003	<.001 <.001
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	.004 <.001	.018 .004	<.001 <.001
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	.004 <.001	.017 .003	<.001 <.001
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	.003 <.001	.013 .003	<.001 <.001
43. Celery	Air: 1.5 Other: 1.5	.005 .003	.019 .013	<.001 <.001
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	.004 .003	.018 .014	<.001 <.001
45. Anise	Air: .9375 Other: .9375	.002 <.001	.007 .001	<.001 <.001
46. Strawberry	Air: 2 Other: 2	.004 <.001	.016 .003	<.001 <.001
47. Sugar Beet	Air: 1.875 Other: 1.875	.005 .002	.020 .010	<.001 <.001
48. Tomato	Air: 3.5 Other: 3.5	.006 .001	.024 .005	<.001 <.001
49. Okra	Air: 1.5 Other: 1.5	.002 <.001	.010 .002	<.001 <.001
51. Sorghum	Air: 1.5 Other: 1.5	.002 <.001	.009 .002	<.001 <.001
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	.006 .004	.023 .017	<.001 <.001
53. Gooseberry	Air: 16 Other: 16	.030 .006	.12 .024	.003 <.001

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Acute RQs		
		Unicellular plants EC50	Unicellular plants NOEC	Vascular plants NOEC
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	.007 .001	.03 .006	<.001 <.001
55. Blueberry	Air: 2.5 Other: 2.5	.006 .001	.023 .005	<.001 <.001
56. Caneberries and Currant	Air: 2 Other: 2	.004 <.001	.015 .003	<.001 <.001
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	.001 <.001	.006 .001	<.001 <.001
58. Mint and Spearmint	Air: 1 Other: 1	.002 <.001	.007 .001	<.001 <.001
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	.69 .69	2.8* 2.8*	.058 .058
61. Water Cress	Air: 2 Other: 2	.88 .88	3.6* 3.6*	.075 .075
Non-agricultural Uses				
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	.027 .025	.11 .10	.002 .002
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	.26 .26	1.1* 1.1*	.022 .022
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	.004 <.001	.017 .003	<.001 <.001
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	.007 .001	.030 .006	<.001 <.001
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	<.001	<.001	<.001
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	.001 <.001	.006 .001	<.001 <.001
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	.002 <.001	.008 .002	<.001 <.001

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.

[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).

[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

* Acute RQ ≥ 0.1 for listed species.

For maloxon, no effects endpoints were identified for unicellular or vascular plants. Based on the high degree of structural similarity of malathion and maloxon, and no likely specific mechanism of action unique to plants, it was assumed that maloxon toxicity would not likely be greater than malathion. Given the higher exposures associated with parent malathion, it was concluded that maloxon risks were likely to be trivial in relation to malathion.

5.1.2.3 Aquatic Phase Indirect Effects via Reduction in Terrestrial Plant Community (Riparian Habitat)

The risk assessment process relies predominantly on effects endpoints associated with seedling emergence, growth, and plant viability. There are no submitted registrant data for malathion and terrestrial plants. A review of the available ECOTOX data, meeting OPP data quality criteria, did not show any effects on emergence, growth, and plant viability for any dicot plants species under any application conditions. EFED concludes malathion applications consistent with the current label are likely to have ***no indirect effect on the CRLF via Reduction in Terrestrial Plant Community (Riparian Habitat)*** (Table 1).

5.1.3 Terrestrial Phase Direct Effects

Table 38 presents acute RQ values for direct effects of malathion on terrestrial phases of the CRLF. The evaluation in Table 38 uses dietary concentration-based and dose-based risk calculations and uses avian effects data and consumption models as a surrogate for terrestrial amphibians. RQs calculations are based on EECs from the T-Rex model for a 20g bird and the appropriate effects endpoints. The assessment endpoints are 167 mg/kg-bw (ring-necked Pheasant LD_{50}), 2128 mg/kg-diet (Japanese quail LC_{50}), and 110 mg/kg-diet (bobwhite quail NOAEC) for birds and 3400 mg/kg-bw (LD_{50}), 240 mg/kg-bw (NOAEL), and 4000 mg/kg-diet (NOAEC) for mammals. In situations where risks concerns are triggered by this method, refinement of the risk picture, based on more amphibian appropriate consumption models may be undertaken as part of the risk characterization.

Table 38. Assessment of indirect effects on the terrestrial phase of the California Red-legged Frog (CRLF based on dietary- and dose-based risk quotients (RQs) for small (20 g) birds (a prey item of the CRLF).

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
Agricultural Uses									
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	0.32* / 6.17#	0.15* / 2.83#	0.18* / 3.47#	0.02 / 0.39	8.48$	3.89$	4.77$	0.53$
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	2.88$ / 55.7#	1.32$ / 25.5#	1.62$ / 31.3#	.18* / 3.48#	76.6$	35.1$	43.1$	4.79$
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	2.38$ / 46.1#	1.09$ / 21.1#	1.34$ / 25.9#	.15* / 2.88#	63.4$	29.0$	35.6$	3.96$
4. Chestnut	Air: 5 Other: 5	.93$ / 18.1#	.43* / 8.28#	.53$ / 10.2#	.06 / 1.13#	24.8$	11.4$	14.0$	1.55$
5. Almond	Air: 1.25 Other: 4	.24* / 4.61# .76$ / 14.7#	.11* / 2.11# .35* / 6.76#	.13* / 2.59# .43* / 8.30#	.01 / .29 .05 / .92	6.34$ 20.3$	2.90$ 9.29$	3.56$ 11.4$	.40* 1.27$
6. Date	Air: 1 Other: 2	.14* / 2.62# .27* / 5.24#	.06 / 1.20# .12* / 2.40#	.08 / 1.47# .15* / 2.95#	.01 / .16 .02 / .33	3.60$ 7.20$	1.65$ 3.30$	2.03$ 4.05$	.23* .45*
7. Filbert (Hazelnut)	Air: .625 Other: .625	.12* / 2.30#	.05 / 1.06#	.07 / 1.30#	.01 / .14	3.17$	1.45$	1.78$	.20*
8. Avocado	Air: 9 Other: 9	1.49$ / 28.9#	.68$ / 13.2#	.84$ / 16.2#	.09 / 1.80#	39.7$	18.2$	22.3$	2.48$
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	4.76$ / 92.2#	2.18$ / 42.2#	2.68$ / 51.8#	.30* / 5.76#	127$	58.1$	71.3$	7.92$

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	.48* / 9.26#	.22* / 4.24#	.27* / 5.21#	.03 / .58	12.7$	5.83$	7.16$	.80$
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	.40* / 7.79#	.18* / 3.57#	.23* / 4.38#	.03 / .49	10.7$	4.91$	6.03$	.67$
12. Cotton	Air: 4 Other: 4	1.43$ / 27.7#	.66$ / 12.7#	.81$ / 15.6#	.09 / 1.73#	38.1$	17.5$	21.4$	2.38$
15. Apricot	Air: 10 Other: 10	2.02$ / 39.1#	.93$ / 17.9#	1.14$ / 22.0#	.13* / 2.45#	53.8$	24.7$	30.3$	3.36$
16. Nectarine and Peach	Air: 9 Other: 9	1.82$ / 35.2#	.83$ / 16.1#	1.02$ / 19.8#	.11* / 2.20#	48.4$	22.2$	27.2$	3.03$
17. Cherry	Air: 8 Other: 8	1.68$ / 32.5#	.77$ / 14.9#	.95$ / 18.3#	.11* / 2.03#	44.7$	20.5$	25.2$	2.80$
18. Fig	Air: 2.5 Other: 2.5	.51$ / 9.91#	.23* / 4.54#	.29* / 5.57#	.03 / .62	13.6$	6.24$	7.66$	.85$
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	.27* / 5.14# .32* / 6.17#	.12* / 2.35# .15* / 2.83#	.15* / 2.89# .18* / 3.47#	.02 / .32 .02 / .39	7.06$ 8.48$	3.24$ 3.89$	3.97$ 4.77$	.44* .53$
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	.16* / 3.08# .32* / 6.17#	.07 / 1.41# .15* / 2.83#	.09 / 1.73# .18* / 3.47#	.01 / .19 .02 / .39	4.24$ 8.48$	1.94$ 3.89$	2.39$ 4.77$	.27* .53$
21. Papaya	Air: .175 Other: .175	.04 / .72	.02 / .33	.02 / .40	<.01 / .04	.99$	.45*	.56$	.06

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
22. Garlic and Leek	Air: 2 Other: 2	.38* / 7.35#	.17* / 3.37#	.21* / 4.14#	.02 / .46	10.1$	4.63$	5.69$	.63$
23. Grapes	Air: 2.75 Other: 27.47	.46* / 8.82# 4.55$ / 88.1#	.21* / 4.04# 2.09$ / 40.4#	.26* / 4.96# 2.56$ / 49.5#	.03 / .55 .28* / 5.50#	12.1$ 121$	5.56$ 55.5$	6.82$ 68.1$	.76$ 7.57$
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	.45* / 8.65#	.20* / 3.96#	.25* / 4.86#	.03 / .54	11.9$	5.45$	6.69$	.74$
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	.47* / 9.12#	.22* / 4.18#	.27* / 5.13#	.03 / .57	12.5$	5.75$	7.05$	.78$
28. Peppermint	Air: 1 Other: 1	.18* / 3.46#	.08 / 1.59#	.10* / 1.95#	.01 / 0.22	4.76$	2.18$	2.67$	.30*
29. Eggplant	Air: 3.5 Other: 3.5	.81$ / 15.6#	.37* / 7.17#	.45* / 8.80#	.05 / .98	21.5$	9.85$	12.1$	1.34$
30. Pumpkin	Air: 2 Other: 2	.42* / 8.14#	.19* / 3.73#	.24* / 4.58#	.03 / .51	11.2$	5.13$	6.29$	.70$
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew /Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	.39* / 7.63#	.18* / 3.50#	.22* / 4.29#	.02 / .48	10.5$	4.81$	5.90$	.66$
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	.38* / 7.35#	.17* / 3.37#	.21* / 4.14#	.02 / .46	10.1$	4.63$	5.69$	.63$
33. Potato - White/Irish	Air: 3 Other: 3	.57$ / 11.0#	.26* / 5.06#	.32* / 6.21#	.04 / .69	15.2$	6.95$	8.53$	.95$

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
34. Turnip	Air: 2.5 Other: 2.5	.48* / 9.19#	.22* / 4.21#	.27* / 5.17#	.03 / .57	12.6$	5.79$	7.11$	.79$
35. Parsnip and Rutabaga	Air: 2 Other: 2	.38* / 7.35#	.17* / 3.37#	.21* / 4.14#	.02 / .46	10.1$	4.63$	5.69$	.63$
36. Sweet Potato	Air: 1.875 Other: 1.875	.30* / 5.78#	.14* / 2.65#	.17* / 3.25#	.02 / .36	7.95$	3.64$	4.47$	.50$
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	.37* / 7.25#	.17* / 3.32#	.21* / 4.08#	.02 / .45	9.97$	4.57$	5.61$	.62$
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	.48* / 9.19#	.22* / 4.21#	.27* / 5.17#	.03 / .57	12.6$	5.79$	7.11$	.79$
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	.48* / 9.22#	.22* / 4.23#	.27* / 5.19#	.03 / .58	12.7$	5.81$	7.13$	.79$
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	.33* / 6.45#	.15* / 2.96#	.19* / 3.63#	.02 / .40	8.87$	4.07$	4.99$	.55$
43. Celery	Air: 1.5 Other: 1.5	.24* / 4.63#	.11* / 2.12#	.13* / 2.60#	.01 / .29	6.36$	2.92$	3.58$	.40*
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	.24* / 4.65#	.11* / 2.13#	.14* / 2.62#	.02 / .29	6.40$	2.93$	3.60$	.40*
45. Anise	Air: .9375 Other: .9375	.18* / 3.48#	.08 / 1.60#	.10* / 1.96#	.01 / .22	4.79$	2.19$	2.69$	.30*
46. Strawberry	Air: 2 Other: 2	.42* / 8.14#	.19* / 3.73#	.24* / 4.58#	.03 / .51	11.2$	5.13$	6.29$	.70$
47. Sugar Beet	Air: 1.875 Other: 1.875	.36* / 6.89#	.16* / 3.16#	.20* / 3.88#	.02 / .43	9.48$	4.34$	5.33$	.59$

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
48. Tomato	Air: 3.5 Other: 3.5	.81$ / 15.6#	.37* / 7.17#	.45* / 8.80#	.05 / .98	21.5$	9.85$	12.1$	1.34$
49. Okra	Air: 1.5 Other: 1.5	.32* / 6.10#	.14* / 2.80#	.18* / 3.43#	.02 / .38	8.39$	3.85$	4.72$	.52$
51. Sorghum	Air: 1.5 Other: 1.5	.27* / 5.19#	.12* / 2.38#	.15* / 2.92#	.02 / .32	7.13$	3.27$	4.01$	.45*
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	.22* / 4.32#	.10* / 1.98#	.13* / 2.43#	.01 / .27	5.94$	2.72$	3.34$	.37*
53. Gooseberry	Air: 16 Other: 16	3.24$ / 62.6#	1.48$ / 28.7#	1.82$ / 35.2#	.20* / 3.91#	86.1$	39.4$	48.4$	5.38$
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	.81$ / 15.7#	.37* / 7.17#	.46* / 8.80#	.05 / .98	21.5$	9.86$	12.1$	1.34$
55. Blueberry	Air: 2.5 Other: 2.5	.62$ / 11.9#	.28* / 5.47#	.35* / 6.72#	.04 / .75	16.4$	7.52$	9.24$	1.03$
56. Caneberries and Currant	Air: 2 Other: 2	.40* / 7.83#	.19* / 3.59#	.23* / 4.40#	.03 / .49	10.8$	4.93$	6.05$	.67$
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	.16* / 3.08#	.07 / 1.41#	.09 / 1.73#	.01 / .19	4.23$	1.94$	2.38$	.26*
58. Mint and Spearmint	Air: 1 Other: 1	.18* / 3.46#	.08 / 1.59#	.10* / 1.95#	.01 / 0.22	4.76$	2.18$	2.67$	.30*
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	.28* / 5.40#	.13* / 2.48#	.16* / 3.04#	.02 / .34	7.43$	3.41$	4.18$	.46*
61. Water Cress	Air: 2 Other: 2	.46* / 8.93#	.21* / 4.10#	.26* / 5.03#	.03 / .56	12.3$	5.63$	6.91$	.77$
Non-agricultural Uses									
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	.49* / 9.52#	.23* / 4.36#	.28* / 5.36#	.03 / .60	13.1$	6.00$	7.36$	.82$

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	.09 / 1.82#	.04 / .84	.05 / 1.03#	.01 / .11	2.51$	1.15$	1.41$	.16*
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	.52$ / 10.1#	.24* / 4.61#	.29* / 5.66#	.03 / .63	13.8$	6.34$	7.78$	.86$
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	.12* / 2.28# .03 / .51	.05 / 1.04# .01 / .23	.07 / 1.28# .01 / .28	.01 / .14 <.01 / .03	3.13$ .70$	1.44$ .32*	1.76$ .39*	.20* .04
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	.05 / .94	.02 / .43	.03 / .53	<.01 / .06	1.29$	.59$	.73$	.08

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	.14* / 2.76#	.07 / 1.27#	.08 / 1.55#	.01 / .17	3.80$	1.74$	2.14$	.24*
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	.20* / 3.80#	.09 / 1.74#	.11* / 2.14#	.01 / .24	5.23$	2.40$	2.94$	.33*

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.
* Acute RQ ≥ 0.1 for listed species.
$ Acute RQ ≥ 0.5 for listed and non-listed species.
# Chronic RQ ≥ 1.0 for listed and non-listed species.

Risk calculations based on consumption of amphibian prey within application areas do not result in acute concerns, and only result in chronic concerns for 4 of 68 use scenarios (macadamia nuts, citrus, grapes, and gooseberries). Consumption of small insectivorous mammal prey within application areas triggers acute listed species and chronic concerns in 5 of 68 use scenarios (macadamia nuts, pecan/walnuts, citrus, grapes, and gooseberries) , yet no RQs exceed the non-listed species acute LOC. Higher RQ results can be seen with consumption of small herbivorous mammals, where prey body burdens of malathion trigger acute listed species concerns in 53 use scenarios, acute non-listed concerns in 14 use scenarios, and chronic concerns in all 68 use scenarios. With large insects as a food source, RQ values exceed the non-listed species acute concern level for 8 use scenarios (macadamia nuts, pecan/walnuts, citrus, apricots, nectarine/peaches, cherries, grapes, and gooseberries) and exceed the chronic concern level for 11 use scenarios (macadamia nuts, pecan/walnuts, chestnuts, avocados, cotton, citrus, apricots, nectarine/peaches, cherries, grapes, and gooseberries). Small insect food residues are high enough to trigger acute listed species concerns in 54 use scenarios, acute non-listed species concern levels in 11 use scenarios (macadamia nuts, pecan/walnuts, chestnuts, avocados, cotton, citrus, apricots, nectarine/peaches, cherries, grapes, and gooseberries). Chronic concerns are triggered for residues in small insects for all but 2 scenarios (residential yard lawn and ornamental use and the papaya use).

Based on the highest terrestrial direct effect RQs, all of the uses modeled with aerial and air-blast application methods to land and all of the uses with direct application to water exceed both the LOCs for listed (0.1) as well as non-listed (0.5) species. All of the uses modeled with other application methods to land exceed both the LOCs for listed (0.1) as well as non-listed (0.5) species, except residential (RQ = 0.31) and papaya (RQ = 0.22) uses, which only exceeded the LOC for listed species. Malathion EECs would need to be reduced by factors of 11 to 1600 for aerial and air-blast application methods to land, 2.2 to 850 for other applications to land, and 9100 to 30,000 for applications to water in order to not exceed the listed species LOC (0.1) for *acute* affects (the most sensitive assessment endpoint for direct aquatic phase effects).

5.1.4 Terrestrial Phase Indirect and Effects

Potentially, indirect effects on the aquatic phase of the CRLF include toxic effects on prey items including mammals, birds, and invertebrates. Terrestrial plant effects may indirectly result in alterations in habitat, which could limit sheltering opportunities. The following sections present the results of RQ evaluations for mammal, bird, invertebrate, and terrestrial plant taxonomic groups.

5.1.4.1 Terrestrial Phase Indirect Effects via Reduction in Food Items

Mammal Prey

Mammalian prey effects for terrestrial phase CRLF were assessed using the RQ estimates for small 15 g mammals (Table 39). When exposure were estimated on a dietary basis and compared to a chronic effects endpoint in the same units, only 2 use scenarios triggered concerns (macadamia nuts and pecan/walnuts) and only for an herbivorous small mammal consuming short grasses. Granivorous mammal RQs in this size category do not trigger any acute or chronic effects concerns for any use scenario modeled when risk are evaluated on a dose-based approach. Herbivorous/insectivorous small mammal prey categories exhibit dose-based RQ values exceeding chronic concerns in 45 of 68 use scenarios, and most of the exceeding RQs are limited to short grass, tall grass, and broadleaf plant/small insect residues categories.

Table 39. Assessment of indirect effects on the terrestrial phase of the California Red-legged Frog (CRLF based on dietary- and dose-based risk quotients (RQs) for small (15 g) mammals (a prey item of the CRLF).

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Chronic RQs				Dose-based RQs (Acute / Chronic)				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
Agricultural Uses										
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	0.17	0.08	0.10	0.01	0.09 / 1.23#	0.04 / 0.56	0.05 / 0.69	0.01 / 0.08	<.01 / 0.02
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	1.53#	.70	.86	.10	.78$ / 11.1#	.36* / 5.08#	.44* / 6.23#	.05 / .69	.01 / .15
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	1.27#	.58	.71	.08	.65$ / 9.16#	.30* / 4.2#	.36* / 5.15#	.04 / .57	.01 / .13
4. Chestnut	Air: 5 Other: 5	.50	.23	.28	.03	.25* / 3.59#	.12* / 1.65#	.14* / 2.02#	.02 / .22	<.01 / .05
5. Almond	Air: 1.25 Other: 4	.13 .41	.06 .19	.07 .23	.01 .03	.06 / .92 .21* / 2.93#	.03 / .42 .09 / 1.34#	.04 / .52 .12* / 1.65#	<.01 / .06 .01 / .18	<.01 / .01 <.01 / .04
6. Date	Air: 1 Other: 2	.07 .14	.03 .07	.04 .08	<.01 .01	.04 / .52 .07 / 1.04#	.02 / .24 .03 / .48	.02 / .29 .04 / .59	<.01 / .03 <.01 / .07	<.01 / .01 <.01 / .01
7. Filbert (Hazelnut)	Air: .625 Other: .625	.06	.03	.04	<.01	.03 / .46	.01 / .21	.02 / .26	<.01 / .03	<.01 / .01
8. Avocado	Air: 9 Other: 9	.79	.36	.45	.05	.40* / 5.74#	.19* / 2.63#	.23* / 3.23#	.03 / .36	.01 / .08
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	2.53	1.16	1.43	.16	1.29$ / 18.3#	.59$ / 8.4#	.73$ / 10.3#	.08 / 1.15#	.02 / .25

		Dietary-based Chronic RQs				Dose-based RQs (Acute / Chronic)				
						Herbivores and Insectivores				Granivores
Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	.25	.12	.14	.02	.13* / 1.84#	.06 / .84	.07 / 1.04#	.01 / .12	<.01 / .03
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	.21	.10	.12	.01	.11* / 1.55#	.05 / .71	.06 / .87	.01 / .10	<.01 / .02
12. Cotton	Air: 4 Other: 4	.76	.35	.43	.05	.39* / 5.51#	.18* / 2.53#	.22* / 3.1#	.02 / .34	.01 / .08
15. Apricot	Air: 10 Other: 10	1.08	.49	.61	.07	.55$ / 7.78#	.25* / 3.57#	.31* / 4.38#	.03 / .49	.01 / .11
16. Nectarine and Peach	Air: 9 Other: 9	.97	.44	.54	.06	.49* / 7.0#	.23* / 3.21#	.28* / 3.94#	.03 / .44	.01 / .10
17. Cherry	Air: 8 Other: 8	.90	.41	.50	.06	.46* / 6.47#	.21* / 2.97#	.26* / 3.64#	.03 / .40	.01 / .09
18. Fig	Air: 2.5 Other: 2.5	.27	.12	.15	.02	.14* / 1.97#	.06 / .90	.08 / 1.11#	.01 / .12	<.01 / .03
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	.14 .17	.06 .08	.08 .10	.01 .01	.07 / 1.02# .09 / 1.23#	.03 / .47 .04 / .56	.04 / .57 .05 / .69	<.01 / .06 .01 / .08	<.01 / .01 <.01 / .02
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	.08 .17	.04 .08	.05 .10	.01 .01	.04 / .61 .09 / 1.23#	.02 / .28 .04 / .56	.02 / .34 .05 / .69	<.01 / .04 .01 / .08	<.01 / .01 <.01 / .02
21. Papaya	Air: .175 Other: .175	.02	.01	.01	<.01	.01 / .14	<.01 / .07	.01 / .08	<.01 / .01	<.01 / <.01

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Chronic RQs				Dose-based RQs (Acute / Chronic)				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
22. Garlic and Leek	Air: 2 Other: 2	.20	.09	.11	.01	.10* / 1.46#	.05 / .67	.06 / .82	.01 / .09	<.01 / .02
23. Grapes	Air: 2.75 Other: 27.47	.24 2.42	.11 1.11	.14 1.36	.02 .15	.12* / 1.75# 1.24$ / 17.5#	.06 / .80 .57$ / 8.03#	.07 / .99 .70$ / 9.85#	.01 / .11 .08 / 1.09#	<.01 / .02 .02 / .24
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	.24	.11	.13	.01	.12* / 1.72#	.06 / .79	.07 / .97	.01 / .11	<.01 / .02
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	.25	.11	.14	.02	.13* / 1.81#	.06 / .83	.07 / 1.02#	.01 / .11	<.01 / .03
28. Peppermint	Air: 1 Other: 1	.10	.04	.05	.01	.05 / .69	.02 / .32	.03 / .39	<.01 / .04	<.01 / .01
29. Eggplant	Air: 3.5 Other: 3.5	.43	.20	.24	.03	.22* / 3.11#	.10* / 1.42#	.12* / 1.75#	.01 / .19	<.01 / .04
30. Pumpkin	Air: 2 Other: 2	.22	.10	.13	.01	.11* / 1.62#	.05 / .74	.06 / .91	.01 / .10	<.01 / .02
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew /Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	.21	.10	.12	.01	.11* / 1.52#	.05 / .70	.06 / .85	.01 / .09	<.01 / .02
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	.20	.09	.11	.01	.10* / 1.46#	.05 / .67	.06 / .82	.01 / .09	<.01 / .02

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Chronic RQs				Dose-based RQs (Acute / Chronic)				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
33. Potato - White/Irish	Air: 3 Other: 3	.30	.14	.17	.02	.15* / 2.19#	.07 / 1.01#	.09 / 1.23#	.01 / .14	<.01 / .03
34. Turnip	Air: 2.5 Other: 2.5	.25	.12	.14	.02	.13* / 1.83#	.06 / .84	.07 / 1.03#	.01 / .11	<.01 / .03
35. Parsnip and Rutabaga	Air: 2 Other: 2	.20	.09	.11	.01	.10* / 1.46#	.05 / .67	.06 / .82	.01 / .09	<.01 / .02
36. Sweet Potato	Air: 1.875 Other: 1.875	.16	.07	.09	.01	.08 / 1.15#	.04 / .53	.05 / .65	.01 / .07	<.01 / .02
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	.20	.09	.11	.01	.10* / 1.44#	.05 / .66	.06 / .81	.01 / .09	<.01 / .02
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	.25	.12	.14	.02	.13* / 1.83#	.06 / .84	.07 / 1.03#	.01 / .11	<.01 / .03
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	.25	.12	.14	.02	.13* / 1.83#	.06 / .84	.07 / 1.03#	.01 / .11	<.01 / .03
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	.18	.08	.10	.01	.09 / 1.28#	.04 / .59	.05 / .72	.01 / .08	<.01 / .02
43. Celery	Air: 1.5 Other: 1.5	.13	.06	.07	.01	.06 / .92	.03 / .42	.04 / .52	<.01 / .06	<.01 / .01
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	.13	.06	.07	.01	.07 / .92	.03 / .42	.04 / .52	<.01 / .06	<.01 / .01
45. Anise	Air: .9375 Other: .9375	.10	.04	.05	.01	.05 / .69	.02 / .32	.03 / .39	<.01 / .04	<.01 / .01
46. Strawberry	Air: 2 Other: 2	.22	.10	.13	.01	.11* / 1.62#	.05 / .74	.06 / .91	.01 / .10	<.01 / .02

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Chronic RQs				Dose-based RQs (Acute / Chronic)				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
47. Sugar Beet	Air: 1.875 Other: 1.875	.19	.09	.11	.01	.10 / 1.37#	.04 / .63	.05 / .77	.01 / .09	<.01 / .02
48. Tomato	Air: 3.5 Other: 3.5	.43	.20	.24	.03	.22* / 3.11#	.10* / 1.42#	.12* / 1.75#	.01 / .19	<.01 / .04
49. Okra	Air: 1.5 Other: 1.5	.17	.08	.09	.01	.09 / 1.21#	.04 / .56	.05 / .68	.01 / .08	<.01 / .02
51. Sorghum	Air: 1.5 Other: 1.5	.14	.07	.08	.01	.07 / 1.03#	.03 / .47	.04 / .58	<.01 / .06	<.01 / .01
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	.12	.05	.07	.01	.06 / .86	.03 / .39	.03 / .48	<.01 / .05	<.01 / .01
53. Gooseberry	Air: 16 Other: 16	1.72	.79	.97	.11	.88$ / 12.4#	.40* / 5.7#	.49* / 7#	.05 / .78	.01 / .17
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	.43	.20	.24	.03	.22* / 3.11#	.10* / 1.43#	.12* / 1.75#	.01 / .19	<.01 / .04
55. Blueberry	Air: 2.5 Other: 2.5	.33	.15	.18	.02	.17* / 2.37#	.08 / 1.09#	.09 / 1.34#	.01 / .15	<.01 / .03
56. Caneberries and Currant	Air: 2 Other: 2	.22	.10	.12	.01	.11* / 1.56#	.05 / .71	.06 / .88	.01 / .10	<.01 / .02
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	.08	.04	.05	.01	.04 / .61	.02 / .28	.02 / .34	<.01 / .04	<.01 / .01
58. Mint and Spearmint	Air: 1 Other: 1	.10	.04	.05	.01	.05 / .69	.02 / .32	.03 / .39	<.01 / .04	<.01 / .01
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	.15	.07	.08	.01	.08 / 1.07#	.03 / .49	.04 / .60	<.01 / .07	<.01 / .01
61. Water Cress	Air: 2 Other: 2	.25	.11	.14	.02	.13* / 1.78#	.06 / .81	.07 / 1.0	.01 / .11	<.01 / .02

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Chronic RQs				Dose-based RQs (Acute / Chronic)				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
Non-agricultural Uses										
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	.26	.12	.15	.02	.13* / 1.89#	.06 / .87	.08 / 1.07#	.01 / .12	<.01 / .03
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	.05	.02	.03	<.01	.03 / .36	.01 / .17	.01 / .20	<.01 / .02	<.01 / .01
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	.28	.13	.16	.02	.14* / 2.0#	.06 / .92	.08 / 1.12#	.01 / .12	<.01 / .03
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	.06 .01	.03 .01	.04 .01	<.01 <.01	.03 / .45 .01 / .10	.01 / .21 <.01 / .05	.02 / .25 <.01 / .06	<.01 / .03 <.01 / .01	<.01 / .01 <.01 / <.01

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Chronic RQs				Dose-based RQs (Acute / Chronic)				
						Herbivores and Insectivores				Granivores
		Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/ Seeds/ Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects	Seeds
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	.03	.01	.01	<.01	.01 / .19	.01 / .09	.01 / .10	<.01 / .01	<.01 / <.01
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	.08	.03	.04	<.01	.04 / .55	.02 / .25	.02 / .31	<.01 / .03	<.01 / .01
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	.10	.05	.06	.01	.05 / .76	.02 / .35	.03 / .43	<.01 / .05	<.01 / .01

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.
* Acute RQ ≥ 0.1 for listed species.
$ Acute RQ ≥ 0.5 for listed and non-listed species.
# Chronic RQ ≥ 1.0 for listed and non-listed species.

Avian Prey

Table 40 present risk quotients for avian food items of the CRLF. Chronic dietary RQs trigger concern levels for all but 2 use scenarios (residential yard lawn and ornamental use and the papaya use). Acute listed and non-listed species concern levels are exceeded by dose-based RQs in one or more food items for all use scenarios. Dietary-based acute RQs exceed the listed species LOC in one or more food residue categories for all uses except papaya, residential lawn and ornamental, and mosquito control uses. Eighteen use scenarios show dietary RQs that exceed the non-listed species acute LOC.

Table 40. Assessment of indirect effects on the terrestrial phase of the California Red-legged Frog (CRLF based on dietary- and dose-based risk quotients (RQs) for small (20 g) birds (used as surrogate for CRLF).

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
Agricultural Uses									
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	0.32* / 6.17#	0.15* / 2.83#	0.18* / 3.47#	0.02 / 0.39	8.48$	3.89$	4.77$	0.53$
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	2.88$ / 55.7#	1.32$ / 25.5#	1.62$ / 31.3#	.18* / 3.48#	76.6$	35.1$	43.1$	4.79$
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	2.38$ / 46.1#	1.09$ / 21.1#	1.34$ / 25.9#	.15* / 2.88#	63.4$	29.0$	35.6$	3.96$
4. Chestnut	Air: 5 Other: 5	.93$ / 18.1#	.43* / 8.28#	.53$ / 10.2#	.06 / 1.13#	24.8$	11.4$	14.0$	1.55$
5. Almond	Air: 1.25 Other: 4	.24* / 4.61# .76$ / 14.7#	.11* / 2.11# .35* / 6.76#	.13* / 2.59# .43* / 8.30#	.01 / .29 .05 / .92	6.34$ 20.3$	2.90$ 9.29$	3.56$ 11.4$	.40* 1.27$
6. Date	Air: 1 Other: 2	.14* / 2.62# .27* / 5.24#	.06 / 1.20# .12* / 2.40#	.08 / 1.47# .15* / 2.95#	.01 / .16 .02 / .33	3.60$ 7.20$	1.65$ 3.30$	2.03$ 4.05$	.23* .45*
7. Filbert (Hazelnut)	Air: .625 Other: .625	.12* / 2.30#	.05 / 1.06#	.07 / 1.30#	.01 / .14	3.17$	1.45$	1.78$	.20*
8. Avocado	Air: 9 Other: 9	1.49$ / 28.9#	.68$ / 13.2#	.84$ / 16.2#	.09 / 1.80#	39.7$	18.2$	22.3$	2.48$
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	4.76$ / 92.2#	2.18$ / 42.2#	2.68$ / 51.8#	.30* / 5.76#	127$	58.1$	71.3$	7.92$

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	.48* / 9.26#	.22* / 4.24#	.27* / 5.21#	.03 / .58	12.7$	5.83$	7.16$	.80$
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	.40* / 7.79#	.18* / 3.57#	.23* / 4.38#	.03 / .49	10.7$	4.91$	6.03$	.67$
12. Cotton	Air: 4 Other: 4	1.43$ / 27.7#	.66$ / 12.7#	.81$ / 15.6#	.09 / 1.73#	38.1$	17.5$	21.4$	2.38$
15. Apricot	Air: 10 Other: 10	2.02$ / 39.1#	.93$ / 17.9#	1.14$ / 22.0#	.13* / 2.45#	53.8$	24.7$	30.3$	3.36$
16. Nectarine and Peach	Air: 9 Other: 9	1.82$ / 35.2#	.83$ / 16.1#	1.02$ / 19.8#	.11* / 2.20#	48.4$	22.2$	27.2$	3.03$
17. Cherry	Air: 8 Other: 8	1.68$ / 32.5#	.77$ / 14.9#	.95$ / 18.3#	.11* / 2.03#	44.7$	20.5$	25.2$	2.80$
18. Fig	Air: 2.5 Other: 2.5	.51$ / 9.91#	.23* / 4.54#	.29* / 5.57#	.03 / .62	13.6$	6.24$	7.66$	.85$
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	.27* / 5.14# .32* / 6.17#	.12* / 2.35# .15* / 2.83#	.15* / 2.89# .18* / 3.47#	.02 / .32 .02 / .39	7.06$ 8.48$	3.24$ 3.89$	3.97$ 4.77$	.44* .53$
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	.16* / 3.08# .32* / 6.17#	.07 / 1.41# .15* / 2.83#	.09 / 1.73# .18* / 3.47#	.01 / .19 .02 / .39	4.24$ 8.48$	1.94$ 3.89$	2.39$ 4.77$	.27* .53$
21. Papaya	Air: .175 Other: .175	.04 / .72	.02 / .33	.02 / .40	<.01 / .04	.99$	.45*	.56$	.06

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
22. Garlic and Leek	Air: 2 Other: 2	.38* / 7.35#	.17* / 3.37#	.21* / 4.14#	.02 / .46	10.1$	4.63$	5.69$	.63$
23. Grapes	Air: 2.75 Other: 27.47	.46* / 8.82# 4.55$ / 88.1#	.21* / 4.04# 2.09$ / 40.4#	.26* / 4.96# 2.56$ / 49.5#	.03 / .55 .28* / 5.50#	12.1$ 121$	5.56$ 55.5$	6.82$ 68.1$	.76$ 7.57$
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	.45* / 8.65#	.20* / 3.96#	.25* / 4.86#	.03 / .54	11.9$	5.45$	6.69$	.74$
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	.47* / 9.12#	.22* / 4.18#	.27* / 5.13#	.03 / .57	12.5$	5.75$	7.05$	.78$
28. Peppermint	Air: 1 Other: 1	.18* / 3.46#	.08 / 1.59#	.10* / 1.95#	.01 / 0.22	4.76$	2.18$	2.67$	.30*
29. Eggplant	Air: 3.5 Other: 3.5	.81$ / 15.6#	.37* / 7.17#	.45* / 8.80#	.05 / .98	21.5$	9.85$	12.1$	1.34$
30. Pumpkin	Air: 2 Other: 2	.42* / 8.14#	.19* / 3.73#	.24* / 4.58#	.03 / .51	11.2$	5.13$	6.29$	.70$
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew /Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	.39* / 7.63#	.18* / 3.50#	.22* / 4.29#	.02 / .48	10.5$	4.81$	5.90$	.66$
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	.38* / 7.35#	.17* / 3.37#	.21* / 4.14#	.02 / .46	10.1$	4.63$	5.69$	.63$
33. Potato - White/Irish	Air: 3 Other: 3	.57$ / 11.0#	.26* / 5.06#	.32* / 6.21#	.04 / .69	15.2$	6.95$	8.53$	.95$

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
34. Turnip	Air: 2.5 Other: 2.5	.48* / 9.19#	.22* / 4.21#	.27* / 5.17#	.03 / .57	12.6$	5.79$	7.11$	.79$
35. Parsnip and Rutabaga	Air: 2 Other: 2	.38* / 7.35#	.17* / 3.37#	.21* / 4.14#	.02 / .46	10.1$	4.63$	5.69$	.63$
36. Sweet Potato	Air: 1.875 Other: 1.875	.30* / 5.78#	.14* / 2.65#	.17* / 3.25#	.02 / .36	7.95$	3.64$	4.47$	.50$
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	.37* / 7.25#	.17* / 3.32#	.21* / 4.08#	.02 / .45	9.97$	4.57$	5.61$	.62$
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	.48* / 9.19#	.22* / 4.21#	.27* / 5.17#	.03 / .57	12.6$	5.79$	7.11$	.79$
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	.48* / 9.22#	.22* / 4.23#	.27* / 5.19#	.03 / .58	12.7$	5.81$	7.13$	.79$
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	.33* / 6.45#	.15* / 2.96#	.19* / 3.63#	.02 / .40	8.87$	4.07$	4.99$	.55$
43. Celery	Air: 1.5 Other: 1.5	.24* / 4.63#	.11* / 2.12#	.13* / 2.60#	.01 / .29	6.36$	2.92$	3.58$	.40*
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	.24* / 4.65#	.11* / 2.13#	.14* / 2.62#	.02 / .29	6.40$	2.93$	3.60$	.40*
45. Anise	Air: .9375 Other: .9375	.18* / 3.48#	.08 / 1.60#	.10* / 1.96#	.01 / .22	4.79$	2.19$	2.69$	.30*
46. Strawberry	Air: 2 Other: 2	.42* / 8.14#	.19* / 3.73#	.24* / 4.58#	.03 / .51	11.2$	5.13$	6.29$	.70$
47. Sugar Beet	Air: 1.875 Other: 1.875	.36* / 6.89#	.16* / 3.16#	.20* / 3.88#	.02 / .43	9.48$	4.34$	5.33$	.59$

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
48. Tomato	Air: 3.5 Other: 3.5	.81$ / 15.6#	.37* / 7.17#	.45* / 8.80#	.05 / .98	21.5$	9.85$	12.1$	1.34$
49. Okra	Air: 1.5 Other: 1.5	.32* / 6.10#	.14* / 2.80#	.18* / 3.43#	.02 / .38	8.39$	3.85$	4.72$	.52$
51. Sorghum	Air: 1.5 Other: 1.5	.27* / 5.19#	.12* / 2.38#	.15* / 2.92#	.02 / .32	7.13$	3.27$	4.01$	.45*
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	.22* / 4.32#	.10* / 1.98#	.13* / 2.43#	.01 / .27	5.94$	2.72$	3.34$	.37*
53. Gooseberry	Air: 16 Other: 16	3.24$ / 62.6#	1.48$ / 28.7#	1.82$ / 35.2#	.20* / 3.91#	86.1$	39.4$	48.4$	5.38$
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	.81$ / 15.7#	.37* / 7.17#	.46* / 8.80#	.05 / .98	21.5$	9.86$	12.1$	1.34$
55. Blueberry	Air: 2.5 Other: 2.5	.62$ / 11.9#	.28* / 5.47#	.35* / 6.72#	.04 / .75	16.4$	7.52$	9.24$	1.03$
56. Caneberries and Currant	Air: 2 Other: 2	.40* / 7.83#	.19* / 3.59#	.23* / 4.40#	.03 / .49	10.8$	4.93$	6.05$	.67$
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	.16* / 3.08#	.07 / 1.41#	.09 / 1.73#	.01 / .19	4.23$	1.94$	2.38$	.26*
58. Mint and Spearmint	Air: 1 Other: 1	.18* / 3.46#	.08 / 1.59#	.10* / 1.95#	.01 / 0.22	4.76$	2.18$	2.67$	.30*
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	.28* / 5.40#	.13* / 2.48#	.16* / 3.04#	.02 / .34	7.43$	3.41$	4.18$	.46*
61. Water Cress	Air: 2 Other: 2	.46* / 8.93#	.21* / 4.10#	.26* / 5.03#	.03 / .56	12.3$	5.63$	6.91$	.77$
Non-agricultural Uses									
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	.49* / 9.52#	.23* / 4.36#	.28* / 5.36#	.03 / .60	13.1$	6.00$	7.36$	.82$

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	.09 / 1.82#	.04 / .84	.05 / 1.03#	.01 / .11	2.51$	1.15$	1.41$	.16*
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	.52$ / 10.1#	.24* / 4.61#	.29* / 5.66#	.03 / .63	13.8$	6.34$	7.78$	.86$
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	.12* / 2.28# .03 / .51	.05 / 1.04# .01 / .23	.07 / 1.28# .01 / .28	.01 / .14 <.01 / .03	3.13$ .70$	1.44$ .32*	1.76$ .39*	.20* .04
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	.05 / .94	.02 / .43	.03 / .53	<.01 / .06	1.29$	.59$	.73$	.08

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based Acute RQs (Acute / Chronic)				Dose-based Acute RQs			
		Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruit/ Pods/ Seeds/Large Insects	Short Grass	Tall Grass	Broadleaf Plants/ Small Insects	Fruit/ Pods/Seeds/ Large Insects
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	.14* / 2.76#	.07 / 1.27#	.08 / 1.55#	.01 / .17	3.80$	1.74$	2.14$	.24*
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	.20* / 3.80#	.09 / 1.74#	.11* / 2.14#	.01 / .24	5.23$	2.40$	2.94$	.33*

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.

[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).

[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

* Acute RQ ≥ 0.1 for listed species.

$ Acute RQ ≥ 0.5 for listed and non-listed species.

\# Chronic RQ ≥ 1.0 for listed and non-listed species.

Terrestrial Invertebrate Prey

Commonly, terrestrial insect prey base risk assessments involve an assessment of on and off-field risk calculations. Like other insecticide uses, there are a variety of agricultural scenarios of malathion use that involve direct application to agriculture. However, there are also labeled uses that are much more varied in potential use site geography and include rights of way, public health programs, medfly control, forestry, and mosquito control. Therefore it was assumed that drift assessment off site, while suitable for evaluating a single use site of a pesticide, in this case, were probably of limited utility because direct application to these areas was also possible, and would tend to dominate the risk conclusions.

Consequently RQ calculations were conducted to evaluate effects on terrestrial invertebrates. The risk discussion section of this document will rely on other lines of evidence.

5.1.4.2 Terrestrial Phase Indirect Effects via Reduction in Terrestrial Plant Community (Riparian Habitat)

The risk assessment process relies predominantly on effects endpoints associated with seedling emergence, growth, and plant viability. There are no submitted registrant data for malathion and terrestrial plants. A review of the available ECOTOX data, meeting OPP data quality criteria, did not show any effects on emergence, growth, and plant viability for any dicot plants species under any application conditions. Therefore, EFED concludes malathion applications consistent with the current label are likely to have ***no indirect effect on the CRLF via Reduction in Terrestrial Plant Community (Riparian Habitat)*** (Table 1).

5.2 Risk Description

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

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 malathion 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 41 presents the conclusions of effects determinations for aquatic and terrestrial phase amphibians from either direct or indirect effects.

Table 41. Malathion Effects Determination Summary for the CRLF.

Assessment Endpoint	Exposure (Duration, Habitat)	Effects Determination[1]	Basis for Determination
Direct effects to CRLF	Acute, aquatic	LAA	- Acute LOC[2] is exceeded for most uses based on estimated concentrations of malathion in water and on the most sensitive surrogate vertebrate data. - At the highest estimated concentration of malathion in water, the likelihood of individual mortality is well in excess of 1 in 2. - Maximum observed concentrations of malathion in surface waters are sufficient to exceed the LOC.
	Chronic, aquatic	LAA	- Chronic LOC is exceeded for all uses based on estimated concentrations of malathion in water and on the most sensitive surrogate vertebrate data extrapolated to a chronic endpoint through the application of an ACR.

Assessment Endpoint	Exposure (Duration, Habitat)	Effects Determination[1]	Basis for Determination
	Acute, terrestrial	LAA	- Using the avian surrogate approach the acute listed species LOC is exceeded for 53 of 68 use scenarios. - Refined estimates of exposure based on CRLF-specific diet considerations result in listed species LOC exceedances for dose-based or dietary-based exposures for 53 uses and reduces uses exceeding the non-listed LOC to 8.
	Chronic, terrestrial	LAA	- Chronic LOC is exceeded for all uses, except the papaya and residential ornamental and lawn uses, based on the most sensitive surrogate bird data. - Refined estimates of exposure based on CRLF-specific diet considerations result in LOC exceedances for dietary-based exposures except for papaya and residential ornamental and lawns.
Indirect effects to tadpole CRLF via reduction of primary production based food (*i.e.*, algae)	Aquatic	NLAA	- Only the listed species LOC is exceeded for some uses of malathion. - However, the listed species LOC is only applicable for indirect effects to listed species with an obligate relationship to a specific plant, which is not applicable to the CRLF which is a generalist herbivore.
Indirect effects to juvenile and adult CRLF via reduction of prey (*i.e.*, invertebrates)	Acute, aquatic	LAA	- Acute LOC is exceeded for all uses based on estimated concentrations of malathion in water and on the most sensitive surrogate invertebrate data. - Estimated concentrations of malathion in water resulting from all uses result in a likelihood of individual mortality of 50% to 100% for the most sensitive species tested. - Considering species sensitivity distributions for aquatic vertebrates and estimated exposure concentrations for malathion, all uses may affect substantial numbers of invertebrate species at 50% or greater mortality.
	Chronic, aquatic	LAA	- Chronic LOC is exceeded for all uses based on estimated concentrations of malathion in water and the most sensitive surrogate invertebrate data.
	Acute, terrestrial	LAA	Malathion is an insecticide with a highly varied suite of agricultural and non-agricultural uses. Field effects data show that label relevant application rates can reduce invertebrate populations at sites of treatment.

Assessment Endpoint	Exposure (Duration, Habitat)	Effects Determination[1]	Basis for Determination
Indirect effects to adult CRLF via reduction of prey (*i.e.*, fish, frogs, and mice)	Acute, aquatic	LAA	- Acute LOC is exceeded for several uses based on estimated concentrations of malathion in water and the most sensitive surrogate vertebrate data. - At the highest estimated concentration of malathion in water (resulting from use on lettuce), the level of effects on exposed populations exceeds 50%. - Maximum observed concentrations of malathion in surface waters are sufficient to exceed the LOC. - Considering species sensitivity distributions for aquatic vertebrates and estimated exposure concentrations for malathion several uses (gooseberry, rice/wild rice, watercress, forestry, and mosquito control) may affect substantial numbers of fish species at 50% or greater mortality.
	Chronic, aquatic	LAA	- Chronic LOC is exceeded for all uses based on estimated concentrations of malathion in water and on the most sensitive surrogate vertebrate data.
	Acute, terrestrial	LAA	- Acute LOC is exceeded for all uses based on the most sensitive surrogate amphibian data. - Refined estimates of exposure based on amphibian-specific diet considerations result in LOC exceedances for dietary-based and dose-based exposures. - For foliar uses, effects determination based on acute effects to mice is NLAA.
	Chronic, terrestrial	LAA	- Chronic LOC is exceeded for all foliar uses based on the most sensitive surrogate mammalian and amphibian data. - Refined estimates of exposure based on amphibian-specific diet considerations result in LOC exceedances for dietary-based exposures.
Indirect effects to CRLF via reduction of habitat and/or primary productivity (*i.e.*, plants)	Aquatic	NE	- Only the listed species LOC is exceeded for some uses of malathion. - However, the listed species LOC is only applicable for indirect effects to listed species with an obligate relationship to a specific plant, which is not applicable to the CRLF (a generalist herbivore).
	Terrestrial	NE	-There are no data to support any finding that field relevant effects on terrestrial plants occur with any field relevant application of malathion.

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

[2]Although a number of uses exceed the acute risk LOC for listed species, it is possible that for at least some of these uses, the likelihood of individual mortality may be sufficiently low to arrive at a NLAA determination.

5.2.1 Direct Effects to the California Red Legged Frog

5.2.1.1 Aquatic Phase Direct Effects

Of the 68 use scenarios modeled for this assessment, all but two yielded acute water concentration estimates in excess of the non-listed species effects benchmark equivalent to one-half of the lowest median lethal concentration for larval stage amphibians. In fact the RQ values for these 66 uses exceed the larval frog medial lethal concentration, suggesting that the chance of mortality for frogs exposed to concentrations equivalent to those modeled is greater than 1 in 2. Because exposures are several times to hundreds of times greater than the acute endpoints, regardless of the slope of the dose response curve for larval frog toxicity, the probability for individual mortality may be more than 99%.

Section 3.1.2 presents a figure on the use of malathion over the course of several years. The pattern suggests that usage increases in the spring to peak in summer and rapid taper off in the fall. Superimposing this pattern on critical stages in the frog life history (Figure 2) suggests that the development cascade from egg to tadpole to young juveniles occurs during the March though August period of the year. Highest malathion usage appears to be restricted to periods when young juveniles are most likely present in aquatic systems. The overlap of life stage data with usage data suggests that it is feasible that reproduction effects, as manifested in the survival growth and development from egg though larval stages, are a concern. However, at the height of malathion season, young juveniles, and the potential for acute lethal effects on this life state, may be of the highest concern. As a consequence, use of the available larval effects data for malathion for acute effects introduces considerable uncertainty in the extrapolation of such effects to juvenile frogs. This uncertainty may lead to either over or underestimation of effects at this juvenile life stage. However, given the very high magnitudes of effects encountered for many of the risk estimations of labeled uses, it is unlikely that higher resolution information on young juvenile frog sensitivity to malathion would result in radical alterations of the risk assessment conclusions.

As can be seen in Figure 14 potential use sites which span a variety agricultural crops (NOTE Review panel) including orchards and vineyards is extensive in California suggesting that there is a reasonable opportunity for malathion use in any given agricultural area and these areas do coincide with the frog.

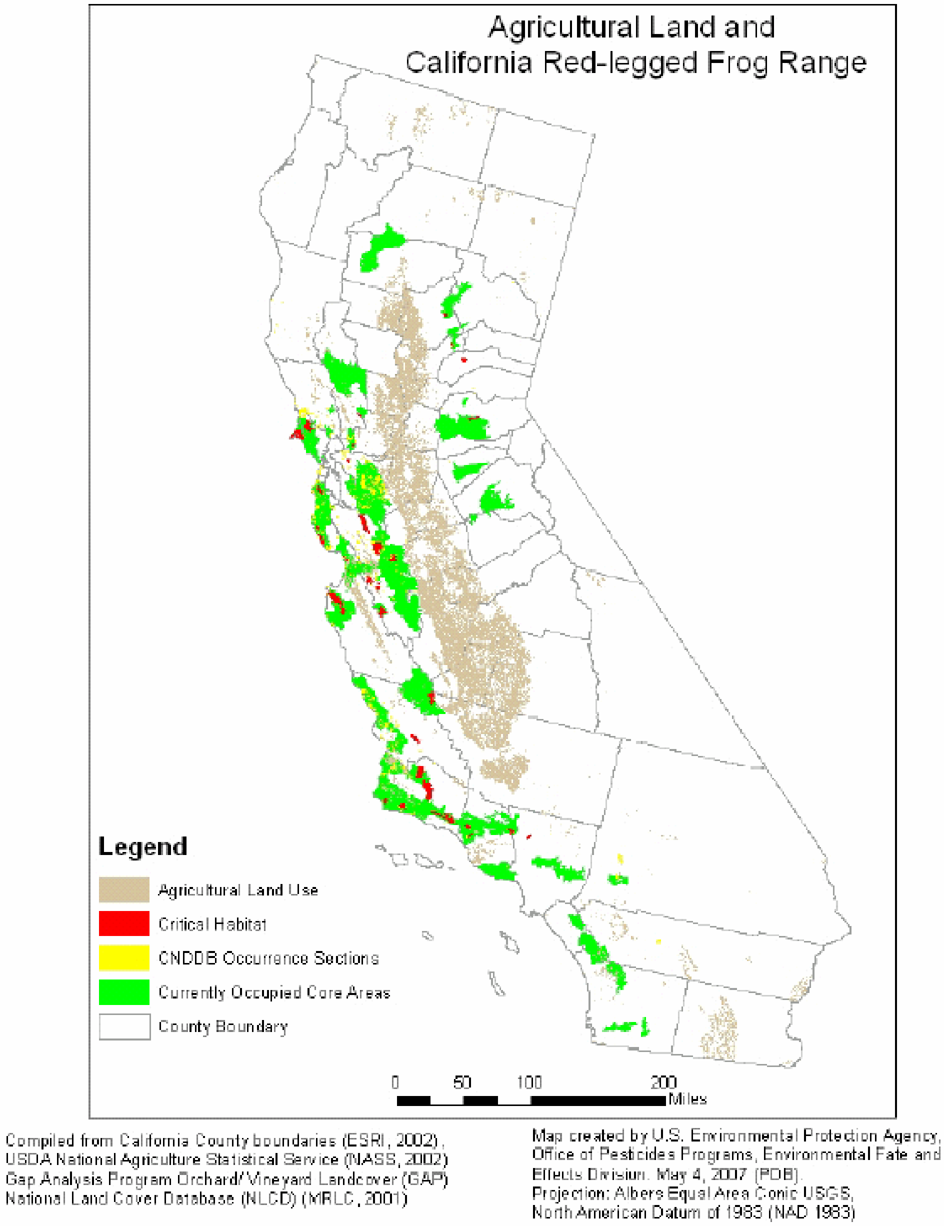


Figure 14. Comparison of the range of the California Red-legged Frog (CRLF) location of agricultural lands in California.

Because malathion is also used as a mosquito control agent it is expected that its use will be closely associated with surface waters and such uses can occur anywhere across the state. Additional uses such as medfly control suggest there is opportunity for the pesticide to be used in areas where this pest may be detected and those areas may involve places outside of agricultural use, save possibly desert regions which are outside the known range of the CRLF.

There are adequate lines of evidence to conclude that labeled malathion use can produce water exposure levels with high probability to be lethal to individual larval frogs and that the use sites associated with malathion coincide spatially with areas potentially inhabited by aquatic phase frogs. While malathion peak usage in California does not fully coincide with the larval life stage of the frog, there is still temporal overlap of the larval stages with periods of malathion use and one cannot preclude the reasonable possibility of exposures of larval frogs to lethal malathion concentrations. Moreover, juvenile and adult frogs may also be present in water, and information on the life cycle suggests that these stages may be present in water at time periods of peak malathion use in California. Insofar as the available acute toxicity data for larval frogs is used to characterize toxic risks to all aquatic phases, there is evidence to suggest that individual adult and juvenile frogs are at lethal risk from malathion use.

All uses of malathion assessed in this document triggered concerns for reproduction (chronic) effects in aquatic phase frogs. As stated earlier, patterns of malathion use suggest that the periods of greatest application of the pesticide do not coincide with egg and larval stages. Nevertheless, patterns of malathion use in California still suggests that uses overlap temporally to some extent with egg and larval stages in the reproduction cycle. The available chronic toxicity data available for fish, the data used for extrapolation of frog reproduction effects, suggests that the differences between the NOAEC and LOAEC values (no effect and frank effects for reproduction) is less than a factor of two. The significance of this difference is that any use sites with a chronic aquatic phase frog RQ greater than 2 falls within an area of potentially high confidence for producing adverse effects with respect to individual production of viable offspring. In every use scenario modeled, the chronic malathion RQ was several to hundreds of times greater than the extrapolated NOAEC, which is highly suggestive of a potential to produce adverse effects on the ability of exposed frogs to reproduce.

Again there are adequate lines of evidence to conclude that labeled malathion use can produce water exposures at levels likely to impair the reproductive capacity of individual larval frogs, and the use sites associated with malathion coincide spatially with areas inhabited by aquatic phase frogs. While California usage data does not suggest that peak malathion usage occurs during egg and larval life cycle stages, there is still sufficient temporal overlap to suggest that exposures to reproductively significant levels of malathion is reasonably possible. **Therefore the effects finding for direct acute effects to the CRLF is that malathion labeled use is likely to adversely affect individuals of the species (LAA).**

One area of uncertainty with respect to the assessment of aquatic phase frogs is the selection of the acute endpoint. This endpoint (LD_{50} 0.59 μg/L) is derived from the most sensitive larval frog tested and the potential for it to be an outlier is suggested when compared to the range of similar endpoints for other tested larval frogs (200 to 9810 μg/L). Careful review of the testing protocol showed no significant problems with toxicity methods except for the use of wild caught organisms. To determine if this species was unusually sensitive or that wild caught individuals were somehow highly stressed or susceptible to pesticide intoxication, a comparison of other pesticide endpoints was made with available ranges for other tested amphibians with those chemicals. This comparison indicated that acute effect endpoints for this test species with other pesticides fell within the range of toxicities for other tested amphibians with those chemicals. It was concluded that there was insufficient evidence to declare the existing malathion larval frog acute toxicity endpoint an outlier. It should be noted that, even if this endpoint was not selected for use, a default to the most sensitive fish endpoint (policy in the absence of amphibian data) would not alter the risk conclusions for aquatic phase amphibians.

Another area of uncertainty with the assessment of direct effects to the aquatic phase of the frog is the extrapolation of available fish chronic data to aquatic phase amphibians. While amphibian eggs and larvae are in direct contact with the water for extended periods, adult frogs may or may not be. However, the majority of available fish chronic effects data are from early life stage tests, which involve direct exposure of eggs and developing fry of fish to the toxicant and not adult stage breeding organisms. **Given the nature of the testing methods and the large RQ values for chronic effects to frogs in this assessment there is insufficient evidence to dismiss chronic effects concerns for aquatic phase frogs (LAA CRLF)**

Additional consideration of maloxon impacts suggests that the conclusions reached for malathion alone are adequate to cover the potential effects associated with maloxon.

5.2.1.2 Terrestrial Phase Direct Effects

The initial screening level risk assessment methods using avian effects data and an avian exposure model as surrogates suggests concern for direct acute and chronic toxic risks to frogs. In such situations where conservative screening level methods trigger concerns, additional evaluation of potential direct effects on terrestrial phase frogs is accomplished through the application of an exposure model modified to be more reflective of the food requirements of amphibians (T-Herps). This involves adjusting daily food intake with an allometric model that accounts for the lower food intake of poikilothermic reptiles and amphibians. The net effect of this approach is a reduction in pesticide exposure due to reduced food consumption. Tables 42 and 43 present the results of this T-Herps model and the attendant RQ calculations for acute and chronic effects. Even under this more species specific risk model, consumption of small insects or small mammals represent an acute and chronic risk at levels exceeding the non-listed species LOC for most uses except papaya and residential ornamental and lawn use. **The available lines of evidence suggest that labeled malathion uses are likely to adversely affect terrestrial phase CRLF through direct toxic effects (LAA)**.

Table 42. Assessment of direct effects on terrestrial phase California Red-legged Frog (CRLF) using dietary-based acute and chronic risk quotients (RQs) based on the T-Herps model estimated environmental concentrations (EECs) for malathion.

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based RQs (Acute / Chronic) for Terrestrial Phase CRLF Direct Effects				
		Small Insect Prey	Large Insect Prey	Small Herbivore Mammal Prey	Small Insectivore Mammal Prey	Small Terrestrial Phase Amphibian Prey
Agricultural Uses						
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	0.18* / 3.47#	0.02 / 0.39	0.21* / 4.07#	0.01 / 0.25	0.01 / 0.12
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	1.62$ / 31.3#	.18* / 3.48#	1.90$ / 36.7#	.12* / 2.29#	.06 / 1.09#
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	1.34$ / 25.9#	.15* / 2.88#	1.57$ / 30.4#	.10* / 1.9#	.05 / .90
4. Chestnut	Air: 5 Other: 5	.53$ / 10.2#	.06 / 1.13#	.62$ / 11.9#	.04 / .74	.02 / .35
5. Almond	Air: 1.25 Other: 4	.13* / 2.59# .43* / 8.30#	.01 / .29 .05 / .92	.16* / 3.04# .50$ / 9.72#	.01 / .19 .03 / .61	<.01 / .09 .01 / .29
6. Date	Air: 1 Other: 2	.08 / 1.47# .15* / 2.95#	.01 / .16 .02 / .33	.09 / 1.73# .18* / 3.45#	.01 / .11 .01 / .22	<.01 / .05 .01 / .10
7. Filbert (Hazelnut)	Air: .625 Other: .625	.07 / 1.30#	.01 / .14	.08 / 1.52#	<.01 / .09	<.01 / .04
8. Avocado	Air: 9 Other: 9	.84$ / 16.2#	.09 / 1.80#	.98$ / 19.0#	.06 / 1.19#	.03 / .56
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	2.68$ / 51.8#	.30* / 5.76#	3.14$ / 60.7#	.20* / 3.80#	.09 / 1.80#
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	.27* / 5.21#	.03 / .58	.32* / 6.10#	.02 / .38	.01 / .18
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	.23* / 4.38#	.03 / .49	.27* / 5.14#	.02 / .32	.01 / .15

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based RQs (Acute / Chronic) for Terrestrial Phase CRLF Direct Effects				
		Small Insect Prey	Large Insect Prey	Small Herbivore Mammal Prey	Small Insectivore Mammal Prey	Small Terrestrial Phase Amphibian Prey
12. Cotton	Air: 4 Other: 4	.81$ / 15.6#	.09 / 1.73#	.94$ / 18.3#	.06 / 1.14#	.03 / .54
15. Apricot	Air: 10 Other: 10	1.14$ / 22.0#	.13* / 2.45#	1.33$ / 25.8#	.08 / 1.61#	.04 / .76
16. Nectarine and Peach	Air: 9 Other: 9	1.02$ / 19.8#	.11* / 2.20#	1.20$ / 23.2#	.07 / 1.45#	.04 / .69
17. Cherry	Air: 8 Other: 8	.95$ / 18.3#	.11* / 2.03#	1.11$ / 21.4#	.07 / 1.34#	.03 / .64
18. Fig	Air: 2.5 Other: 2.5	.29* / 5.57#	.03 / .62	.34* / 6.53#	.02 / .41	.01 / .19
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	.15* / 2.89# .18* / 3.47#	.02 / .32 .02 / .39	.18* / 3.39# .21* / 4.06#	.01 / .21 .01 / .25	.01 / .1 .01 / .12
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	.09 / 1.73# .18* / 3.47#	.01 / .19 .02 / .39	.11* / 2.03# .21* / 4.06#	.01 / .13 .01 / .25	<.01 / .06 .01 / .12
21. Papaya	Air: .175 Other: .175	.02 / .40	<.01 / .04	.02 / .47	<.01 / .03	<.01 / .01
22. Garlic and Leek	Air: 2 Other: 2	.21* / 4.14#	.02 / .46	.25* / 4.85#	.02 / .30	.01 / .14
23. Grapes	Air: 2.75 Other: 27.47	.26* / 4.96# 2.56$ / 49.5#	.03 / .55 .28* / 5.50#	.30* / 5.81# 3.00$ / 58.0#	.02 / .36 .19* / 3.63#	.01 / .17 .09 / 1.72#
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	.25* / 4.86#	.03 / .54	.29* / 5.70#	.02 / .36	.01 / .17
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	.27* / 5.13#	.03 / .57	.31* / 6.01#	.02 / .38	.01 / .18
28. Peppermint	Air: 1 Other: 1	.10* / 1.95#	.01 / .22	.12* / 2.28#	.01 / .14	<.01 / .07
29. Eggplant	Air: 3.5 Other: 3.5	.45* / 8.80#	.05 / .98	.53$ / 10.3#	.03 / .64	.02 / .31

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based RQs (Acute / Chronic) for Terrestrial Phase CRLF Direct Effects				
		Small Insect Prey	Large Insect Prey	Small Herbivore Mammal Prey	Small Insectivore Mammal Prey	Small Terrestrial Phase Amphibian Prey
30. Pumpkin	Air: 2 Other: 2	.24* / 4.58#	.03 / .51	.28* / 5.36#	.02 / .34	.01 / .16
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	.22* / 4.29#	.02 / .48	.26* / 5.03#	.02 / .31	.01 / .15
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	.21* / 4.14#	.02 / .46	.25* / 4.85#	.02 / .30	.01 / .14
33. Potato - White/Irish	Air: 3 Other: 3	.32* / 6.21#	.04 / .69	.38* / 7.27#	.02 / .45	.01 / .22
34. Turnip	Air: 2.5 Other: 2.5	.27* / 5.17#	.03 / .57	.31* / 6.06#	.02 / .38	.01 / .18
35. Parsnip and Rutabaga	Air: 2 Other: 2	.21* / 4.14#	.02 / .46	.25* / 4.85#	.02 / .30	.01 / .14
36. Sweet Potato	Air: 1.875 Other: 1.875	.17* / 3.25#	.02 / .36	.20* / 3.81#	.01 / .24	.01 / .11
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	.21* / 4.08#	.02 / .45	.25* / 4.78#	.02 / .30	.01 / .14
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	.27* / 5.17#	.03 / .57	.31* / 6.06#	.02 / .38	.01 / .18
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	.27* / 5.19#	.03 / .58	.31* / 6.08#	.02 / .38	.01 / .18
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	.19* / 3.63#	.02 / .40	.22* / 4.25#	.01 / .27	.01 / .13
43. Celery	Air: 1.5 Other: 1.5	.13* / 2.60#	.01 / .29	.16* / 3.05#	.01 / .19	<.01 / .09
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	.14* / 2.62#	.02 / .29	.16* / 3.07#	.01 / .19	<.01 / .09

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based RQs (Acute / Chronic) for Terrestrial Phase CRLF Direct Effects				
		Small Insect Prey	Large Insect Prey	Small Herbivore Mammal Prey	Small Insectivore Mammal Prey	Small Terrestrial Phase Amphibian Prey
45. Anise	Air: .9375 Other: .9375	.10* / 1.96#	.01 / .22	.12* / 2.29#	.01 / .14	<.01 / .07
46. Strawberry	Air: 2 Other: 2	.24* / 4.58#	.03 / .51	.28* / 5.36#	.02 / .34	.01 / .16
47. Sugar Beet	Air: 1.875 Other: 1.875	.20* / 3.88#	.02 / .43	.23* / 4.54#	.01 / .28	.01 / .13
48. Tomato	Air: 3.5 Other: 3.5	.45* / 8.80#	.05 / .98	.53$ / 10.3#	.03 / .64	.02 / .31
49. Okra	Air: 1.5 Other: 1.5	.18* / 3.43#	.02 / .38	.21* / 4.02#	.01 / .25	.01 / .12
51. Sorghum	Air: 1.5 Other: 1.5	.15* / 2.92#	.02 / .32	.18* / 3.42#	.01 / .21	.01 / .10
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	.13* / 2.43#	.01 / .27	.15* / 2.85#	.01 / .18	<.01 / .08
53. Gooseberry	Air: 16 Other: 16	1.82$ / 35.2#	.20* / 3.91#	2.13$ / 41.3#	.13* / 2.58#	.06 / 1.22#
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	.46* / 8.80#	.05 / .98	.53$ / 10.3#	.03 / .64	.02 / .31
55. Blueberry	Air: 2.5 Other: 2.5	.35* / 6.72#	.04 / .75	.41* / 7.87#	.03 / .49	.01 / .23
56. Caneberries and Currant	Air: 2 Other: 2	.23* / 4.40#	.03 / .49	.27* / 5.16#	.02 / .32	.01 / .15
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	.09 / 1.73#	.01 / .19	.10* / 2.03#	.01 / .13	<.01 / .06
58. Mint and Spearmint	Air: 1 Other: 1	.10* / 1.95#	.01 / .22	.12* / 2.28#	.01 / .14	<.01 / .07
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	.16* / 3.04#	.02 / .34	.18* / 3.56#	.01 / .22	.01 / .11
61. Water Cress	Air: 2 Other: 2	.26* / 5.03#	.03 / .56	.30* / 5.89#	.02 / .37	.01 / .17

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dietary-based RQs (Acute / Chronic) for Terrestrial Phase CRLF Direct Effects				
		Small Insect Prey	Large Insect Prey	Small Herbivore Mammal Prey	Small Insectivore Mammal Prey	Small Terrestrial Phase Amphibian Prey
Non-agricultural Uses						
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	.28* / 5.36#	.03 / .60	.32* / 6.28#	.02 / .39	.01 / .19
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	.05* / 1.03#	.01 / .11	.06* / 1.20#	<.01 / .08	<.01 / .04
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	.29* / 5.66#	.03 / .63	.34* / 6.63#	.02 / .41	.01 / .20
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	.07 / 1.28# .01 / .28	.01 / .14 <.01 / .03	.08 / 1.5# .02 / .33	<.01 / .09 <.01 / .02	<.01 / .04 <.01 / .01
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	.03 / .53	<.01 / .06	.03 / .62	<.01 / .04	<.01 / .02
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	.08 / 1.55#	.01 / .17	.09 / 1.82#	.01 / .11	<.01 / .05
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	.11* / 2.14#	.01 / .24	.13* / 2.51#	.01 / .16	<.01 / .07

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.
* Acute RQ ≥ 0.1 for listed species.
$ Acute RQ ≥ 0.5 for listed and non-listed species.

Chronic RQ $\geq$ 1.0 for listed and non-listed species.

Table 43. Assessment of direct effects on terrestrial phase California Red-legged Frog (CRLF) using dose-based acute risk quotients (RQs) based on the T-Herps model estimated environmental concentrations (EECs) of malathion.

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based Acute RQs for 3 Sizes (Small / Medium / Large) of Terrestrial Phase CRLF				
		Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
Agricultural Uses						
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	0.09 / .09 / .06	0.01 / .01 / .01	N.A. / 2.5$ / .39*	N.A. / .16* / .02	N.A. / <.01 / <.01
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	.8$ / .79$ / .52$	.09 / .09 / .06	N.A. / 23$ / 3.6$	N.A. / 1.4$ / .22*	N.A. / .03 / .02
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	.66$ / .65$ / .43*	.07 / .07 / .05	N.A. / 19$ / 2.9$	N.A. / 1.2$ / .18*	N.A. / .02 / .01
4. Chestnut	Air: 5 Other: 5	.26* / .26* / .17*	.03 / .03 / .02	N.A. / 7.4$ / 1.2$	N.A. / .46* / .07	N.A. / .01 / .01
5. Almond	Air: 1.25 Other: 4	.07 / .07 / .04 .21* / .21* / .14*	.01 / .01 / <.01 .02 / .02 / .02	N.A. / 1.9$ / .29* N.A. / 6.1$ / .94$	N.A. / .12* / .02 N.A. / .38* / .06	N.A. / <.01 / <.01 N.A. / .01 / <.01
6. Date	Air: 1 Other: 2	.04 / .04 / .02 .08 / .07 / .05	<.01 / <.01 / <.01 .01 / .01 / .01	N.A. / 1.1$ / .17* N.A. / 2.2$ / .33*	N.A. / .07 / .01 N.A. / .13* / .02	N.A. / <.01 / <.01 N.A. / <.01 / <.01
7. Filbert (Hazelnut)	Air: .625 Other: .625	.03 / .03 / .02	<.01 / <.01 / <.01	N.A. / .95$ / .15*	N.A. / .06 / .01	N.A. / <.01 / <.01
8. Avocado	Air: 9 Other: 9	.42* / .41* / .27*	.05 / .05 / .03	N.A. / 12$ / 1.8$	N.A. / .74$ / .12*	N.A. / .01 / .01
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	1.3$ / 1.3$ / .85$	.15* / .14* / .09	N.A. / 38$ / 5.9$	N.A. / 2.4$ / .37*	N.A. / .05 / .03
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	.13* / .13* / .09	.01 / .01 / .01	N.A. / 3.8$ / .59$	N.A. / .24* / .04	N.A. / <.01 / <.01
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	.11* / .11* / .07	.01 / .01 / .01	N.A. / 3.2$ / .50*	N.A. / .20* / .03	N.A. / <.01 / <.01

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based Acute RQs for 3 Sizes (Small / Medium / Large) of Terrestrial Phase CRLF				
		Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
12. Cotton	Air: 4 Other: 4	.40* / .39* / .26*	.04 / .04 / .03	N.A. / 11$ / 1.8$	N.A. / .71$ / .11*	N.A. / .01 / .01
15. Apricot	Air: 10 Other: 10	.56$ / .55$ / .36*	.06 / .06 / .04	N.A. / 16$ / 2.5$	N.A. / 1.0$ / .16*	N.A. / .02 / .01
16. Nectarine and Peach	Air: 9 Other: 9	.51$ / .50* / .33*	.06 / .06 / .04	N.A. / 14$ / 2.2$	N.A. / .9$ / .14*	N.A. / .02 / .01
17. Cherry	Air: 8 Other: 8	.47* / .46* / .30*	.05 / .05 / .03	N.A. / 13$ / 2.1$	N.A. / .84$ / .13*	N.A. / .02 / .01
18. Fig	Air: 2.5 Other: 2.5	.14* / .14* / .09	.02 / .02 / .01	N.A. / 4.1$ / .63$	N.A. / .25* / .04	N.A. / <.01 / <.01
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	.07 / .07 / .05 .09 / .09 / .06	.01 / .01 / .01 .01 / .01 / .01	N.A. / 2.1$ / .33* N.A. / 2.5$ / .39*	N.A. / .13* / .02 N.A. / .16* / .02	N.A. / <.01 / <.01 N.A. / <.01 / <.01
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	.04 / .04 / .03 .09 / .09 / .06	<.01 / <.01 / <.01 .01 / .01 / .01	N.A. / 1.3$ / .20* N.A. / 2.5$ / .39*	N.A. / .08 / .01 N.A. / .16* / .02	N.A. / <.01 / <.01 N.A. / <.01 / <.01
21. Papaya	Air: .175 Other: .175	.01 / .01 / .01	<.01 / <.01 / <.01	N.A. / .30* / .05	N.A. / .02 / <.01	N.A. / <.01 / <.01
22. Garlic and Leek	Air: 2 Other: 2	.11* / .10* / .07	.01 / .01 / .01	N.A. / 30$ / .47*	N.A. / .19* / .03	N.A. / <.01 / <.01
23. Grapes	Air: 2.75 Other: 27.47	.13* / .12* / .08 1.3$ / 1.2$ / .82$	.01 / .01 / .01 .14* / .14* / .09	N.A. / 3.6$ / .56$ N.A. / 36$ / 5.6$	N.A. / .23* / .04 N.A. / 2.3$ / .35*	N.A. / <.01 / <.01 N.A. / .04 / .03
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	.12* / .12* / .08	.01 / .01 / .01	N.A. / 3.5$ / .55$	N.A. / .22* / .03	N.A. / <.01 / <.01
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	.13* / .13* / .08	.01 / .01 / .01	N.A. / 3.7$ / .58$	N.A. / .23* / .04	N.A. / <.01 / <.01
28. Peppermint	Air: 1 Other: 1	.05 / .05 / .03	.01 / .01 / <.01	N.A. / 1.4$ / .22*	N.A. / .09 / .01	N.A. / <.01 / <.01
29. Eggplant	Air: 3.5 Other: 3.5	.23* / .22* / .14*	.03 / .02 / .02	N.A. / 6.4$ / 1.0$	N.A. / .4* / .06	N.A. / .01 / .01

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based Acute RQs for 3 Sizes (Small / Medium / Large) of Terrestrial Phase CRLF				
		Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
30. Pumpkin	Air: 2 Other: 2	.12* / .12* / .08	.01 / .01 / .01	N.A. / 3.3$ / .52$	N.A. / .21* / .03	N.A. / <.01 / <.01
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	.11* / .11* / .07	.01 / .01 / .01	N.A. / 3.1$ / .49*	N.A. / .20* / .03	N.A. / <.01 / <.01
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	.11* / .10* / .07	.01 / .01 / .01	N.A. / 3.0$ / .47*	N.A. / .19* / .03	N.A. / <.01 / <.01
33. Potato - White/Irish	Air: 3 Other: 3	.16* / .16* / .10*	.02 / .02 / .01	N.A. / 4.5$ / .70$	N.A. / .28* / .04	N.A. / .01 / <.01
34. Turnip	Air: 2.5 Other: 2.5	.13* / .13* / .09	.01 / .01 / .01	N.A. / 3.8$ / .59$	N.A. / .24* / .04	N.A. / <.01 / <.01
35. Parsnip and Rutabaga	Air: 2 Other: 2	.11* / .10* / .07	.01 / .01 / .01	N.A. / 3.0$ / .47*	N.A. / .19* / .03	N.A. / <.01 / <.01
36. Sweet Potato	Air: 1.875 Other: 1.875	.08 / .08 / .05	.01 / .01 / .01	N.A. / 2.4$ / .37*	N.A. / .15* / .02	N.A. / <.01 / <.01
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	.10* / .10* / .07	.01 / .01 / .01	N.A. / 3.0$ / .46*	N.A. / .19* / .03	N.A. / <.01 / <.01
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	.13* / .13* / .09	.01 / .01 / .01	N.A. / 3.8$ / .59$	N.A. / .24* / .04	N.A. / <.01 / <.01
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	.13* / .13* / .09	.01 / .01 / .01	N.A. / 3.8$ / .59$	N.A. / .24* / .04	N.A. / <.01 / <.01
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	.09 / .09 / .06	.01 / .01 / .01	N.A. / 2.6$ / .41*	N.A. / .17* / .03	N.A. / <.01 / <.01
43. Celery	Air: 1.5 Other: 1.5	.07 / .07 / .04	.01 / .01 / <.01	N.A. / 1.9$ / .30*	N.A. / .12* / .02	N.A. / <.01 / <.01
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	.07 / .07 / .04	.01 / .01 / <.01	N.A. / 1.9$ / .30*	N.A. / .12* / .02	N.A. / <.01 / <.01
45. Anise	Air: .9375 Other: .9375	.05 / .05 / .03	.01 / .01 / <.01	N.A. / 1.4$ / .22*	N.A. / .09 / .01	N.A. / <.01 / <.01

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based Acute RQs for 3 Sizes (Small / Medium / Large) of Terrestrial Phase CRLF				
		Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
46. Strawberry	Air: 2 Other: 2	.12* / .12* / .08	.01 / .01 / .01	N.A. / 3.3$ / .52$	N.A. / .21* / .03	N.A. / <.01 / <.01
47. Sugar Beet	Air: 1.875 Other: 1.875	.10 / .10 / .06	.01 / .01 / .01	N.A. / 2.8$ / .44*	N.A. / .18* / .03	N.A. / <.01 / <.01
48. Tomato	Air: 3.5 Other: 3.5	.23* / .22* / .14*	.03 / .02 / .02	N.A. / 6.4$ / 1.0$	N.A. / .40* / .06	N.A. / .01 / .01
49. Okra	Air: 1.5 Other: 1.5	.09 / .09 / .06	.01 / .01 / .01	N.A. / 2.5$ / .39*	N.A. / .16* / .02	N.A. / <.01 / <.01
51. Sorghum	Air: 1.5 Other: 1.5	.07 / .07 / .05	.01 / .01 / .01	N.A. / 2.1$ / .33*	N.A. / .13* / .02	N.A. / <.01 / <.01
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	.06 / .06 / .04	.01 / .01 / 0	N.A. / 1.8$ / .28*	N.A. / .11* / .02	N.A. / <.01 / <.01
53. Gooseberry	Air: 16 Other: 16	.90$ / .89$ / .58$	.10* / .10 / .06	N.A. / 26$ / 4.0$	N.A. / 1.6$ / .25*	N.A. / .03 / .02
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	.23* / .22* / .15*	.03 / .02 / .02	N.A. / 6.4$ / 1.0$	N.A. / .40* / .06	N.A. / .01 / .01
55. Blueberry	Air: 2.5 Other: 2.5	.17* / .17* / .11*	.02 / .02 / .01	N.A. / 4.9$ / .76$	N.A. / .31* / .05	N.A. / .01 / <.01
56. Caneberries and Currant	Air: 2 Other: 2	.11* / .11* / .07	.01 / .01 / .01	N.A. / 3.2$ / .50*	N.A. / .20* / .03	N.A. / <.01 / <.01
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	.04 / .04 / .03	<.01 / <.01 / <.01	N.A. / 1.3$ / .20*	N.A. / .08 / .01	N.A. / <.01 / <.01
58. Mint and Spearmint	Air: 1 Other: 1	.05 / .05 / .03	.01 / .01 / <.01	N.A. / 1.4$ / .22*	N.A. / .09 / .01	N.A. / <.01 / <.01
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	.08 / .08 / .05	.01 / .01 / .01	N.A. / 2.2$ / .34*	N.A. / .14* / .02	N.A. / <.01 / <.01
61. Water Cress	Air: 2 Other: 2	.13* / .13* / .08	.01 / .01 / .01	N.A. / 3.7$ / .57$	N.A. / .23* / .04	N.A. / <.01 / <.01
Non-agricultural Uses						
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	.14* / .13* / .09	.02 / .01 / .01	N.A. / 3.9$ / .61$	N.A. / .24* / .04	N.A. / <.01 / <.01

Scenario Group: Crop/Site	Maximum Application Rates[1] (Lbs. ai/A)	Dose-based Acute RQs for 3 Sizes (Small / Medium / Large) of Terrestrial Phase CRLF				
		Small Insects	Large Insects	Small Herbivore Mammals	Small Insectivore Mammals	Small Terrestrial Phase Amphibian
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	.03 / .03 / .02	<.01 / <.01 / <.01	N.A. / .75$ / .12*	N.A. / .05 / .01	N.A. / <.01 / <.01
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	.14* / .14* / .09	.02 / .02 / .01	N.A. / 4.1$ / .64$	N.A. / .26* / .04	N.A. / <.01 / <.01
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	.03 / .03 / .02 .01 / .01 / <.01	<.01 / <.01 / <.01 <.01 / <.01 / <.01	N.A. / .94$ / .15* N.A. / .21* / .03	N.A. / .06 / .01 N.A. / .01 / <.01	N.A. / <.01 / <.01 N.A. / <.01 / <.01
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	.01 / .01 / .01	<.01 / <.01 / <.01	N.A. / .39* / .06	N.A. / .02 / <.01	N.A. / <.01 / <.01
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	.04 / .04 / .03	<.01 / <.01 / <.01	N.A. / 1.1$ / .18*	N.A. / .07 / .01	N.A. / <.01 / <.01
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	.05 / .05 / .04	.01 / .01 / <.01	N.A. / 1.6$ / .24*	N.A. / .10 / .02	N.A. / <.01 / <.01

[1] “Air” refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. “Other” refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.
* Acute RQ ≥ 0.1 for listed species.
$ Acute RQ ≥ 0.5 for listed and non-listed species.

5.2.2 Indirect Effects via Reduction in Food Items

5.2.2.1 Aquatic Phase Frog- Fish as Prey

The evaluation of acute and chronic risks to freshwater fish (a potential prey of frogs in the aquatic environment) revealed that malathion acute fish RQs exceeded the non-listed species acute LOC in 58 of 68 aerial and air-blast application scenarios and 29 of 68 scenarios involving other application methods. In addition, consultation for the RQ table for fish reveals that 50 of the 68 use sites assessed produced RQ values of 1 or greater, suggesting that exposures could produce 50% or greater mortality in sensitive fish populations.

However it must be noted that the endpoint selected for RQ calculation was the most sensitive acute endpoint for the tested species rainbow trout) and other higher endpoints were available for this species as well as a large variety of other fish. If this or other species are not truly affected at levels suggested by the conservative RQ approach, it would be likely that adequate fish prey resources may still be available to a generalist feeder such as the CRLF. A review of the available acute effects data in this assessment reveals that endpoints for other fish are between 5 and 11,000 times less sensitive than the rainbow trout endpoint used in RQ calculations. Because this range reflects a large number of alternative tested species (N=44) additional analysis considering this robust distribution of endpoints was undertaken to see if malathion exposures would produce acute risks of concern for additional species. For every species with one or more 96-h LC_{50} endpoints reported in the effects section of this document, either a measured value or the geometric mean of 2 or more values was assigned. This suite of acute endpoints was then adjusted downward by a factor of 2 to correspond with the Agency non-listed species acute concern level and then compared with the EECs available from acute aquatic residue estimates for all use scenarios. Table 44 presents the results of the comparison, which suggest that the RQ approach employed in the risk assessment may be unduly conservative for many use sites. In most cases only a small percentage of effect endpoints were exceeded by the EECs estimated for malathion use sites. **Assuming that the distribution of tested species endpoints approximates the distribution of sensitivities of fish in CRLF habitats, it is unlikely that substantial number of fish species would be significantly affected by malathion residues in the water (NLAA for CRLF), except for the following uses: pecan and walnuts, avocados, citrus, apricots, gooseberries, rice, watercress, forestry, and mosquito control. Therefore, there appears to be sufficient evidence to support a finding that acute effects are likely to result in significant impairment of fish prey (LAA for CRLF) for the following uses: pecan and walnuts, avocados, citrus, apricots, gooseberries, rice, watercress, forestry, and mosquito control.**

Table 44. Results of Acute Malathion EECs Compared with Distribution of Fish LC_{50} Values Adjusted for Acute Non-Listed Species LOC.

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Peak EEC (µg/L)	Maximum Number of Fish $LC_{50}/2$ Values Exceeded	Percentage of Tested Fish Species Significantly Affected
Agricultural Uses				
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	9.6 5.3	1	2.3
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	52 13	2	4.5
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	43 8.6	8	18
4. Chestnut	Air: 5 Other: 5	16 3.3	2	4.5
5. Almond	Air: 1.25 Other: 4	7.4 13	0	0
6. Date	Air: 1 Other: 2	2.9 1.1	0	0
7. Filbert (Hazelnut)	Air: .625 Other: .625	2.1 .43	0	0
8. Avocado	Air: 9 Other: 9	31 6.1	5	11
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	97 20	12	27
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	8.9 1.8	1	2.3
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	7.9 1.6	0	0
12. Cotton	Air: 4 Other: 4	20 5.2	2	4.5
15. Apricot	Air: 10 Other: 10	34 6.8	6	14
16. Nectarine and Peach	Air: 9 Other: 9	29 5.9	4	9
17. Cherry	Air: 8 Other: 8	29 5.8	4	9
18. Fig	Air: 2.5 Other: 2.5	8.5 1.7	1	2.3
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	4.1 .98	0	0
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	2.8 .56	0	0
21. Papaya	Air: .175 Other: .175	.65 .13	0	0
22. Garlic and Leek	Air: 2 Other: 2	9.9 5.9	1	2.3

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Peak EEC (µg/L)	Maximum Number of Fish $LC_{50}/2$ Values Exceeded	Percentage of Tested Fish Species Significantly Affected
23. Grapes	Air: 2.75 Other: 27.47	9 18	1	2.3
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	9.1 1.8	1	2.3
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	20 14	2	4.5
28. Peppermint	Air: 1 Other: 1	3.6 .73	0	0
29. Eggplant	Air: 3.5 Other: 3.5	12 2.5	1	2.3
30. Pumpkin	Air: 2 Other: 2	6.9 1.4	0	0
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	6.5 1.7	0	0
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	7.9 3.2	0	0
33. Potato - White/Irish	Air: 3 Other: 3	9.8 2	1	2.3
34. Turnip	Air: 2.5 Other: 2.5	8.5 1.7	1	2.3
35. Parsnip and Rutabaga	Air: 2 Other: 2	6.1 1.2	0	0
36. Sweet Potato	Air: 1.875 Other: 1.875	5.9 1.2	0	0
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	8.5 1.7	1	2.3
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	8.9 1.8	1	2.3
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	8.3 1.7	1	2.3
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	6.5 1.3	0	0
43. Celery	Air: 1.5 Other: 1.5	9.5 6.3	1	2.3
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	9 6.9	1	2.3
45. Anise	Air: .9375 Other: .9375	3.3 .67	0	0
46. Strawberry	Air: 2 Other: 2	7.8 1.6	0	0

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Peak EEC (µg/L)	Maximum Number of Fish $LC_{50}/2$ Values Exceeded	Percentage of Tested Fish Species Significantly Affected
47. Sugar Beet	Air: 1.875 Other: 1.875	10 4.8	1	2.3
48. Tomato	Air: 3.5 Other: 3.5	12 2.4	1	2.3
49. Okra	Air: 1.5 Other: 1.5	5.1 1	0	0
51. Sorghum	Air: 1.5 Other: 1.5	4.6 .93	0	0
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	12 8.7	1	2.3
53. Gooseberry	Air: 16 Other: 16	61 12	9	20
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	15 3	2	4.5
55. Blueberry	Air: 2.5 Other: 2.5	11 2.3	1	2.3
56. Caneberries and Currant	Air: 2 Other: 2	7.6 1.5	0	0
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	2.9 .58	0	0
58. Mint and Spearmint	Air: 1 Other: 1	3.4 .68	0	0
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	1404	26	59
61. Water Cress	Air: 2 Other: 2	1797	27	61
Non-agricultural Uses				
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	56 50	9	20
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	539	19	43
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	8.7 1.7	1	2.3
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	15 3	2	4.5
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	.18	0	0
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	3 .59	0	0

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Peak EEC (µg/L)	Maximum Number of Fish LC_{50}/2 Values Exceeded	Percentage of Tested Fish Species Significantly Affected
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	4 .8	0	0

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

The assessment of food supply impacts also extends to chronic risks to aquatic invertebrates. Extrapolated NOAEC values for each acute toxicity endpoint from above can be estimated by dividing by the ACR value of 40.6 as for the RQ calculations. While there is considerable uncertainty in using a uniform ACR for all species, it does allow for an evaluation of the number and percent of tested fish species that would potentially be at reproduction risks when exposed to malathion at EEC levels. Table 45 shows the results of this comparison. In Table 45 use scenarios, a substantial number of tested species could be at reproduction risk. The chronic EECs for another 22 scenarios do not trigger concerns for many species (alfalfa *et al*. almonds, dates, filberts, corn, figs, guava *et al*., papaya, grapes, peppermint, parsnip/rutabaga, sweet potato, bluegrass *et al*., beans, celery, anise, okra, sorghum, passion fruit, mint/spearmint, residential ornamental and lawn, and rights of ways). **For uses other than those listed above, the effects determination is that the labeled uses are likely to adversely affect (LAA) individuals of the species through impairment of the invertebrate food supply through chronic toxic effects (LAA). However, for alfalfa *et al*., almonds, dates, filberts, corn, figs, guava *et al*., papaya, grapes, peppermint, parsnip/rutabaga, sweet potato, bluegrass *et al*., beans, celery, anise, okra, sorghum, passion fruit, mint/spearmint, residential ornamental and lawn, and rights of ways the effects determination is NLAA.**

Table 45. Results of Chronic Malathion EECs Compared with a Distribution of Fish NOAEC Values Adjusted for Acute Non-Listed Species LOC.

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Chronic EEC (µg/L)	Maximum Number of Fish NOAC Values Exceeded	Percentage of Tested Fish Species Significantly Affected
Agricultural Uses				
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	1.4 .58	3	7
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	18 3.8	19	43
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	6.5 1.3	15	34

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Chronic EEC (µg/L)	Maximum Number of Fish NOAC Values Exceeded	Percentage of Tested Fish Species Significantly Affected
4. Chestnut	Air: 5 Other: 5	3.5 .7	9	20
5. Almond	Air: 1.25 Other: 4	1.3 1.9	3	7
6. Date	Air: 1 Other: 2	.52 .21	1	2
7. Filbert (Hazelnut)	Air: .625 Other: .625	.32 .066	0	0
8. Avocado	Air: 9 Other: 9	3.3 .66	9	20
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	17 3.5	19	43
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	3.2 .63	6	14
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	.76 .15	2	5
12. Cotton	Air: 4 Other: 4	12 2.3	19	43
15. Apricot	Air: 10 Other: 10	6.5 1.3	15	34
16. Nectarine and Peach	Air: 9 Other: 9	5.2 1	13	30
17. Cherry	Air: 8 Other: 8	8.1 1.6	17	39
18. Fig	Air: 2.5 Other: 2.5	1 .21	2	5
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	1.7 .41	6	14
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	1.3 .27	3	7
21. Papaya	Air: .175 Other: .175	.31 .063	0	0
22. Garlic and Leek	Air: 2 Other: 2	2 .61	8	18
23. Grapes	Air: 2.75 Other: 27.47	.87 1.7	2	5
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	1.7 .34	6	14
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	3.5 1.5	9	20

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Chronic EEC (µg/L)	Maximum Number of Fish NOAC Values Exceeded	Percentage of Tested Fish Species Significantly Affected
28. Peppermint	Air: 1 Other: 1	.68 .14	2	5
29. Eggplant	Air: 3.5 Other: 3.5	2.6 .61	9	20
30. Pumpkin	Air: 2 Other: 2	1.8 .39	6	14
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	1.8 .4	6	14
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	2.3 .55	8	18
33. Potato - White/Irish	Air: 3 Other: 3	2.4 .48	8	18
34. Turnip	Air: 2.5 Other: 2.5	2.3 .46	8	18
35. Parsnip and Rutabaga	Air: 2 Other: 2	1.3 .26	3	7
36. Sweet Potato	Air: 1.875 Other: 1.875	.61 .13	1	2
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	.77 .16	2	5
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	2.7 .53	9	20
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	2.9 .58	9	20
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	1.1 .22	2	5
43. Celery	Air: 1.5 Other: 1.5	1 .53	2	5
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	3.2 1.2	9	20
45. Anise	Air: .9375 Other: .9375	1.4 .27	3	7
46. Strawberry	Air: 2 Other: 2	2.7 .53	9	20
47. Sugar Beet	Air: 1.875 Other: 1.875	2.3 .69	8	18
48. Tomato	Air: 3.5 Other: 3.5	2.4 .48	8	18
49. Okra	Air: 1.5 Other: 1.5	1.3 .27	3	7
51. Sorghum	Air: 1.5 Other: 1.5	.63 .13	2	5
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	1.8 1.1	6	14

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Chronic EEC (µg/L)	Maximum Number of Fish NOAC Values Exceeded	Percentage of Tested Fish Species Significantly Affected
53. Gooseberry	Air: 16 Other: 16	14 2.7	19	43
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	3.4 .68	9	20
55. Blueberry	Air: 2.5 Other: 2.5	2.1 .42	8	18
56. Caneberries and Currant	Air: 2 Other: 2	1.7 .34	6	14
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	1.3 .25	3	7
58. Mint and Spearmint	Air: 1 Other: 1	.57 .12	1	2
59. Rice and Wild Rice	Air: 1.5625	110	28	64
61. Water Cress	Air: 2	141	32	73
Non-agricultural Uses				
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	6.5 4.7	15	34
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6	42	21	48
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	2 .4	8	18
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	3.7 .61	9	20
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	.096	0	0
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	.62 .12	1	2
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	1.6 .33	6	14

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

5.2.2.2 Aquatic Phase Frog- Invertebrates as Prey

The freshwater invertebrate acute RQ values for all uses are well in excess of the level of concern and orders of magnitude in excess of the median lethal concentration endpoint used in the risk assessment. This would suggest that mortality levels, regardless of the slope of the dose response function for the tested species, are in excess of 50% for this species. Exploration of the available data summarized in the effects section of this document reveals that 79 species of aquatic invertebrates are represented. A distribution of effects endpoints was established and a comparison of these data, adjusted to reflect the non-listed species acute effects concern level (endpoint/2), with acute EECs is summarized in Table 46 in only one use scenario (residential ornamental and lawn) did the acute EEC exceed a small number of tested species acute effects endpoints adjusted to the acute risk LOC. In all other cases substantial percentages of tested species endpoint were exceeded, suggesting that for all these uses (except residential ornamental and lawn) there is likely to be impairment of the invertebrate prey base for the frog.

Table 46. Results of Acute Malathion EECs Compared with Distribution of invertebrate LC_{50} Values Adjusted for Acute Non-Listed Species LOC.

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Peak EEC (µg/L)	Maximum Number of Invertebrate LC_{50}/2 Values Exceeded	Percentage of Tested Invertebrate Species Significantly Affected
Agricultural Uses				
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	9.6 5.3	26	36
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	52 13	50	68
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	43 8.6	49	67
4. Chestnut	Air: 5 Other: 5	16 3.3	32	44
5. Almond	Air: 1.25 Other: 4	7.4 13	26	36
6. Date	Air: 1 Other: 2	2.9 1.1	22	30
7. Filbert (Hazelnut)	Air: .625 Other: .625	2.1 .43	20	27
8. Avocado	Air: 9 Other: 9	31 6.1	43	59
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	97 20	55	75

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Peak EEC (µg/L)	Maximum Number of Invertebrate LC_{50}/2 Values Exceeded	Percentage of Tested Invertebrate Species Significantly Affected
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	8.9 1.8	26	36
11. Corn (Unspecified, Field, Pop, and Sweet) and Millet (Foxtail)	Air: 1.5 Other: 1.5	7.9 1.6	26	36
12. Cotton	Air: 4 Other: 4	20 5.2	34	47
15. Apricot	Air: 10 Other: 10	34 6.8	46	63
16. Nectarine and Peach	Air: 9 Other: 9	29 5.9	43	59
17. Cherry	Air: 8 Other: 8	29 5.8	43	59
18. Fig	Air: 2.5 Other: 2.5	8.5 1.7	26	36
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	4.1 .98	23	32
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	2.8 .56	22	30
21. Papaya	Air: .175 Other: .175	.65 .13	9	12
22. Garlic and Leek	Air: 2 Other: 2	9.9 5.9	26	36
23. Grapes	Air: 2.75 Other: 27.47	9 18	26	36
26. Brussel Sprouts and Dandelion	Air: 2.5 Other: 2.5	9.1 1.8	26	36
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	20 14	34	47
28. Peppermint	Air: 1 Other: 1	3.6 .73	23	32
29. Eggplant	Air: 3.5 Other: 3.5	12 2.5	28	38
30. Pumpkin	Air: 2 Other: 2	6.9 1.4	26	36
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	6.5 1.7	26	36

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Peak EEC (µg/L)	Maximum Number of Invertebrate LC_{50}/2 Values Exceeded	Percentage of Tested Invertebrate Species Significantly Affected
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	7.9 3.2	26	36
33. Potato - White/Irish	Air: 3 Other: 3	9.8 2	26	36
34. Turnip	Air: 2.5 Other: 2.5	8.5 1.7	26	36
35. Parsnip and Rutabaga	Air: 2 Other: 2	6.1 1.2	26	36
36. Sweet Potato	Air: 1.875 Other: 1.875	5.9 1.2	25	34
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	8.5 1.7	26	36
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	8.9 1.8	26	36
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	8.3 1.7	26	36
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	6.5 1.3	26	36
43. Celery	Air: 1.5 Other: 1.5	9.5 6.3	26	36
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	9 6.9	26	36
45. Anise	Air: .9375 Other: .9375	3.3 .67	22	30
46. Strawberry	Air: 2 Other: 2	7.8 1.6	26	36
47. Sugar Beet	Air: 1.875 Other: 1.875	10 4.8	26	36
48. Tomato	Air: 3.5 Other: 3.5	12 2.4	28	38
49. Okra	Air: 1.5 Other: 1.5	5.1 1	25	34
51. Sorghum	Air: 1.5 Other: 1.5	4.6 .93	24	33
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	12 8.7	28	38
53. Gooseberry	Air: 16 Other: 16	61 12	52	71
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	15 3	30	41
55. Blueberry	Air: 2.5 Other: 2.5	11 2.3	26	36
56. Caneberries and Currant	Air: 2 Other: 2	7.6 1.5	26	36
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	2.9 .58	22	30

Scenario Group: Crop/Site	Maximum Malathion Application Rates[1] (Lbs. ai/A)	Peak EEC (µg/L)	Maximum Number of Invertebrate LC_{50}/2 Values Exceeded	Percentage of Tested Invertebrate Species Significantly Affected
58. Mint and Spearmint	Air: 1 Other: 1	3.4 .68	22	30
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	1404	70	96
61. Water Cress	Air: 2 Other: 2	1797	71	97
Non-agricultural Uses				
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	56 50	52	71
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	Air: .6 Other: .6	539	66	90
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	8.7 1.7	26	36
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	15 3	30	41
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	.18	1	1
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	3 .59	22	30
Turf. Golf Course Turf (Bermudagrass)	Air: 1.25 Other: 1.25	4 .8	23	32

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.

[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).

[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

Similar refined analyses could be performed for chronic effects to invertebrates and their implications on prey availability for the frog. However, further refinement was concluded to be unnecessary for the following reasons:

- Chronic effects data distributions would rely on a uniform application of available ACR data and yield less certain results than already observed for acute effects.
- The very high magnitude of chronic risk quotients, up to 7 orders of magnitude in excess of the chronic LOC, suggest that further refinement would not likely alter the existing risk picture considering that the distribution of chronic effects and chronic effects data would be essentially identical to the acute effects distribution, just shifted toward greater sensitivity
- The additional refinement of chronic effect risks would not alter risk concerns given the conclusions reached for acute effects

The effects determination for indirect effects (acute and chronic toxic effects to the invertebrate prey) on the CRLF is that such impairments are likely to adversely affect individuals of the species (LAA).

5.2.3 Indirect Effects via Reduction in Habitat and/or Primary Productivity (Freshwater Aquatic Plants)

The RQ values for aquatic plants only exceed the Agency LOC for listed unicellular algae. This endpoint is commonly used as a lower limit screening tool for those organisms with an obligate relationship with a particular plant species. In the case of the CRLF, no such obligate relationship exists and the non-listed plant LOCs apply. In the case of malathion and maloxon assessment, there are no RQs exceeding the non-listed plant levels of concern. **Consequently, the available information suggests no likely adverse effects (NLAA) on the CRLF stemming from effects on aquatic plants.**

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

No evidence of malathion producing field relevant plant effects at field relevant exposure levels suggests no effects on terrestrial plants associated with labeled uses of malathion and no effects for maloxon as well. **Therefore there are no effects relative to the CRLF.**

5.2.5 Modification to Critical Habitat

Table 47. 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 CRLF.	No effect	Risk of malathion to plants assumed to be negligible with no expected effects on terrestrial vegetation and extremely limited effects on aquatic vegetation that would be pertinent only to obligate animals.

Assessment Endpoint	Effects Determination	Basis
Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLF and their food source.[1]	No effect	Risk of malathion to plants assumed to be negligible based on presumed low phytotoxicity and mode of action.
Alteration of other chemical characteristics necessary for normal growth and viability of CRLF and their food source.	Adverse habitat modification	RQs exceeded for acute and chronic effects for CRLF and prey items (invertebrates, fish, and aquatic phase amphibians).
Reduction and/or modification of aquatic-based food sources (*e.g.,* algae) for pre-metamorphs.	No effect	Aquatic plant effects are only at a level critical for obligate animals, no habitat modification relavent to the generalist CRLF.
Terrestrial Phase PCEs (Upland Habitat and Dispersal Habitat)		
Elimination and/or disturbance of upland habitat; ability of habitat to support food sources of CRLF: 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 provide the CRLF shelter, forage, and predator avoidance	No effect	No effects expected for terrestrial plants.
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.	No effect	No effects expected for terrestrial plants.
Reduction and/or modification of food sources for terrestrial phase juveniles and adults.	Adverse habitat modification	Malathion poses acute and chronic risk to prey items of the CRLF (terrestrial invertebrates, mice, and terrestrial-phase frogs).
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLF and their food sources.	Adverse habitat modification	Malathion poses acute and chronic risk to prey items of the CRLF (terrestrial invertebrates, mice, and terrestrial-phase frogs).

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

When evaluating the significance of this risk assessment's direct/indirect and adverse habitat modification effects determinations, it is important to note that pesticide exposures and predicted risks to the CRLF and its resources (*i.e.*, food and habitat) are not expected to be uniform across the action area or uniform over time. Risks to the CRLF and its resources are expected to decrease with increasing distance away from the treated field or site of application because both spray drift through air and dilution with downstream transport in surface water will cause the pesticide eposure to attenuate with distance.

For sites distant from the site of malathion application, the adverse effects may be intermittent because malathion is not expected to persist in most environments and the conditions that cause it to exceed LOCs (*e.g.*, right wind direction, heavy rain immediately after application, etc.) may occur infrequently. Theses sites may experience long periods of recovery between exposures of sufficient magnitude to cause any adverse effects.

For sites closer to the site of malathion application, adverse conditions would be expected to be more severe, causing mortality to both the CRLF and to the prey items on which the CRLF depends, and more frequent, providing little time to recover before adverse conditions re-occur. Because malathion has many uses and most of those uses would cause adverse effects, it is expected that malathion would cause a larger proportion of sites to experience severe adverse effects at greater frequency than pesticides that have fewer uses and less severe effects. Additionally, because malathion does have so many uses, it is possible that some sites are impacted by multiple uses.

Evaluation of the implication of this non-uniform distribution of risk to the CRLF 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 extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population within the geographical areas where those effects are predicted to occur. Additionally, such population-specific information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individual CRLF.
- *Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase CRLF*. While existing information indicates 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 identify geographical limits to those effect thresholds. This information could be used together with the density data (discussed above) to characterize the likelihood of adverse effects to individual CRLF.
- *Information on population responses of prey base organisms to malathion*. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth, or reproductive impairment of prey base organisms immediately following exposure to malathion. Potentially, more ecologically relevant effects to the prey base (*e.g.*, the degree to which repeated exposure events and inherent demographic characteristics of the prey population limit the extent to which prey resources may recover) can not currently be predicted. An enhanced understanding of long-term prey responses to pesticide exposure would allow for an estimate of the magnitude and duration of resource impairment to be

made. Combining such an estimate with the information described above might provide a more comprehensive prediction of effects to individual frogs and potential modification to critical habitat.

6. *Uncertainties*

Risk assessment, by its very nature, is not exact, and requires the risk assessor to make assumptions regarding a number of parameters, to use data which may or may not accurately reflect the species of concern, and to use models which are a simplified representation of complex ecological processes. In this risk assessment, EFED has attempted to locate the best available data regarding such important parameters as the life history of the CRLF, typical environmental conditions in the proximity of the CRLF's habitat, toxicity of malathion and maloxon, and usage of malathion in the action area. Frequently, such information is better expressed as ranges rather then points, and when this is the case, EFED typically opts to use the end of range which would result in the highest estimate of risk in order to ensure protection of the CRLF and its habitat. These uncertainties, and the directions in which they may bias the risk estimate, are described below.

6.1 *Exposure Assessment Uncertainties*

Typically, the uncertainties inherent in the exposure assessment tend to result in over-estimation of exposures. In many assessments, this is apparent when comparing modeling results with monitoring data. In particular, estimated peak exposures are generally an order of magnitude above 90th percentile site concentrations in non-targeted surface water monitoring data. In general, the monitoring data should be considered a lower bound on exposure, while modeling represents an upper bound. For malathion, however, the comparison of predicted aquatic EECs to targeted and non-targeted monitoring data (Figure 13) indicates the aquatic exposure assessment is not conservative.

6.1.1 Modeling Assumptions

The uncertainties incorporated in the exposure assessment cannot be quantitatively characterized. However, given the available data and the EFED's policy to rely on conservative modeling assumptions, it is typically expected that the modeling results in an over-prediction of exposure. Qualitatively, conservative assumptions which may affect exposure include the following:

- *Modeling for each use site assumes that the entire 10-hectare watershed is taken up by the respective use pattern.* This assumption applies to PRZM/EXAMS modeling (aquatic phase effects) and is likely a *valid* assumption for crops that are grown in large, contiguous tracks or for land uses that cover large, contiguous areas (*e.g.*, forestry, mosquito control in urban areas, etc.). However, it is likely *invalid* for many minor crops that are grown in small plots interspersed with crops on which pesticides other than malathion are used or to which malathion is applied at a different time. For uses where this assumption is valid, this assumption does not result in a conservative assessment (overly protective of the CRLF). The degree of conservatism in this assumption varies indirectly (varies inversely) with the likelihood that the assumption is valid (less validity results in more conservatism).

- *The assessment assumes all applications have occurred concurrently on the same day at the exact same application rate.* This assumption occurs in PRZM/EXAMS modeling and defining the action area (aquatic phase effects). Again, this is likely a *valid* assumption for crops that are grown in large, contiguous tracks and becomes an increasingly conservative assumption as the application areas become smaller, less contiguous, and more heterogeneous in terms of uses.
- *The assessment assumes all applications are at the maximum label rate.* This assumption is addressed in the following section (6.1.2).

6.1.2 Application Rate Uncertainty

This risk assessment focuses on maximum malathion application rates because the EPA approved maximum application rates that appear on malathion labels are the federal actions that are being evaluated in this assessment. However, pesticides are not necessarily applied at the maximum application rates that appear on the current labels. Under those circumstances in which malathion is applied at the maximum rate, the assumption that malathion is applied at the maximum rate would not be conservative. It is only when malathion is applied at lower application rate that the assessment becomes increasingly conservative.

Besides the current labels, there are two additional useful sources of information on malathion application rates. First, the CDPR PUR data set describes how malathion has been applied in the recent past (2001 through 2005) in California. From the CDPR PUR data, average pesticide application rates can be determined for individual crop/sites. The CDPR PUR averages can serve as a lower boundary estimate of the typical application rate. Second, the RED (USEPA 2006) describes maximum application rates that were agreed to be supported by the registrant for malathion, *Cheminova*, and the USDA's inter-regional team #4 (IR-4) for future pesticide labeling for approximately 100 food crop uses. Because this agreement would produce a reduction in intensity of malathion application (lower application rates) from many of the current labels, this agreement likely represents an upper-bound of what future labels will allow. USEPA may require further reductions in malathion application rates than the *Cheminova*/IR-4 agreement, but would be unlikely to issue future labels that allow higher application rates.

Table 48 compares the maximum current label rates, maximum *Cheminova*/IR-4 agreement rate, and average CDPR PUR application rates (averaged annually and across all years). These 3 information sources (current labels, *Cheminova*/IR-4 agreement, and CDPR PUR data) refer to similar uses using dissimilar names. Some professional judgment was necessary to interpret which specific uses in each of these information sources were comparable. Other interpretations are possible (and potentially preferable), but it is assumed that small changes (*e.g.*, interpreting a minor use in one data set as belonging to a different scenario group) would not lead to substantial changes in this comparison. (The "total acres" values provided for the CDPR PUR data refers to the sum of acres treated across all years (2001 – 2005). Care should be taken in interpreting these total acres values. For many crop/sites, the same lands will be treated year after year, while for other crop/sites, different lands may be treated each year.)

Table 48. Comparison of maximum application rates from current labels to the maximum supported *Cheminova* and IR-4 application rates and the average application rates calculated from the 2001-2005 CDPR PUR data for each crop/site grouping (all application rates in lbs ai/A).

Maximum Current Label Rates		Cheminova/IR-4 Agreement		CaPUR						
					Average Lbs. ai/A					
Group Crop/Site	Maximum Lbs. ai/A[1]	Crop/Site	Max. Lbs. ai/A	Crop/Site	2001	2002	2003	2004	2005	All Years (Total Acres)
Agricultural Uses										
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Air: 2 Other: 2	**G2(14D)** Alfalfa, Clover, Lespedeza, Lupine and Vetch	1.25	Alfalfa Clover	1.23 1.53	1.34 N.A.	1.24 N.A.	1.27 3.91	1.18 N.A.	1.26 (477,150) 1.90 (195)
2. Macadamia Nut (Bushnut)	Air: 15 Other: 15	**E7(7D)** Macadamia	.94	N.A.						
3. Pecan and Walnut (English/Black)	Air: 12.5 Other: 12.5	**L3(7D)** Mustards, Walnuts, and Pecans	2.5	Pecan Walnut (English/Black)	N.A. 3.72	.94 3.43	N.A. 3.96	6.22 3.89	9.69 4.22	7.43 (31.1) 3.80 (36,938)
4. Chestnut	Air: 5 Other: 5	**P4(7D)** Chestnuts	5	N.A.						
5. Almond	Air: 1.25 Other: 4	N.A.		Almond	1.60	6.13	1.80	N.A.	N.A.	1.92 (187)
6. Date	Air: 1 Other: 2	N.A.		Date	2.81	2.79	2.78	2.48	2.72	2.72 (17,008)
7. Filbert (Hazelnut)	Air: .625 Other: .625	N.A.		N.A.						
8. Avocado	Air: 9 Other: 9	**O2(30D)** Avocado	6.25	Avocado	7.99	.14	.16	.33	3.54	.19 (42,945)
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Air: 25 Other: 25	**A10** Orange, Grapefruit, Lemon, Lime, Tangerine, Tangelo, and Kumquat **Q3(30D)** Oranges, Grapefruit, Lemon, Lime, Tangerine and Tangelo	.175 6.25	Citrus Grapefruit Kumquat Lemon Lime Orange Tangelo Tangerine	1.84 6.93 N.A. 29.61 N.A. 3.18 9.80 16.95	3.17 2.37 N.A. 38.26 N.A. 1.92 9.98 5.37	1.79 .14 .07 1.72 .12 .99 3.61 8.62	1.05 .38 N.A. 23.65 N.A. 1.11 5.18 3.93	1.24 4.47 N.A. 2.30 11.52 2.02 .43 7.10	2.18 (532) .66 (2200) .07 (105) 27.69 (1278) 2.20 (22) 1.66 (44,081) 4.85 (295) 7.72 (1673)

Maximum Current Label Rates		Cheminova/IR-4 Agreement		CaPUR						
					Average Lbs. ai/A					
Group Crop/Site	Maximum Lbs. ai/A[1]	Crop/Site	Max. Lbs. ai/A	Crop/Site	2001	2002	2003	2004	2005	All Years (Total Acres)
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Air: 2.5 Other: 2.5	**G2(7D)** Brussel sprouts, cauliflower, collards, kale, kohlrabi **G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify **G6(7D)** Cabbage and Cherry (ULV) **L3(7D)** Mustards, Walnuts, and Pecans	1.25 1.25 1.25 2.5	Bok Choy	1.64	1.91	1.94	2.01	1.69	1.83 (1966)
				Broccoli	1.86	1.72	2.03	1.96	1.99	1.94 (16,735)
				Cabbage	1.72	1.62	1.61	1.82	2.02	1.83 (3529)
				Canola (Rape)	1.92	1.92	2.10	2.40	1.78	2.10 (1227)
				Cauliflower	1.86	1.91	1.73	1.83	2.17	1.98 (1824)
				Chinese Cabbage (Nappa)	1.92	2.15	1.94	1.93	1.88	1.98 (8571)
				Chinese Greens	.70	1.02	1.86	2.23	2.20	1.32 (376)
				Collard	1.58	2.48	2.82	2.50	1.72	2.47 (205)
				Gai Choy	N.A.	N.A.	N.A.	1.20	.60	1.08 (5.1)
				Gai Lon	1.85	1.89	2.05	1.85	1.65	1.89 (1232)
				Kale	1.91	1.96	2.00	2.05	2.04	1.99 (2484)
				Kohlrabi	1.40	1.03	1.02	1.11	1.02	1.14 (42.5)
				Mizuna	N.A.	N.A.	N.A.	2.16	N.A.	2.16 (40)
				Mustard	1.59	1.93	2.53	1.57	2.40	2.07 (683)
				Rappini (Broccoli Rabe)	1.92	N.A.	N.A.	2.13	2.01	2.05 (86.6)
				Vegetable	1.96	N.A.	2.00	N.A.	N.A.	1.98 (11.2)
				Leafy Vegetables	1.92	N.A.	N.A.	N.A.	N.A.	1.92 (20)
11. Corn (Unspecified, Field, Pop, and Sweet), and Millet (Foxtail)	Air: 1.5 Other: 1.5	**G2(3D)** Field corn **G3(7D)** Rice, Sorghum, Wheat, Rye, Barley, Oats, and Corn	1.25 1.25	Corn (Forage - Fodder)	1.13	1.10	.97	.86	.89	1.01 (1820)
				Corn, Human Consumption	.68	.84	.84	.89	1.04	.83 (7797)
12. Cotton	Air: 4 Other: 4	**L25(3D)** Cotton	2.5	Cotton	.55	.77	1.90	1.24	1.27	1.03 (19,616)
15. Apricot	Air: 10 Other: 10	**N4(7D)** Apricots	3.75	Apricot	N.A.	4.09	4.09	N.A.	2.73	3.41 (6)
16. Nectarine and Peach	Air: 9 Other: 9	**N4(14D)** Peach and Nectarine	3.75	Nectarine	7.68	3.27	4.93	7.47	5.88	5.04 (72.4)
				Peach	5.64	1.18	1.93	3.84	4.09	3.43 (91.2)
17. Cherry	Air: 8 Other: 8	**N6(7D)** Cherry	3.75	Cherry	2.85	.51	6.45	4.13	6.40	6.19 (432)

Maximum Current Label Rates		Cheminova/IR-4 Agreement		CaPUR						
					Average Lbs. ai/A					
Group Crop/Site	Maximum Lbs. ai/A[1]	Crop/Site	Max. Lbs. ai/A	Crop/Site	2001	2002	2003	2004	2005	All Years (Total Acres)
18. Fig	Air: 2.5 Other: 2.5	**L3(5D)** Figs	2.5	Fig	2.47	1.53	2.06	2.41	N.A.	2.35 (1895)
19. Apple, Pear, and Quince	Air: 1.25 Other: 1.5	**G10(7D)** Pears and Quince **G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify	1.25 1.25	Apple Pear Quince	1.98 19.69 N.A.	.22 16.35 N.A.	.84 N.A. .75	1.08 3.89 N.A.	.73 3.75 N.A.	1.19 (95.3) 4.8 (107.4) .75 (16)
20. Guava, Mango, Plum, and Prune	Air: .75 Other: 1.5	**G12(7D)** Guava and Papaya **G8(7D)** Mango and Passion fruit	1.25 1.25	Mango Plum Prune Tropical/Subtropical Fruit	N.A. 37.01 .39 N.A.	N.A. 1.58 .05 N.A.	.27 N.A. N.A. .11	N.A. N.A. N.A. 2.47	N.A. .30 N.A. N.A.	.27 (30) .5 (21.5) .28 (89) 1.79 (21)
21. Papaya	Air: .175 Other: .175	**G12(7D)** Guava and Papaya	1.25	N.A.						
22. Garlic and Leek	Air: 2 Other: 2	**I5(7D)** Onion, Garlic, Shallot, and Leeks	1.56	Garlic Leek	1.92 1.92	1.57 1.92	1.11 1.75	1.93 1.72	1.82 1.60	1.87 (5329) 1.8 (152.7)
23. Grapes	Air: 2.75 Other: 27.47	**J2(14D)** Grapes	1.88	Grape Wine Grape	1.25 1.57	1.33 1.56	1.62 2.08	2.62 1.73	1.53 1.90	1.55 (4858) 1.67 (10,136)
26. Brussel Sprouts and . Dandelion	Air: 2.5 Other: 2.5	**G2(7D)** Brussel sprouts, cauliflower, collards, kale, and kohlrabi	1.25	Brussel Sprout	.68	1.41	1.51	1.20	2.29	1.17 (78.8)
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Air: 2 Other: 2	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify **J6(5D)** Lettuce **K3(7D)** Spinach, Dandelion, Endive, Parsley, and Swiss Chard	1.25 1.88 2.03	Arrugula Endive (Escarole) Lettuce, Head Lettuce, Leaf Parsley Spinach Swiss Chard	N.A. 1.62 1.78 1.38 1.50 1.58 1.70	1.28 1.52 1.45 1.41 1.02 1.50 1.86	N.A. 1.39 1.54 1.52 2.45 1.48 1.38	1.93 1.39 1.61 1.55 1.42 1.55 1.86	2.04 1.37 1.66 1.68 1.28 1.44 1.47	1.88 (69.1) 1.51 (1670) 1.61 (103,880) 1.48 (57,737) 1.5 (46.9) 1.49 (4228) 1.71 (408.6)

Maximum Current Label Rates		Cheminova/IR-4 Agreement		CaPUR						
Group Crop/Site	Maximum Lbs. ai/A[1]	Crop/Site	Max. Lbs. ai/A	Crop/Site	Average Lbs. ai/A 2001	2002	2003	2004	2005	All Years (Total Acres)
28. Peppermint	Air: 1 Other: 1	**E3(7D)** Peppermint and spearmint	.94	Pepper, Spice	.96	1.02	N.A.	1.45	N.A.	1.24 (71.5)
29. Eggplant	Air: 3.5 Other: 3.5	**M5(5D)** Tomato, Pepper, and Eggplant	3.43	Eggplant	1.16	.94	.77	1.56	2.08	1.55 (110.4)
30. Pumpkin	Air: 2 Other: 2	**F6(7D)** Melons, Watermelon, Pumpkin, and Winter Squash	1.0	Cantaloupe Cucumber Pumpkin	1.23 1.50 1.46	1.14 1.83 1.64	1.20 1.72 .49	1.73 1.65 1.46	1.22 1.88 1.20	1.27 (955) 1.63 (1216) 1.37 (3926)
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Air: 1.875 Other: 1.875	**F6(7D)** Melons, Watermelon, Pumpkin, and Winter Squash **J3(7D)** Cucumber and Chayote	1.0 1.88	Melon Squash Squash, Summer Squash, Winter Squash, Zucchini Watermelon	6.32 1.58 1.57 1.45 1.38 1.44	2.41 1.63 1.65 .19 N.A. 1.60	1.77 1.39 1.49 N.A. N.A. 1.43	3.72 1.58 1.65 2.45 N.A. 1.48	2.04 1.31 1.64 1.54 1.50 1.53	2.54 (33.6) 1.52 (1436) 1.61 (1311) .84 (17.7) 1.4 (110) 1.48 (454.9)
32. Onion (Unspecified and Green), Radish, and Shallot	Air: 2 Other: 2	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify **I5(7D)** Onion, Garlic, Shallot, and Leeks	1.25 1.56	Chive Daikon Onion, Dry Onion, Green Radish Shallot	N.A. .59 1.19 1.77 1.52 N.A.	N.A. N.A. 1.30 1.98 1.72 N.A.	N.A. N.A. 1.74 1.70 1.79 N.A.	1.18 N.A. 1.47 1.97 1.41 N.A.	1.02 N.A. 1.54 2.16 1.92 2.04	1.16 (11) .59 (1.25) 1.49 (15,907) 1.89 (5440) 1.79 (301.4) 2.04 (65.9)
33. Potato - White/Irish	Air: 3 Other: 3	**I2(7D)** Potato and Sweet potato	1.56	Potato	1.25	.98	1.88	2.04	N.A.	1.7 (771)
34. Turnip	Air: 2.5 Other: 2.5	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify	1.25	Turnip	2.04	2.01	2.24	1.48	1.61	1.97 (420.8)
35. Parsnip and Rutabaga	Air: 2 Other: 2	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify	1.25	Parsnip	N.A.	N.A.	1.94	N.A.	N.A.	1.94 (32.32)

Maximum Current Label Rates		Cheminova/IR-4 Agreement		CaPUR						
					Average Lbs. ai/A					
Group Crop/Site	Maximum Lbs. ai/A[1]	Crop/Site	Max. Lbs. ai/A	Crop/Site	2001	2002	2003	2004	2005	All Years (Total Acres)
36. Sweet Potato	Air: 1.875 Other: 1.875	**I2(7D)** Potato and Sweet potato	1.56	Sweet Potato	1.62	9.45	1.54	2.15	1.22	2.15 (288)
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Air: 1.25 Other: 1.25	**G1(3D)** Grass for hay	1.25	Forage Hay/Silage Grass, Seed Pastureland Rangeland Sudangrass	1.39 N.A. .79 .66 N.A.	1.32 N.A. 1.00 N.A. N.A.	1.25 1.19 1.25 1.41 1.19	1.23 N.A. 1.24 N.A. N.A.	1.20 N.A. 1.33 .98 N.A.	1.31 (10,938) 1.19 (58) 1.19 (733) .72 (318) 1.19 (90)
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Air: 2.5 Other: 2.5	**G5(7D)** Beans, Corn, Rice, Sorghum, Wheat, and Rye **L5(7D)** Peas	1.25 2.5	Beet Peas	2.16 .55	2.68 .57	1.78 .97	2.03 1.32	1.53 .69	2.22 (441.4) .85 (8670)
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Air: 2 Other: 2	**G7(7D)** Carrot **K3(7D)** Spinach, Dandelion, Endive, Parsley, and Swiss Chard **M5(5D)** Tomato, Pepper, and Eggplant	1.25 2.03 3.43	Carrot Fennel Fruiting Pepper	1.80 2.04 .99	1.05 N.A. 1.16	1.71 N.A. 1.39	2.00 1.52 1.49	1.67 2.05 1.28	1.78 (5521) 1.81 (86) 1.25 (3637)
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Air: 1.75 Other: 1.75	**C3(7D)** Beans, Corn, Rice, Sorghum, Wheat, and Rye	.61	Dried Bean Succulent Bean Unspecified Bean	1.46 1.07 1.38	.88 1.28 1.46	1.35 1.26 1.40	1.21 1.31 1.50	1.56 1.52 1.46	1.17 (12,043) 1.23 (5378) 1.42 (1247)
43. Celery	Air: 1.5 Other: 1.5	**H2(7D)** Celery	1.5	Celery	1.42	1.41	1.41	1.46	1.50	1.44 (57,200)
44. Asparagus and Safflower (Unspecified)	Air: 1.25 Other: 1.25	**G9(7D)** Asparagus	1.25	Asparagus Safflower	1.12 1.20	1.36 N.A.	1.23 N.A.	1.22 N.A.	1.28 N.A.	1.19 (1052) 1.2 (140)
45. Anise	Air: .9375 Other: .9375	**G7(7D)** Carrot	1.25	N.A.						
46. Strawberry	Air: 2 Other: 2	**E6(6D)** Strawberry **K6(6D)** Strawberry	.94 2.03	Strawberry	1.87	1.84	1.85	1.98	2.08	1.92 (211,559)

Maximum Current Label Rates		Cheminova/IR-4 Agreement		CaPUR						
					Average Lbs. ai/A					
Group Crop/Site	Maximum Lbs. ai/A[1]	Crop/Site	Max. Lbs. ai/A	Crop/Site	2001	2002	2003	2004	2005	All Years (Total Acres)
47. Sugar Beet	Air: 1.875 Other: 1.875	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify	1.25	Sugarbeet (*CDPR PUR data appears to be erroneous*)	0	N.A.	N.A.	N.A.	N.A.	0 (775)
48. Tomato	Air: 3.5 Other: 3.5	**M5(5D)** Tomato, Pepper, and Eggplant	3.43	Tomatillo Tomato Processing Tomato	.61 1.56 1.15	.64 1.28 1.11	.58 .32 1.10	.90 .91 1.22	N.A. 1.70 1.40	.67 (142) .78 (3765) 1.12 (18,094)
49. Okra	Air: 1.5 Other: 1.5	**H6(7D)** Okra	1.5	Okra	N.A.	N.A.	N.A.	N.A.	1.40	1.4 (140)
51. Sorghum	Air: 1.5 Other: 1.5	**G3(7D)** Rice, Sorghum, Wheat, Rye, Barley, Oats, and Corn	1.25	Sorghum (Forage - Fodder) Sorghum/Milo	N.A. N.A.	.03 N.A.	N.A. N.A.	N.A. 1.53	1.47 N.A.	1.28 (188) 1.53 (30.2)
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Air: 1.25 Other: 1.25	**G3(7D)** Rice, Sorghum, Wheat, Rye, Barley, Oats, and Corn	1.25	Barley Oat Oat (Forage - Fodder) Wheat Wheat (Forage - Fodder)	1.09 1.27 1.21 1.03 N.A.	1.04 .87 1.19 1.02 1.25	1.07 .99 1.44 .98 1.00	1.14 1.21 .75 1.03 .96	1.07 1.13 1.20 .99 .97	1.07 (5316) 1.08 (1082) 1.11 (486.9) 1.01 (18,978) 1.05 (1303)
53. Gooseberry	Air: 16 Other: 16	**K4(7D)** Blackberry, Raspberry, Gooseberry, Loganberry, Dewberry, Currant, and Boysenberry	2.03	N.A.						
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Air: 4 Other: 4	**K4(7D)** Blackberry, Raspberry, Gooseberry, Loganberry, Dewberry, Currant, and Boysenberry	2.03	Blackberry Raspberry	3.38 1.23	3.33 1.29	2.78 1.45	3.45 1.81	3.44 1.29	3.26 (2297) 1.42 (8172)
55. Blueberry	Air: 2.5 Other: 2.5	**G4(7D)** Blueberry	1.25	Blueberry	1.47	1.92	2.18	1.00	N.A.	2.16 (325.1)
56. Caneberries and Currant	Air: 2 Other: 2	**K4(7D)** Blackberry, Raspberry, Gooseberry, Loganberry, Dewberry, Currant, and Boysenberry	2.03	N.A.						

Maximum Current Label Rates		Cheminova/IR-4 Agreement		CaPUR						
					Average Lbs. ai/A					
Group Crop/Site	Maximum Lbs. ai/A[1]	Crop/Site	Max. Lbs. ai/A	Crop/Site	2001	2002	2003	2004	2005	All Years (Total Acres)
57. Passion Fruit (Granadilla)	Air: .75 Other: .75	**G8(7D)** Mango and Passion fruit	1.25	N.A.						
58. Mint and Spearmint	Air: 1 Other: 1	**E3(7D)** Peppermint and spearmint	.94	Mint	.87	.88	.99	.94	.90	.95 (1116)
59. Rice and Wild Rice	Air: 1.5625 Other: 1.5625	**G3(7D)** Rice, Sorghum, Wheat, Rye, Barley, Oats, and Corn	1.25	Rice Wild Rice	1.16 1.76	1.23 1.48	1.52 1.48	N.A. 1.09	1.49 1.45	1.31 (1772) 1.45 (3083)
61. Water Cress	Air: 2 Other: 2	**G5(5D)** Watercress	1.25	Watercress	1.08	.97	1.17	1.09	.95	1.07 (1628)
Non-agricultural Uses										
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Air: 3.2 Other: 3.2	Commercial Tree Production	N.A.	Christmas Tree	N.A.	N.A.	2.94	7.47	2.08	3.48 (223)
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/ Stagnant Water	Air: .6 Other: .6	Mosquito Control	N.A.	N.A.						
Nursery. Outdoor Nursery	Air: 2.25[2] Other: 2.25[2]	Ornamental Plant Uses-Nurseries-Homeowner	N.A.	N-Outdoor Flower N-Outdoor Plants In Containers N-Outdoor Transplants	1.74 .99 2.77	1.13 .53 1.87	.63 1.71 1.81	.75 1.88 1.50	1.12 1.75 1.72	1.09 (1311) 1.16 (23,446) 2.23 (1471)

Maximum Current Label Rates		Cheminova/IR-4 Agreement		CaPUR						
Group Crop/Site	Maximum Lbs. ai/A[1]	Crop/Site	Max. Lbs. ai/A	Crop/Site	Average Lbs. ai/A					
					2001	2002	2003	2004	2005	All Years (Total Acres)
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Air: .6119 Other: .1361	Public Health	N.A.	Buildings/Non-Ag Outdoor	*Not reported on a lbs. ai/A basis.*					
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Other: .25[3]	Homeowner Use	N.A.	Landscape Maintenance	N.A.	N.A.	1.28	2.47	.78	1.29 (7.5)
Rights-of-way. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Air: .9281 Other: .9281	Nonagricultural rights of way/fencerows/hedgerows	N.A.	Rights Of Way Uncultivated Ag Uncultivated Non-Ag	N.A. .24 1.81	N.A. N.A. 2.38	N.A. N.A. N.A.	1.24 .59 N.A.	N.A. 1.18 N.A.	1.24 (.62) .6 (102.5) 1.94 (131)
Turf. Golf Course Turf	Air: 1.25 Other: 1.25	Turf Use/Golf Courses/ Commercial Lawn care	N.A.	Bermudagrass	1.06	1.05	1.18	1.32	1.07	1.13 (19,770)

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
[2] Based on CDPR PUR (Nursery Outdoor transplants) data average for 2001 through 2005 (rounded from 2.23 lbs./A).
[3] Assumes 0.1 acres of a ten acre watershed treated at 25 lbs ai/A (citrus) on 10 consecutive weekends (does not assume the same parcels are re-treated each weekend): 25 lbs. ai/A × 0.1acres/10 acre watershed = 0.25 lbs. ai/A.

Table 48 shows that many application rates would be reduced if the maximum application rates proposed under the *Cheminova*/IR-4 agreement were implemented. Similarly, the average CDPR PUR average application rates are much lower than the current maximum label application rates.

To help determine if the risk to the CRLF might be solely due to the conservative assumption that malathion is applied at maximum application rates, Table 49 compares the malathion RQs for acute aquatic invertebrates to estimated RQs for the proposed *Cheminova*/IR-4 agreement application rates. The estimated *Cheminova*/IR-4 RQs ($RQ_{Estimate}$) assume RQs are linear function of application rate:

$$RQ_{Estimate} = RQ_{Model} \frac{AppRate_{Estimate}}{AppRate_{Model}}$$

Where: RQ_{Model} is the RQ derived from the maximum label application rate for a use, $AppRate_{Estimate}$ is the proposed *Cheminova*/IR-4 agreement, and $AppRate_{Model}$ is the maximum label application rate for a use. Although many of the processes modeled by EFED models are nonlinear, the assumption of a linear relationship between application rate and RQ is sufficiently accurate to indicate whether the risks identified in Section 5 are potentially due primarily from assuming malathion is applied at the maximum label rates.

Table 49. Chronic invertebrate risk quotients (RQs) estimated for *Cheminova*/IR-4 supported maximum malathion application rates (agricultural uses only) listed by current label crop/site.

Current Label	Cheminova/IR-4 Agreement	
Crop/Site	**Crop/Site**	**RQ (Estimated)**
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	**G2(14D)** Alfalfa, Clover, Lespedeza, Lupine and Vetch	Air[1]: 88,017# Other: 36,918#
2. Macadamia Nut (Bushnut)	**E7(7D)** Macadamia	Air: 56,499# Other: 13,214#
3. Pecan and Walnut (English/Black)	**L3(7D)** Mustards, Walnuts, and Pecans	Air: 134,662# Other: 27,444#
4. Chestnut	**P4(7D)** Chestnuts	Air: 281,854# Other: 57,323#
5. Almond	N.A.	
6. Date	N.A.	
7. Filbert (Hazelnut)	N.A.	
8. Avocado	**O2(30D)** Avocado	Air: 247,284# Other: 49,460#
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	**A10** Orange, Grapefruit, Lemon, Lime, Tangerine, Tangelo, and Kumquat **Q3(30D)** Oranges, Grapefruit, Lemon, Lime, Tangerine and Tangelo	Air: 12,196# Other: 2,462# Air: 435,577# Other: 87,913#

Current Label	Cheminova/IR-4 Agreement	
Crop/Site	**Crop/Site**	**RQ (Estimated)**
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	**G2(7D)** Brussel sprouts, cauliflower, collards, kale, kohlrabi **G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify **G6(7D)** Cabbage and Cherry (ULV) **L3(7D)** Mustards, Walnuts, and Pecans	Air: 87,221# Other: 17,446# Air: 87,221# Other: 17,446# Air: 87,221# Other: 17,446# Air: 174,442# Other: 34,892#
11. Corn (Unspecified, Field, Pop, and Sweet), and Millet (Foxtail)	**G2(3D)** Field corn **G3(7D)** Rice, Sorghum, Wheat, Rye, Barley, Oats, and Corn	Air: 68,378# Other: 13,679# Air: 68,378# Other: 13,679#
12. Cotton	**L25(3D)** Cotton	Air: 304,784# Other: 60,933#
15. Apricot	**N4(7D)** Apricots	Air: 235,240# Other: 47,061#
16. Nectarine and Peach	**N4(14D)** Peach and Nectarine	Air: 211,939# Other: 42,401#
17. Cherry	**N6(7D)** Cherry	Air: 261,653# Other: 52,358#
18. Fig	**L3(5D)** Figs	Air: 112,254# Other: 22,447#
19. Apple, Pear, and Quince	**G10(7D)** Pears and Quince **G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify	Air: 73,642# Other: 14,726# Air: 73,642# Other: 14,726#
20. Guava, Mango, Plum, and Prune	**G12(7D)** Guava and Papaya **G8(7D)** Mango and Passion fruit	Air: 98,449# Other: 9,845# Air: 98,449# Other: 9,845#
21. Papaya	**G12(7D)** Guava and Papaya	Air: 98,467# Other: 19,691#
22. Garlic and Leek	**I5(7D)** Onion, Garlic, Shallot, and Leeks	Air: 108,810# Other: 41,043#
23. Grapes	**J2(14D)** Grapes	Air: 65,135# Other: 13,026#
26. Brussel Sprouts and . Dandelion	**G2(7D)** Brussel sprouts, cauliflower, collards, kale, and kohlrabi	Air: 83,992# Other: 17,073#
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify **J6(5D)** Lettuce **K3(7D)** Spinach, Dandelion, Endive, Parsley, and Swiss Chard	Air: 162,406# Other: 79,469# Air: 244,259# Other: 119,521# Air: 263,748# Other: 129,057#
28. Peppermint	**E3(7D)** Peppermint and spearmint	Air: 63,533# Other: 12,972#

Current Label	Cheminova/IR-4 Agreement	
Crop/Site	Crop/Site	RQ (Estimated)
29. Eggplant	**M5(5D)** Tomato, Pepper, and Eggplant	Air: 223,289# Other: 45,084#
30. Pumpkin	**F6(7D)** Melons, Watermelon, Pumpkin, and Winter Squash	Air: 62,498# Other: 12,501#
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	**F6(7D)** Melons, Watermelon, Pumpkin, and Winter Squash **J3(7D)** Cucumber and Chayote	Air: 64,841# Other: 13,600# Air: 121,901# Other: 25,568#
32. Onion (Unspecified and Green), Radish, and Shallot	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify **I5(7D)** Onion, Garlic, Shallot, and Leeks	Air: 96,925# Other: 26,007# Air: 120,963# Other: 32,457#
33. Potato - White/Irish	**I2(7D)** Potato and Sweet potato	Air: 81,926# Other: 16,387#
34. Turnip	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify	Air: 76,058# Other: 15,213#
35. Parsnip and Rutabaga	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify	Air: 54,474# Other: 10,897#
36. Sweet Potato	**I2(7D)** Potato and Sweet potato	Air: 55,293# Other: 11,467#
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	**G1(3D)** Grass for hay	Air: 83,827# Other: 17,320#
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	**G5(7D)** Beans, Corn, Rice, Sorghum, Wheat, and Rye **L5(7D)** Peas	Air: 87,158# Other: 17,431# Air: 174,315# Other: 34,863#
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	**G7(7D)** Carrot **K3(7D)** Spinach, Dandelion, Endive, Parsley, and Swiss Chard **M5(5D)** Tomato, Pepper, and Eggplant	Air: 121,077# Other: 24,207# Air: 196,629# Other: 39,312# Air: 332,235# Other: 66,423#
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	**C3(7D)** Beans, Corn, Rice, Sorghum, Wheat, and Rye	Air: 39,793# Other: 7,959#
43. Celery	**H2(7D)** Celery	Air: 109,042# Other: 55,730#
44. Asparagus and Safflower (Unspecified)	**G9(7D)** Asparagus	Air: 162,981# Other: 83,231#
45. Anise	**G7(7D)** Carrot	Air: 86,656# Other: 17,335#

Current Label	Cheminova/IR-4 Agreement	
Crop/Site	**Crop/Site**	**RQ (Estimated)**
46. Strawberry	**E6(6D)** Strawberry **K6(6D)** Strawberry	Air: 83,132# Other: 16,626# Air: 179,530# Other: 35,906#
47. Sugar Beet	**G5(7D)** Turnip, Broccoli, Apple, Sweet Corn, Beet, Horseradish, Parsnip, Radish, Rutabaga, and Salsify	Air: 100,469# Other: 33,146#
48. Tomato	**M5(5D)** Tomato, Pepper, and Eggplant	Air: 215,721# Other: 43,131#
49. Okra	**H6(7D)** Okra	Air: 94,900# Other: 19,043#
51. Sorghum	**G3(7D)** Rice, Sorghum, Wheat, Rye, Barley, Oats, and Corn	Air: 55,343# Other: 11,069#
52. Barley, Cereal Grains, Oats, Rye, and Wheat	**G3(7D)** Rice, Sorghum, Wheat, Rye, Barley, Oats, and Corn	Air: 170,862# Other: 110,385#
53. Gooseberry	**K4(7D)** Blackberry, Raspberry, Gooseberry, Loganberry, Dewberry, Currant, and Boysenberry	Air: 156,242# Other: 31,253#
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	**K4(7D)** Blackberry, Raspberry, Gooseberry, Loganberry, Dewberry, Currant, and Boysenberry	Air: 156,259# Other: 31,248#
55. Blueberry	**G4(7D)** Blueberry	Air: 108,077# Other: 21,650#
56. Caneberries and Currant	**K4(7D)** Blackberry, Raspberry, Gooseberry, Loganberry, Dewberry, Currant, and Boysenberry	Air: 156,259# Other: 31,252#
57. Passion Fruit (Granadilla)	**G8(7D)** Mango and Passion fruit	Air: 107,077# Other: 21,428#
58. Mint and Spearmint	**E3(7D)** Peppermint and spearmint	Air: 54,831# Other: 10,966#
59. Rice and Wild Rice	**G3(7D)** Rice, Sorghum, Wheat, Rye, Barley, Oats, and Corn	Air: Other: 9,640,659#
61. Water Cress	**G5(5D)** Watercress	Air: Other: 9,640,659#

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
Chronic RQ ≥ 1.0 for listed and unlisted species.

All of the *Cheminova*/IR-4 supported maximum malathion application rates produce chronic invertebrate RQs that exceed the LOC of 1 by factors ranging from 2462 to 9,640,659. Therefore, exceedances of the LOC for chronic invertebrate are likely to occur even if the *Cheminova*/IR-4 supported maximum malathion application rates were accepted as the maximum malathion application rates in future malathion labels.

Similar to Table 49, Table 50 presents estimates of the RQs based on the average CDPR PUR application rates. Also similar, all of the average CDPR PUR application rates produce chronic invertebrate RQs that exceed the LOC of 1 by factors ranging from 266 to 13,574,048. Therefore, it appears that the risks identified in this assessment are <u>not</u> solely attributable to the conservatism introduced through modeling based on current label maximum application rates

Table 50. Chronic invertebrate risk quotients (RQs) estimated for the average malathion application rates calculated from the 2001-2005 CDPR PUR data for each CDPR PUR crop/site grouping listed by current label crop/site.

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
Agricultural Uses								
1. Alfalfa, Clover, Lespedeza, Lupine, Trefoil, and Vetch	Alfalfa	Air: Other:	86,609# 36,328#	94,354# 39,576#	87,313# 36,623#	89,425# 37,509#	83,088# 34,851#	88,721# 37,214#
	Clover	Air: Other:	107,733# 45,188#	N.A.	N.A.	275,317# 115,480#	N.A.	133,786# 561,16#
2. Macadamia Nut (Bushnut)	N.A.							
3. Pecan and Walnut (English/Black)	Pecan	Air: Other:	N.A.	50,633# 10,319#	N.A.	335,038# 68,280#	521948# 106372#	400214# 81563#
	Walnut (English/Black)	Air: Other:	200,376# 40,836#	184,756# 37,653#	213,304# 43,471#	209,533# 42,703#	227,309# 46,325#	204,686# 41,715#
4. Chestnut	N.A.							
5. Almond	Almond	Air: Other:	169,822# 76,815#	650,629# 294,299#	191,049# 86,417#	N.A.	N.A.	203,786# 92,178#
6. Date	Date	Air: Other:	101,345# 20,364#	100,623# 20,219#	100,263# 20,146#	89,443# 17,972#	98,099# 19,712#	98,099# 19,712#
7. Filbert (Hazelnut)	N.A.							
8. Avocado	Avocado	Air: Other:	316,127# 63,230#	5539# 1108#	6330# 1266#	13,057# 2612#	140,061# 28,014#	7517# 1504#
9. Citrus, Citrus Hybrids other than Tangelo, Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, and Tangerines	Citrus	Air: Other:	128,234# 25,881#	220,925# 44,589#	124,749# 25,178#	73,177# 14,769#	86,418# 17,442#	151,929# 30,664#
	Grapefruit	Air: Other:	482,968# 97,477#	165,171# 33,336#	9757# 1969#	26,483# 5345#	311,525# 62,875#	45,997# 9284#
	Kumquat	Air: Other:	N.A.	N.A.	4878# 985#	N.A.	N.A.	4878# 985#
	Lemon	Air: Other:	2,063,589# 416,494#	2,666,428# 538,165#	119,871# 24,194#	1,648,223# 332,661#	160,292# 32,352#	1,929,780# 389,488#
	Lime	Air: Other:	N.A.	N.A.	8363# 1688#	N.A.	802,855# 162,040#	153,323# 30,945#
	Orange	Air: Other:	221,622# 44,730#	133,809# 27,007#	68,995# 13,925#	77,358# 15,613#	140,778# 28,413#	115,689# 23,350#

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
	Tangelo	Air: Other:	682,985# 137,847#	695,529# 140,379#	251,589# 50,778#	361,006# 72,862#	29,968# 6048#	338,008# 68,220#
	Tangerine	Air: Other:	1,181,285# 238,419#	374,248# 75,534#	600,748# 121,249#	273,891# 55,279#	494,815# 99,869#	538,025# 108,590#
10. Amaranth - Chinese, Broccoli (Unspecified, Chinese, and Raab), Cabbage (Unspecified and Chinese), Canola\Rape, Cauliflower, Collards, Corn Salad, Dock (Sorrel), Horseradish, Kale, Kohlrabi, Mustard, Mustard Cabbage (Gai Choy/Pak-Choi), and Purslane (Garden and Winter)	Bok Choy	Air: Other:	114,434# 22,889#	133,274# 26,658#	135,367# 27,076#	140,252# 28,053#	117,923# 23,587#	127,692# 25,541#
	Broccoli	Air: Other:	129,785# 25,960#	120,016# 24,006#	141,647# 28,333#	136,763# 27,356#	138,856# 27,774#	135,367# 27,076#
	Cabbage	Air: Other:	120,016# 24,006#	113,039# 22,610#	112,341# 22,471#	126,994# 25,402#	140,949# 28,193#	127,692# 25,541#
	Canola (Rape)	Air: Other:	133,972# 26,797#	133,972# 26,797#	146,532# 29,310#	167,465# 33,497#	124,203# 24,843#	146,532# 29,310#
	Cauliflower	Air: Other:	129,785# 25,960#	133,274# 26,658#	120,714# 24,145#	127,692# 25,541#	151,416# 30,287#	138,158# 27,635#
	Chinese Cabbage (Nappa)	Air: Other:	133,972# 26,797#	150,020# 30,007#	135,367# 27,076#	134,669# 26,937#	131,181# 26,239#	138,158# 27,635#
	Chinese Greens	Air: Other:	48,844# 9770#	71,172# 14,236#	129,785# 25,960#	155,603# 31,124#	153,509# 30,705#	92,106# 18,423#
	Collard	Air: Other:	110,248# 22,052#	173,047# 34,613#	196,771# 39,359#	174,442# 34,892#	120,016# 24,006#	172,349# 34,474#
	Gai Choy	Air: Other:	N.A.	N.A.	N.A.	83,732# 16,748#	41,866# 8374#	75,359# 15,073#
	Gai Lon	Air: Other:	129,087# 25,820#	131,878# 26,379#	143,043# 28,612#	129,087# 25,820#	115,132# 23,029#	131,878# 26,379#
	Kale	Air: Other:	133,274# 26,658#	136,763# 27,356#	139,554# 27,914#	143,043# 28,612#	142,345# 28,472#	138,856# 27,774#
	Kohlrabi	Air: Other:	97,688# 19,540#	71,870# 14,376#	71,172# 14,236#	77,452# 15,492#	71,172# 14,236#	79,546# 15,911#
	Mizuna	Air: Other:	N.A.	N.A.	N.A.	150,718# 30,147#	N.A.	150,718# 30,147#
	Mustard	Air: Other:	110,945# 22,192#	134,669# 26,937#	176,536# 35,311#	109,550# 21,912#	167,465# 33,497#	144,438# 28,891#

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
	Rappini (Broccoli Rabe)	Air: Other:	133,972# 26,797#	N.A.	N.A.	148,625# 29,728#	140,252# 28,053#	143,043# 28,612#
	Vegetable	Air: Other:	136,763# 27,356#	N.A.	139,554# 27,914#	N.A.	N.A.	138,158# 27,635#
	Leafy Vegetables	Air: Other:	133,972# 26,797#	N.A.	N.A.	N.A.	N.A.	133,972# 26,797#
11. Corn (Unspecified, Field, Pop, and Sweet), and Millet (Foxtail)	Corn (Forage - Fodder)	Air: Other:	61,814# 12,365#	60,173# 12,037#	53,061# 10,615#	47,044# 9411#	48,685# 9739#	55,250# 11,052#
	Corn, Human Consumption	Air: Other:	37,198# 7441#	45,950# 9192#	45,950# 9192#	48,685# 9739#	56,891# 11381#	45,403# 9083#
12. Cotton	Cotton	Air: Other:	67,052# 13,405#	93,873# 18,767#	231,636# 46,309#	151,173# 30,223#	154,830# 30,954#	125,571# 25,104#
15. Apricot	Apricot	Air: Other:	N.A.	256,569# 51,328#	256,569# 51,328#	N.A.	171,255# 34,260#	213,912# 42,794#
16. Nectarine and Peach	Nectarine	Air: Other:	434,051# 86,837#	184,811# 36,973#	278,629# 55,743#	422,183# 84,462#	332,321# 66,484#	284,846# 56,986#
	Peach	Air: Other:	318,756# 63,771#	66,690# 13,342#	109,078# 21,822#	217,026# 43,418#	231,155# 46,245#	193,854# 38,782#
17. Cherry	Cherry	Air: Other:	198,856# 39,792#	35,585# 7121#	450,043# 90,055#	288,167# 57,663#	446,554# 89,357#	431,901# 86,425#
18. Fig	Fig	Air: Other:	110,907# 22,178#	68,699# 13,738#	92,497# 18,497#	108,213# 21,639#	N.A.	105,519# 21,100#
19. Apple, Pear, and Quince	Apple	Air: Other:	116,649# 23,326#	12,961# 2592#	49,488# 9896#	63,627# 12,723#	43,007# 8600#	70,107# 14,019#
	Pear	Air: Other:	1,160,014# 231,963#	963,241# 192,616#	N.A.	229,175# 45,827#	220,927# 44,178#	282,786# 56,548#
	Quince	Air: Other:	N.A.	N.A.	44,185# 8836#	N.A.	N.A.	44,185# 8836#
20. Guava, Mango, Plum, and Prune	Mango	Air: Other:	N.A.	N.A.	21,265# 2127#	N.A.	N.A.	21,265# 2127#
	Plum	Air: Other:	2,914,870# 291,496#	124,439# 12,444#	N.A.	N.A.	23,628# 2363#	39,379# 3938#

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
	Prune	Air: Other:	30,716# 3072#	3938# 394#	N.A.	N.A.	N.A.	22,053# 2205#
	Tropical/Subtropical Fruit	Air: Other:	N.A.	N.A.	8663# 866#	194,535# 19,454#	N.A.	140,979# 14,098#
21. Papaya	N.A.							
22. Garlic and Leek	Garlic	Air: Other:	133,920# 50,514#	109,508# 41,306#	77,423# 29,204#	134,618# 50,778#	126,945# 47,884#	130,433# 49,199#
	Leek	Air: Other:	133,920# 50,514#	133,920# 50,514#	122,063# 46,042#	119,970# 45,253#	111,600# 42,095#	125,550# 47,357#
23. Grapes	Grape	Air: Other:	43,308# 8661#	46,079# 9215#	56,127# 11,224#	90,773# 18,153#	53,009# 10,601#	53,702# 10,739#
	Wine Grape	Air: Other:	54,394# 10,878#	54,048# 10,809#	72,064# 14,411#	59,938# 11,986#	65,828# 13,164#	57,859# 11,571#
26. Brussel Sprouts and . Dandelion	Brussel Sprout	Air: Other:	45,692# 9288#	94,743# 19,259#	101,463# 20,625#	80,633# 16,391#	153,874# 31,279#	78,617# 15,981#
27. Swiss Chard, Chervil, Endive (Escarole), Lettuce, Head Lettuce, Leaf Lettuce (Black Seeded Simpson, Salad Bowl, Etc.), Orach (Mountain Spinach), Parsley, Roquette (Arrugula), Salsify, and Spinach	Arrugula	Air: Other:	N.A.	166,304# 81,376#	N.A.	250,755# 122,700#	265,047# 129,693#	244,259# 119,521#
	Endive (Escarole)	Air: Other:	210,479# 102,992#	197,486# 96,634#	180,596# 88,369#	180,596# 88,369#	177,997# 87,098#	196,187# 95,998#
	Lettuce, Head	Air: Other:	231,267# 113,164#	188,391# 92,184#	200,085# 97,906#	209,179# 102,356#	215,676# 105,535#	209,179# 102,356#
	Lettuce, Leaf	Air: Other:	179,297# 87,734#	183,194# 89,641#	197,486# 96,634#	201,384# 98,541#	218,274# 106,806#	192,289# 94,091#
	Parsley	Air: Other:	194,888# 95,363#	132,524# 64,847#	318,316# 155,759#	184,494# 90,277#	166,304# 81,376#	194,888# 95,363#
	Spinach	Air: Other:	205,282# 100,449#	194,888# 953,63#	192,289# 94,091#	201,384# 98,541#	187,092# 91,548#	193,588# 94,727#
	Swiss Chard	Air: Other:	220,873# 108,078#	241,661# 118,250#	179,297# 87,734#	241,661# 118,250#	190,990# 93,455#	222,172# 108,713#
28. Peppermint	Pepper, Spice	Air: Other:	64,885# 13,248#	68,940# 14,076#	N.A.	98,003# 20,009#	N.A.	83,810# 17,112#
29. Eggplant	Eggplant	Air: Other:	75,515# 15,247#	61,193# 12,355#	50,126# 10,121#	10,1554# 20,505#	135,406# 27,339#	100,903# 20,373#

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
30. Pumpkin	Cantaloupe	Air: Other:	76,873# 15,376#	71,248# 14,251#	74,998# 15,001#	108,122# 21,627#	76,248# 15,251#	79,373# 15,876#
	Cucumber	Air: Other:	93,747# 18,752#	114,371# 22,877#	107,497# 21,502#	103,122# 20,627#	117,496# 23,502#	101,872# 20,377#
	Pumpkin	Air: Other:	91,247# 18,252#	102,497# 20,502#	30,624# 6126#	91,247# 18,252#	74,998# 15,001#	85,622# 17,127#
31. Cucumber, Cucurbit Vegetables, Melons - Unspecified, Cantaloupe, Honeydew, Musk, Water, and Winter (Casaba/Crenshaw/Honeydew/Persian), and Squash (All Or Unspecified)	Melon	Air: Other:	409,795# 85,953#	156,267# 32,776#	114,769# 24,072#	241,209# 50,593#	132,276# 27,744#	164,696# 34,545#
	Squash	Air: Other:	102,449# 21,488#	105,691# 22,168#	90,129# 18,904#	102,449# 21,488#	84,942# 17,816#	98,558# 20,672#
	Squash, Summer	Air: Other:	101,800# 21,352#	106,988# 22,440#	96,613# 20,264#	106,988# 22,440#	106,339# 22,304#	104,394# 21,896#
	Squash, Winter	Air: Other:	94,019# 19,720#	12,320# 2584#	N.A.	158,861# 33,321#	99,855# 20,944#	54,466# 11,424#
	Squash, Zucchini	Air: Other:	89,481# 18,768#	N.A.	N.A.	N.A.	97,262# 20,400#	90,777# 19,040#
	Watermelon	Air: Other:	93,371# 19,584#	103,746# 21,760#	92,723# 19,448#	95,965# 20,128#	99,207# 20,808#	95,965# 20,128#
32. Onion (Unspecified and Green), Radish, and Shallot	Chive	Air: Other:	N.A.	N.A.	N.A.	91,498# 24,551#	79,091# 21,222#	89,947# 24,135#
	Daikon	Air: Other:	45,749# 12,275#	N.A.	N.A.	N.A.	N.A.	45,749# 12,275#
	Onion, Dry	Air: Other:	92,273# 24,759#	100,803# 27,048#	134,920# 36,202#	113,984# 30,584#	119,412# 32,041#	115,535# 31,001#
	Onion, Green	Air: Other:	137,246# 36,826#	153,530# 41,195#	131,819# 35,370#	152,755# 40,987#	167,487# 44,940#	146,551# 39,323#
	Radish	Air: Other:	117,861# 31,625#	133,369# 35,786#	138,797# 37,242#	109,332# 29,336#	148,878# 39,947#	138,797# 37,242#
	Shallot	Air: Other:	N.A.	N.A.	N.A.	N.A.	158,182# 42,444#	158,182# 42,444#
33. Potato - White/Irish	Potato	Air: Other:	65,646# 13, 131#	51,466# 10,295#	98,731# 19,749#	107,134# 21,429#	N.A.	89,278# 17,858#

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
34. Turnip	Turnip	Air: Other:	124,126# 24,828#	122,301# 24,463#	136,295# 27,262#	90,052# 18,013#	97,962# 19,595#	119,867# 23,976#
35. Parsnip and Rutabaga	Parsnip	Air: Other:	N.A.	N.A.	84,543# 16,912#	N.A.	N.A.	84,543# 16,912#
36. Sweet Potato	Sweet Potato	Air: Other:	57,419# 11,908#	334,947# 69,465#	54,584# 11,320#	76,205# 15,804#	43,242# 8968#	76,205# 15,804#
37. Bluegrass, Canarygrass, Grass Forage/Fodder/Hay, Pastures, Peas (Including Vines), Rangeland, Sudangrass, and Timothy	Forage Hay/Silage	Air: Other:	93,216# 19,260#	88,521# 18,290#	83,827# 17,320#	82,486# 17,043#	80,474# 16,628#	87,851# 18,152#
	Grass, Seed	Air: Other:	N.A.	N.A.	79,803# 16,489#	N.A.	N.A.	79,803# 16,489#
	Pastureland	Air: Other:	52,979# 10,946#	67,062# 13,856#	83,827# 17,320#	83,156# 17,182#	89,192# 18,429#	79,803# 16,489#
	Rangeland	Air: Other:	44,261# 9145#	N.A.	94,557# 19,537#	N.A.	65,720# 13,579#	48,284# 9977#
	Sudangrass	Air: Other:	N.A.	N.A.	79,803# 16,489#	N.A.	N.A.	79,803# 16,489#
40. Beets, Cowpea/Blackeyed Pea, and Peas (Unspecified and Field)	Beet	Air: Other:	150,608# 30,121#	186,866# 37,373#	124,113# 24,822#	141,544# 28,309#	106,681# 21,336#	154,792# 30,958#
	Peas	Air: Other:	38,349# 7670#	39,744# 7949#	67,634# 13,527#	92,039# 18,408#	48,111# 9622#	59,267# 11,853#
41. Carrot (Including Tops), Celtuce, Fennel, and Pepper	Carrot	Air: Other:	174,351# 34,858#	101,705# 20,334#	165,633# 33,115#	193,723# 38,731#	161,759# 32,340#	172,414# 34,470#
	Fennel	Air: Other:	197,598# 39,505#	N.A.	N.A.	147,230# 29,435#	198,566# 39,699#	175,319# 35,051#
	Fruiting Pepper	Air: Other:	95,893# 19,172#	112,359# 22,464#	134,638# 26,918#	144,324# 28,854#	123,983# 24,788#	121,077# 24,207#
42. Beans, Beans - Dried-Type, Beans - Succulent (Lima), and Beans - Succulent (Snap)	Dried Bean	Air: Other:	952,43# 19,049#	57,407# 11,482#	88,067# 17,614#	78,935# 15,787#	101,767# 20,354#	76,325# 15,265#
	Succulent Bean	Air: Other:	69,802# 13,961#	83,501# 16,700#	82,196# 16,440#	85,458# 17,092#	99,157# 19,832#	80,239# 16,048#
	Unspecified Bean	Air: Other:	90,025# 18,005#	95,243# 19,049#	91,329# 18,266#	97,853# 19,571#	95,243# 19,049#	92,634# 18,527#

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
43. Celery	Celery	Air: Other:	103,227# 52,758#	102,500# 52,387#	102,500# 52,387#	106,135# 54,244#	109,042# 55,730#	104,681# 53,501#
44. Asparagus and Safflower (Unspecified)	Asparagus	Air: Other:	146,031# 74,575#	177,323# 90,555#	160,373# 81,899#	159,069# 81,233#	166,892# 85,228#	155,158# 79,236#
	Safflower	Air: Other:	156,462# 79,902#	N.A.	N.A.	N.A.	N.A.	156,462# 79,902#
45. Anise	N.A.							
46. Strawberry	Strawberry	Air: Other:	165,380# 33,076#	162,727# 32,545#	163,611# 32,722#	175,108# 35,022#	183,952# 36,790#	169,802# 33,960#
47. Sugar Beet	Sugarbeet (*CDPR PUR data appears to be erroneous*)							
48. Tomato	Tomatillo	Air: Other:	38,364# 7671#	40,251# 8048#	36,478# 7293#	56,603# 11,317#	N.A.	42,138# 8425#
	Tomato	Air: Other:	98,112# 19,617#	80,502# 16,096#	20,126# 4024#	57,232# 11,443#	106,917# 21,377#	49,056# 9808#
	Processing Tomato	Air: Other:	72,326# 14,461#	69,810# 13,958#	69,182# 13,832#	76,729# 15,341#	88,049# 17,605#	70,439# 14,084#
49. Okra	Okra	Air: Other:	N.A.	N.A.	N.A.	N.A.	88,573# 17,774#	88,573# 17,774#
51. Sorghum	Sorghum (Forage - Fodder)	Air: Other:	N.A.	1328# 266#	N.A.	N.A.	65,083# 13,017#	56,671# 11,334#
	Sorghum/Milo	Air: Other:	N.A.	N.A.	N.A.	67,740# 13,548#	N.A.	67,740# 13,548#
52. Barley, Cereal Grains, Oats, Rye, and Wheat	Barley	Air: Other:	148,991# 96,255#	142,157# 91,840#	146,257# 94,489#	155,826# 100,671#	146,257# 94,489#	146,257# 94,489#
	Oat	Air: Other:	173,595# 112,151#	118,920# 76,828#	135,322# 87,425#	165,394# 106,852#	154,459# 99,788#	147,624# 95,372#
	Oat (Forage - Fodder)	Air: Other:	165,394# 106,852#	162,660# 105,086#	196,832# 127,163#	102,517# 66,231#	164,027# 105,969#	151,725# 98,022#
	Wheat	Air: Other:	140,790# 90,957#	139,423# 90,074#	133,955# 86,542#	140,790# 90,957#	135,322# 87,425#	138,056# 89,191#
	Wheat (Forage - Fodder)	Air: Other:	N.A.	170,862# 110,385#	136,689# 88,308#	131,222# 84,775#	132,589# 85,658#	143,524# 92,723#
53. Gooseberry	N.A.							

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
54. Blackberry, Boysenberry, Dewberry, Loganberry, and Raspberry (Black - Red)	Blackberry	Air: Other:	260,176# 52,029#	256,327# 51,260#	213,991# 42,793#	265,564# 53,107#	264,794# 52,953#	250,939# 50,182#
	Raspberry	Air: Other:	94,679# 18,934#	99,298# 19,857#	111,614# 22,320#	139,325# 27,862#	99,298# 19,857#	109,305# 21,858#
55. Blueberry	Blueberry	Air: Other:	127098# 25460#	166006# 33254#	188486# 37758#	86462# 17320#	N.A.	186,757# 37,411#
56. Caneberries and Currant	N.A.							
57. Passion Fruit (Granadilla)	N.A.							
58. Mint and Spearmint	Mint	Air: Other:	50,748# 10,150#	51,331# 10,266#	57,747# 11,549#	54,831# 10,966#	52,498# 10,500#	55,414# 11,083#
59. Rice and Wild Rice	Rice	Air: Other:	8,946,531#	9,486,408#	11,723,041#	N.A.	11,491,665#	10,103,410#
	Wild Rice	Air: Other:	13,574,048#	11,414,540#	11,414,540#	8,406,655#	11,183,164#	11,183,164#
61. Water Cress	Watercress	Air: Other:	8,329,529#	7,481,151#	9,023,657#	8,406,655#	7,326,901#	8,252,404#
Non-agricultural Uses								
Forestry. Christmas Tree Plantations, Pine (Seed Orchard), and Slash Pine (Forest)	Christmas Tree	Air: Other:	N.A.	N.A.	513,087# 428,742#	1,303,659# 1,089,354#	363,000# 303,328#	607,327# 507,490#
Mosquito Control. Intermittently Flooded Areas/Water, Lakes/Ponds/Reservoirs (with Human or Wildlife Use), Lakes/Ponds/Reservoirs (without Human or Wildlife Use), Polluted Water, and Swamps/Marshes/Wetlands/Stagnant Water	N.A.							
Nursery. Outdoor Nursery	N-Outdoor Flower	Air: Other:	135,669# 27,242#	88,107# 17,692#	49,122# 9863#	58,478# 11,742#	87,327# 17,535#	84,988# 17,065#
	N-Outdoor Plants In Containers	Air: Other:	77,191# 15,500#	41,325# 8298#	133,330# 26,772#	146,585# 29,434#	136,449# 27,398#	90,446# 18,161#

Maximum Current Label Rates	CaPUR							
Group Crop/Site	Crop/Site	RQ (Estimated)						
		Method[1]	2001	2002	2003	2004	2005	All Years
	N-Outdoor Transplants	Air: Other:	215,980# 43,368#	145,806# 29,277#	141,127# 28,338#	116,956# 23,484#	134,110# 26,929#	173,875# 34,913#
Public Health and Medfly Control. Nonagricultural Areas (Public Health Use), Urban Areas, and Wide Area/General Outdoor Treatment (Public Health Use)	Buildings/Non-Ag Outdoor	*Not reported on a lbs. ai/A basis.*						
Residential. Household/Domestic Dwellings Outdoor Premises, Ornamental and/or Shade Trees, Ornamental Herbaceous Plants, Ornamental Lawns and Turf, Ornamental Non-flowering Plants, Ornamental Woody Shrubs and Vines, and Urban Areas	Landscape Maintenance	Other:	N.A.	N.A.	19,224#	37,097#	11,715#	19,374#
Right-of-ways. Nonagricultural Rights-of-way/Fencerows/Hedgerows and Nonagricultural Uncultivated Areas/Soils	Rights Of Way	Air: Other:	N.A.	N.A.	N.A.	63,555# 12,715#	N.A.	63,555# 12,715#
	Uncultivated Ag	Air: Other:	12,301# 2461#	N.A.	N.A.	30,240# 6050#	60,480# 12,100#	30,753# 6153#
	Uncultivated Non-Ag	Air: Other:	92,771# 18,560#	121,986# 24,405#	N.A.	N.A.	N.A.	99,434# 19,893#
Turf. Golf Course Turf	Bermudagrass	Air: Other:	58,532# 11,707#	57,979# 11,596#	65,158# 13,032#	72,888# 14,578#	59,084# 11,817#	62,397# 12,480#

[1] "Air" refers to aerial and air-blast application methods for which EFED policy assumes 5% spray drift when estimating environmental concentrations. "Other" refers other application methods for which EFED policy assumes 1% spray drift.
Chronic RQ ≥ 1.0 for listed and unlisted species.

6.1.3 Timing of Malathion Applications

The choice of application dates made for this assessment may bias the assessment results to be less conservative (*i.e.*, less protective of the CRLF). This is because the application time period (the simulated first through last application dates) may cover only a small portion of the time period over which malathion is applied in California (Figure 9) or can be legally applied (*e.g.*, year-round for labels that do not have temporal restrictions). Malathion is applied in every month of the year (Figure 2). Because rain is more frequent in the winter for many of the scenarios while the peak malathion applications tend to occur in the summer, many of the scenarios will generate a much lower runoff contribution to EEC than would happen during other earlier or later times of the year when malathion is being applied to that use (Figure 10).

6.1.4 Impact of Vegetative Setbacks on Runoff

EFED does not currently have an effective tool to evaluate the impact of vegetative setbacks on runoff and pesticide loadings. The effectiveness of such setbacks is highly dependent on the condition of the vegetative strip. A well-established, healthy vegetative setback can be a very effective means of reducing runoff and erosion from agricultural fields and may substantially reduce loading to aquatic ecosystems. However, a setback that is narrow, of poor vegetative quality, or channelized is likely to be ineffective at reducing loadings. The presence and quality of setbacks are site-specific, and may vary widely, even within a small geographic area. EFED does not currently incorporate any “buffer reduction” in its exposure estimates. Until such time as quantitative methods to estimate the effect of vegetative setbacks of various conditions on pesticide loadings become available, EFED’s aquatic exposure predictions are likely to overestimate exposure where healthy vegetative setbacks exist and may underestimate exposure where poorly developed, channelized or no setbacks exist.

6.1.5 PRZM Modeling inputs and Predicted Aquatic Concentrations

EFED currently typically uses the linked PRZM/EXAMS model which produces estimated aquatic concentrations based on site conditions and historical meteorological files (generally 30-year). The “peak” pesticide concentration used in the assessment is probability-based, and is expected to be exceeded once within a ten-year period. PRZM is a process-based "simulation" model, which 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. The two major components are hydrology and chemical transport. Water movement in and off the field is simulated by the use of generalized soil parameters, including field capacity, wilting point, and saturation water content. Soils in each scenario are selected to represent high availability conditions for the pesticide. The chemical transport component simulates the method of pesticide application on the soil or on the plant foliage and the environmental processes acting on the pesticide. 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.

Uncertainty associated with each of these individual components adds to the overall uncertainty of the modeled concentrations. Equations in the model have not been shown to exert any directional bias. Model inputs from the required environmental degradation studies are chosen to represent the upper confidence bound of the mean, and are not expected to be exceeded in the environment 90% of the time. Mobility input values are selected to be representative of conditions in the open environment. Natural variation in soils adds to the uncertainty of modeled values. Factors such as application date, crop emergence date, and canopy cover can affect estimated concentrations. Ambient environmental factors, such as soil temperatures, sunlight intensity, antecedent soil moisture, and surface water temperatures may cause actual aquatic concentrations to differ from the modeled values.

The quality of the analysis is directly related to the quality of the input parameters. Most of the fate data for malathion is complete, however, there is little fate and transport data on toxic impurities and degradates such as maloxon. In addition, the aquatic persistence inputs were derived from studies conducted under alkaline conditions which would be likely to increase degradation rates and reduce the conservatism of this analysis.

Most of the uncertainties described pertain to the runoff and groundwater contributions to the total EECs generated by PRZM/EXAMS. Because EECs for many scenarios in this assessment are dominated by the drift contributions to the total EEC, the PRZM input that likely most impacts this assessment is the spray drift fraction. EFED policy specifies that aerial and air blast methods are modeled with a 5% spray drift fraction, while other application methods are modeled with a 1% spray drift fraction.

Under actual field conditions, the spray drift fraction can be much higher especially with ultra-low volume (ULV) formulations. ULV formulations are highly prone to drift when applied aerially, but are popular with aerial applicators because they are very concentrated and allow the treatment of large acreage without returning to the airfield for refilling or refueling.

An assessment of drift from malathion use was conducted for the Boll Weevil Eradication Program by measuring off-target drift adjacent to aerial ULV malathion applications (Pennsylvania State University 1993).[14] Maximum depositions were 21, 12, 2.8, and 0.7% of the expected maximum at 100, 200, 300, and 1000 m downwind (Pennsylvania State University 1993). The highest amount of drift at 1 km occurred when atmospheric conditions were stable, meaning vertical air mass movements are dampened. Higher drift levels at shorter distances occurred under unstable, windy conditions. Averages of results under different atmospheric conditions show deposition of 9.4% at 100 m while at 1000 m the deposition rate was 0.08%.

[14] Application conditions were the same as those used in the eradication program. The spray system was a conventional boom and nozzle system fitted with Spraying Systems stainless steel 8002 Flat Fan spray tips. The nozzle position was straight down and the flying height was a nominal 5 feet above the crop canopy. Drift was measured from single aircraft passes delivering 1 lb/A. Wind direction was perpendicular to the flight path. Seventeen runs were conducted under varying meteorological conditions.

6.2 Effects Assessment Uncertainties

6.2.1 Age Class and Sensitivity of Effects Thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. For guideline tests, young (and theoretically more sensitive) organisms are used. Testing of juveniles may overestimate toxicity at older age classes for active ingredients of pesticides which act directly (without metabolic transformation) on the organism, because younger age classes often have not developed enzymatic systems associated with the detoxification of xenobiotics. When the available toxicity data provides a range of sensitivity information with respect to age class, the risk assessors use the most sensitive life-stage information as measures of effect.

6.2.2 Extrapolation of Effects

Length of exposure and concurrent environmental stressors (*e.g.,* urban expansion, habitat modification, and predators) will likely affect the response of the CRLF to malathion. Because of the complexity of an organism's response to multiple stressors, the overall "direction" of the response is unknown. Additional environmental stressors may decrease or increase the sensitivity to the herbicide. Timing, peak concentration, and duration of exposure are critical in terms of evaluating effects, and these factors will vary both temporally and spatially within the action area. Overall, the effect of this variability may result in either an overestimation or underestimation of risk.

6.2.3 Acute LOC Assumptions

The risk characterization section of this assessment includes an evaluation of the potential for individual effects. The individual effects probability associated with the acute RQ is based on the assumption that the dose-response curve fits a probit model. It uses the mean estimate of the slope and the LC_{50} to estimate the probability of individual effects.

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