Risks of Phorate Use
to Federally Threatened California Red-legged Frog
(*Rana aurora draytonii*)
to Federally Threatened Valley Elderberry Longhorn Beetle
(*Desmocerus californicus dimorphus*)
to Federally Threatened Bay Checkerspot Butterfly
(*Euphydryas editha bayensis*)
to Federally Endangered San Joaquin Kit Fox
(*Vulpes macrotis mutica*)

Pesticide Effects Determinations

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

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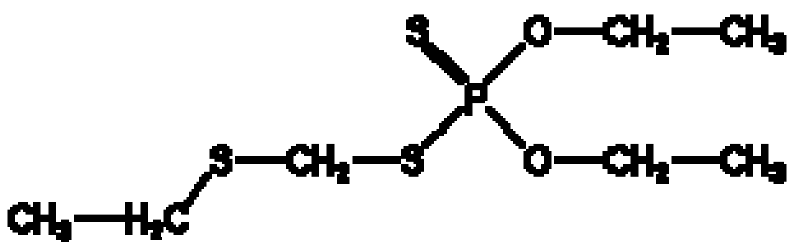

PHORATE CHEMICAL STRUCTURE

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1. Executive Summary

Based on the best available information, the Agency makes a Likely to Adversely Affect (LAA) determination for California red-legged frog (*Rana aurora draytonii*), Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), Bay checkerspot butterfly (*Euphydryas editha bayensis*), and San Joaquin kit fox (*Vulpes macrotis mutica*) from the use of phorate. Additionally, the Agency has determined that there is the potential for modification of designated critical habitat for California red-legged frog (CRLF) and Valley elderberry longhorn beetle (VELB) from the use of the chemical. Include a brief description and summary of the results. A summary of the risk conclusions and effects determinations for each listed species assessed here and their designated critical habitat is presented in Tables 1 and 2. Further information on the results of the effects determination is included as part of the Risk Description in Section 5.2. Given the LAA determination for the CRLF, VELB, BCB, and SJKF and potential modification of designated critical habitat for CRLF and VELB, a description of the baseline status and cumulative effects for the CRLF is provided in **Attachment 2** and the baseline status and cumulative effects for the CRLF, VELB, BCB, and SJKF is provided in **Attachment 4**.

The purpose of this assessment is to evaluate potential direct and indirect effects on the California red-legged frog *(Rana aurora draytonii*) (CRLF), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB), bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB), and San Joaquin kit fox (*Vulpes macrotis mutica*) (SJKF) arising from FIFRA regulatory actions regarding use of Phorate on agricultural sites. In addition, this assessment evaluates whether these actions can be expected to result in modification of designated critical habitat for the CRLF, VELB, and BCB (there is no designated critical habitat for the SJKF). This assessment was completed in accordance with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998 and procedures outlined in the Agency's Overview Document (U.S. EPA, 2004).

- The CRLF was listed as a threatened species by USFWS in 1996. The species is endemic to California and Baja California (Mexico) and inhabits both coastal and interior mountain ranges.
- The BCB was listed as threatened in 1987 by the USFWS. The species primarily inhabits native grasslands on serpentine outcrops around the San Francisco Bay Area in California.
- The SJKF was listed as endangered in 1967 by the USFWS. The species is found in a variety of habitats in the Central Valley area of California.
- The VELB was listed as threatened in 1980 by the USFWS. The species is found in areas with elderberry shrubs throughout California's Central Valley and associated foothills on the east and the watershed of the Central Valley on the west.

Phorate is an organophosphate (OP) pesticide, used primarily for control of leaf-eating insects, mites, and soil insects. Only granular forms of phorate are permitted. Currently, labeled uses of Phorate include Beans, Corn, Sweet Corn, Cotton, Peanut, Potato, Radish, Sorghum, Soybean, Sugarbeet, Sugarcane, Wheat, and Ornamentals. The following uses are considered as part of the federal action evaluated in this assessment, and are permitted uses in the state of California:

- Wheat
- Sugarbeet
- Sorghum
- Potato
- Peanut
- Cotton
- Corn
- Sweet Corn
- Beans
- Ornamentals

Phorate is fairly mobile (K_{OC} of parent and degradates ranging from 50 to 705), somewhat persistent in the terrestrial environment (aerobic soil half-life ranging from 65 to 137 days; anaerobic soil half-life = 32 days) but subject to fairly rapid hydrolysis in water (half-life ≈ 3 days). Phorate photolyzes rapidly in water (half-life ≈ 1 day) if exposed to direct sunlight. Terrestrial field dissipation studies indicate half-lives ranging from 9 to126 days for phorate residues (parent and degradates), which is similar to or greater than what was observed in the laboratory studies. Atmospheric transport (including spray drift and volatilization) is unlikely, as this product is marketed exclusively in granular form. Runoff is another potential mode of off-site transport. Potential environmental impacts considered in this assessment result mainly from terrestrial exposure to granules and aquatic exposure from runoff, and are assessed using terrestrial and aquatic models.

The effects determinations for each listed species assessed are based on a weight-of-evidence method. This method relies heavily on an evaluation of risks to each taxon, relevant to assess both direct and indirect effects to the listed species and the potential for modification of their designated critical habitat (*i.e.*, a taxon-level approach). Since the assessed species exist within aquatic and terrestrial habitats, exposure of the listed species, their prey and their habitats to phorate are assessed separately for the two habitats. Tier-II aquatic exposure models are used to estimate high-end exposures of phorate in aquatic habitats resulting from runoff and spray drift from different uses. One-in-ten-year peak model-estimated environmental concentrations resulting from different phorate uses range from 0.34 to 15.9 µg/L (total phorate residues). These estimates are generally supplemented with analysis of available California surface water monitoring data from the US Geological Survey's National Water Quality Assessment (NAWQA) program and the California Department of Pesticide Regulation (CDPR) if available. However, there have been no detections of phorate or its degradates in either database, or in any additional (national or other) water monitoring datasets.

To estimate direct phorate exposures to terrestrial species the T-REX model is used for granular applications. AgDRIFT and AGDISP models are not appropriate for estimating deposition of phorate on terrestrial or aquatic habitats from spray drift, because all phorate formulations are granular and therefore, atmospheric transport and drift are not expected. In addition, recent label changes (since 2006) allow only soil-incorporated application methods; prior to 2006, product was still being marketed that allowed non-soil-incorporated uses. Therefore, in this document both sets of application methods (soil-incorporated and non-soil-incorporated) are considered because substantial amounts of product containing instructions for non- soil-incorporated are likely still available and in current use. The TerrPlant model is not used for this assessment because there were insufficient plant toxicity data. The T-HERPS model is not used since it can not be used for granular formulations.

The effects determination assessment endpoints for the listed species include direct toxic effects on the survival, reproduction, and growth of the listed species itself, as well as indirect effects, such as reduction of the prey base or modification of its habitat. If appropriate data are not available, toxicity data for birds are generally used as a surrogate for reptiles and terrestrial-phase amphibians and toxicity data from fish are used as a surrogate for aquatic-phase amphibians.

There are two toxic degradates of concern, phorate sulfoxide and phorate sulfone, that are also considered in this assessment. Both degradates appear to form primarily through microbially-mediated metabolism (in soil and water), and systemically within plants. Hydrolysis does not significantly produce these degradates. Parent phorate and the sufoxide and sulfone degradates are considered together in this assessment as "total toxic phorate residues of concern" and are evaluated as such.

Risk quotients (RQs) are derived as quantitative estimates of potential high-end risk. Acute and chronic RQs are compared to the Agency's levels of concern (LOCs) to identify instances where phorate use within the action area has the potential to adversely affect the assessed species and designated critical habitat (if applicable) via direct toxicity or indirectly based on direct effects to its food supply or habitat. When RQs for each particular type of effect are below LOCs, the pesticide is determined to have "no effect" on the listed species being assessed. Where RQs exceed LOCs, a potential to cause adverse effects is identified, leading to a conclusion of "may affect." If a determination is made that use of phorate use "may affect" the listed species being assessed and/or its designated critical habitat, additional information is considered to refine the potential for exposure and effects. Best available information is used to distinguish those actions that "may affect, but are not likely to adversely affect" (NLAA) from those actions that are "likely to adversely affect" (LAA) for each listed species assessed. For designated critical habitat, distinctions are made for actions that are expected to have 'no effect' on a designated critical habitat from those actions that have a potential to result in 'habitat modification'.

Based on the best available information, the Agency makes a Likely to Adversely Affect determination for the CRLF, SJKF, BCB, and VELB from the use of phorate. Additionally, The Agency has determined there is a potential for habitat modification for PCEs of the designated critical habitat for the CRLF and VELB. The Agency has determined there is no habitat modification for PCEs of the designated crticial habitat for the BCB. Critical Habitat has not been designated by the US FWS for the SJKF.

A summary of the risk conclusions and effects determinations for each listed species assessed here and their designated critical habitat is presented in Tables 1 and 2. Further information on the results of the effects determination is included as part of the Risk Description in Section 5.2.

Table 1. Effects Determination Summary for Effects of Phorate on the CRLF, BCB, VELB, and SJKF

Species	Effects Determination [1]	Basis for Determination
California red-legged frog (*Rana aurora draytonii*)	**LAA[1]**	**Potential for Direct Effects** ***Aquatic-phase (Eggs, Larvae, and Adults)***: freshwater fish (as a surrogate to the aquatic-phase amphibian). Listed species LOC (0.05) was exceeded for all uses; chronic LOC (1.0) was exceeded for all uses except peanut (0.1), corn (0.6) , beans (0.6), ornamentals (0.9), and potato (0.4). Potential acute and chronic effects were not considered discountable or insignificant. ***Terrestrial-phase (Juveniles and Adults)***: birds (as a surrogate to the terrestrial-phase frog). Listed species LOC (0.05) was exceeded for all uses; chronic LOC was not calculated. However, with chronic effects (Reduction in number of eggs laid, viable embryos, and normal hatchlings) to birds measured as low 5 ppm, the potential for chronic effects to CRLF can not be ruled out. Potential chronic and acute effect was not considered discountable or insignificant. **Potential for Indirect Effects** ***Aquatic prey items, aquatic habitat, cover and/or primary productivity***: Aquatic invertebrates: RQs exceed acute LOC (0.5) for all uses. RQs exceed Chronic LOC (1.0) for all uses except peanut (0.3). Acute RQs ranged from 0.6 to 26.5 and chronic RQs ranged from 0.3 to 14.2. Potential acute and chronic effects were not considered discountable or insignificant. Fish and frogs: RQs exceed acute LOC (0.5) for all uses except peanut (0.1). Chronic LOC (1.0) was exceeded for all uses, except peanut (0.1), corn (0.6), beans (0.6), ornamentals (0.9), and potato (0.4). Acute RQs ranged from 0.1 to 6.2 and chronic RQs ranged from 0.1 to 3.1. Potential acute and chronic effects were not considered discountable or insignificant. Aquatic Plants: RQs below LOC. ***Terrestrial prey items, riparian habitat*** Birds and frogs: RQs exceed acute LOC (0.5) for all uses. Acute RQs ranged from 11 to 5,580. The potential magnitude of effect could be sufficient to result in potential indirect effects to the CRLF. Chronic LOC was not calculated. However, with chronic effects (Reduction in number of eggs laid, viable embryos, and normal hatchlings) to birds measured as low 5 ppm, the potential for chronic effects to CRLF can not be ruled out. Terrestrial invertebrates: RQs were not calculated for insects due to granular formulation. Phorate is very highly toxic to honey bee (surrogate for insects). Phorate is systemic in plants where insects feeding on plants will be exposed to phorate. Potential risk to insect prey items is expected. Potential acute and chronic effects were not considered discountable or insignificant. Small mammals: RQs exceeded the acute LOC (0.5) for all uses and the RQs ranged from 6 to 778. In addition, phorate is very toxic to small mammals via dermal and inhalation. Chronic RQs are not calculated due to granular formulation. Mammalian reproductive data show phorate to have reproductive

		effects at very low levels of exposure. Potential acute and chronic effects were not considered discountable or insignificant. *Terrestrial plants*: Leaf injury may occur and plant may recover.
Bay checkerspot butterfly (*Euphydryas editha bayensis*)	**LAA**[1]	**Potential for Direct Effects**
		Phorate is highly toxic to insects. Exposure to insects would be through systemic activity of the plants on which they feed. Potential for phorate exposure to BCB is minimal. However, since BCB has metapopulation characteristics, there is some uncertainty of phorate exposure to BCB traveling from one population to another population. The longest distance known for BCB to travel is 7.6 Km. BCB may travel from one population to another and land on a plant that has phorate residues. If such conditions occur, BCB may be adversely impacted.
		Potential for Indirect Effects
		Host plants are not expected to be exposed to phorate.
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	**LAA**[1]	**Potential for Direct Effects**
		Honey bee is surrogate for VELB. Runoff from use sites may move to riparian areas inhabited by host plants. Host plant takes up phorate residues and the VELB could then be exposed. Phorate is considered to be very highly toxic to honey bee and by extension, to the VELB. Due to granular nature of phorate, RQs are not calculated. Potential effect was not considered discountable or insignificant.
		Potential for Indirect Effects
		In the absence of phytotoxicity data, it is assumed that the effects to non-target plants that VELB depend on may potentially have a small reduction in biomass; thereby indirectly having an effect on the listed insect species. Although it appears that the effects to the plants may be insignificant, there is an uncertainty as to the effects of phorate on plants because of a lack of phytotoxicity data. Therefore, VELB may be indirectly affected from reduction in food supply.
San Joaquin kit fox (*Vulpes macrotis mutica*)	**LAA**[1]	**Potential for Direct Effects**
		Rat is surrogate for SJKF. Rat RQs exceeded the acute listed species LOC (0.1) for all uses. RQs ranged from 6 to 778. The listed species LOC is exceeded from 60X to 7780X. In addition, phorate is very toxic to small mammals via dermal and inhalation routes of exposure. Chronic RQs are not calculated due to granular formulation. However, with chronic effects (decreased pup survival and pup body weight) to rats measured as low as 2 ppm, the potential for chronic effects to SJKF can not be ruled out. Potential effect was not considered discountable or insignificant.
		Potential for Indirect Effects
		Reduction in Prey *Birds.* RQs exceed acute LOC (0.5) for all uses. Chronic LOC was not calculated due to granular formulation. Birds are very sensitive to chronic endpoints. If birds survive acute risk, they may still have chronic risk. Acute RQs ranged from 11 to 5,580. The potential magnitude of effect could be sufficient to result in potential indirect effects to the SJKF. *Small mammals*: RQs exceeded the acute LOC (0.5) for all use and the RQs ranged from 6 to 778. In addition, phorate is very toxic to small mammals via dermal and inhalation routes of exposure. Chronic RQs are not calculated due to granular formulation. However, with chronic effects (decreased pup survival and pup body weight) to rats measured as low as 2 ppm, the potential for chronic effects to CRLF can not be ruled out. The potential magnitude of effect could be sufficient to result in potential indirect effects to the SJKF. *Terrestrial insects*: Honey bee is surrogate for insects. Runoff from use sites go

		to plants. Plants take up phorate residues and insects are exposed to phorate. Phorate is considered to be very highly toxic to honey bee and by extension, to insects. Due to granular nature of phorate, RQ are not calculated. Insect prey base may be reduced. Reduction of prey items may result in a potential for indirect effects to the SJKF. *Terrestrial plants*: No RQs are calculated for non-target plants due to lack of plant toxicity data. Plants may take up phorate residues from runoff. SJKF may eat plant items containing phorate residues. SJKF will then have exposure to phorate residues via consumption of plants. The amount of plant items in diet, the toxicity of phorate to mammals, and incidents reported of swift fox mortality from phorate may result in a potential for indirect effects to the SJKF.

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

Table 2 Effects Determination Summary for the Critical Habitat Impact Analysis

Designated Critical Habitat for:	Effects Determination [1]	Basis for Determination
California red-legged frog (*Rana aurora raytonii*)	**HM**[1]	PCE - Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond.
		PCE - Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.
		PCE - Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source. – **Phorate potentially reduces aquatic invertebrate population which is food source for aquatic-phase CRLF.**
		PCE - Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)
		PCE - Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance. **Insects feed off of plant leaves will be exposed to phorate residues from phorate being translocated to plant leaves from runoff to riparian areas. This may potentially reduce insect prey population for CRLF.**
		PCE - 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.
		PCE - Reduction and/or modification of food sources for terrestrial phase juveniles and adults. **Insects feed off of plant leaves will be exposed to phorate residues from phorate being translocated to plant leaves from runoff to riparian areas. This may potentially reduce insect prey population for CRLF.**
		PCE - Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source. **Insects feed off of plant leaves will be exposed to phorate residues from phorate being translocated to plant leaves from runoff to riparian areas. This may potentially reduce insect prey population for CRLF.**
Bay checkerspot butterfly (*Euphydryas editha bayensis*)	**NE**[1]	**There is no exposure to BCB critical habitat from registered use of phorate.**
		PCE - The presence of annual or perennial grasslands with little to no overstory that provide north/south and east/west slopes with a tilt of more than 7 degrees for larval host plant survival during periods of atypical weather (e.g., drought).
		PCE - The presence of the primary larval host plant, dwarf plantain (*Plantago erecta*) (a dicot) and at least one of the secondary host plants, purple owl's-clover or exserted paintbrush, are required for reproduction, feeding, and larval development.
		PCE - The presence of adult nectar sources for feeding.
		PCE - Aquatic features such as wetlands, springs, seeps, streams, lakes, and ponds and their associated banks, that provide moisture during periods of spring drought; these features can be ephemeral, seasonal, or permanent.
		PCE - Soils derived from serpentinite ultramafic rock (Montara, Climara, Henneke, Hentine, and Obispo soil series) or similar soils (Inks, Candlestick, Los Gatos, Fagan, and Barnabe soil series) that provide areas with fewer aggressive, nonnative plant species for larval host plant and adult nectar plant survival and reproduction.[2]
		PCE - The presence of stable holes and cracks in the soil, and surface rock outcrops that provide shelter for the larval stage of the bay checkerspot butterfly during summer diapause.[2]
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	**HM**[1]	PCE - Areas that contain the host plant of this species [*i.e.*, elderberry trees (*Sambucus* sp.)] (a dicot). **The host plants inhabit riparian areas. Runoff from agricultural fields containing phorate may come to these riparian areas. In the absence of phytotoxicity data, it is assumed that the effects to non-target plants that VELB depend on may potentially have a small reduction in biomass; thereby indirectly having an effect on the listed insect species. Although it appears that the effects to the plants may be insignificant, there is an uncertainty as to the effects of phorate on**

		plants because of a lack of phytotoxicity data. Therefore, VELB may be indirectly affected from reduction in food supply.

[1] Habitat Modification (HM) or No effect (NE). These PCEs are in addition to more general requirements for habitat areas that provide essential life cycle needs of the species such as, 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.
[2] PCEs that are abiotic, including, 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.

Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated to determine whether there are reasonable and prudent alternatives and/or measures to reduce and/or eliminate potential incidental take.

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

- Enhanced information on the density and distribution of the different species life stages within specific recovery units and/or designated critical habitat within the action area. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the assessed species.
- Quantitative information on prey base requirements for the assessed species. While existing information provides a preliminary picture of the types of food sources utilized by the assessed species, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.
- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures

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

2. Problem Formulation

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

2.1 Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the federally threatened California red-legged frog *(Rana aurora draytonii*) (CRLF), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB), bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB) and San Joaquin kit fox (*Vulpes macrotis mutica*) (SJKF), arising from FIFRA regulatory actions regarding all registered uses of phorate in California. In addition, this assessment evaluates whether the action is expected to result in modification of designated critical habitat for the CRLF, VELB, and BCB. This ecological risk assessment has been prepared consistent with the settlement agreement in *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 02-1580-JSW(JL)) entered in Federal District Court for the Northern District of California on October 20, 2006. This assessment also addresses three species for which phorate was alleged to be of concern in a separate suit, *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS). The second case referring to the VELB, BCB, and SJKF is the *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS).

In this assessment, direct and indirect effects to the CRLF ,VELB, BCB, and SJKF and potential modification to designated critical habitat for the CRLF, VELB and BCB, are evaluated in accordance with the methods described in the Agency's Overview Document (U.S. EPA 2004). The effects determinations for each listed species assessed is based on a weight-of-evidence method that relies heavily on an evaluation of risks to each taxon relevant to assess both direct and indirect effects to the listed species and the potential for modification of their designated critical habitat (*i.e.*, a taxon-level approach). Screening level methods include use of standard models such as PRZM-EXAMS and T-REX, all of which are described at length in the Overview Document. Use of such information is consistent with the methodology described in the Overview Document (U.S. EPA 2004), which specifies that "the assessment process may, on a case-by-case basis, incorporate additional methods, models, and lines of evidence that EPA finds technically appropriate for risk management objectives" (Section V, page 31 of U.S. EPA 2004).

In accordance with the Overview Document, provisions of the ESA, and the Services' *Endangered Species Consultation Handbook,* the assessment of effects associated with registrations of phorate is based on an action area. The action area is the area directly or indirectly affected by the federal action, as indicated by the exceedance of the Agency's Levels of Concern (LOCs). It is acknowledged that the action area for a national-level FIFRA regulatory decision associated with a use of phorate may potentially involve numerous areas throughout the United States and its Territories. However, for the purposes of this assessment, attention will be focused on relevant sections of the action area including those geographic areas associated with locations of the CRLF, BCB, and VELB and their designated critical habitat within the state of California. As part of the "effects determination," one of the following three conclusions will be reached separately for each of the assessed species in the lawsuits regarding the potential use of Phorate 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 has been designated by the US FWS for the CRLF, VELB, and BCB but has not been designated for the SJKF. Designated critical habitat identifies specific areas that have the physical and biological features, (known as primary constituent elements or PCEs) essential to the conservation of the listed species. The PCEs for CRLFs are aquatic and upland areas where suitable breeding and non-breeding aquatic habitat is located, interspersed with upland foraging and dispersal habitat. The PCEs for BCBs are areas on serpentinite-derived soils that support the primary larval host plant (*i.e*., dwarf plantain) and at least one of the species' secondary host plants. Additional BCB PCE's include the presence of adult nectar sources, aquatic features that provide moisture during the spring drought, and areas that provide adequate shelter during the summer diapause. The PCEs for the VELBs must include areas that contain its host plant (*i.e.,* elderberry trees).

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

If a determination is made that use of phorate "may affect" a listed species or its designated critical habitat, additional information is considered to refine the potential for exposure and for effects to each species and other taxonomic groups upon which these species depend (*e.g,* prey items). Additional information, including spatial analysis (to determine the geographical proximity of the assessed species' habitat and phorate use sites) and further evaluation of the potential impact of phorate on the PCEs is also used to determine whether modification of designated critical habitat may occur. Based on the refined information, the Agency uses the best available information to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that "may affect and are likely to adversely affect" the assessed listed species and/or result in "no effect" or potential modification to the PCEs of its designated critical habitat. This information is presented as part of the Risk Characterization in Section 5 of this document.

The Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Because phorate is expected to directly impact living organisms within the action area (defined in Section 2.7), critical habitat analysis for phorate is limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes (*i.e*., the biological resource requirements for the listed species associated with the critical habitat or important physical aspects of the habitat that may be reasonably influenced through biological processes). Activities that may modify critical habitat are those that alter the PCEs and appreciably diminish the value of the habitat. Evaluation of actions related to use of phorate that may alter the PCEs of the assessed species' critical habitat form the basis of the critical habitat impact analysis. Actions that may affect the assessed species' designated critical habitat have been identified by the Services and are discussed further in Section 2.6.

2.2 Scope

Phorate is an organophosphate insecticide registered for agricultural uses in California on wheat, sugarbeets, sorghum, potato, peanut, cotton, corn, sweet corn, and beans, and for non-agricultural use on ornamentals. Other uses not registered in CA are not considered in this assessment.

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

Although current registrations of phorate allow for use nationwide, this ecological risk assessment and effects determination addresses currently registered uses of phorate in portions of the action area that are reasonably assumed to be biologically relevant to the CRLF and VELB, BCB, and SJKF and their designated critical habitats. Further discussion of the action area for the CRLF and VELB, BCB, and SJKF and their critical habitats is provided in Section 2.7.

- Two degradates of concern, phorate sulfoxide and phorate sulfone, were considered along with parent phorate as "total toxic residues of concern" in this assessment. Insufficient data were available to establish all definitive fate properties for the degradates, so conservative assumptions were made where necessary. The most persistent of the degradates (phorate, sulfoxide, or sulfone) for a given fate parameter was selected to represent total phorate residues. In the absence of information for a specific parameter, the degradate (and thus total residues) was considered stable to degradation.

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).

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

2.3 Previous Assessments

The most recent ecological risk assessment conducted for phorate was for the Reregistration Eligibility Document (RED) completed in 1996. Mitigation required as a result of the findings discussed in this RED included prohibition on aerial applications and a requirement that all uses were to be soil-incorporated Not all phorate labels were in compliance until May 2008. The Cumulative Risk Assessment for organophosphates, including a phorate Drinking Water Assessment, was completed in 2006. The assessment indicated that qualitatively, phorate was designated as highly toxic and capable of being transported off-site. It was determined that phorate labels should include a groundwater advisory (despite absence of detections in targeted groundwater studies), especially in light of the potentially greater mobility of the sulfoxide and sulfone degradates. Additional targeted prospective groundwater (PGW) studies were requested but not received.

A Biological Opinion was provided by the US FWS on January 22, 1982 for phorate. The Biological Opinion was in response to EPA's request for section 7 consultation on the conditional registration of Thimet 20 Granular (Phorate) and its potential effects on Endangered and Threatened species. The reference number is FWS/OES EPA-81-10.

The following statement was made in the Biological Opinion, "Regarding the San Joaquin kit fox, these foxes do not readily adapt to intensive modern agricultural practices as evident from the extirpation of the species from much of its original range. This species is carnivorous, primarily small mammals, although they will eat birds, a few reptiles, and insects. Since the majority of the San Joaquin kit fox population is 1ocated away from irrigated agricultural areas, where Phorate might be used as opposed to dry-land farming, and the use of these irrigated areas by remnant populations of foxes is marginal, the impact of Phorate on the San Joaquin kit fox is expected to be low."

2.4 Stressor Source and Distribution

2.4.1 Environmental Fate Properties

Based on physical/chemical properties, phorate has the potential to be transported off-site to non-target areas. Applied phorate (and degradates) could be available for runoff for several days to weeks post-application (aerobic soil metabolism half-life of 65-137 days; terrestrial field dissipation half-lives ranging from 9-126 days). Parent phorate has reported K_{OC} values of 450, 512, 705, and 505; and K_ds of 1.5, 7.5, 20, and 3.2. There are two toxic degradates of concern: phorate sulfoxide has K_{OC} values ranging from 50-106; phorate sulfone K_{OC}s are 50-138.

The susceptibility of phorate to hydrolysis (half-lives of 2.6, 3.2, and 3.9 days at pHs 5, 7, and 9, respectively), direct photolysis, and aerobic metabolism indicate that phorate will not be very persistent in the water column, even in waters with long hydrological residence times. Phorate appears to have comparable susceptibility to anaerobic metabolism (anaerobic soil metabolism half-life of 32 days) as to aerobic metabolism, although less data are available.

Reported bioconcentration factors (BCFs) for the bluegill sunfish of 326X, 816X, and 483X for edible tissue, non-edible tissue, and the whole fish, respectively indicate that the bioaccumulation potential of phorate is not sufficient to be of concern. The phorate degradates of concern (sulfoxide and sulfone) may be even less apt than parent to bioaccumulate based on Koc values; however, there are no bioaccumulation data available for these degradates.

The major degradates of phorate in terrestrial field dissipation studies were the sulfoxide and sulfone degradates. The extent of vertical movement of those degradates in terrestrial field dissipation studies suggests they may be somewhat more persistent and mobile than parent phorate.

Table 3 lists the environmental fate properties of phorate. **Table 4** gives additional information about the sulfoxide and sulfone degradates.

Table 3 Physical/Chemical Properties of Phorate (Parent Only)

PARAMETER	VALUE	SOURCE(S)
Molecular Weight	260.4	EXTOXNET
Henry's Law Constant	5.8×10^{-6}	EPA-OPP RED 1996
Vapor Pressure (torr)	7.5×10^{-4}	EPA-OPP RED 1996
Solubility (mg/L)	50 / 50	EXTOXNET / EPA-OPP RED 1996
K_{OC}	450 – 705	MRID #42208201
Hydrolysis (days)	pH 5 = 2.6	

PARAMETER	VALUE	SOURCE(S)
	pH 7 = 3.2 pH 9 = 3.9	MRID #41348507
Aerobic Aquatic half-life (days)	2.0	MRID #44863002
Anaerobic Aquatic half-life (days)		No data
Aerobic Soil half-life (days)	82	EXTOXNET
Anaerobic Soil half-life (days)	32	MRID #41936002
Aqueous Photolysis (days)	1.1	MRID #41348508
Field Dissipation half-life (days)	9 – 15 / 48	MRID #40586506 / MRID #42547701

Table 4 Additional Properties of Phorate Sulfoxide and/or Sulfone Degradates

PARAMETER	VALUE	COMMENTS
K_{OC}	50-106 (sulfoxide) 50-138 (sulfone)	MRID #44671204
Aerobic Aquatic half-life (days)	7.5 (sulfoxide) 20.9 (sulfone)	MRID #44863002
Anaerobic Aquatic half-life (days)	- -	No Data
Aerobic Soil half-life (days)	65 (sulfoxide) 137 (sulfone)	MRID #42459401
Field Dissipation half-life (days)	14 – 126 (sufoxide+sulfone)	MRID #42547701

2.4.2 Environmental Transport Mechanisms

Potential transport mechanisms for pesticides may include surface water runoff, spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Phorate is formulated exclusively as granules and is not subject to significant volatility, so long-range atmospheric transport is unlikely. Surface water runoff and non-target deposition of whole granules (especially with non-soil-incorporated application methods) are expected to be the major routes of exposure for phorate.

2.4.3 Mechanism of Action

Phorate is an acetylcholine esterase inhibitor (cholinesterase inhibitor) and is highly toxic to mammals, birds, bees and aquatic species. Phorate is a member of a chemical group called organophosphates.

2.4.4 Use Characterization

Phorate is a soil-incorporated or surface-applied systemic and contact organophosphate insecticide, acaricide, and nematocide registered for use on terrestrial food, ornamental, and feed crops. Phorate is a cholinesterase inhibitor and is highly toxic to mammals, birds, bees and aquatic species. Because of its high toxicity, it is marketed only as a granular product.

Phorate is registered for use in CA on: beans, corn, sweet corn, cotton, peanut, potato, sorghum, sugarbeet, wheat, and ornamentals. Total phorate use in CA is listed by county in **Table 6**. **Table 7** shows the phorate usage data (CDPR PUR, 2002-2005) compiled by Site Name (type of crop or non-crop).

Analysis of labeled use information is the critical first step in evaluating the federal action. The current label for phorate represents the FIFRA regulatory action; therefore, labeled use and application rates specified on the label form the basis of this assessment. The assessment of use information is critical to the development of the action area and selection of appropriate modeling scenarios and inputs. **Table 5** shows phorate label information for California. Subsequent label updates (since May 2008) are not included in this Table; this information was received after the official label information was obtained (March 2008) and could not be fully integrated into this document. Nevertheless, exposure estimates and risks were evaluated exclusively for the more current labels as well (requiring soil-incorporation for all uses). Each crop/non-crop item (Use Site) is assessed in this document; any possible indoor uses are not considered here. All listed application rates pertain to a single crop cycle. Although there may be more than one crop cycle per year in CA for some of these uses, only a single cycle was evaluated. However, the application dates selected for these single cycles were within the annual time frame during which exposures were expected to be highest (so that a relatively protective estimate is given) but consistent with real application dates for these uses. Additional estimates conducted at other times of year resulted in lower exposure values, and would not significantly affect the results of this assessment if added to exposure estimates already presented in this document.

Table 5 Phorate Use Sites and Corresponding Application Rates and Methods

Use Site	Application Equipment Application Type Application Timing	Max. Single Appl. Rate	Registration label	Comments
Ornamental herbaceous plants	Soil incorporation equipment. Soil in-furrow treatment At planting	8 lb ai/A	CA87006900	CA label
Beans	Soil incorporation equipment Soil drill treatment At planting	2.04 lb ai/ A	002749-00521, 005481-00526, 005481-00527, 005481-00530, 009779-00293, 034704-00259	
	Soil incorporation equipment Soil band treatment At planting	1.52 lb ai/A		
	Soil incorporation equipment Soil incorporation Treatment At planting	0.1125 lb ai/1K linear ft		
	Granule applicator equipment Soil sidedress treatment At planting	0.1175 lb ai/1K linear ft		
	Granule applicator Soil drill treatment At planting	2.04 lb ai/A		
	Granule applicator Soil band treatment At planting	1.52 lb ai/A		
Corn	Soil incorporation equipment Soil band or soil incorporated treatment	1.3 lb ai/A	002749-00521, 005481-00526, 005481-00527,	

Use Site	Application Equipment Application Type Application Timing	Max. Single Appl. Rate	Registration label	Comments
	At planting or foliar or tillering		005481-00530, 009779-00293, 034704-00259	
	Soil incorporation equipment Soil band treatment At planting or foliar	0.075 lb ai/ 1K linear ft		
	Granule applicator Soil band treatment At planting or foliar	0.075 lb ai/ 1K linear ft; 1.3 lb ai/A		
	Ground equipment Broadcast At whorl.	1 lb ai/ A		
Sweet Corn	Soil incorporation equipment Soil band treatment At planting or foliar or tillering	0.075 lb ai/ 1K linear ft;	002749-00521, 005481-00526, 005481-00527, 005481-00530, 009779-00293, 034704-00259	
	Soil incorporation equipment Soil band or soil incorporated treatment At planting or foliar or tillering	1.3 lb ai/A		
	Granule applicator Soil band treatment At planting or postplant	0.075 lb ai/ 1K linear ft;		
	Granule applicator Soil band treatment At June	1.3 lb ai/A		
Cotton	Soil incorporation equipment Soil sidedress treatment At post emergence or foliar	2.18 lb ai/A	002749-00521, 005481-00526, 005481-00527, 005481-00530, 009779-00293, 034704-00259	CA label
	Soil incorporation equipment Soil in-furrow treatment At planting	1.64 lb ai/A		
	Soil incorporation equipment Soil in-furrow treatment (hill-drop) At planting	0.33 lb ai/A		
	Granule applicator Soil in-furrow treatment At planting	1.64 lb A 0.1125 lb/1K linear ft		
	Granule applicator Soil sidedress treatment At postplant	0.15 lb/1K linear ft		
	Granule applicator Soil in-furrow treatment (hill-drop) At planting	0.4 lb ai/A		
Peanut	Soil incorporation equipment Soil in-furrow treatment At planting	0.06875 lb/1K linear ft 1.6 lb ai/A	002749-00521, 005481-00526, 005481-00527, 005481-00530, 009779-00293, 034704-00259	
	Granule applicator Soil band treatment At pegging	0.1375 lb/1K linear ft		
	Granule applicator Soil in-furrow treatment At planting	0.0688 lb/1 K linear ft 1.38 lb ai/A		
Potato	Soil incorporation equipment Soil in-furrow or soil band treatment At planting	0.21625 lb/1K linear ft 3.5 lb A	002749-00521, 005481-00526, 005481-00527, 005481-00530, 009779-00293, 034704-00259	
	Soil incorporation equipment Soil incorporation Treatment	0.1413 lb/1K linear ft		

Use Site	Application Equipment Application Type Application Timing	Max. Single Appl. Rate	Registration label	Comments
	At post emergence			
	Granule applicator Soil in-furrow or soil band treatment At planting	0.21625 lb/1K linear ft 3.45 lb A		
	Granule applicator Soil sidedress treatment At post emergence	0.1413 lb/1K linear ft		
Sorghum	Soil incorporation equipment Soil band, soil drill, or soil incorporated treatment At planting or foliar	0.075 lb ai/1K linear ft 1.3125 lb ai/A	002749-00521, 005481-00526, 005481-00527, 005481-00530, 009779-00293, 034704-00259	
	Granule applicator soil band treatment At planting	0.075 lb ai/1K linear ft		
	Granule applicator Soil band or soil drill treatment At planting	1.3 lb ai/A		
	Ground equipment Broadcast At whorl	1.0 lb ai/A		
Sugarbeet	Soil incorporation equipment Soil band or soil drill treatment At planting	0.05625 lb ai/1K linear ft 1.5 lb ai/A	002749-00521, 005481-00526, 005481-00527, 005481-00530, 009779-00293, 034704-00259	
	Soil incorporation equipment Soil drill treatment At post emergence	1.5 lb ai/A		
	Shovel Soil incorporated treatment At post emergence	1.5 lb ai/A		
	Granule applicator Broadcast or soil drill treatment At planting	0.05625 lb ai/1K linear ft		
	Granule applicator Soil band, soil drill, or broadcast treatment At planting	1.5 lb ai/A		
	Ground equipment Broadcast At post emergence	1.5 lb ai/A		
Wheat	Soil in-furrow treatment. Granule applicator At planting	0.015 lb ai/1K linear ft	009779-00293	
	Broadcast. At post emergence	1.0 lb ai/A		

* all application rates are per crop cycle.

The Agency's Biological and Economic Analysis Division (BEAD) provides an analysis of both national- and county-level usage information (Kaul and Jones, 2006) using state-level usage data obtained from USDA-NASS[1], Doane (www.doane.com; the full dataset

[1] 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.

is not provided due to its proprietary nature) and the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[2]. CDPR PUR is considered a more comprehensive source of usage data than USDA-NASS or EPA proprietary databases, and thus the usage data reported for phorate by county in this California-specific assessment were generated using CDPR PUR data. Four years (2002-2005) of usage data were included in this analysis. Data from CDPR PUR were obtained for every pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system. BEAD summarized these data to the county level by site, pesticide, and unit treated. Calculating county-level usage involved summarizing across all applications made within a section and then across all sections within a county for each use site and for each pesticide. The county level usage data that were calculated include: average annual pounds applied, average annual area treated, and average and maximum application rate across four years. The units of area treated are also provided where available.

Table 6 gives a summary of phorate usage for counties in California, based on CDPR PUR data. Fresno county leads the state in terms of average annual pounds of phorate applied (11,000 lbs) for all uses, followed by Riverside county (~10, 000 lbs), San Joaquin and Tulare counties. Alameda and Orange counties show negligible use; no use was reported for Mendocino County. However, if average annual application rates by county (for all uses) are compared, Del Norte county exhibits the highest rates (7 lb/A), followed by Santa Barbara (2.4 lb/A) and San Luis Obispo (2.3 lb/A). **Table 7** displays the CDPR PUR data by Site Name (type of crop or non-crop). Uses with the highest average annual amounts applied in CA are: cotton (27,264 lbs), potato (12,431 lbs), corn (11, 290 lbs), sweet corn (5,746 lbs), sugarbeet (6,613 lbs), and ornamentals (3070 lbs). All other uses combined add up to only 535 lbs per year on average.

Table 6 Phorate Use by County (CA)

County	AVG Annual Pounds Applied	AVG Annual Area Treated (acres)	AVG Application Rate (lb/acre)	95 Percentile Application Rate	99 Percentile Application Rate	MAX Application Rate (lb/acre)
ALAMEDA	0.51	0.00				
COLUSA	40.05	44.10	0.90	1.00	1.00	1.00
CONTRA COSTA	420.39	356.66	1.21	1.72	1.72	1.72
DEL NORTE	3,070.18	433.65	7.14	8.00	8.00	27.88
FRESNO	11,036.76	10,995.71	1.06	1.50	1.60	12.00
GLENN	130.96	126.75	1.05	1.31	1.31	1.31
IMPERIAL	4,066.74	3,178.86	1.36	2.00	3.00	3.20
KERN	5,846.24	3,128.32	1.93	2.40	2.64	5.33
KINGS	6,471.65	6,262.41	1.07	1.38	1.64	12.58
LOS ANGELES	40.25	19.63	2.05	2.05	2.05	2.05
MADERA	673.44	690.81	0.96	1.31	1.35	1.35
MENDOCINO	0.00	0.00				

[2] 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.

MERCED	2,923.10	2,702.24	1.09	1.64	1.82	2.17
MONTEREY	216.07	98.09	2.21	2.00	18.00	18.00
ORANGE	0.01	0.01	2.18	2.18	2.18	2.18
RIVERSIDE	9,687.59	6,368.04	1.39	2.20	3.00	14.01
SACRAMENTO	5,789.15	5,107.50	1.14	1.34	2.35	13.06
SAN BENITO	137.50	126.13	1.07	1.60	1.60	1.64
SAN DIEGO	331.91	182.50	1.82	2.17	2.86	2.86
SAN JOAQUIN	8,443.15	6,594.95	1.18	3.32	3.32	10.84
SAN LUIS OBISPO	64.81	28.13	2.33	2.40	2.40	2.40
SANTA BARBARA	81.00	33.75	2.40	2.40	2.40	2.40
SANTA CLARA	75.30	85.39	0.88	1.60	1.71	1.71
SISKIYOU	18.00	9.00	2.00	2.00	2.00	2.00
STANISLAUS	60.58	89.88	0.69	1.44	1.44	1.44
SUTTER	163.25	127.94	1.31	1.96	1.96	1.96
TULARE	7,355.36	7,449.54	0.98	1.38	1.42	12.02
YOLO	26.16	26.59	0.98	1.01	1.01	1.01

Table 7 Phorate Use by Site Name (CA)

County	Site Name	AVG Annual Pounds Applied	AVG Annual Area Treated (acres)	AVG Application Rate (lb/acre)	95 Percentile Application Rate	99 Percentile Application Rate	MAX Application Rate (lb/acre)
FRESNO	BEAN, DRIED	2.98	2.13	1.40	1.40	1.40	1.40
KERN	BEAN, DRIED	5.27	4.38	1.20	1.20	1.20	1.20
TULARE	BEAN, DRIED	42.98	32.63	1.26	1.44	1.44	1.44
MONTEREY	BEAN, DRIED	49.00	24.50	2.00	2.00	2.00	2.00
SUTTER	BEAN, DRIED	106.37	71.06	1.49	1.96	1.96	1.96
MONTEREY	BEAN, SUCCULENT	155.56	67.78	2.35	2.00	18.00	18.00
MONTEREY	BEAN, UNSPECIFIED	11.50	5.75	2.00	2.00	2.00	2.00
YOLO	CORN (FORAGE - FODDER)	18.41	18.69	0.99	1.01	1.01	1.01
IMPERIAL	CORN (FORAGE - FODDER)	25.41	25.45	0.98	1.30	1.30	1.30
RIVERSIDE	CORN (FORAGE - FODDER)	41.32	31.79	1.30	1.30	1.30	1.30
STANISLAUS	CORN (FORAGE - FODDER)	50.58	79.88	0.67	1.44	1.44	1.44
MADERA	CORN (FORAGE - FODDER)	66.43	50.89	1.30	1.31	1.31	1.31
KERN	CORN (FORAGE - FODDER)	94.38	74.63	1.26	1.31	1.31	1.31
GLENN	CORN (FORAGE - FODDER)	130.96	126.75	1.05	1.31	1.31	1.31
MERCED	CORN (FORAGE - FODDER)	296.67	234.05	1.29	1.31	1.40	1.40
CONTRA COSTA	CORN (FORAGE - FODDER)	381.19	316.66	1.25	1.72	1.72	1.72
TULARE	CORN (FORAGE - FODDER)	492.80	416.38	1.16	1.31	1.38	1.38
FRESNO	CORN (FORAGE - FODDER)	688.84	589.13	1.17	1.31	7.22	7.22
SACRAMENTO	CORN (FORAGE - FODDER)	728.40	618.95	1.14	1.40	1.45	1.52
KINGS	CORN (FORAGE - FODDER)	826.18	683.26	1.23	1.31	4.55	4.55
SAN JOAQUIN	CORN (FORAGE - FODDER)	7,448.76	6,206.70	1.05	1.31	2.14	10.84
KINGS	CORN, HUMAN CONSUMPTION	47.65	46.19	1.03	1.03	1.03	1.03
SANTA CLARA	CORN, HUMAN CONSUMPTION	75.30	85.39	0.88	1.60	1.71	1.71
MERCED	CORN, HUMAN CONSUMPTION	79.44	60.85	1.30	1.31	1.31	1.31

SAN BENITO	CORN, HUMAN CONSUMPTION	137.50	126.13	1.07	1.60	1.60	1.64
MADERA	CORN, HUMAN CONSUMPTION	145.30	114.31	1.28	1.31	1.31	1.31
FRESNO	CORN, HUMAN CONSUMPTION	532.26	499.13	1.17	1.60	1.63	1.63
SACRAMENTO	CORN, HUMAN CONSUMPTION	4,728.13	4,303.31	1.12	1.32	1.46	13.06
COLUSA	COTTON	40.05	44.10	0.90	1.00	1.00	1.00
SUTTER	COTTON	56.88	56.88	1.00	1.00	1.00	1.00
MADERA	COTTON	352.93	424.30	0.83	1.16	1.20	1.20
KERN	COTTON	603.09	689.13	1.01	2.40	2.40	2.40
MERCED	COTTON	1,088.73	1,066.00	1.03	1.64	1.64	1.64
IMPERIAL	COTTON	3,136.27	2,383.66	1.35	1.60	1.62	2.24
RIVERSIDE	COTTON	4,539.04	4,038.33	1.11	1.50	2.00	14.01
FRESNO	COTTON	4,977.23	4,800.04	1.09	1.59	1.60	12.00
KINGS	COTTON	5,535.91	5,476.83	1.05	1.38	1.64	12.58
TULARE	COTTON	6,794.57	6,976.73	0.96	1.38	1.40	12.02
RIVERSIDE	COTTON (FORAGE - FODDER)	139.16	30.13	3.49	12.26	12.26	12.26
MONTEREY	N-GRNHS FLOWER	0.00	0.06	0.07	0.07	0.07	0.07
SAN DIEGO	N-GRNHS PLANTS IN CONTAINERS	0.00	0.13	0.02	0.02	0.02	0.02
DEL NORTE	N-OUTDR TRANSPLANTS	3,070.18	433.65	7.14	8.00	8.00	27.88
ORANGE	POTATO	0.01	0.01	2.18	2.18	2.18	2.18
SISKIYOU	POTATO	18.00	9.00	2.00	2.00	2.00	2.00
LOS ANGELES	POTATO	40.25	19.63	2.05	2.05	2.05	2.05
SAN LUIS OBISPO	POTATO	64.81	28.13	2.33	2.40	2.40	2.40
SANTA BARBARA	POTATO	81.00	33.75	2.40	2.40	2.40	2.40
SACRAMENTO	POTATO	244.46	104.95	2.87	4.48	4.48	4.48
SAN DIEGO	POTATO	315.91	174.38	1.90	2.86	2.86	2.86
IMPERIAL	POTATO	681.74	254.88	2.55	3.17	3.20	3.20
SAN JOAQUIN	POTATO	980.84	367.25	2.55	3.32	3.32	3.32
RIVERSIDE	POTATO	4,883.02	2,230.28	2.15	3.00	3.00	3.00
KERN	POTATO	5,120.51	2,350.19	2.20	2.40	2.65	5.33
TULARE	RESEARCH COMMODITY	0.83	0.56	1.47	1.47	1.47	1.47
SACRAMENTO	SORGHUM/MILO	12.38	8.88	1.39	1.39	1.39	1.39
CONTRA COSTA	SORGHUM/MILO	39.21	40.00	0.98	0.98	0.98	0.98
YOLO	SUGARBEET	7.74	7.90	0.98	0.98	0.98	0.98
KINGS	SUGARBEET	18.63	18.63	1.00	1.00	1.00	1.00
SACRAMENTO	SUGARBEET	53.16	51.71	1.01	1.30	1.30	1.30
MADERA	SUGARBEET	108.78	101.31	1.07	1.35	1.35	1.35
IMPERIAL	SUGARBEET	223.33	514.88	0.43	0.60	1.39	1.39
MERCED	SUGARBEET	1,445.13	1,330.46	1.08	1.76	1.82	2.17
FRESNO	SUGARBEET	4,755.82	5,006.18	1.00	1.50	1.50	1.60
SACRAMENTO	UNCULTIVATED AG	4.23	4.31	0.98	0.98	0.98	0.98
TULARE	UNCULTIVATED NON-AG	0.33	0.13	2.60	2.60	2.60	2.60
SACRAMENTO	WHEAT	3.68	3.38	1.09	1.09	1.09	1.09
FRESNO	WHEAT	15.71	34.25	0.51	0.99	0.99	0.99
KERN	WHEAT	23.00	10.00	2.30	2.30	2.30	2.30
TULARE	WHEAT	23.86	23.13	1.03	1.03	1.03	1.03

KINGS	WHEAT	43.29	37.50	1.15	1.15	1.15	1.15

2.5 Assessed Species

Table 8 provides a summary of the current distribution, habitat requirements, and life history parameters for the listed species being assessed. More detailed life-history and distribution information can be found in **Attachment 1**. See **Figures 1 to 4,** a map of the current range and designated critical habitat, if applicable, of the assessed listed species.

Table 8 Summary of Current Distribution, Habitat Requirements, and Life History Information for the Assessed Listed Species [1]

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
California red-legged frog (*Rana aurora draytonii*)	Adult (85-138 cm in length), Females – 9-238 g, Males – 13-163 g; Juveniles (40-84 cm in length)	Northern CA coast, northern Transverse Ranges, foothills of Sierra Nevada, and in southern CA south of Santa Barbara	Freshwater perennial or near-perennial aquatic habitat with dense vegetation; artificial impoundments; riparian and upland areas	Yes	Breeding: Nov. to Apr. Tadpoles: Dec. to Mar. Young juveniles: Mar. to Sept.	Aquatic-phase[2]: algae (tadpoles only), freshwater aquatic invertebrates and fish Terrestrial-phase: terrestrial invertebrates, small mammals, and frogs
Bay checkerspot butterfly (BCB) (*Euphydryas editha bayensis*)	Adult butterfly - 5 cm in length	Santa Clara and San Mateo Counties [Because the BCB distribution is considered a metapopulation, any site with appropriate habitat in the vicinity of its historic range (Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara counties) should be considered potentially occupied by the butterfly (USFWS 1998, p. II-177)].	1) Primary habitat – native grasslands on large serpentine outcrops; 2) Secondary habitat – 'islands' of smaller serpentine outcrops with native grassland; 3) Tertiary habitat – non-serpentine areas where larval food plants occur	Yes	Larvae hatch in March – May and grow to the 4th instar in about two weeks. The larvae enter into a period of dormancy (diapause) that lasts through the summer. The larvae resume activity with the start of the rainy season. Larvae pupate once they reach a weight of 300 - 500 milligrams. Adults emerge within 15 to 30 days depending on	Obligate with dwarf plantain. Primary diet is dwarf plantain plants (may also feed on purple owl's-clover or exserted paintbrush if the dwarf plantains senesce before the larvae pupate). Adults feed on the nectar of a variety of plants found in association with serpentine grasslands

Table 8 Summary of Current Distribution, Habitat Requirements, and Life History Information for the Assessed Listed Species [1]						
Assessed Species	**Size**	**Current Range**	**Habitat Type**	**Designated Critical Habitat?**	**Reproductive Cycle**	**Diet**
					thermal conditions, feed on nectar, mate and lay eggs during a flight season that lasts 4 to 6 weeks from late February to early May	
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	Males: 1.25–2.5 cm length Females: 1.9–2.5 cm length		Completely dependent on its host plant, elderberry (*Sambucus species*), which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley	Yes	The larval stage may last 2 years living within the stems of an elderberry plant. Then larvae enter the pupae stage and transform into adults. Adults emerge and are active from March to June feeding and mating, when the elderberry produces flowers.	Obligates with elderberry trees (*Sambucus* sp). Adults eat the elderberry foliage until about June when they mate. Upon hatching the larvae tunnel into the tree where they will spend 1-2 years eating the interior wood which is their sole food source.
San Joaquin kit fox (*Vulpes macrotis mutica*)	Adult ~2 kg	Alameda, Contra Costa, Fresno, Kern, Kings, Madera, Merced, Monterey, San Benito, San Joaquin, San Luis Obispo, Santa Barbara, Santa Clara, Stanislaus, Tulare and Ventura counties	A variety of habitats, including grasslands, scrublands (*e.g.*, chenopod scrub and sub-shrub scrub), vernal pool areas, oak woodland, alkali meadows and playas, and an agricultural matrix of row crops, irrigated pastures, orchards, vineyards, and grazed annual grasslands. Kit foxes	No	Mating and conception: late December - March. Gestation period: 48 to 52 days. Litters born: February - late March Pups emerge from their dens at about 1-month of age and may begin to disperse after 4 – 5 months usually in Aug. or Sept.	Small animals including blacktailed hares, desert cottontails, mice, kangaroo rats, squirrels, birds, lizards, insects and grass. It satisfies its moisture requirements from prey and does not depend on freshwater sources.

Table 8 Summary of Current Distribution, Habitat Requirements, and Life History Information for the Assessed Listed Species [1]

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
			dig their own dens, modify and use those already constructed by other animals (ground squirrels, badgers, and coyotes), or use human-made structures. (culverts, abandoned pipelines, or banks in sumps or roadbeds). They move to new dens within their home range often (likely to avoid predation by coyotes)			

[1] For more detailed information on the distribution, habitat requirements, and life history information of the assessed listed species, see Attachment 3

[2] For the purposes of this assessment, tadpoles and submerged adult frogs are considered "aquatic" because exposure pathways in the water are considerably different than those that occur on land.

[3] Oviparous = eggs hatch within the female's body and young are born live.

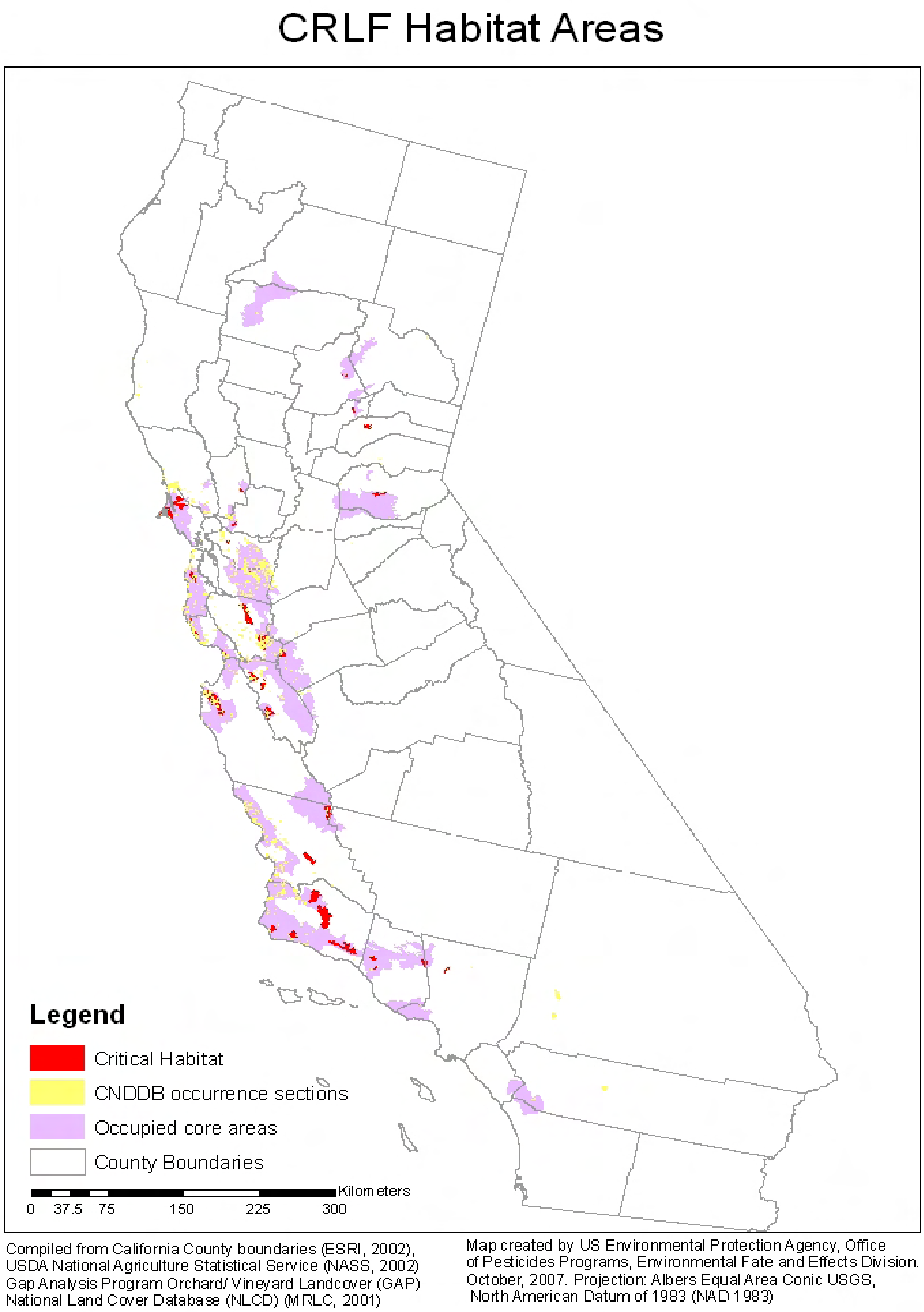

Figure 1. California Red-Legged Frog Habitat Areas

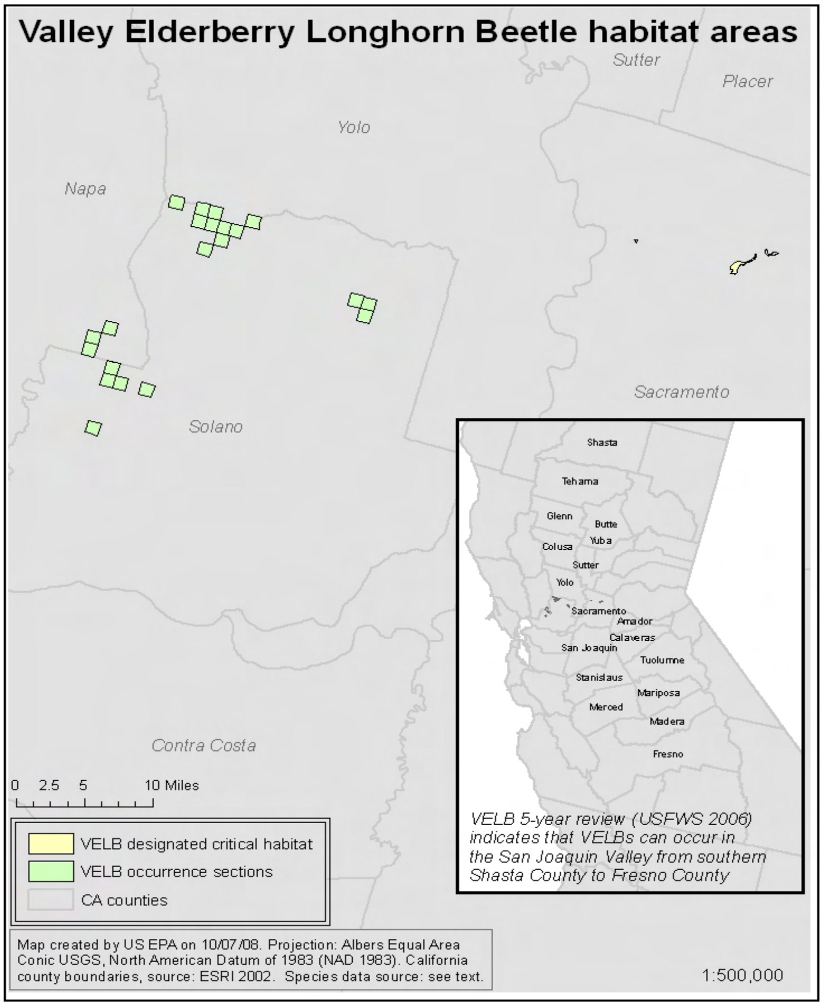

Figure 2. Valley Elderberry Longhorn Beetle Habitat Areas
Species location information obtained from USFWS 5-year review (2006), and from *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS). Critical habitat information obtained from USFWS (1980).

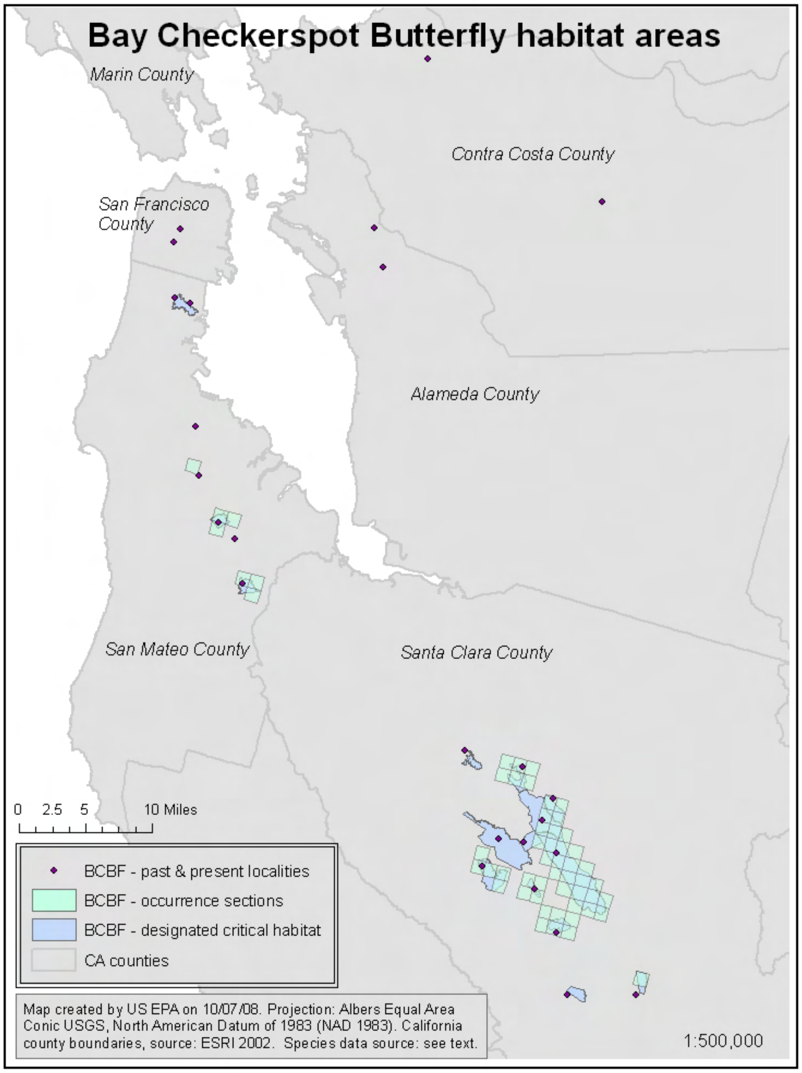

Figure 3. Bay Checkerspot Butterfly Habitat Areas
Species location information obtained from USFWS Recovery Plan (1998), and from *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS). Critical habitat information obtained from USFWS (2001).

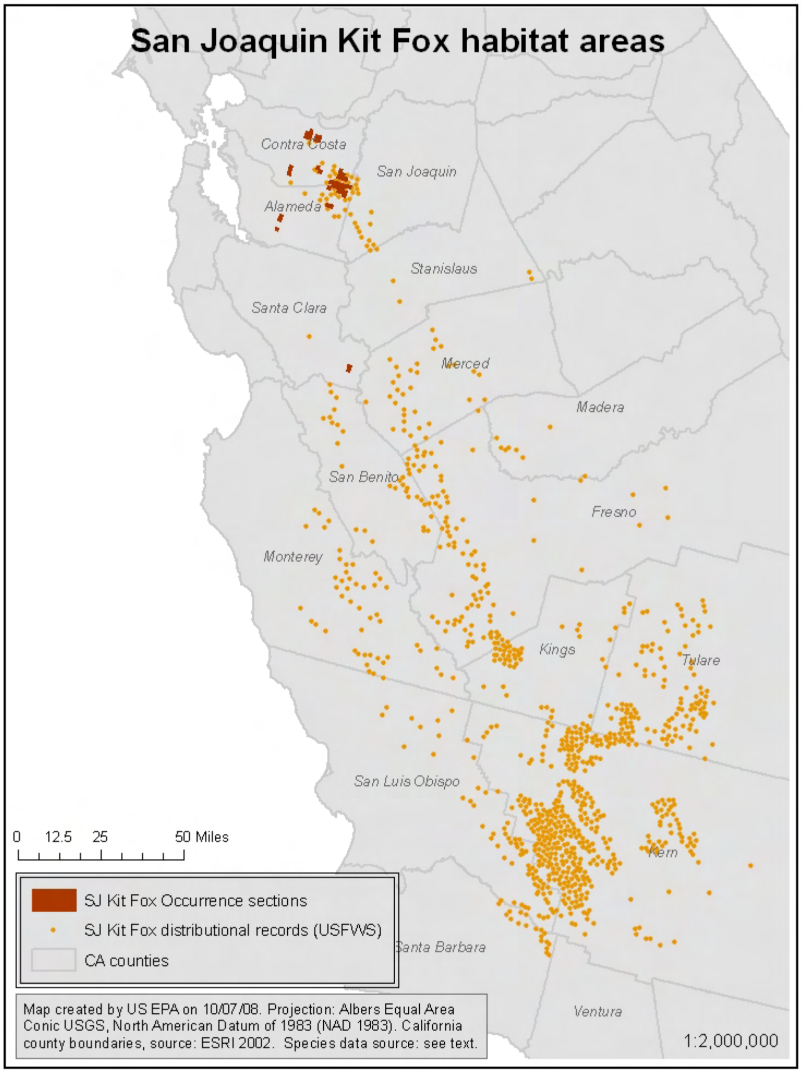

Figure 4. San Joaquin Kit Fox Habitat Areas
Species location information obtained from USFWS Recovery Plan (1998), and from *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS).

2.6 Designated Critical Habitat

Critical habitat has been designated for the CRLF; and VELB and BCB.

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

To be included in a critical habitat designation, the habitat must be 'essential to the conservation of the species.' Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas that provide essential life cycle needs of the species or areas that contain certain primary constituent elements (PCEs) (as defined in 50 CFR 414.12(b)). PCEs include, but are not limited to, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing (or development) of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species. **Table 9** describes the PCEs for the critical habitats designated for the CRLF, VELB and BCB.

Table 9. Designated Critical Habitat PCEs for the CRLF, VELB and BCB Species [1].		
Species	**PCEs**	**Reference**
CRLF	Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond.	50 CFR 414.12(b), 2006
	Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	
	Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	
	Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)	
	Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance	
	Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal	
	Reduction and/or modification of food sources for terrestrial phase juveniles and adults	
	Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	
Valley Elderberry Longhorn Beetle	Areas that contain the host plant of this species [*i.e.*, elderberry trees (*Sambucus* sp.)] (a dicot)	43 FR 35636 35643, 1978
Bay Checkerspot Butterfly	The presence of annual or perennial grasslands with little to no overstory that provide north/south and east/west slopes with a tilt of more than 7 degrees for larval host plant survival during periods of atypical weather (e.g., drought).	66 FR 21449 21489, 2001
	The presence of the primary larval host plant, dwarf plantain (*Plantago erecta*) (a dicot) and at least one of the secondary host plants, purple owl's-clover or exserted paintbrush, are required for reproduction, feeding, and larval development.	
	The presence of adult nectar sources for feeding.	
	Aquatic features such as wetlands, springs, seeps, streams, lakes, and ponds and their associated banks, that provide moisture during periods of spring drought; these features can be ephemeral, seasonal, or permanent.	
	Soils derived from serpentinite ultramafic rock (Montara, Climara, Henneke, Hentine, and Obispo soil series) or similar soils (Inks, Candlestick, Los Gatos, Fagan, and Barnabe soil series) that provide areas with fewer aggressive, nonnative plant species for larval host plant and adult nectar plant survival and reproduction.[2]	
	The presence of stable holes and cracks in the soil, and surface rock outcrops that provide shelter for the larval stage of the bay checkerspot butterfly during summer diapause.[2]	

[1] These PCEs are in addition to more general requirements for habitat areas that provide essential life cycle needs of the species such as, 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.
[2] PCEs that are abiotic, including, 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.

More detail on the designated critical habitat applicable to this assessment can be found in Attachment 1 (for the CRLF) and **Attachment 1** (for VELB and BCB). Activities that may destroy or adversely modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the species. Evaluation of actions related to use of phorate that may alter the PCEs of the designated critical habitat for the CRLF, and VELB and BCB form the basis of the critical habitat impact analysis.

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

2.7 Action Area

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). It is recognized that the overall action area for the national registration of phorate is likely to encompass considerable portions of the United States based on the large array of agricultural uses. However, the scope of this assessment limits consideration of the overall action area to those portions that may be applicable to the protection of the CRLF, BCB, VELB, and SJKF and their designated critical habitat within the state of California. Although the watershed for the San Francisco Bay extends northward into the very southwestern portion of Lake County, Oregon, and westward into the western edge of Washoe County, Nevada, the non-California portions of the watershed are small and very rural with little, if any, agriculture. Therefore, little or no use of phorate is expected in these areas, and they are not considered as part of the action area applicable to this assessment.

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 phorate. An analysis of labeled uses and review of available product labels was completed. Some currently labeled crop uses (sugarcane, soybean, radish) are not applicable to California, and are excluded from this assessment. In addition, a distinction has been made between food use crops and those that are non-food/non-agricultural uses. For those uses relevant to the assessed species, the analysis indicates that, for phorate, the following agricultural uses are considered as part of the federal action evaluated in this assessment:

- Wheat

- Sugarbeet
- Sorghum
- Potato
- Peanut
- Cotton
- Corn
- Sweet Corn
- Beans

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

- Ornamentals

Following a determination of the assessed uses, an evaluation of the potential "footprint" of phorate use patterns (*i.e*., the area where pesticide application occurs) is determined. This "footprint" represents the initial area of concern, based on an analysis of available land cover data for the state of California. The initial area of concern is defined as all land cover types and the stream reaches within the land cover areas that represent the labeled uses described above. A map representing all the land cover types that make up the initial area of concern for phorate is presented in **Figure 5**.

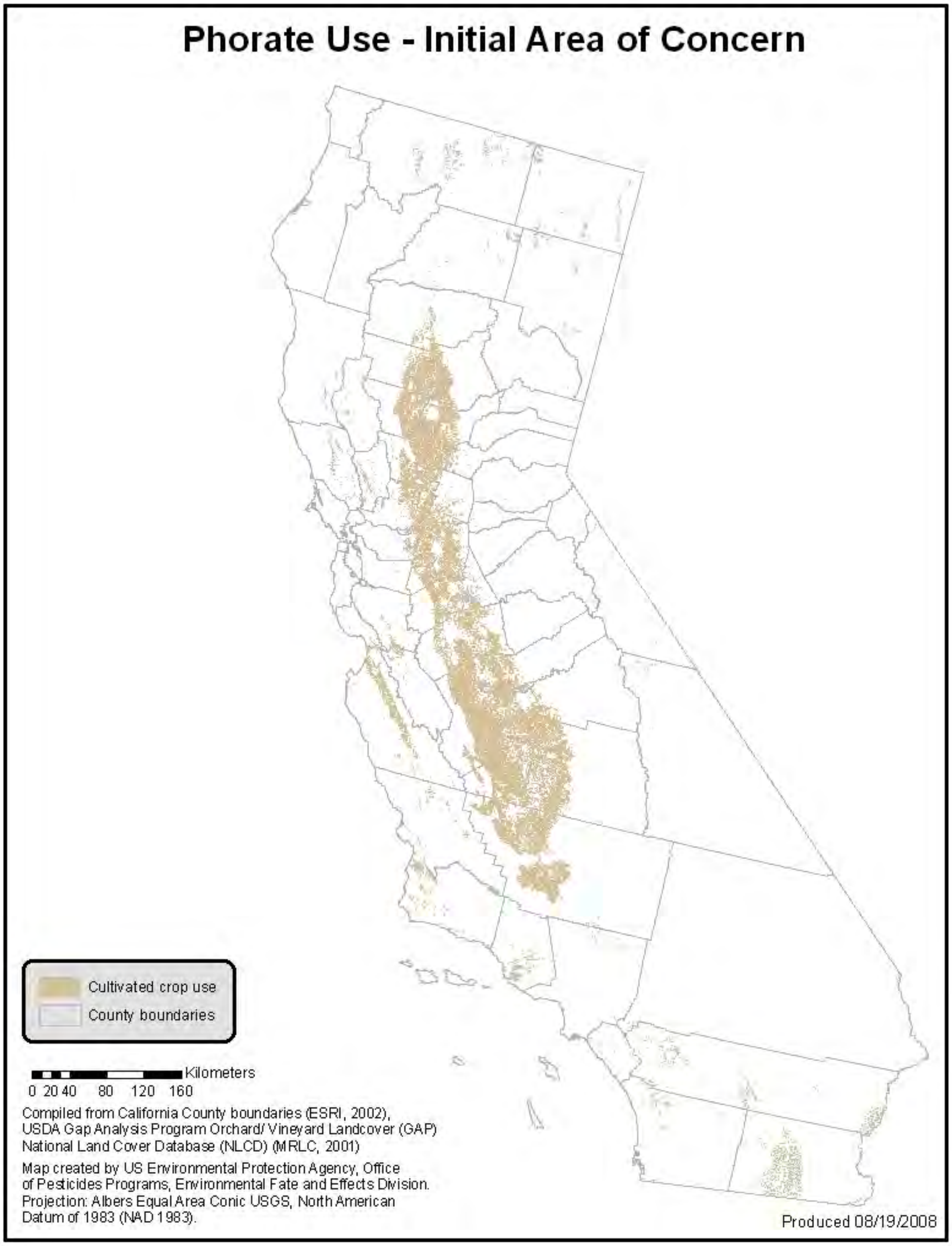

Figure 5. Initial area of concern, or "footprint" of potential use, for Phorate

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

The Agency's approach to defining the action area under the provisions of the Overview Document (USEPA 2004) considers the results of the risk assessment process to establish boundaries for that action area with the understanding that exposures below the Agency's defined Levels of Concern (LOCs) constitute a no-effect threshold. Deriving the geographical extent of this portion of the action area is based on consideration of the types of effects that phorate may be expected to have on the environment, the exposure levels to phorate that are associated with those effects, and the best available information concerning the use of phorate and its fate and transport within the state of California. Specific measures of ecological effect for the assessed species that define the action area include any direct and indirect toxic effect to the assessed species and any potential modification of its critical habitat, including reduction in survival, growth, and fecundity as well as the full suite of sublethal effects available in the effects literature. Therefore, the action area extends to a point where environmental exposures are below any measured lethal or sublethal effect threshold for any biological entity at the whole organism, organ, tissue, and cellular level of organization. In situations where it is not possible to determine the threshold for an observed effect, the action area is not spatially limited and is assumed to be the entire state of California.

Toxicity data from HED indicates that phorate is not mutagenic or carcinogenic. Therefore the action area will be limited to where the exposure exceeds the Agency's LOC.

The action area is determined by the footprint of the action plus all offsite areas where exposure of one or more taxonomic groups to phorate exceeds the Agency's LOCs. The spatial extent at which the Agency's LOCs are not exceeded is based on the potential exposure level and the most sensitive effects endpoint. Based upon the maximum aquatic RQ (26.5 ppb) and most sensitive aquatic LOC (0.05), the extent of downstream dilution (beyond which there should be minimal adverse impact) resulting from phorate use is approximately 285 km. Therefore, in terms of aquatic exposure, the Action Area should include all streams and surface water bodies downstream of anywhere phorate is applied – essentially extending from any application area all the way to the surface water discharge point (e.g., Pacific Ocean, San Francisco Bay, etc.). However, since this chemical is applied solely in granular form, there should be no aquatic exposure in waters upstream (up-gradient) of the uppermost potential phorate application areas within any given watershed.

The dominant route of exposure in aquatic and non-target terrestrial environments is likely to be via surface runoff from treated areas, and incidental direct exposure to granules in proximity to areas treated with phorate. Infiltration into soil and ultimately to groundwater is possible, but fairly rapid hydrolysis ($t_{½}$ ~3 days) reduces risk of long-term exposure through groundwater. Other routes of exposure, particularly long-range atmospheric transport, are much less likely.

An evaluation of usage information was conducted to determine the area where use of phorate may impact the assessed species. This analysis is used to characterize where predicted exposures are most likely to occur, but does not preclude use in other portions of the action area. A more detailed review of the county-level use information was also completed. These data suggest that phorate is used most heavily in counties with significant corn, cotton, potato, and sugarbeet production (e.g., Fresno, Kern, Kings, Riverside, Sacramento, San Joaquin, Tulare); these areas are likely to have greatest exposure risks.

2.8 Assessment Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected."[3] Selection of the assessment endpoints is based on valued entities (*e.g.,* CRLF, BCB, VELB, and SJKF, organisms important in the life cycle of the assessed species, and the PCEs of its designated critical habitat), the ecosystems potentially at risk (*e.g.,* waterbodies, riparian vegetation, and upland and dispersal habitats), the migration pathways of phorate (*e.g.,* runoff, spray drift, *etc*.), and the routes by which ecological receptors are exposed to phorate *(e.g.,* direct contact, *etc.).*

2.8.1. Assessment Endpoints

Assessment endpoints for the CRLF, BCB, VELB, and SJKF include direct toxic effects on the survival, reproduction, and growth of individuals, as well as indirect effects, such as reduction of the prey base or modification of its habitat. In addition, potential modification of critical habitat is assessed by evaluating potential effects to PCEs, which are components of the habitat areas that provide essential life cycle needs of the assessed species. Each assessment endpoint requires one or more "measures of ecological effect," defined as changes in the attributes of an assessment endpoint or changes in a surrogate entity or attribute in response to exposure to a pesticide. Specific measures of ecological effect are generally evaluated based on acute and chronic toxicity information from registrant-submitted guideline tests that are performed on a limited number of organisms. Additional ecological effects data from the open literature are also considered. It should be noted that assessment endpoints are limited to direct and indirect effects associated with survival, growth, and fecundity, and do not include the full suite of sublethal effects used to define the action area. According to the Overview Document (USEPA 2004), the Agency relies on acute and chronic effects endpoints that are either direct measures of impairment of survival, growth, or fecundity or endpoints for which there is a scientifically robust, peer reviewed relationship that can quantify the impact of the measured effect endpoint on the assessment endpoints of survival, growth, and fecundity.

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 risks for each of the assessed species associated with exposure to phorate is provided in Section 2.5 and **Table 11**.

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

Phorate is categorized as being highly toxic to very highly toxic to birds on an acute basis, highly toxic to birds on a sub-acute dietary basis, highly toxic to mammals on an acute basis, moderately to highly toxic to honey bees on an acute basis, highly to very highly toxic to fish on an acute basis, and highly toxic to aquatic invertebrates on an acute basis.

As described in the Agency's Overview Document (U.S. EPA, 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include aquatic-phase amphibians, freshwater fish, freshwater invertebrates, aquatic plants, birds (surrogate for terrestrial-phase amphibians), mammals, terrestrial invertebrates, and terrestrial plants. Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and a comprehensive review of the open literature on phorate.

Table 10 identifies the taxa used to assess the potential for direct and indirect effects from the uses of phorate for each listed species assessed here. The specific assessment endpoints used to assess the potential for direct and indirect effects to each listed species are provided in **Table 11.**

Table 10. Taxa Used in the Analyses of Direct and Indirect Effects for the Assessed Listed Species.

Listed Species	Birds	Mammal	Frogs	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Aquatic Plants
California red-legged frog	Direct	Indirect (prey)	Direct Indirect (prey)	Indirect (habitat)	Indirect (prey)	Direct Indirect (prey)	Indirect (prey)	Indirect (food/ habitat)
Bay checkerspot butterfly	N/A	N/A	N/A	Indirect (food/ habitat)*	Direct	N/A	N/A	N/A
San Joaquin kit fox	Indirect (prey)	Direct Indirect (prey)	N/A	Indirect (food/ habitat)	Indirect (prey)	N/A	N/A	N/A
Valley elderberry longhorn beetle	N/A	N/A	N/A	Indirect (food/ habitat)*	Direct	N/A	N/A	N/A

N/A = Not applicable
Terr. = Terrestrial
Invert. = Invertebrate
FW = Freshwater
* = obligate relationship

Table 11. Taxa and Assessment Endpoints Used to Evaluate the Potential for the Use of Phorate to Result in Direct and Indirect Effects to the Assessed Listed Species.			
Taxa Used to Assess Direct and/or Indirect Effects to Assessed Species	**Assessed Listed Species**	**Assessment Endpoints**	**Measures of Ecological Effects**
1. Freshwater Fish and Aquatic-phase Amphibians	Direct Effect – -Aquatic-phase CRLF	Survival, growth, and reproduction of individuals via direct effects	1a. Amphibian acute LC_{50} (ECOTOX) or most sensitive fish acute LC_{50} (guideline or ECOTOX) if no suitable amphibian data are available 1b. Amphibian chronic NOAEC (ECOTOX) or most sensitive fish chronic NOAEC (guideline or ECOTOX) 1c. Amphibian early-life stage data (ECOTOX) or most sensitive fish early-life stage NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -Aquatic-phase CRLF	Survival, growth, and reproduction of individuals via indirect effects on aquatic prey food supply (*i.e.*, fish and aquatic-phase amphibians)	
2. Freshwater Invertebrates	Indirect Effect (prey) -Aquatic-phase CRLF	Survival, growth, and reproduction of individuals via indirect effects on aquatic prey food supply (*i.e.*, freshwater invertebrates)	2a. Most sensitive freshwater invertebrate EC_{50} (guideline or ECOTOX) 2b. Most sensitive freshwater invertebrate chronic NOAEC (guideline or ECOTOX)
3. Aquatic Plants (freshwater/marine)	Indirect Effect (food/habitat) -Aquatic-phase CRLF	Survival, growth, and reproduction of individuals via indirect effects on habitat, cover, food supply, and/or primary productivity (*i.e.*, aquatic plant community)	5a. Vascular plant acute EC_{50} (duckweed guideline test or ECOTOX vascular plant) 5b. Non-vascular plant acute EC_{50} (freshwater algae or diatom, or ECOTOX non-vascular)
4. Birds	Direct Effect -Terrestrial-phase CRLF	Survival, growth, and reproduction of individuals via direct effects	6a. Most sensitive bird[b] or terrestrial-phase amphibian acute LC_{50} or LD_{50} (guideline or ECOTOX) 6b. Most sensitive bird[b] or terrestrial-phase amphibian chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -San Joaquin Kit Fox	Survival, growth, and reproduction of individuals via indirect effects on terrestrial prey (birds)	
5. Mammals	Direct Effect -San Joaquin Kit Fox	Survival, growth, and reproduction of individuals via direct effects	7a. Most sensitive laboratory rat acute LC_{50} or LD_{50} (guideline or ECOTOX) 7b. Most sensitive laboratory rat chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey/habitat from burrows) -Terrestrial-phase CRLF -San Joaquin Kit Fox	Survival, growth, and reproduction of individuals via indirect effects on terrestrial prey (mammals)	
6. Terrestrial Invertebrates	Direct Effect -Bay Checkerspot Butterfly -Valley elderberry longhorn beetle	Survival, growth, and reproduction of individuals via direct effects	8a. Most sensitive terrestrial invertebrate acute EC_{50} or LC_{50} (guideline or ECOTOX)[c] 8b. Most sensitive terrestrial invertebrate chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -Terrestrial-phase CRLF -San Joaquin Kit Fox	Survival, growth, and reproduction of individuals via indirect effects on terrestrial prey (terrestrial	

		invertebrates)	
7. Terrestrial Plants	Indirect Effect (food/habitat) (non-obligate relationship) -Terrestrial-phase CRLF -San Joaquin Kit Fox Indirect Effect (food/habitat) (obligate relationship) -Bay Checkerspot Butterfly -Valley Elderberry Longhorn Beetle	Survival, growth, and reproduction of individuals via indirect effects on food and habitat (*i.e.*, riparian and upland vegetation)	9a. Distribution of EC_{25} for monocots (seedling emergence, vegetative vigor, or ECOTOX 9b. Distribution of EC_{25} (EC_{05} or NOAEC for the Bay checkerspot butterfly and the Valley elderberry longhorn beetle) for dicots (seedling emergence, vegetative vigor, or ECOTOX)

2.8.2 Assessment Endpoints for Designated Critical Habitat

As previously discussed, designated critical habitat is assessed to evaluate actions related to the use of phorate that may alter the PCEs of the assessed species' designated critical habitat. PCEs for the assessed species were previously described in Section 2.6. Actions that may modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the assessed species. Therefore, these actions are identified as assessment endpoints. It should be noted that evaluation of PCEs as assessment endpoints is limited to those of a biological nature (*i.e*., the biological resource requirements for the listed species associated with the critical habitat) and those for which phorate effects data are available.

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. Measures of ecological effect used to assess the potential for adverse modification to the critical habitat of the CRLF, BCB, and VELB are described in **Table 12**.

Table 12. Summary of Assessment Endpoints and Measures of Ecological Effect for Primary Constituent Elements of Designated Critical Habitat for CRLF, BCB, and VELB.

Taxon Used to Assess Modification of PCE	Assessed Listed Species Associated with the PCE	Assessment Endpoints	Measures of Ecological Effects
1. Freshwater Fish and Aquatic-phase Amphibians	Direct Effect – -Aquatic-phase CRLF	Survival, growth, and reproduction of individuals via direct effects	1a. Amphibian acute LC_{50} (ECOTOX) or most sensitive fish acute LC_{50} (guideline or ECOTOX) if no suitable amphibian data are available 1b. Amphibian chronic NOAEC (ECOTOX) or most sensitive fish chronic NOAEC (guideline or ECOTOX) 1c. Amphibian early-life stage data (ECOTOX) or most sensitive fish early-life stage NOAEC (guideline or ECOTOX) *(if sufficient data are available, split the evaluation for eggs*
	Indirect Effect (prey) -Aquatic-phase CRLF	Modification of critical habitat via change in aquatic prey food supply (*i.e.*, fish and aquatic-phase amphibians)	

Table 12. Summary of Assessment Endpoints and Measures of Ecological Effect for Primary Constituent Elements of Designated Critical Habitat for CRLF, BCB, and VELB.			
Taxon Used to Assess Modification of PCE	**Assessed Listed Species Associated with the PCE**	**Assessment Endpoints**	**Measures of Ecological Effects**
			and larvae out, and use the ELS endpoint)
2. Freshwater Invertebrates	Indirect Effect (prey) -Aquatic-phase CRLF	Survival, growth, and reproduction of individuals via indirect effects on aquatic prey food supply (*i.e.*, freshwater invertebrates)	2a. Most sensitive freshwater invertebrate EC_{50} (guideline or ECOTOX) 2b. Most sensitive freshwater invertebrate chronic NOAEC (guideline or ECOTOX)
3. Aquatic Plants (freshwater/marine)	Indirect Effect (food/habitat) -Aquatic-phase CRLF	Modification of critical habitat via change in habitat, cover, food supply, and/or primary productivity (*i.e.*, aquatic plant community)	5a. Vascular plant acute EC_{50} (duckweed guideline test or ECOTOX vascular plant) 5b. Non-vascular plant acute EC_{50} (freshwater algae or diatom, or ECOTOX non-vascular)
4. Birds	Direct Effect -Terrestrial-phase CRLF	Survival, growth, and reproduction of individuals via direct effects	6a. Most sensitive bird[b] or terrestrial-phase amphibian acute LC_{50} or LD_{50} (guideline or ECOTOX) 6b. Most sensitive bird[b] or terrestrial-phase amphibian chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -Terrestrial-phase CRLF	Modification of critical habitat via change in terrestrial prey (birds)	
5. Mammals	Direct Effect None of listed species	Survival, growth, and reproduction of individuals via direct effects. Modification of critical habitat via change in terrestrial prey (mammals)	7a. Most sensitive laboratory rat acute LC_{50} or LD_{50} (guideline or ECOTOX) 7b. Most sensitive laboratory rat chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey/habitat from burrows) -Terrestrial-phase CRLF		
6. Terrestrial Invertebrates	Direct Effect -Bay Checkerspot Butterfly -Valley elderberry longhorn beetle	Survival, growth, and reproduction of individuals via direct effects	8a. Most sensitive terrestrial invertebrate acute EC_{50} or LC_{50} (guideline or ECOTOX)[c] 8b. Most sensitive terrestrial invertebrate chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -Terrestrial-phase CRLF	Modification of critical habitat via change in terrestrial prey (terrestrial invertebrates)	
7. Terrestrial Plants	Indirect Effect (food/habitat) (non-obligate relationship) -Terrestrial-phase CRLF	Modification of critical habitat via change in food and habitat (*i.e.*, riparian and upland vegetation)	9a. Distribution of EC_{25} for monocots (seedling emergence, vegetative vigor, or ECOTOX 9b. Distribution of EC_{25} (EC_{05} or NOAEC for the Bay checkerspot butterfly and the valley elderberry longhorn beetle) for dicots (seedling emergence, vegetative vigor, or ECOTOX)
	Indirect Effect (food/habitat) (obligate relationship) -Bay Checkerspot Butterfly -Valley Elderberry Longhorn Beetle		

2.9 Conceptual Model

2.9.1 Risk Hypotheses

Risk hypotheses are specific assumptions about potential adverse effects (*i.e.*, changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (U.S. EPA, 1998). For this assessment, the risk is stressor-linked, where the stressor is the release of phorate to the environment. The following risk hypotheses are presumed for each assessed species in this assessment:

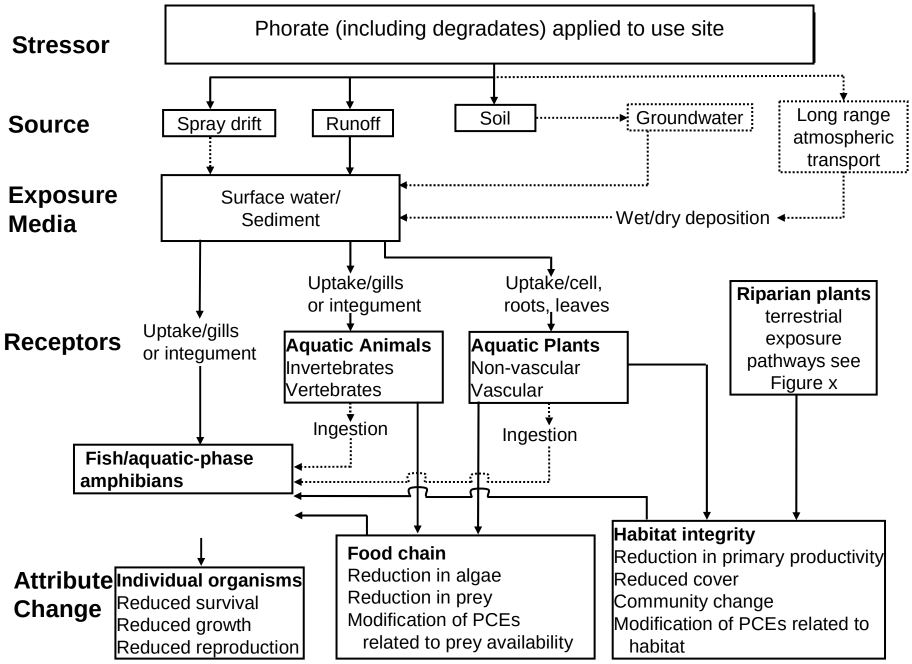
The labeled use of phorate within the action area may:

- directly affect the CRLF, BCB, VELB, and/or SJKF by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect the CRLF, BCB, VELB, and/or SJKF and/or modify their designated critical habitat by reducing or changing the composition of food supply;
- indirectly affect the CRLF, BCB, and/or VELB and/or modify their designated critical habitat by reducing or changing the composition of the aquatic plant community in the species' current range, thus affecting primary productivity and/or cover;
- indirectly affect the CRLF, BCB, and/or VELB and/or modify their designated critical habitat by reducing or changing the composition of the terrestrial plant community in the species' current range;
- indirectly affect the CRLF and/or modify their designated critical habitat by reducing or changing aquatic habitat in their current range (via modification of water quality parameters, habitat morphology, and/or sedimentation);
- modify the designated critical habitat of the CRLF by reducing or changing upland habitat within 200 ft of the edge of the riparian vegetation necessary for shelter, foraging, and predator avoidance.
- modify the designated critical habitat of the CRLF by reducing or changing dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.

2.9.2 Diagram

The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the phorate release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for aquatic and terrestrial phases of the CRLF, VELB, BCB, and SJKF and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in **Figures 6** and **7**. Although the conceptual models for direct/indirect effects and modification of designated critical habitat PCEs are shown on the same diagrams, the potential for direct/indirect effects and modification of PCEs will be evaluated separately in this assessment. Exposure routes shown in dashed lines are not quantitatively considered because the contribution of those potential exposure routes to potential risks to the CRLF, VELB, BCB, and SJKF and modification to designated critical habitat is expected to be negligible.

The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the phorate release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for aquatic and terrestrial phases of the CRLF and BCB, VELB, and SJKF are shown in **Figures 6 and 7**, respectively, and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in **Figures 8 and 9**, respectively. Although the conceptual models for direct/indirect effects and modification of designated critical habitat PCEs are shown on the same diagrams, the potential for direct/indirect effects and modification of PCEs will be evaluated separately in this assessment. Exposure routes shown in dashed lines are not quantitatively considered because the contribution of those potential exposure routes to potential risks to the CRLF, BCB, VELB, and SJKF and modification to designated critical habitat is expected to be negligible.



** Route of exposure includes only ingestion of aquatic fish and invertebrates

Figure 6. Conceptual Model for Aquatic Exposure of Listed Species.

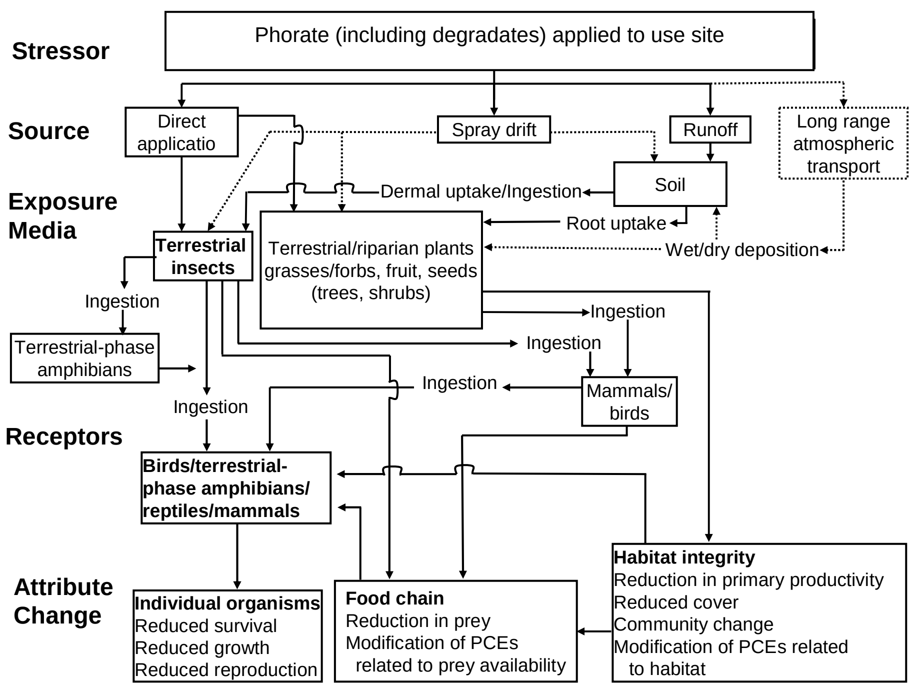


Figure 7 Conceptual Model for Terrestrial Exposure of Listed Species.

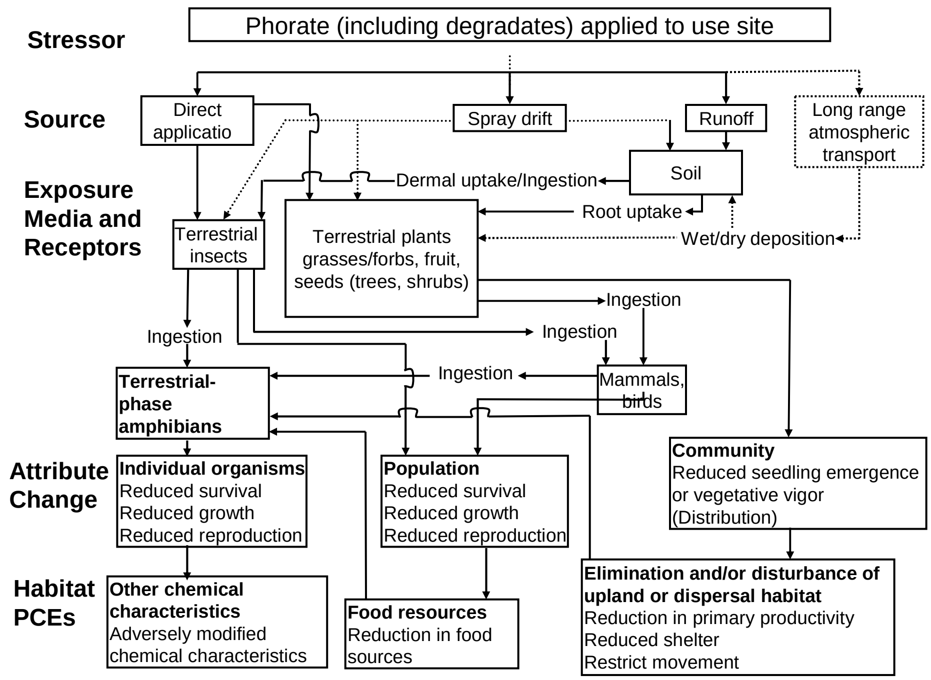


Figure 8. Conceptual Model for Terrestrial Exposure of Critical Habitat

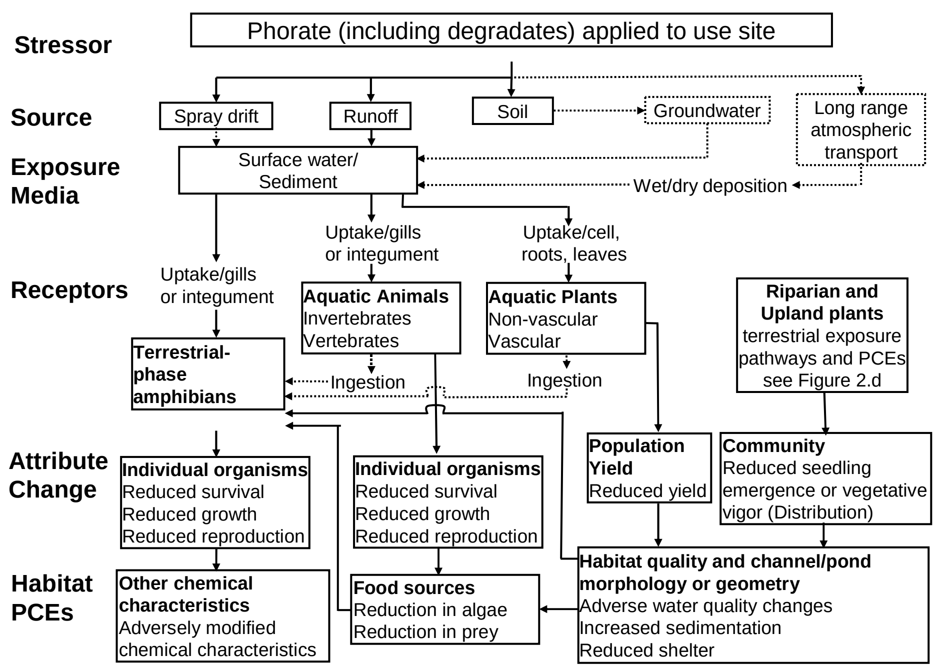


Figure 9. Conceptual Model for Aquatic Exposure of Critical Habitat

2.10 Analysis Plan

In order to address the risk hypothesis, the potential for direct and indirect effects to the CRLF, BCB, VELB, and SJKF, their prey items, and habitat, is estimated based on a taxon-level approach. In the following sections, the use, environmental fate, and ecological effects of phorate are characterized and integrated to assess the risks. This is accomplished using a risk quotient (ratio of exposure concentration to effects concentration) approach. Although risk is often defined as the likelihood and magnitude of adverse ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/or magnitude of an adverse effect. However, as outlined in the Overview Document (U.S. EPA, 2004), the likelihood of effects to individual organisms from particular uses of phorate is estimated using the probit dose-response slope and either the level of concern (discussed below) or actual calculated risk quotient value.

2.10.1 Measures to Evaluate the Risk Hypothesis and Conceptual Model

2.10.1.1 Measures of Exposure

The environmental fate properties of phorate indicate that runoff is the principle potential transport mechanism of phorate to the aquatic and terrestrial habitats of the CRLF and BCB, VELB, and SJKF. In this assessment, transport of phorate through runoff is considered in deriving quantitative estimates of phorate exposure to CRLF, BCB, VELB, and SJKF and their prey and habitats.

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

PRZM (v3.12.2, May 2005) and EXAMS (v2.98.4.6, April 2005) are simulation models coupled with the input shell pe5.pl (Aug 2007) to generate daily exposures and 1-in-10 year EECs of phorate that may occur in surface water bodies adjacent to application sites receiving phorate through runoff and spray drift. PRZM simulates pesticide application, movement and transformation on an agricultural field and the resultant pesticide loadings to a receiving water body via runoff, erosion and spray drift. EXAMS simulates the fate of the pesticide and resulting concentrations in the water body. The standard scenario used for ecological pesticide assessments assumes application to a 10-hectare agricultural field that drains into an adjacent 1-hectare water body, 2-meters deep (20,000 m^3 volume) with no outlet. PRZM/EXAMS was used to estimate screening-level exposure of aquatic organisms to phorate. The measure of exposure for aquatic species is the 1-in-10 year return peak or rolling mean concentration. The 1-in-10-year 60-day mean is used for assessing chronic exposure to fish; the 1-in-10-year 21-day mean is used for assessing chronic exposure for aquatic invertebrates.

For modeling purposes, direct exposures of the CRLF, BCB, VELB, and SJKF to phorate through contaminated food are estimated using the EECs for the small bird (20 g) which consumes small insects. Dietary-based and dose-based exposures of potential prey (small mammals) are assessed using the small mammal (15 g) which consumes short grass. The small bird (20g) consuming small insects and the small mammal (15g) consuming short grass are used because these categories represent the largest RQs of the size and dietary categories in T-REX that are appropriate surrogates for the CRLF and one of its prey items. Estimated exposures of terrestrial insects to phorate are bound by using the dietary based EECs for small insects and large insects.

Spray drift models, AGDISP and/or AgDRIFT (if applicable) are used to assess exposures of terrestrial animals to chemicals deposited on terrestrial habitats by spray drift. However, since phorate is only formulated as granules, there is no spray drift component – off-site (non-target) application will be limited to immediately adjacent areas.

2.10.1.2 Measures of Effect

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

The assessment of risk for direct effects to the terrestrial-phase CRLF makes the assumption that toxicity of phorate to birds is similar to or less than the toxicity to terrestrial-phase amphibians and reptiles (this also applies to potential prey items). The same assumption is made for fish and aquatic-phase CRLF (again, this also applies to potential prey items).

The acute measures of effect used for animals in this screening level assessment are the LD_{50}, LC_{50} and EC_{50}. LD stands for "Lethal Dose", and LD_{50} is the amount of a material, given all at once, that is estimated to cause the death of 50% of the test organisms. LC stands for “Lethal Concentration” and LC_{50} is the concentration of a chemical that is estimated to kill 50% of the test organisms. EC stands for “Effective Concentration” and the EC_{50} is the concentration of a chemical that is estimated to produce a specific effect in 50% of the test organisms. Endpoints for chronic measures of exposure for listed and non-listed animals are the NOAEL/NOAEC and NOAEC. NOAEL stands for “No Observed-Adverse-Effect-Level” and refers to the highest tested dose of a substance that has been reported to have no harmful (adverse) effects on test organisms. The NOAEC (*i.e.*, "No-Observed-Adverse-Effect-Concentration") is the highest test concentration at which none of the observed effects were statistically different from the control. The NOAEC is the No-Observed-Effects-Concentration. For non-listed plants, only acute exposures are assessed (*i.e.*, EC_{25} for terrestrial plants and EC_{50} for aquatic plants).

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

2.10.1.3 Integration of Exposure and Effects

Risk characterization is the integration of exposure and ecological effects characterization to determine the potential ecological risk from agricultural and non-agricultural uses of phorate, and the likelihood of direct and indirect effects to CRLF, BCB, VELB, and SJKF in aquatic and terrestrial habitats. The exposure and toxicity effects data are integrated in order to evaluate the risks of adverse ecological effects on non-target species. For the assessment of phorate risks, the risk quotient (RQ) method is used to compare exposure and measured toxicity values. EECs are divided by acute and chronic toxicity values. The resulting RQs are then compared to the Agency's levels of concern (LOCs) (USEPA, 2004) (see **Appendix C**).

For this endangered species assessment, listed species LOCs are used for comparing RQ values for acute and chronic exposures of phorate directly to the CRLF, BCB, VELB, and SJKF. If estimated exposures directly to the assessed species of phorate resulting from a particular use are sufficient to exceed the listed species LOC, then the effects determination for that use is "may affect". When considering indirect effects to the assessed species due to effects to prey, the listed species LOCs are also used. If estimated exposures to the prey of the assessed species of phorate resulting from a particular use are sufficient to exceed the listed species LOC, then the effects determination for that use is a "may affect." If the RQ being considered also exceeds the non-listed species acute risk LOC, then the effects determination is a LAA. If the acute RQ is between the listed species LOC and the non-listed acute risk species LOC, then further lines of evidence (*i.e.* probability of individual effects, species sensitivity distributions) are considered in distinguishing between a determination of NLAA and a LAA. If the RQ being considered for a particular use exceeds the non-listed species LOC for plants, the effects determination is "may affect". Specifically for the Bay checkerspot butterfly and the Valley elderberry longhorn beetle, since they are obligates with a dicot, any exceedance of the endangered species LOC for dicots would also result in an LAA. Further information on LOCs is provided in **Appendix C**.

2.10.2 Data Gaps

There are no available data on the anaerobic aquatic degradation rates for phorate, or its degradates of concern (sulfoxide and sulfone).

There are no chronic toxicity data for bluegill sunfish which has the most sensitive acute toxicity endpoint.

There are no terrestrial toxicity data on the sulfoxide and sulfone degradates of phorate.

There are no terrestrial toxicity data on the sulfoxide and sulfone degradates of phorate.

There are no terrestrial plant toxicity data available.

There are no aquatic vascular plant toxicity data.

There is insufficient toxicity data on aquatic unicellular plants.

3. Exposure Assessment

Phorate is formulated as granules. Application methods based on pre-May 2008 labels include: ground application, band treatment, soil-incorporated treatment, and granule spreaders. Soil-incorporated methods have been required for all uses since May 2008, and likely pose the least exposure risks. Since there are likely still significant amounts of product available from earlier (pre-May 2008) formulations, EFED has evaluated the risks based on these uses. Risks associated with soil-incorporated-only application methods are also evaluated in this document, to reflect the current state of the labels for this chemical. Although phorate use is allowed in many areas, mobility/persistence characteristics, formulation, and usage patterns indicate that potential exposure risks from phorate use are likely limited by proximity to application areas.

Model-generated exposure estimates (and discussions of risks therefrom) throughout this document reflect total toxic residues of concern. Since there is significant uncertainty regarding phorate aquatic metabolic degradation, and the relative formation, mobility, and fate of the degradates of concern under different conditions, conservative assumption were made for modeling purposes. There were insufficient data to develop a combined residues degradation curve; instead the most conservative value for a given model input was used. For example, a K_{OC} value of 50 was selected for modeling because, although parent phorate K_{OC} values are somewhat higher (with a low-end value of 450), both the sulfoxide and sulfone degradates display greater mobility potential (both having a low-end K_{OC} value of 50). Input values used in the PRZM-EXAMS modeling are generally consistent with those used in the *2006 OP Cumulative Drinking Water Assessment* (of which the phorate component was completed in 2001) – a minor exception being the aerobic aquatic degradation half-life input. In that document, an aerobic aquatic input value of 11 days was used (it is unclear how this value was established); however, because of the uncertainties involved and lack of adequate data with which to establish a robust total toxic residues degradation rate, the longer half life for the degradate phorate sulfoxide (21 days) is used here.

3.1 Label Application Rates and Intervals

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

Currently registered agricultural and non-agricultural uses of phorate within California include wheat, sugarbeet, sorghum, potato, peanut, cotton, corn, sweet corn, beans, and ornamentals. The uses being assessed are summarized in **Table 13**. These include labeled uses (and application methods) that remained until May 2008 but have since been revised – since May 2008 all uses require soil-incorporation. All uses below have also been assessed for soil-incorporation applications only.

Table 13 Assessed Phorate Uses.

Use Site	Application Equipment Application Type Application Timing	Max. Single Appl. Rate
Ornamental herbaceous plants	Soil incorporation equipment. Soil in-furrow treatment At planting	8 lb ai/A
Beans	Granule applicator Soil drill treatment At planting	2.04 lb ai/A
	Granule applicator Soil band treatment At planting	1.52 lb ai/A
Corn	Granule applicator Soil band treatment At planting or foliar	1.3 lb ai/A
	Ground equipment Broadcast At whorl.	1 lb ai/ A
Sweet Corn	Granule applicator Soil band treatment At June	1.3 lb ai/A
Cotton	Soil incorporation equipment Soil sidedress treatment At post emergence or foliar	2.18 lb ai/A
Peanut	Soil incorporation equipment Soil in-furrow treatment At planting	1.6 lb ai/A
	Granule applicator Soil in-furrow treatment At planting	1.38 lb ai/A
Potato	Soil incorporation equipment Soil in-furrow or soil band treatment At planting	3.5 lb A
Sorghum	Soil incorporation equipment Soil band, soil drill, or soil incorporated treatment At planting or foliar	1.3125 lb ai/A
	Ground equipment Broadcast At whorl	1.0 lb ai/A
Sugarbeet	Ground equipment Broadcast At post emergence	1.5 lb ai/A
Wheat	Broadcast At post emergence	1.0 lb ai/A

** all application rates are per crop cycle.*

3.2 Aquatic Exposure Assessment

3.2.1 Modeling Approach

Aquatic exposures are quantitatively estimated for all assessed uses with scenarios that represent high exposure sites for phorate use. Each of these sites represents a 10 hectare field that drains into a 1-hectare pond that is 2 meters deep and has no outlet. Exposure estimates generated using the standard pond are intended to represent a wide variety of vulnerable water bodies that occur at the top of watersheds including prairie pot holes, playa lakes, wetlands, vernal pools, man-made and natural ponds, and intermittent and first-order streams. As a group, there are factors that make these water bodies more or less vulnerable than the standard surrogate pond. Static water bodies that have larger ratios of drainage area to water body volume would be expected to have higher peak EECs than the standard pond. These water bodies will be either shallower or have large drainage areas (or both). Shallow water bodies tend to have limited additional storage capacity, and thus, tend to overflow and carry pesticide in the discharge whereas the standard pond has no discharge. As watershed size increases beyond 10 hectares, at some point, it becomes unlikely that the entire watershed is planted to a single crop, which is all treated with the pesticide. Headwater streams can also have peak concentrations higher than the standard pond, but they tend to persist for only short periods of time and are then carried downstream. For uncertainties related to modeling EECs in estuarine/marine environments, please see Section 6 - Uncertainties.

Use-specific management practices for all of the assessed uses of phorate were used for modeling, including application rates, number of applications per year, application intervals, buffer widths, and the first application date for each use. The date of first application was developed based on several sources of information including data provided by BEAD, a summary of individual applications from the CDPR PUR data, and Crop Profiles maintained by the USDA. According to the labels, most of the phorate applications are intended for “at-plant” and/or “post-emergent” conditions. In these cases, a Spring date (15 April) was selected to represent a relatively high-end aquatic exposure estimate within a time frame during which phorate use is most likely. (Summer applications mostly yield lower-end estimates due to lack of rainfall in many of the agricultural regions.)

More detail on the crop profiles and the previous assessments may be found at:
http://pestdata.ncsu.edu/cropprofiles/cropprofiles.cfm

3.2.2 Model Inputs

Phorate is an insecticide used on a wide variety of crops. Phorate environmental fate data used for generating model parameters are listed in **Table 3** and in **Section 2.4.1**. The input parameters for PRZM and EXAMS are shown in **Table 14**. All inputs are intended to reflect total phorate residues of concern (parent phorate, plus sulfoxide and sulfone degradates). There is a paucity of data available for determining some physical/chemical parameters of phorate and its degradates of concern (phorate sulfoxide and phorate sulfone). There is limited useable information on the aquatic metabolic degradation rates of the sulfoxide and sulfone degradates; some aerobic aquatic degradation rates were cited in MRID #44863002, but the study results are not suitable for use as model inputs Thus, for modeling purposes, phorate was considered stable to microbially-mediated aquatic degradation (both aerobic and anaerobic). The longer aerobic soil degradation rate for the sulfone degradate (137 days; as opposed to 65 days for sulfoxide and 3 days for parent) was used because the total toxic residues of phorate, rather than just the parent residues, were assessed here; sulfoxide and sulfone were the chief degradates formed in aerobic and anaerobic soil metabolism studies (although percentages formed from parent were not cited). Sulfoxide is also a major degradation product of microbially-influenced aerobic aquatic metabolism, forming a maximum of 10-15% of total applied parent at 2 days post-application (MRID #44863002). Sulfone was a minor degradation product, forming at a maximum of approximately 1.5% of parent, 10 days post-application (MRID #44863002). Phorate sulfoxide was detected only in trace amounts in hydrolysis studies conducted at pH 5, and not detected at pH 7 or 9 (MRID #44863001). Phorate sulfone was not detected in the hydrolysis studies at any pH. Because of a lack of detailed studies, and the overall greater persistence of the degradates, the Agency assumed that use of the longer half-lives was both appropriate and protective. In any case, for the aquatic environment, hydrolysis dominates phorate degradation; adjusting the aquatic metabolism half-lives barely affects the model outputs (EECs).

Table 14 Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs for PHORATE (and Degradates) Endangered Species Assessment

Fate Property	Value	MRID (or other source)
Molecular Weight	260.4	EXTOXNET
Henry's constant	5.8×10^{-6}	EPA-OPP RED 1996
Vapor Pressure (torr)	7.5×10^{-4}	EPA-OPP RED 1996
Solubility in Water (mg/L)	500	EXTOXNET (X10)
Photolysis in Water (days)	1.1	MRID #41348508
Aerobic Soil Metabolism Half-life	137	MRID #42459401
Hydrolysis (days)	3.2 at pH 7	MRID #41348507
Aerobic Aquatic Metabolism (days)	21	MRID #44863002
Anaerobic Aquatic Metabolism (days)	42	2X aerobic aquatic value
Koc	50	MRID #44671204 (lowest value for both degradates)
Application rate and frequency	See Table 12	Label
Application intervals	1 application per crop cycle	Label
Chemical Application Method (CAM)	1	Guidance document

Table 14 Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs for PHORATE (and Degradates) Endangered Species Assessment		
Fate Property	**Value**	**MRID (or other source)**
Application Efficiency	0.99	Guidance document
Spray Drift Fraction[1]	0 (granular)	

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

3.2.3 Results

The aquatic EECs for the various scenarios and application practices are listed in **Table 15.** The highest peak EEC values were associated with wheat, sorghum, and cotton (non-soil-incorporated applications); the lowest values were predicted for peanuts (soil-incorporated). PRZM-EXAMS model output files are presented in Appendix K.

Table 15 Aquatic EECs (µg/L) for PHORATE Uses in California

Scenario	Application Rate	Date of First Application	Crops Represented (Appl. Method)	Peak EEC	21-day average EEC	60-day average EEC
CAWheatRLF	1.0 lb a.i./A	April 15	wheat, sorghum (ground broadcast)	11.17	2.29	0.81
CAsugarbeet_WirrigOP	1.5 lb a.i./A	April 15	sugarbeet (ground broadcast)	5.85	1.12	0.393
CAWheatRLF	1.3125 lb a.i./A	April 15	sorghum (ground broadcast)	14.66	3.01	1.06
CAPotatoRLF	3.45 lb a.i./A	April 15	potato (ground broadcast)	1.95	0.366	0.129
CAalmond_WirrigSTD	1.6 lb a.i./A (85% soil-incorp.)	April 15	peanut* (soil-incorporated)	0.341	0.073	0.026
CAcotton_WirrigSTD	2.18 lb a.i./A	April 15	cotton (ground broadcast)	15.91	2.987	1.051
CAcornOP	1.3 lb a.i./A	April 15	corn (ground broadcast)	3.05	0.603	0.213
CAcornOP	1.3 lb a.i./A	June 15	sweet corn (ground broadcast)	6.75	1.35	0.478
CARowCropRLF	1.52 lb a.i./A	April 15	beans (ground broadcast)	3.01	0.613	0.216
CAnurserySTD	8.0 lb a.i./A (85% soil-incorp.)	April 15	ornamentals (soil-incorporated)	4.56	0.852	0.322

* No Peanut (or surrogate) scenario for CA. Used "CAalmond" scenario because although peanut is a (below)ground crop (probably more similar to tuber/root crops), in CA it is typically grown between rows of orchard trees. Thus, almond was selected since they are grown in widely spaced rows of trees and could support peanut cultivation between tree corridors.

Table 16 shows EECs for the same uses, but with soil-incorporation required for all applications. Thus, only 15% of applied product is considered available at the surface. This information complies with current label restrictions; however, both sets of data (Tables 15 & 16) are cited in this document in the interest of practical usage and protectiveness (i.e., earlier product labels are still on the market and could be used such that potential exposures would be consistent with Table 15), but also accuracy (Table 16 results reflect the most recent label restrictions).

Table 16 Aquatic EECs (µg/L) for PHORATE Uses in California; Soil-Incorporated Only						
Scenario	**Application Rate**	**Date of First Application**	**Crops Represented**	**Peak EEC**	**21-day average EEC**	**60-day average EEC**
CAWheatRLF	1.0 lb a.i./A (85% soil-incorp.)	April 15	wheat, sorghum	1.68	0.344	0.121
CAsugarbeet_WirrigOP	1.5 lb a.i./A (85% soil-incorp.)	April 15	sugarbeet	0.877	0.167	0.059
CAWheatRLF	1.3125 lb a.i./A (85% soil-incorp.)	April 15	sorghum	2.51	0.52	0.18
CAPotatoRLF	3.45 lb a.i./A (85% soil-incorp.)	April 15	potato	0.293	0.055	0.019
CAalmond_WirrigSTD	1.6 lb a.i./A (85% soil-incorp.)	April 15	peanut*	0.341	0.073	0.026
CAcotton_WirrigSTD	2.18 lb a.i./A (85% soil-incorp.)	April 15	cotton	2.39	0.45	0.16
CAcornOP	1.3 lb a.i./A (85% soil-incorp.)	April 15	corn	0.457	0.09	0.032
CAcornOP	1.3 lb a.i./A (85% soil-incorp.)	June 15	sweet corn	1.01	0.203	0.072
CARowCropRLF	1.52 lb a.i./A (85% soil-incorp.)	April 15	beans	0.452	0.092	0.032
CAnurserySTD	8.0 lb a.i./A (85% soil-incorp.)	April 15	ornamentals	4.56	0.852	0.322

* No Peanut (or surrogate) scenario for CA. Used "CAalmond" scenario because although peanut is a (below)ground crop (probably more similar to tuber/root crops), in CA it is typically grown between rows of orchard trees. Thus, almond was selected since they are grown in widely spaced rows of trees and could support peanut cultivation between tree corridors.

3.2.4 Existing Monitoring Data

A critical step in the process of characterizing EECs is comparing the modeled estimates with available surface water monitoring data. For this assessment, surface water data from the USGS NAWQA program (http://water.usgs.gov/nawqa) and from the California Department of Pesticide Regulation (CDPR) were examined, along with any available additional (surface or groundwater) data from other sources. There were no detections in any of the databases reviewed. In some cases, other chemicals would be detected while phorate would be absent, despite local usage of all monitored chemicals (e.g., Hoheisel et al., 1992; where chlorpyrifos, fonofos, terbufos, terbufos sulfone, carbaryl, aldicarb, aldicarb sulfoxide, and aldicarb sulfone were all detected in groundwater, but not phorate residues). Rapid hydrolysis of phorate under most common 'natural' pH conditions (pH = 5-9) may explain why phorate residues were not found in targeted groundwater studies – unlike some chemicals (such as aldicarb) where hydrolysis is highly pH-dependant.

3.2.4.1 USGS NAWQA Surface Water Data

Phorate is typically sampled for, but there were no detections of phorate or phorate residues in the USGS NAWQA Surface Water Database. Phorate has been analyzed but not detected in targeted studies as well. These studies include:

> The State of Illinois (Moyer and Cross 1990) sampled 30 surface water sites for pesticides at various times from October 1985 through October 1988. Although substantial use in Illinois was a criteria for pesticides being included in the analyses, total phorate was not detected in any of the samples above a detection limit of 0.05 ug/L.
>
> The USGS (Coupe etal 1995) sampled 8 widely dispersed locations in the Mississippi Basin from April 1991 through September 1992. Samples were collected once per week, twice per week, or once every two weeks depending upon the time of year. The samples were filtered before analysis. Phorate (dissolved) was not detected above a detection limit of 0.011 ug/L in any of the 360 samples for which an analysis for phorate was performed.
>
> The USGS (Kimbrough and Litke 1995) collected samples from each of two Colorado watersheds (one agricultural and one urban) at least monthly from April 1993 through March 1994. Samples were collected more frequently in late spring and early summer. A total of 25 samples were collected from each watershed. Phorate was detected above a method reporting limit of 0.02 ug/L in 2 of the samples collected from the agricultural watershed at concentrations of 0.08 ug/L to 0.60 ug/L. Phorate was not detected in any of the samples collected from the urban watershed.
>
> The South Florida Water Management District (SFWMD) (Miles and Pfeuffer 1994) collected samples every two to three months from 27 surface water sites within the SFWMD from November 1988 through November 1993. Approximately 810 samples (30 sampling intervals X 27 sites sampled/interval) were collected from the 27 sites from November 1988 through November 1993. Phorate was not detected in any of the samples above detection limits ranging from 0.016 to 0.13 ug/L.

3.2.4.2 USGS NAWQA Groundwater Data

There were no detections of phorate or phorate residues in the USGS NAWQA Groundwater Database. Phorate has been analyzed for but not detected in targeted groundwater studies as well (e.g., Hoheisel *et al*., 1992).

3.2.4.3 California Department of Pesticide Regulation (CPR) Data

Phorate is typically sampled for, but there were no detections of phorate or phorate residues in the CDPR Database.

3.3 Terrestrial Animal Exposure Assessment

T-REX (Version 1.3.1) is used to calculate dietary and dose-based EECs of phorate for birds, mammals, and terrestrial invertebrates. T-REX simulates a 1-year time period. For this assessment, granular applications of phorate were considered Terrestrial EECs for granular formulations of phorate were derived for the uses summarized in **Table 17**. Only the aerobic soil degradation half-life was available for parent phorate and the sulfoxide and sulfone degradates; no specific foliar dissipation data were available. However, since phorate is applied in granular form and is commonly applied on bare or nearly-bare ground, foliar interception (and dissipation) is minimal to non-existent. Also, as the sulfoxide/sulfone degradates appear to form within the soil and plants (and are of roughly equal toxicity to parent), it is more appropriate to use the aerobic soil half-life for total toxic phorate residues – 137 days – than the default foliar dissipation half-life of 35 days. Use-specific input values, including number of applications, application rate, foliar half-life and application interval are provided in **Table 17**. An example output from T-REX is available in **Appendix E**.

Table 17 Input Parameters for Granular Applications Used to Derive Terrestrial EECs for PHORATE with T-REX

Use (Application method)	Application Rate (lbs ai/A)	Number of Applications	Application Interval	Foliar Dissipation Half-Life
Wheat & Corn	1.0	1	N/A	137 days
Sugarbeet	1.5	1	N/A	137 days
Sorghum	1.3125	1	N/A	137 days
Potato	3.45	1	N/A	137 days
Peanut	1.6	1	N/A	137 days
Ornamentals	8.0	1	N/A	137 days
Cotton	2.18	1	N/A	137 days
Beans	1.52	1	N/A	137 days
Sweet Corn	1.3	1	N/A	137 days

N/A = Non-applicable

Table 18 gives the terrestrial exposure amounts for each use site, including mammals and birds, and all weight classes. The exposure estimates used to determine LD_{50}/ft^2 is in mg ai/ft^2.

Table 18 Terrestrial Granular Exposures

Use site	Mg/ft^2 [broadcast]
Wheat and corn	10.41
sugarbeet	15.62
sorghum	13.67

Use site	Mg/ft^2 [broadcast]
potato	35.92
peanut	16.66
ornamentals	83.3
cotton	22.7
Sweet corn	13.54
Beans	15.83

3.4 Terrestrial Plant Exposure Assessment

TerrPlant (Version 1.1.2) is generally used to calculate EECs for non-target plant species. However, due to a lack of available plant toxicity data, TerrPlant is not used in this assessment. Instead a general potential for whether there is any likelihood of exposure to obligate host plants and plant communities. In addition, there will be a general qualitative assumption that will be used to estimate the potential risk to obligate host plants and to plant communities.

4. Effects Assessment

This assessment evaluates the potential for Phorate to directly or indirectly affect the CRLF, BCB, VELB, and SJKF or modify their designated critical habitat. As previously discussed in Section 2.7, assessment endpoints for the effects determination for each assessed species include direct toxic effects on the survival, reproduction, and growth, as well as indirect effects, such as reduction of the prey base or modification of its habitat. In addition, potential modification of critical habitat is assessed by evaluating effects to the PCEs, which are components of the critical habitat areas that provide essential life cycle needs of each assessed species. Direct effects to the aquatic-phase CRLF are based on toxicity information for freshwater fish (or amphibian data if appropriate), while terrestrial-phase amphibian effects (terrestrial-phase CRLF) and reptiles are based on avian toxicity data, given that birds are generally used as a surrogate for terrestrial-phase amphibians and reptiles.

As described in the Agency's Overview Document (U.S. EPA, 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include freshwater fish (used as a surrogate for aquatic-phase amphibians), freshwater invertebrates, aquatic plants, birds (used as a surrogate for terrestrial-phase amphibians), mammals, terrestrial invertebrates, and terrestrial plants. Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and a comprehensive review of the open literature on Phorate.

Toxicity endpoints are established based on data generated from guideline studies submitted by the registrant, and from open literature studies that meet the criteria for inclusion into the ECOTOX database maintained by EPA/Office of Research and Development (ORD) (U.S. EPA, 2004). Open literature data presented in this assessment were obtained from ECOTOX on 2/28/08. In order to be included in the ECOTOX database, papers must meet the following minimum criteria:

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

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

Phorate is not considered to be carcinogenic or mutagenic. No sublethal endpoint has been identified to use for defining the action area. Therefore, action area will be defined by acute or chronic endpoints.

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

In addition to registrant-submitted and open literature toxicity information, other sources of information, including use of the acute probit dose response relationship to establish the probability of an individual effect and reviews of the Ecological Incident Information System (EIIS), are conducted to further refine the characterization of potential ecological effects associated with exposure to Phorate. A summary of the available aquatic and terrestrial ecotoxicity information, use of the probit dose response relationship, and the incident information for Phorate are provided in Sections 4.1 through 4.4, respectively.

Toxicity of degradates are discussed in section 4.1.2.3.

A detailed summary of the available ecotoxicity information for all phorate degradates and formulated products can be found in **Appendix A**.

4.1 Toxicity of Phorate to Aquatic Organisms

Table 19 summarizes the most sensitive aquatic toxicity endpoints, based on an evaluation of both the submitted studies and the open literature, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the CRLF, BCB, VELB, and SJKF is presented below. Additional information is provided in **Appendix A.**

Table 19 Aquatic Toxicity Profile for PHORATE					
Assessment Endpoint	**Acute/ Chronic**	**Species**	**Toxicity Value (ppb) Used in Risk Assessment**	**Citation MRID # (Author & Date)**	**Comment**
Freshwater fish (surrogate for aquatic-phase amphibians)	A	bluegill sunfish *(Lepomis macrochirus)*	LC_{50} = 2.35	40098001 Mayer, et. Al., 1986	supplemental
	C	bluegill sunfish *(Lepomis macrochirus)*	NOAEC = 0.34	Acute to Chronic ratio	See section 4.1.1.2
Freshwater invertebrates	A	Scud (*Gammarus fasciatus*)	EC_{50} = 0.60	05017538 Sanders, 1972	Supplemental
	C	Waterflea (*Daphnia magna*)	NOAEC = 0.21	42227102, Yurk, 1991	LOAEC = 0.41 ppb with affected endpoints of number of offspring per female, and growth of parental Daphnids
Aquatic plants (non-vascular)	A	Marine diatom (*Skeletonema costatum*)	EC_{50} > 1300	00066341 EPA, 1981	acceptable
Aquatic plants (vascular)	A	No data available			

Toxicity to fish and aquatic invertebrates is categorized using the system shown in **Table 20** (U.S. EPA, 2004). Toxicity categories for aquatic plants have not been defined.

Table 20 Categories of Acute Toxicity for Aquatic Animals.	
LC_{50} (ppm)	**Toxicity Category**
< 0.1	Very highly toxic
> 0.1 - 1	Highly toxic
> 1 - 10	Moderately toxic
> 10 - 100	Slightly toxic
> 100	Practically nontoxic

4.1.1 Toxicity to Freshwater Fish and Aquatic-Phase Amphibians

As specified in the Overview Document, the Agency uses fish as a surrogate for aquatic - phase amphibians when toxicity data for each specific taxon are not available (U.S. EPA, 2004). A summary of acute and chronic fish, aquatic-phase amphibian data, including data published in the open literature, is provided below in Sections 4.1.1.1 through 4.1.1.3.

4.1.1.1 Freshwater Fish: Acute Exposure (Mortality) Studies

Seven species of fish (rainbow trout, bluegill sunfish, channel catfish, cutthroat trout, northern pike, largemouth bass, and walleye) were tested with the technical grade phorate. Three species (rainbow trout, bluegill sunfish, and channel catfish) were tested with phorate formulation product (20% granular) and two species (rainbow trout and bluegill sunfish) were tested with three different mixtures involving another active ingredient with phorate.

Among the technical grade studies, bluegill is the most sensitive species with LC_{50} ranging from 1.4 ppb to 3.95 ppb. The value selected for this risk assessment is 2.35 ppb ai. More discussion can be found in **Appendix A** Ecological Effects Data. The range of sensitivity among the species from most sensitive to less sensitive is bluegill (2.35 ppb), largemouth bass (5 ppb), rainbow trout (13 ppb), largemouth bass (5 ppb), cutthroat trout (44 ppb), walleye (57 ppb), northern pike (110 ppb), and channel catfish (280 ppb). Based on these data, phorate is classified as very highly toxic to all of the species except northern pike and catfish to which it was classified as highly toxic.

The bluegill study was done with different weight groups (0.6 gm, 1.0 gm, 1.22 gm, and 1.6 gm). The lowest LC_{50} value of 1.4 ppb was not chosen since this value is an extrapolated value of which the lowest dose concentration tested is 2.1 ppb ai which has 60% mortality. The 95% confidence interval is 0.01-2.2 ppb and the slope is 3.2. There is much uncertainty in this value in that the LC_{50} value may be more or less sensitive and that there was no 50% mortality found within the dose concentrations tested.

The bluegill endpoint selected (2.35 ppb ai) has dose response with the lowest dose concentration (2.1 ppb) and has 30% mortality. The fish weight size is 1.6 gram which is within EPA guidelines. The endpoint (2.35 ppb ai) selected is the most sensitive valid endpoint value.

The other bluegill weight groups tested in this study showed LC50 values of 2.42 ppb ai for the 0.6 gram, 1.4 ppb ai for the 1.0 gram, 3.57 ppb ai for the 1.22 gram, 2.35 ppb ai for the 1.6 gram, and 3.9 ppb ai for the 4.1 gram group. Of the different weight groups, only the 1.0 gram groups did not have adequate dose response. The lowest concentration tested in the 1.0 gram group is 2.1 ppb ai with 60% mortality.

The fish species tested with 20% granular formulation have mixed results regarding sensitivity to phorate when compared to the technical grade material. The catfish tested with the technical grade phorate had LC_{50} of 280 ppb ai, whereas the formulated product had LC_{50} of 2.2 ppb product basis or 0.44 ppb ai basis. The catfish is more sensitive to the formulated product than to the technical grade phorate. The rainbow trout tested with the technical grade phorate had LC_{50} of 13 ppb ai, whereas the formulated product had LC_{50} of 45 ppb product basis or 9 ppb ai basis. The study results indicate that sensitivity of rainbow trout between the technical grade and the formulated product are similar.

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

The acute freshwater fish LC50 value (2.35 ppb from 40098001) is similar to the chronic freshwater fish NOAEC value (1.9 ppb from MRIDs 00015835, 41695101). Usually, the acute value would be at least 3X more than the chronic value. However, different freshwater species were tested. There is no chronic study available that uses the sensitive bluegill sunfish. The acute and chronic value for freshwater fish cannot have similar values. Because of the uncertainty regarding the chronic freshwater fish value, an acute-to-chronic ratio (ACR) was calculated to determine the chronic NOAEC for bluegill sunfish. Furthermore, the acute and chronic endpoints used should be from the same species if possible. The chronic value for the bluegill sunfish was calculated from the ACR. The ACR calculation is made as follows:

$$\frac{\text{Acute trout}}{\text{Chronic trout}} = \frac{\text{Acute bluegill}}{\text{Chronic bluegill}} = \frac{13\ \text{ppb}}{1.9\ \text{ppb}} = \frac{2.35\ \text{ppb}}{X}$$

X (bluegill NOAEC) = (1.9 x 2.35) / 13 = 0.343 **ppb**

The ACR calculated chronic NOAEC for bluegill sunfish is **0.34 ppb ai.**

4.1.1.3 Freshwater Fish: Sublethal Effects and Additional Open Literature Information

No additional information was found in ECOTOX database that could be useful for this risk assessment.

A letter dated 11/24/1998 from Lynn Miko (Vice-President, Global Qud, Assurance & Regulatory Compliance, American Cynamid Co.) and Dr. Mark Gallery of American Cynamid to OPP/EPA provided information on degradate toxicity of phorate sulfoxide. The letter indicated that phorate sulfoxide tested on bluegill sunfish resulted in a LC_{50} value of 22 ppb ai. This would place phorate sulfoxide to be very highly toxic to bluegill sunfish. This information is considered to be supplemental since no raw data were provided and this test was a preliminary screen with 10X progression.

4.1.2 Toxicity to Freshwater Invertebrates

A summary of acute and chronic freshwater invertebrate data, including data published in the open literature, is provided below in Sections 4.1.2.1 through 4.1.2.3.

4.1.2.1 Freshwater Invertebrates: Acute Exposure Studies

Three species of aquatic invertebrates (scud, crayfish and stoneflies) were tested with the technical grade phorate. Three species (water flea, mayfly nymphs, and midge larvae) were tested with phorate formulation product (20% granular) and the water flea was tested with two different mixtures involving another active ingredient with phorate.

Among the technical grade studies, scud is the most sensitive species with LC_{50}s of 0.68, 0.60, 9, and 4.0 ppb ai. The scud values came from 3 different studies. In two of the studies, the scuds were tested at different temperatures. For the scud with the LC_{50} value of 0.68 and 0.60 ppb, the temperature was 21^{o}C and for the scud with an LC_{50} of 9 ppb, the temperature was 70^{o}F. The study is considered to be supplemental due to the scud being too mature for testing and for the lack of raw data. The value selected for this risk assessment is scud LC_{50} = **0.60 ppb ai**. The range of sensitivity among the species from most sensitive to less sensitive is scud (0.60 ppb), stoneflies (4 ppb), and crayfish (50 ppb). All of the species lead to an acute toxicity classification of very highly toxic to freshwater aquatic invertebrates.

The aquatic invertebrate species tested with 20% granular formulation have similar sensitivities regarding toxicity from phorate when compared to the results of tests with technical grade material. Species that were tested with the technical were not tested with the formulated product. It is difficult to compare formulation with the technical grade testing with different species. Generally, the formulated products may appear to be slightly less toxic or similar to the technical grade phorate. The sensitivity of the species tested with the 20% granular from most sensitive to least sensitive ranges from water flea (7.4 ppb), midge larvae (8.2 ppb), and mayfly nymphs (13.0 ppb).

4.1.2.2 Freshwater Invertebrates: Chronic Exposure Studies

There are two chronic studies using the water flea (*Daphnis magna*) that were submitted to the Agency. They both show very similar results. The NOAECs from the studies are 0.29 ppb (MRIDs 00158336, 41131115; Suprenant, 1990) and 0.21 ppb (MRID 42227102; Yurk, 1991). The most sensitive waterflea NOAEC (**0.21 ppb ai**) was used for this assessment. The endpoints affected are number of offspring per female, survival of adults, production of young, and growth of parents. These studies are considered to be acceptable.

4.1.2.3 Freshwater Invertebrates: Open Literature and Other Data

No additional information was found in the ECOTOX database that could be useful for this risk assessment. However, a letter dated 11/24/1998 from Lynn Miko (Vice-President, Global Qud, Assurance & Regulatory Compliance, American Cynamid Co.) and Dr. Mark Gallery (American Cynamid Co.) to OPP/EPA provided information on the toxicity of two of phorate's degradates, phorate sulfone and phorate sulfoxide. The following information was made available:

<u>Phorate sulfoxide</u>
Daphnia magna EC_{50} = 4.0 ppb ai

<u>Phorate sulfone</u>
Daphnia magna EC_{50} = 0.4 ppb ai

The phorate sulfone appears to be more toxic than phorate sulfoxide by an order of magnitude. The phorate sulfone also appears to be either similar or slightly more toxic than the parent phorate These data lead to a classification for phorate sulfoxide and sulfone of very highly toxic to aquatic invertebrates on an acute basis. This information is considered to be supplemental since no raw data were provided; this test was a preliminary screen with 10X progression.

4.1.3 Toxicity to Aquatic Plants

Two types of studies were used to evaluate the potential of Phorate to affect aquatic plants. Laboratory and field studies were used to determine whether Phorate may cause direct effects to aquatic plants. A summary of the laboratory data and freshwater field studies for aquatic plants is provided in Sections 4.1.3.1 and 4.1.4.

4.1.3.1 Aquatic Plants: Laboratory Data

Only one aquatic plant study was submitted to the Agency. It was on Marine diatom (*Skeletonema costatum*) with an EC_{50} of 1300 ppb ai. No other non-vascular or vascular study was submitted. No other data were found available from the ECOTOX database.

It appears that phorate has some phytotoxicity from the following statements from the EFED Science Chapter for Phorate RED:

> Also it should be noted that phorate *can* be phytotoxic. The labeling carries the following warnings: -
>
> 1. Beans - Do not place Phorate 20G granules in direct contact with seed at planting time.
> 2. Field corn, Sorghum, Soybeans, Sugarbeets - Do not place Phorate 20G granules in direct contact with seed.
> 3. Do apply in-furrow or allow to come in direct contact with the seed.
> 4. Do not allow granules to contact the seed piece.
> 5. Do not use on Diakon radish varieties.
>
> The phytotoxicity and label warnings would appear to rule out in-furrow as a risk reduction measure for most crops.

4.1.4 Freshwater Field/Mesocosm Studies

An aquatic field study conducted in Iowa used Thimet 20G (20% granular phorate). The study only produced comparable data for 3 of 5 ponds. Three ponds have similar chemical and physical characteristics. One pond was a reference pond, the other two were watersheds treated with Thimet 20G. Significant rainfall events did not occur until 10-14 days after treatment. Reductions to invertebrate populations, fish growth and bluegill fecundity were apparent in ponds adjacent to the treated field. Most of the population reductions noted in the study were as a result of exposure to the metabolites of phorate, phorate sulfone and sulfoxide. Both metabolites were found when the pond water was analyzed. The authors of the study suggest that phorate may significantly decrease diversity in natural ecosystem. (MRID 42227101).

A mesocosms study in South Dakota investigated the effects of phorate to wetland macroinvertebrates. Each wetland had a reference and 3 treated mesocosms with application rates of 1.2, 2.4, and 4.8 kg/ha (1, 2, and 4.3 lbs/A), respectively. After being treated for one month, all rates of application resulted in mortality to all amphipods and chironomids (MRID 43957801).

4.2 Toxicity of Phorate to Terrestrial Organisms

Table 21 summarizes the most sensitive terrestrial toxicity endpoints, based on an evaluation of both the submitted studies and the open literature. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment is presented below.

Table 21 Terrestrial Toxicity Profile for Phorate

Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation MRID# (Author & Date)	Comment
Birds (surrogate for terrestrial-phase amphibians and reptiles)	A	mallard duck mallard duck	LD_{50} = 0.62 mg/kg bw LC_{50} = 240 ppm diet	00160000 Hudson, 1984 00022923 Hill, 1975	acceptable
	C	Mallard duck	NOAEC = 5 ppm diet	00158333 Beavers, 1986	Acceptable. Affects were on eggs laid, viable embryo, normal hatchlings
Terrestrial-phase Amphibians	A	Bullfrog	LD_{50} = 85.2 mg ai/kg bw	00016000 Hudson, 1984	acceptable
Mammals	A	Rat	Acute oral LD50 = 1.4 mg/kg bw	42857001 Kiplinger, G. 1993	acceptable
	C	Rat	2-generation rat reproduction NOAEL = 0.2 mg/kg bw/day (2 ppm diet) LOAEL = 0.4 mg/kg bw/day (4 ppm diet)	44422302 Schroeder, 1991	Acceptable Offspring affects were on decreased pup survival and pup body weight. Parental systemic toxicity = clinical signs (tremors) and inhibitions of plasma and brain cholinesterase activity (F_1 females only).
Terrestrial invertebrates	A	Honey bee	Acute contact LD_{50} = 0.32 µg/bee	05001991 Stevenson, 1978	acceptable
Terrestrial plants	No data available				

N/A: not applicable

Acute toxicity to terrestrial animals is categorized using the classification system shown in **Table 22** (U.S. EPA, 2004). Toxicity categories for terrestrial plants have not been defined.

Table 22 Categories of Acute Toxicity for Avian and Mammalian Studies		
Toxicity Category	**Oral LD_{50}**	**Dietary LC_{50}**
Very highly toxic	< 10 mg/kg	< 50 ppm
Highly toxic	10 - 50 mg/kg	50 - 500 ppm
Moderately toxic	51 - 500 mg/kg	501 - 1000 ppm
Slightly toxic	501 - 2000 mg/kg	1001 - 5000 ppm
Practically non-toxic	> 2000 mg/kg	> 5000 ppm

4.2.1 Toxicity to Birds and Terrestrial-Phase Amphibians

As specified in the Overview Document, the Agency uses birds as a surrogate for terrestrial-phase amphibians when toxicity data for each specific taxon are not available (U.S. EPA, 2004). A summary of acute and chronic bird, terrestrial-phase amphibian data, including data published in the open literature, is provided below in Sections 4.2.1.1 through 4.2.1.3.

4.2.1.1 Birds: Acute Exposure (Mortality) Studies

Acute oral studies with the technical grade phorate were submitted for six species of birds (mallard duck, ring-necked pheasant, starlings, redwing blackbird, grackle, and chukar). Avian sub-acute toxicity dietary studies with technical grade phorate were submitted for three species of birds (mallard duck, ring-necked pheasant and bobwhite quail). Three Avian sub-acute toxicity dietary studies with another active ingredient in addition to phorate were submitted for two species (mallard duck and bobwhite quail). No formulated product testing with just phorate was submitted for oral acute or sub-acute toxicity dietary.

Among the technical grade studies, mallard duck is the most sensitive species during both the acute oral and subacute dietary studies with LD_{50} of 0.62 mg ai/kg-bw and LC_{50} of 240 ppm ai. These studies are considered to be acceptable. For the acute oral studies, the range of sensitivity among the species from most sensitive to less sensitive is mallard duck (0.62 and 3.55 mg/kg-bw), redwing blackbird (1.0 mg/kg-bw), grackle (1.3 mg/kg-bw), ring-necked pheasant (7.12 mg/kg-bw), starlings (7.5 mg/kg-bw), and chukar (12.8 mg/kg-bw). Phorate is categorized as very highly toxic to all of the species tested except the chukar for which it was categorized as highly toxic. For the subacute dietary studies, the range of sensitivity among the species from most sensitive to less sensitive is mallard duck (240 ppm ai), bobwhite quail (373 ppm ai), and ring-necked pheasant (441 ppm ai). Phorate is categorized as highly toxic to all the species tested.

One of the authors of the avian acute oral studies, Hudson, gave the following account of the bird's exposure to phorate:

> "Ataxia, diarrhea, beak-sharpening reflex, polydipsia, lacrimation, loss of rightening reflex, immobility, irregular heart and respiratory rates, tremors, wing-beat convulsions, or opisthotonos. Levels as low as 0.09 mg/kg produced signs in mallards. This was an extremely fast-acting compound on all species tested.

> Signs occurred in pheasants as soon as 3 minutes after treatment. Mortality usually occurred between 10 minutes and 4 hours after treatment. Remission took up to 2 days."

4.2.1.2 Birds: Chronic Exposure (Growth, Reproduction) Studies

Two avian species were tested for reproductive endpoints – bobwhite quail and mallard duck. No adverse reproductive effects were observed at 60 ppm ai for the bobwhite quail. However, the mallard duck showed adverse reproductive effects with a lowest observed effective level (LOAEL) of 60 ppm ai. The NOAEL for the mallard duck is 5 ppm ai. The acceptable avian reproduction study testing mallard duck showed significant reductions in eggs laid, viable embryo, and normal hatchlings when they are fed 60 ppm of technical Phorate for 19 weeks. Morphological changes in reproductive organs such as regressed gonads and egg yolk peritonitis were observed at 60 ppm.

4.2.1.3 Terrestrial-phase Amphibians: Acute and Chronic Studies

The only frog toxicity data available is a 1984 acute oral toxicity study on the bullfrog. The endpoint measurement is mortality. The LD_{50} is 85.2 mg ai/kg. Since this endpoint is less toxic than the avian acute oral endpoint, the avian oral acute endpoint will be used in this assessment.

4.2.2 Toxicity to Mammals

A summary of acute and chronic mammalian data, including data published in the open literature, is provided below in Sections 4.2.2.1 through 4.2.1.2.

4.2.2.1 Mammals: Acute Exposure (Mortality) Studies

EPA's Health Effects Division (HED) calculated the acute oral LD_{50} for the rat at 3.7 mg/kg-bw for the male and 1.4 mg/kg-bw for the female. The dermal acute LD_{50} = 9.3 mg/kg male rat and 3.9 mg/kg for the female rat. The acute inhalation LD_{50} is 0.06 mg/kg for the male rat and 0.011 mg/kg for the female rat. The studies are considered to be acceptable.

As noted in the HED 2/18/1999 phorate science chapter:

> "Technical phorate is highly toxic on an acute oral, dermal, and inhalation basis. The oral LD_{50} values for phorate with rats were 3.7 and 1.4 mg/kg in males and females, respectively (Toxicity Category I). All of the animals that died in this study showed typical clinical signs of cholinergic toxicity such as salivation, lacrimation, exophthalmos, muscle fasciculation and excessive urination and defecation.

The dermal LD_{50} values for phorate with rats were 9.3 and 3.9 mg/kg in males and females, respectively (Toxicity Category I). The cholinergic signs noted for the acute oral study were also observed in the acute dermal study. In addition, a dermal LD_{50} of 415.6 mg/kg in guinea pigs with typical cholinergic signs noted at higher doses was also reported.

The acute inhalation LC_{50} for rats were 0.06 and 0.011 mg/L for males and females, respectively (Toxicity Category I), based on a one-hour exposure to analytical grade phorate aerosol. Cholinergic signs were observed in intoxicated animals."

4.2.2.2 Mammals: Chronic Exposure (Growth, Reproduction) Studies

The HED 2/18/1999 phorate science chapter supporting the tolerance reassessment eligibility decision also provides information on the rat 2-generation reproductive study. This study showed the NOAEL to be 0.2 mg/kg/day (2 ppm) and the LOAEL to be 0.4 mg/kg/day (4 ppm). The observed offspring toxicity is decreased pup survival and decreased pup body weight. The observed parental systemic toxicity is clinical signs (tremors) and inhibitions of plasma and brain cholinesterase activity (F_1 females only). The study is considered to be acceptable.

In addition, the HED 2/18/1999 science chapter reported that Phorate was not considered carcinogenic under the conditions of the two-year chronic toxicity/carcinogenicity study in rats (50/sex/group) because the treatment did not alter the spontaneous tumor profile in rats. Phorate was also not considered to be mutagenic because technical phorate did not induce a genotoxic response in any of the tests used to detect mutagenicity.

4.2.3 Toxicity to Terrestrial Invertebrates

A summary of acute terrestrial invertebrate data, including data published in the open literature, is provided below in Sections 4.2.3.1 through 4.2.3.2.

4.2.3.1 Terrestrial Invertebrates: Acute Exposure (Mortality) Studies

Honey bee acute toxicity studies were submitted to the Agency. The most sensitive acute toxicity study is an acute contact study with an LD_{50} of 0.32 µg ai/bee (MRID 00016000). The other honeybee acute oral study has an LD_{50} of 0.44 µg ai/bee (MRID 05001991). An acute contact study has an LD_{50} of 10.07 µg /bee (MRID 00036935). These studies are considered to be acceptable.

A study from the literature (MRID 05008149, Gholson, 1978) on acute toxicity to various carabid beetles was submitted to the Agency. The carabid beetles (*Scarites substriatus,* *Pterostichus chalcites, Bembidion quadrimaculatum, Bembidion rapidum, Harpalus pennsylvanicus*) were observed to have 100% mortality at 1.12 kg ai/ha application rate.

4.2.3.2 Terrestrial Invertebrates: Open Literature Studies

No additional information was found in the ECOTOX database that could be useful for this risk assessment.

4.2.4 Toxicity to Terrestrial Plants

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

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

It appears that phorate has some phytotoxicity from the following statements from the EFED Science Chapter for Phorate RED:

> Also it should be noted that phorate *can* be phytotoxic. The labeling carries the following warnings: -
>
> 1. Beans - Do not place Phorate 20G granules in direct contact with seed at planting time.
> 2. Field corn, Sorghum, Soybeans, Sugarbeets - Do not place Phorate 20G granules in direct contact with seed.
> 3. Do apply in-furrow or allow to come in direct contact with the seed.
> 4. Do not allow granules to contact the seed piece.
> 5. Do not use on Diakon radish varieties.
>
> The phytotoxicity and label warnings would appear to rule out in-furrow as a risk reduction measure for most crops.

There are currently no terrestrial plant studies available for assessing risk to non-target terrestrial plants.

4.2.5 Terrestrial Field Studies

Field studies can help document or observe adverse effects to nontarget organisms due to pesticide use. Field studies also can help reduce the uncertainty in extrapolating from laboratory data to the field. Laboratory toxicity data and EECs sometimes fail to show how the effects are influenced by the that may be present under field conditions. Those variables have been identified as having potential influence on the effects of the toxicant to nontarget organisms under field conditions; however, the degree to which these factors influence field effects remains poorly defined. Because of these uncertainties, verification of the presence or absence of effects under actual use conditions can provide useful insight into the risk associated with a pesticide.

Several limitations to field testing also should be considered when evaluating risks associated with pesticide use. Field studies generally sample only a small segment of the field conditions that can occur from actual use. While field studies can provide a significant increase in the understanding of risk to nontarget species over the laboratory experiments, generally it is not practical to collect data on all species, or even a high percentage of species potentially at risk. Also, there are practical limits to sampling the various application methods under all crop use patterns, locations, regions, and weather conditions, particularly for pesticides with large and various uses. Therefore, even with field studies, extrapolation to other field conditions can lead to erroneous conclusions for reasons similar to those involved in extrapolating from the laboratory to the field. Natural variability among endpoints within and between species can complicate interpretation of field study data, making it difficult to sort out effects. However, when field studies are conducted with adequate sample size and appropriate scale to provide reasonable sensitivity, they can provide useful information in evaluating the hazards to nontarget organisms associated with pesticide use.

A field study was conducted using phorate on corn with at-plant, at-cultivation, and aerial applications. The usefulness of the study was limited because the researchers did not sufficiently search the treated areas. Even so, the study showed that phorate granules may kill birds and mammals. Among the killed and poisoned species found were a peacock, raccoon, indigo bunting, goldfinch, short-tailed shrews, and starlings. Residue analysis indicated that phorate and it’s degradates were sufficient to cause death to birds and mammals for two to three weeks after application. (MRID No. 40165901)

Field studies confirmed the expected risk by demonstrating that phorate can kill birds and mammals both large and small. Smaller animals usually eat a higher percent of food relative to their bodyweight than larger animals. Therefore, the effect to the raccoon observed in this study is significant. If a raccoon can receive a lethal dose, animals the size of raccoons are at risk in addition to small mammals such as rodents. Also, this brings up-the possibility of secondary poisoning. Secondary poisoning occurs when an animal is poisoned after feeding on a poisoned animal.

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

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

Individual effect probabilities are calculated based on an Excel spreadsheet tool IECV1.1 (Individual Effect Chance Model Version 1.1) developed by the U.S. EPA, OPP, Environmental Fate and Effects Division (June 22, 2004). The model allows for such calculations by entering the mean slope estimate (and the 95% confidence bounds of that estimate) as the slope parameter for the spreadsheet. In addition, the acute RQ is entered as the desired threshold. Probit slope results are found in section 5.2.1.

4.4 Incident Database Review

A review of the EIIS database for ecological incidents involving phorate was completed on September 3, 2008. The results of this review for terrestrial, plant, and aquatic incidents are discussed below in Sections 4.4.1 through 4.4.3, respectively. A complete list of the incidents involving phorate including associated uncertainties is included as **Appendix J**.

4.4.1 Terrestrial Incidents

The 2001 phorate Interim Reregistration Eligibility Decision (IRED) lists 14 avian and mammalian incidents spanning from 1972 to 1991. Each of these incidents had analysis performed on bird or mammal carcasses and phorate residues were found. More detailed information can be found in the IRED and in EFED Science Chapter for the Phorate RED (July 18, 1998; Wagner, Pauline; USEPA/OPPTS/EFED).

The EFED Science Chapter states in the conclusion that

> "the field studies and the incidents indicate that the use of phorate will result in adverse effects. Phorate and its metabolites can express their toxicity several months after application as shown in the above incidents. The Agency believes

that during the winter the topsoil and subsoil are frozen, and there is slow degradation until spring thaws when phorate and metabolites begin to move. Storage stability data cited in the human health assessment chapter indicating, phorate, and the metabolites are stable for 1 to 3 years if stored under frozen conditions lend support to the above scenario. No downward movement of phorate or metabolites will occur until the subsoil thaws, but spring rains wash phorate and metabolites into surface water ponds, lakes and streams. The waterfowl deaths appear to be connected with this flooding of treated fields. The flooded fields will attract the birds. The water could poison the birds in many different ways. For example, it could be through the skin, drinking, preening, or through eating contaminated flora or fauna growing in the puddle but, as with many incidents, the exact route of exposure could be single or multiple. Also of equal significance, incidents show phorate can kill songbirds, upland gamebirds, and mammals, as well as waterfowl. Field studies both simulated and actual with corn show that phorate presents a risk under more conventional application and exposure scenarios."

Since that time, there have been four additional incidents identified involving terrestrial birds and mammals. They are described as below:

- 1996 (I004756-001) In Kansas, the stomach contents of three out of five dead swift foxes analyzed were found to have residues of phorate. The phorate residue concentrations range from 23.5 to 58.9 ppm. Depressed cholinesterase activity found in one of the foxes is consistent with organophosphate toxicosis. The incident resulted from registered use. It is highly probable that phorate caused the mortalities.

- 1996 (I007495-002) In Kansas, the stomach contents of three out of three dead swift foxes analyzed were found to have residues of phorate. The phorate residue concentrations range from 23.5 to 58.9 ppm. It is unknown as to whether incident resulted from registered use. It is highly probable that phorate caused the mortalities.

The above two incidences (I004756-001 and I007495-002) have same residue concentrations in the carcasses of the foxes. This may lead one to conclude that the incidences may be the same. These incidences came into the EPA as separate incidences with separate documentation with them. Although the incidences may be similar, it can not be ruled out that they may be different and separate incidences.

- 1998 (I008109-001) In California, corn field treated with phorate to control wireworms on June 30, 1998. In late November, 1998, the field was flooded for a "duck club" purpose. In December, 1998, 157 waterfowls were found dead. CA fish and game conducted investigation ruled out avian disease and found phorate in 4 duck gizzards and in one sediment sample. The incident resulted from registered use. It is highly probable that phorate caused the mortalities.

2004 (I018980-012) USGS reported that 5 Canada Geese died in Virginia. The contents within the geese were examined and found to contain phorate residues. No other information is available. It is unknown as to whether incident resulted from registered use. It is highly probable that phorate caused the mortalities.

4.4.2 Plant Incidents

There have been 2 incidents reported involving plants from the use of phorate. In 2001 (I011838-014, -088) a peanut field was treated with Flumioxian (herbicide) and phorate. There were 127 acres affected in Oklahoma and 48 acres in Georgia. Due to the treatment on the fields, there was stunting of the peanut crop in the fields. In addition, there was reported some leaf top necrosis in some of the plants in the fields. Because no follow up information was provided after the observations, Itis uncertain if the plants recovered. The formulation using both active ingredients was 50 WDG which is non-granular foliar spray. Currently, phorate is used only with granular formulations. Both chemicals are registered for use on peanuts.

4.4.3 Aquatic Incidents

The RED indicated that three aquatic incidents occurred from runoff containing phorate residues being deposited in nearby ponds and streams. No aquatic incidents have been reported from the use of phorate since the RED was issued.

5. Risk Characterization

Risk characterization is the integration of the exposure and effects characterizations. Risk characterization is used to determine the potential for direct and/or indirect effects to the CRLF and VELB, BCB, and SJKF species or for modification to their designated critical habitats, from the use of phorate in CA. The risk characterization provides an estimation (Section 5.1) and a description (Section 5.2) of the likelihood of adverse effects; articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the likelihood of adverse effects to the assessed species or their designated critical habitat (*i.e.*, “no effect,” “likely to adversely affect,” or “may affect, but not likely to adversely affect”).

Of the highest-use counties for phorate (Fresno, Riverside, San Joaquin, and Tulare), San Joaquin county is closest to the San Francisco Bay. Tulare and Fresno counties are in the southern portion of the Central Valley. Riverside County is in the far south of California, and is hydrologically distinct from the San Francisco Bay watershed – there should be no impact to the Bay from this region. Counties immediately surrounding San Francisco Bay have little or no phorate use. Thus, direct impact to the San Francisco Bay area is unlikely, as most phorate is used within the Central Valley (which is hydrologically connected to the Bay primarily through drainage from the San Joaquin and Sacramento

River systems) and in the southernmost part of the state. Throughout California, the greatest risks should arise from on-site/near-site deposition of granules, and runoff to nearby low-lying areas and water bodies.

5.1 Risk Estimation

Risk is estimated by calculating the ratio of exposure to toxicity. This ratio is the risk quotient (RQ), which is then compared to pre-establish acute and chronic levels of concern (LOCs) for each category evaluated (**Appendix C**). For acute exposures to the listed aquatic animals (including aquatic-phase amphibians), as well as listed terrestrial invertebrates, the LOC is 0.05. The acute LOC for non-listed aquatic and terrestrial animals is 0.5. For acute exposures to the listed birds (and, thus, reptiles and terrestrial-phase amphibians) and listed mammals, the LOC is 0.1. The LOC for chronic exposures to animals is 1.0.

Acute and chronic risks to aquatic organisms are estimated by calculating the ratio of exposure to toxicity using 1-in-10 year EECs based on the label-recommended phorate usage scenarios summarized in **Table 15 and 16** and the appropriate aquatic toxicity endpoint from **Table 19**. Acute and chronic risks to terrestrial animals are estimated based on exposures resulting from applications of phorate (**Table 18**) and the appropriate toxicity endpoint from **Table 21**.

5.1.1 Exposures in the Aquatic Habitat

Table 23 below provides that acute and chronic RQs for freshwater fish (or aquatic-phase amphibian) and freshwater invertebrates, based on label information prior to May 2008.

Table 23 Summary of Acute and Chronic RQs for Freshwater Fish and Invertebrates (for pre-May 2008 labels)

Uses/Application Rate	Species	Peak EEC (µg/L)	21-Day EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Wheat & Sorghum / 1 lb a.i./A (aerial appl.)	Bluegill Sunfish Scud Daphnia	11.17	2.29	0.81	**4.8** **18.6**	**2.4** **10.9**
Sugarbeet / 1.5 lb a.i./A (aerial appl.)	Bluegill Sunfish Scud Daphnia	5.85	1.12	0.393	**2.5** **9.8**	**1.2** **5.3**
Sorghum / 1.3125 lb a.i./A	Bluegill Sunfish Scud Daphnia	14.66	3.01	1.06	**6.2** **24.4**	**3.1** **14.3**
Potato / 3.45 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	1.95	0.366	0.129	**0.8** **3.3**	0.4 **1.7**
Peanut / 1.6 lb a.i./A (soil-incorp.)	Bluegill Sunfish Scud Daphnia	0.341	0.073	0.026	***0.14*** **0.6**	0.1 0.3
Cotton / 2.18 lb a.i./A (ground appl.)	Bluegill Sunfish Scud	15.91	2.987	1.051	**6.7** **26.5**	**3.1**

	Daphnia					**14.2**
Corn / 1.3 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	3.05	0.603	0.213	**1.3** **5.1**	0.6 **2.9**
Sweet Corn / 1.3 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	6.75	1.35	0.478	**2.9** **11.3**	**1.4** **6.4**
Beans / 1.52 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	3.01	0.613	0.216	**1.2** **5.0**	0.6 **2.9**
Ornamentals 8 lb a.i./A (soil-incorp.)	Bluegill Sunfish Scud Daphnia	4.56	0.852	0.322	**1.9** **7.6**	0.9 **4.1**

* The acute RQ is calculated from peak EEC/LC_{50} or EC_{50} of the fish or invertebrates, respectively. The Chronic RQ is calculated by the 21-day EEC/NOAEC for Daphnia for the invertebrates and the 60-day EEC/NOAEC from the ACR for fish. LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded. Sunfish LC_{50} = 2.35 ppb; NOAEC = 0.34 ppb (chronic). Scud (invert.) EC_{50} = 0.60 ppb; Daphnia NOAEC = 0.21 ppb (chronic). Italicized denotes RQ as being more than listed species LOC but less than acute LOC. Bold denotes LOC exceedance for listed species and for acute.

Table 24 shows EECs for the same uses, but with soil-incorporation required for all applications. Thus, only 15% of applied product is considered available at the surface. This information complies with current label restrictions; however, both sets of data (Tables 23 & 24) are cited in this document in the interest of practical usage and protectiveness (i.e., earlier product labels are still on the market and could be used such that potential exposures would be consistent with Table 23), but also accuracy (Table 24 results reflect the most recent label restrictions).

Table 24 Summary of Acute and Chronic RQs for Freshwater Fish and Invertebrates; Soil-Incorporated Only

Uses/Application Rate	Species	Peak EEC (µg/L)	21-Day EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Wheat & Sorghum / 1 lb a.i./A (aerial appl.)	Bluegill Sunfish Scud Daphnia	1.68	0.344	0.121	**0.7** **2.8**	0.4 **1.6**
Sugarbeet / 1.5 lb a.i./A (aerial appl.)	Bluegill Sunfish Scud Daphnia	0.877	0.167	0.059	***0.4*** **1.5**	0.2 0.8
Sorghum / 1.3125 lb a.i./A	Bluegill Sunfish Scud Daphnia	2.51	0.52	0.18	**1.1** **4.2**	0.5 **2.5**
Potato / 3.45 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	0.293	0.055	0.019	***0.1*** **0.5**	0.1 0.3
Peanut / 1.6 lb a.i./A (soil-incorp.)	Bluegill Sunfish Scud Daphnia	0.341	0.073	0.026	***0.1*** **0.6**	0.1 0.1
Cotton / 2.18 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	2.39	0.45	0.16	**1.0** **4.0**	0.5 0.8
Corn / 1.3 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	0.457	0.09	0.032	***0.2*** **0.8**	0.1 0.4

Uses/Application Rate	**Species**	**Peak EEC (µg/L)**	**21-Day EEC (µg/L)**	**60-day EEC (µg/L)**	**Acute RQ***	**Chronic RQ***
Sweet Corn / 1.3 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	1.01	0.203	0.072	***0.4*** **1.7**	0.2 **1.0**
Beans / 1.52 lb a.i./A (ground appl.)	Bluegill Sunfish Scud Daphnia	0.452	0.092	0.032	***0.2*** **0.8**	0.1 0.4
Ornamentals 8 lb a.i./A (soil-incorp.)	Bluegill Sunfish Scud Daphnia	4.56	0.852	0.322	**1.9** **7.6**	0.9 **4.1**

* The acute RQ is calculated from peak EEC/LC_{50} or EC_{50} of the fish or invertebrates, respectively. The Chronic RQ is calculated by the 21-day EEC/NOAEC for Daphnia for the invertebrates and the 60-day EEC/NOAEC from the ACR for fish. LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded. Sunfish LC_{50} = 2.35 ppb; NOAEC = 0.34 ppb (chronic). Scud (invert.) EC_{50} = 0.60 ppb; Daphnia NOAEC = 0.21 ppb (chronic). Italicized denotes RQ as being more than listed species LOC but less than acute LOC. Bold denotes LOC exceedance for listed species and for acute.

5.1.1.1 Freshwater Fish and Aquatic-phase Amphibians

Acute risk to fish and aquatic-phase amphibians is based on peak EECs in the standard pond and the lowest acute toxicity value for freshwater fish. Chronic risk is based on 60-day EECs and the lowest chronic toxicity value for freshwater fish is used.

Based on pre-May 2008 labels (Table 23), there are acute LOC exceedances for listed species, for every phorate use. Non-listed species RQs are also exceeded (>0.5) for every use, except for peanut use. Chronic LOC exceedances exist for freshwater fish for the following uses: wheat, sorghum, sugarbeet, cotton, and sweet corn. Thus, aquatic-phase CRLF may be affected.

Based on soil-incorporated assumptions only (Table 24), there are acute LOC exceedances for listed species (ES), for every phorate use. Non-listed fish LOCs are only exceeded (>0.5) for wheat, sorghum, cotton, and ornamental use. Chronic LOC exceedances exist for freshwater fish for the following uses: wheat, sorghum, sugarbeet, cotton, and sweet corn. Thus, aquatic-phase CRLF may be affected.

Based on acute RQ exceedance for listed species for every use, phorate has the potential to directly affect the CRLF. Additionally, since the acute and chronic RQs are exceeded, there is a potential for indirect effects to those listed species (CRLF) that rely on fish (and aquatic-phase amphibians) during at least some portion of their life-cycle. However, potential effects on the SJKF, BCB, and VELB are irrelevant here because there is little or no direct or indirect aquatic exposure for these species.

5.1.1.2 Freshwater Invertebrates

Acute risk to freshwater invertebrates is based on peak EECs in the standard pond and the lowest acute toxicity value for freshwater invertebrates. Chronic risk is based on 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates.

Based on pre-May 2008 labels (Table 23), there are acute LOC exceedances for listed species, for every phorate use. Non-listed species RQs are also exceeded (>0.5) for every use. Chronic LOC exceedances exist for aquatic invertebrates for all uses except peanut.

Based on soil-incorporated assumptions only (Table 24), there are acute risks (listed and non-listed) for freshwater invertebrates with every phorate use. Chronic LOC exceedances exist for only the following uses: wheat, sorghum, sweet corn, and ornamentals.

Since the acute and chronic RQs are exceeded, there is a potential for indirect effects to those listed species that rely on freshwater invertebrates during at least some portion of their life-cycle (*i.e.*, CRLF). However, potential effects on the SJKF, BCB, and VELB are irrelevant here because there is little or no direct or indirect aquatic exposure for these species.

5.1.1.3 Non-vascular Aquatic Plants

Acute risk to aquatic non-vascular plants is based on peak EECs in the standard pond and the lowest acute toxicity value. The data available shows that phorate used that will provide the highest level of aquatic EECs, will not exceed the Agency's Level of Concern for aquatic non-vascular plants. Table 25 summarizes the RQ for aquatic plants.

Table 25 Summary of Acute RQs for Non-Vascular Aquatic Plants.

Uses	Peak EEC (μg/L)	RQ*
Sorghum	108.8	0.08
* RQ = use-specific peak EEC/ 1300 ppb (EC50 for Skeletonema costatum).		

Since the acute RQs are not exceeded, there is not a potential for indirect effects to those listed species that rely on non-vascular aquatic plants during at least some portion of their life-cycle (*i.e.*, CRLF).

5.1.1.4 Aquatic Vascular Plants

There are no available toxicity data for aquatic vascular plants. Phorate is an organophosphate insecticide. Available information and incidents suggest that organophosphate insecticides as a whole may cause some injury to mature plant leaves, some injury to developing seedlings during and after germination, and even temporary stunting of vascular plant growth; however, there has been no evidence of plant mortalities from field use at labeled application rates. Therefore, it is reasonable to conclude that aquatic vascular plant communities may not be significantly impacted by runoff residues containing phorate and its degradates.

5.1.2 Exposures in the Terrestrial Habitat

5.1.2.1 Birds (surrogate for Terrestrial-phase amphibians)

As previously discussed in Section 3.3, potential direct effects to terrestrial species are based on granular applications of phorate. Potential risks to birds (and, thus, reptiles and terrestrial-phase amphibians) are derived using T-REX, acute and chronic toxicity data for the most sensitive bird species for which data are available, and a variety of body-size and dietary categories. Results, including RQs (expressed as LD50/ ft^2), are given in **Table 26.**

Table 26 Acute Phorate RQs for Birds and Terrestrial-phase amphibians (for pre-May 2008 labels)

Use site	Wt class (g)	Mg/ft^2 [broadcast]	RQs (LD50/ ft^2) broadcast	RQs (LD50/ ft^2) In-furrow
Wheat and corn birds	20 100 1000	10.41	1617 254 18	
sugarbeet birds	20 100 1000	15.62	2426 381 27	
sorghum birds	20 100 1000	13.67	2123 333 24	
potato birds	20 100 1000	35.92	5580 877 62	
peanut birds	20 100 1000	16.66		2329 366 26
ornamentals birds	20 100 1000	83.3		970 152 11
cotton birds	20 100 1000	22.7	3526 554 39	
Sweet corn birds	20 100 1000	13.54	2103 330 23	
Beans birds	20 100 1000	15.83	2458 386 27	

For pre-May 2008 labels (Table 26), all phorate uses result in RQs far above the LOCs. The highest recorded value (e.g., 5580 for a 20g bird) was associated with potato. Lowest values (e.g., 6 for a 1000g bird) arose from use on ornamentals. Results for soils incorporation only, including RQs (expressed as LD50/ ft^2), are given in **Table 27.**

Table 27. Acute Phorate RQs for Birds and Terrestrial-phase amphibians (for soil-incorporated only)

Use site	Wt class (g)	Mg/ft^2 [on surface of soil]	RQs (LD50/ ft^2) In-furrow application

Use site	Wt class (g)	Mg/ft^2 [on surface of soil]	RQs (LD50/ ft^2) In-furrow application
Wheat and corn birds	20 100 1000	1.6	242.6 38.1 2.7
sugarbeet birds	20 100 1000	2.3	363.9 57.2 4.1
sorghum birds	20 100 1000	2.05	318.5 50.0 3.6
potato birds	20 100 1000	5.4	837.0 131.6 9.3
peanut birds	20 100 1000	16.66	2329 366 26
ornamentals birds	20 100 1000	83.3	970 152 11
cotton birds	20 100 1000	3.4	528.9 83.1 5.9
Sweet corn birds	20 100 1000	2.0	315.5 49.5 3.5
Beans birds	20 100 1000	2.4	368.7 57.9 4.1

For soil-incorporated only (Table 27), all phorate uses result in RQs above the LOCs. The highest recorded value (e.g., 2329 for a 20g bird) was associated with peanut. Lowest value (e.g., 2.7 for a 1000g bird) arose from use on wheat and corn.

Based on exceedences for all uses, phorate does have the potential to directly affect the CRLF. Additionally, since the acute and chronic RQs are exceeded, there is a potential for indirect effects to those listed species (CRLF and SJKF) that rely on birds, reptiles and/or terrestrial-phase amphibians during at least some portion of their life-cycle.

5.1.2.2 Mammals

Potential risks to mammals are derived using T-REX, which incorporates acute and chronic rat toxicity data, avian data, and a variety of body-size categories. Results for pre-May 2008 labels, including RQs (expressed as LD50/ ft^2), are given in **Table 28.**

Table 28 Acute Phorate RQs for Mammals (for pre-May 2008 labels)

Use site	Wt class (g)	Mg/ft^2 [on surface]	RQs (LD50/ ft^2) broadcast	RQs (LD50/ ft^2) In-furrow
Wheat and corn mammals	15 35 1000	10.41	226 120 10	
sugarbeet mammals	15 35 1000	15.62	338 179 15	

Use site	Wt class (g)	Mg/ft^2 [on surface]	RQs (LD50/ ft^2) broadcast	RQs (LD50/ ft^2) In-furrow
sorghum mammals	15 35 1000	13.67	296 157 13	
potato mammals	15 35 1000	35.92	778 412 33	
peanut mammals	15 35 1000	16.66		325 172 14
ornamentals mammals	15 35 1000	83.3		135 72 6
cotton mammals	15 35 1000	22.7	492 261 21	
Sweet corn mammals	15 35 1000	13.54	293 155 13	
Beans mammals	15 35 1000	15.83	343 182 15	

For pre-May 2008 labels (Table 29) the highest RQs for mammals result from potato use (e.g., 778 gm for a 15g mammal) and the lowest for wheat and corn (RQ = 1.5 for a 1000 gm mammal).

Table 29. Acute Phorate RQs for Mammals (for soil-incorporated only)

Use site	Wt class (g)	Mg/ft^2 [on surface of soil]	RQs (LD50/ ft^2) In-furrow
Wheat and corn mammals	15 35 1000	1.6	33.9 18.0 1.5
sugarbeet mammals	15 35 1000	2.3	50.7 26.9 2.3
sorghum mammals	15 35 1000	2.05	44.4 23.6 2.0
potato mammals	15 35 1000	5.4	116.7 61.8 5.0
peanut mammals	15 35 1000	16.66	325 172 14
ornamentals mammals	15 35 1000	83.3	135 72 6
cotton mammals	15 35 1000	3.4	73.8 39.2 3.2
Sweet corn mammals	15 35 1000	2.0	44.0 23.3 2.0
Beans	15	2.4	51.5

Use site	Wt class (g)	Mg/ft^2 [on surface of soil]	RQs (LD50/ ft^2) In-furrow
mammals	35 1000		27.3 2.3

For soil-incorporated only (Table 29), all phorate uses result in RQs above the LOCs. The highest recorded value (e.g., 2329 for a 15g mammal) was associated with peanut. The lowest value (e.g., 1.5 for a 1000g mammal) arose from use on wheat and corn.

Based on exceedences for all uses, phorate does have the potential to directly affect the SJKF. Additionally, since the acute LOCs are exceeded, there is a potential for indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle (CRLF and SJKF).

5.1.2.3 Terrestrial Invertebrates

In order to assess the risks of phorate to terrestrial invertebrates, the honey bee (or other terrestrial invertebrate depending on which is more sensitive) is used as a surrogate. While phorate is systemically taken up by plants, residues **on** plants or insects were not calculated because phorate is solely a granular formulation, which would not result in residues directly **on** plant or insect surfaces. Exposure to insects is qualitatively assessed here.

Runoff containing phorate residues may go to non-target plants near CRLF habitats. These plants will take up the phorate residues. The residues will be available to insects feeding on the plants. Since phorate is very highly toxic to insects (Honey bee LD_{50} = 0.32 µg/bee), it is assumed that insect mortality will increase. VELB and BCB are insects that have obligate relationships with certain plant species. If those host plant species take up phorate residues from runoff and the insects land on them, adverse impact may occur to these insects.

5.1.2.4 Terrestrial Plants

Generally, for indirect effects, potential effects on terrestrial vegetation are assessed using RQs from terrestrial plant seedling emergence and vegetative vigor EC_{25} data as a screen. Since the Bay checkerspot butterfly and the Valley elderberry longhorn beetle have an obligate relationship with specific dicot plant species, the seedling emergence and vegetative vigor EC_{05} or the NOAEC for dicots would be used to calculate RQs for indirect effects to these species via potential effects to dicots. However there are no available data to quantitatively calculate RQs for indirect effects to BCB and VELB.

Phorate is an organophosphate insecticide. Available information and incidents suggest that organophosphate insecticides as a whole may cause some injury to mature plant leaves, some injury to developing seedlings during and after germination, and even temporary stunting of vascular plant growth; however, there has been no evidence of plant mortalities from field use at labeled application rates. Therefore, it is reasonable to conclude that terrestrial plant communities may not be significantly impacted by runoff residues containing phorate and its degradates.

In the absence of phytotoxicity data, the effects to non-target plants that BCB and VELB depend on will depend on whether the plants are exposed to phorate residues from runoff. If the plants are exposed to phorate, an assumption will be made that plants may potentially have a reduction in biomass and there may be an effect on the plants; thereby indirectly having an effect on the listed insect species. Although it appears that the effects to the plants may be insignificant, there is an uncertainty as to the effects of phorate on plants because of a lack of phytotoxicity data.

5.1.3 Primary Constituent Elements of Designated Critical Habitat

The assessment endpoints for designated critical habitat PCEs involve the same endpoints as those being assessed relative to the potential for direct and indirect effects to the listed species assessed here. Therefore, the effects determinations for direct and indirect effects are used as the basis of the determination for potential modification to designated critical habitat.

5.2 Risk Description

The risk description synthesizes overall conclusions 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 assessed species and the potential for modification of their designated critical habitat.

If the RQs presented in the Risk Estimation (Section 5.1) show no direct or indirect effects for the assessed species, and no modification to PCEs of the designated critical habitat, a "no effect" determination is made, based on Phorate's use within the action area. However, if LOCs for direct or indirect effect are exceeded or effects may modify the PCEs of the critical habitat, the Agency concludes a preliminary "may affect" determination for the FIFRA regulatory action regarding Phorate. A summary of the risk estimation results are provided in **Table 30** for direct and indirect effects to the listed species assessed here and in **Table 31** for the PCEs of their designated critical habitat.

Table 30. Risk Estimation Summary for Phorate - Direct and Indirect Effects

Taxa	LOC Exceedances (Y/N)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
Freshwater Fish and Aquatic-phase Amphibians	Non-listed Species (Y)	Acute LOC exceedances ranges from 1.6X to 13.5X (RQ ranges from 0.8 to 6.7) Chronic LOC exceedances ranges ranges from 1.2X to 14.3X (RQ=LOC)	<u>Indirect Effects</u>: CRLF

Table 30. Risk Estimation Summary for Phorate - Direct and Indirect Effects			
Taxa	**LOC Exceedances (Y/N)**	**Description of Results of Risk Estimation**	**Assessed Species Potentially Affected**
	Listed Species (Y)	Acute LOC exceedances ranges from 2.8X to 286X (RQ ranges from 0.14 to 14.3) Chronic LOC exceedances ranges ranges from 1.2X to 14.3X (RQ=LOC)	Direct Effects: CRLF
Freshwater Invertebrates	Non-listed Species (Y)	Acute LOC exceedances ranges from 1.2X to 53X (RQ ranges from 0.6 to 26.5) Chronic LOC exceedances ranges from 1.7X to 14.3X (RQ=LOC)	Indirect Effects: CRLF
Vascular Aquatic Plants	Non-listed Species (N)	There are no available vascular aquatic plant data.	Indirect Effects: none
Non-Vascular Aquatic Plants	Non-listed Species (N)	There are no LOC exceedances	Direct Effects: none
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Y)	Acute LOC exceedances ranges from 22X to 11,160X (RQ ranges from 11 to 5,580) Since Phorate is only used as a granular, chronic RQ calculation can not be made.	Indirect Effects: CRLF, SJKF
	Listed Species (Y)	Acute LOC exceedances ranges from 110X to 55,800X (RQ ranges from 11 to 5,580) Since Phorate is only used as a granular, chronic RQ calculation can not be made.	Direct Effects: CRLF
Mammals	Non-listed Species (Y)	Acute LOC exceedances ranges from 12X to 1,556 (RQ ranges from 6 to 778) Since Phorate is only used as a granular, chronic RQ calculation can not be made.	Indirect Effects: CRLF, SJKF
	Listed Species (Y)	Acute LOC exceedances ranges from 12X to 1,556X (RQ ranges from 6 to 778) Since Phorate is only used as a granular, chronic RQ calculation can not be made.	Direct Effects: SJKF

Table 30. Risk Estimation Summary for Phorate - Direct and Indirect Effects			
Taxa	**LOC Exceedances (Y/N)**	**Description of Results of Risk Estimation**	**Assessed Species Potentially Affected**
Terrestrial Invertebrates	Listed Species (N)	Since Phorate is only used as a granular, terrestrial invertebrate RQ calculation can not be made.	Direct Effects: None Indirect Effects: CRLF, SJKF
Terrestrial Plants - Monocots	Non-listed Species (N)	Since Phorate is only used as a granular, terrestrial plant RQ calculation can not be made. If plants exposed to phorate, phorate residues will be in plant. Listed species eat plant and will be exposed to phorate. Potential impact to listed species may occur.	Indirect Effects: SJKF
Terrestrial Plants - Dicots	Non-listed Species (N)	Since Phorate is only used as a granular, terrestrial plant RQ calculation can not be made. If plants exposed to phorate, phorate residues will be in plant. Listed species eat plant and will be exposed to phorate. Potential impact may occur.	Indirect Effects: SJKF
	Listed Species (N)	Since Phorate is only used as a granular, terrestrial plant RQ calculation can not be made. If the plants are exposed to phorate, an assumption is made that plants may potentially have some reduction in biomass which may be an effect on the individual plants; thereby indirectly having an effect on the listed VELB species. BCB may land on plant containing phorate residues in traveling from one population to another outside of critical habitat.	Direct Effects: BCB, VELB

Table 31. Risk Estimation Summary for Phorate – Effects to Designated Critical Habitat. (PCEs)			
Taxa	**LOC Exceedances (Y/N)**	**Description of Results of Risk Estimation**	**Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action**
Freshwater Fish and Aquatic-phase Amphibians	Non-listed Species (Y)	Acute LOC exceedances ranges from 1.6X to 13.5X (RQ ranges from 0.8 to 6.7) Chronic LOC exceedances ranges ranges from 1.2X to 14.3X (RQ=LOC)	CRLF
	Listed Species (Y)	Acute LOC exceedances ranges from 2.8X to 286X (RQ ranges from 0.14 to 14.3) Chronic LOC exceedances ranges ranges from 1.2X to 14.3X (RQ=LOC)	
Freshwater Invertebrates	Non-listed Species (Y)	Acute LOC exceedances ranges from 1.2X to 53X (RQ ranges from 0.6 to 26.5) Chronic LOC exceedances ranges from 1.7X to 14.3X (RQ=LOC)	CRLF
Vascular Aquatic Plants	Non-listed Species (N)	There are no available vascular aquatic plant data.	CRLF
Non-Vascular Aquatic Plants	Non-listed Species (N)	There are no LOC exceedances	CRLF
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Y)	Acute LOC exceedances ranges from 22X to 11,160X (RQ ranges from 11 to 5,580) Since Phorate is only used as a granular, chronic RQ calculation can not be made.	CRLF
	Listed Species (Y)	Acute LOC exceedances ranges from 110X to 55,800X (RQ ranges from 11 to 5,580) Since Phorate is only used as a granular, chronic RQ calculation can not be made.	
Mammals	Non-listed Species (Y)	Acute LOC exceedances ranges from 12X to 1,556 (RQ ranges from 6 to 778) Since Phorate is only used	CRLF

Table 31. Risk Estimation Summary for Phorate – Effects to Designated Critical Habitat. (PCEs)			
Taxa	**LOC Exceedances (Y/N)**	**Description of Results of Risk Estimation**	**Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action**
		as a granular, chronic RQ calculation can not be made.	
Terrestrial Invertebrates	Listed Species (N)	Since Phorate is only used as a granular, terrestrial invertebrate RQ calculation can not be made.	CRLF
Terrestrial Plants - Monocots	Non-listed Species (N)	Since Phorate is only used as a granular, terrestrial plant RQ calculation can not be made.	none
Terrestrial Plants - Dicots	Non-listed Species (N)	Since Phorate is only used as a granular, terrestrial plant RQ calculation can not be made.	none
	Listed Species (N)	Since Phorate is only used as a granular, terrestrial plant RQ calculation can not be made. If the plants are exposed to phorate, an assumption is made that plants may potentially have a reduction in biomass and there may be an effect on the plants; thereby indirectly having an effect on the listed VELB species. For the BCB, plants in critical habitat is not expected to be exposed to phorate.	VELB

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 assessed species. 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 assessed species and its designated critical habitat.

The criteria used to make determinations that the effects of an action are "not likely to adversely affect" the assessed species or modify its designated critical habitat include the following:

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

  - Harm includes significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.
  - Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.
- Likelihood of the Effect Occurring: Discountable effects are those that are extremely unlikely to occur.
- Adverse Nature of Effect: Effects that are wholly beneficial without any adverse effects are not considered adverse.

A description of the risk and effects determination for each of the established assessment endpoints for the assessed species and their designated critical habitat is provided in **Sections 5.2.1 through 5.2.6**. The effects determination section for each listed species assessed will follow a similar pattern. Each will start with a discussion of the potential for direct effects, followed by a discussion of the potential for indirect effects. For those listed species that have designated critical habitat, the section will end with a discussion on the potential for modification to the critical habitat from the use of Phorate.

5.2.1 California Red-Legged Frog

5.2.1.1 Direct Effects

Aquatic-Phase CRLF, Direct Effects

The aquatic-phase considers life stages of the frog that are obligatory aquatic organisms, including eggs and larvae. It also considers submerged terrestrial-phase juveniles and adults, which spend a portion of their time in water bodies that may receive runoff and spray drift containing phorate and its degradates.

Fish is a surrogate for aquatic-phase CRLF and therefore direct effects to fish would imply direct effects to the aquatic-phase CRLF. Results from the pre-May 2008 labels indicate that acute RQs exceeded the listed species LOC (0.05) for all uses and the RQ ranged from 0.14 to 14.3. Based on the exceedance of the listed species LOC for all uses, exceedance of the acute LOC for all uses but peanuts, and the probit analysis for the peanut use, it is concluded that phorate exposure is likely to adversely affect the CRLF for all uses.

A probit slope analysis was done on the only use site not to exceed the acute LOC for direct effects to fish (or aquatic-phase amphibian) which is the peanut use. The RQ for acute effects to fish from peanut use of phorate is 0.14 which exceeds the LOC (0.05) for listed species but is less than the LOC (0.5) for acute effects. The percentage effect to the freshwater fish (z score in the IECv1.1 model), based on the slope (3.2) of the dose response curve for the acute endpoint used to derive the RQ and the RQ of 0.14 is 7.23%.

The chance of individual effect is one in 13.8 based on the RQ of 0.14 and the slope for acute LC50 for bluegill of 3.2. Base on the confidence interval (1.5-2.86) of the endpoint used for the acute LC_{50} for bluegill, the chance of individual effect may range from one in one to one in 56.6.

Results from the pre-May 2008 labels indicate that the chronic RQs also exceed the LOC (1.0) for wheat and sorghum (RQ = 2.4), sugarbeet (1.2), sorghum at 1.3 lb ai/A (3.1), cotton (3.1), and sweet corn (1.4). Risk to fish and aquatic-phase amphibian from phorate used on potato (0.4), corn (0.6), beans (0.6), ornamentals (0.9), and peanut (0.2) will be below the chronic LOC.

Formulated products containing phorate were tested on rainbow trout, bluegill sunfish, and channel catfish. The results indicate that the range of phorate 20G products have LC_{50} from 2.2 ppb product (catfish) to 45 ppb product (trout). Phorate 20G formulation is also considered to be very highly toxic to fish and aquatic-phase amphibian.

Toxicity data on Phorate degradates, sulfone and sulfoxide, are sparse and limited. Communications from the registrant indicate that the sulfone degradate is similar in toxicity to the parent phorate. The sulfoxide degradate is less toxic than the parent phorate. These data points are limited in that they are results form a preliminary screen with concentration progression of 10X. No methods or data were provided to analyze the result and so the information is considered to be anecdotal. The reported endpoints were:

Phorate
Daphnia magna EC_{50} = 0.6 ppb ai
Bluegill sunfish (*Lepomis macrochirus*) LC_{50} = 2.4 ppb ai

Phorate sulfoxide
Daphnia magna EC_{50} = 4.0 ppb ai
Bluegill sunfish (*Lepomis macrochirus*) LC_{50} = 22 ppb ai

Phorate sulfone
Daphnia magna EC_{50} = 0.4 ppb ai

Phorate residues are expected to persist in the terrestrial environment, with field dissipation half life up to 173 days. Therefore, for many days post application, there is potential for runoff to aquatic systems. The EECs used in this assessment included total toxic residues (parent phorate and its degradates of concern). The most toxic degradate was the sulfone degradate, which is similar in toxicity to phorate to fish; however, exposure may be to parent, sulfoxide, sulfone, or all three. Therefore this is a conservative assessment of exposure.

The effects determination was based on the most sensitive species tested (bluegill). However, a number of fish species have been tested including rainbow trout, channel catfish, cutthroat northern pike, largemouth bass, and walleye. Some species have shown similar sensitivity to bluegill; however, other species tested have shown lower sensitivity

(**Table 32**). RQs would remain above listed species LOC for most uses if the CRLF is as sensitive as the least sensitive fish, channel catfish.

Table 32. Range of Acute Fish and Aquatic-Phase Amphibian LC50s for Phorate.

Freshwater Species	Results (ppb ai)	Toxicity Category	Source of Data
Rainbow trout	13 to 21	very highly toxic	40094602
Bluegill sunfish	2.42 to 3.95	very highly toxic	40098001
Channel catfish	280	highly toxic	40098001
Cutthroat trout	44 to 66	very highly toxic	40098001
Northern pike	110	highly toxic	40098001
Largemouth Bass	5.0	Very highly toxic	40098001
Walleye	57 to 340	very highly toxic	40098001

Two aquatic field studies using mesocosms were conducted. An aquatic field study conducted in Iowa used Thimet 20G insecticide. The study only produced comparable data for 3 of 5 ponds. Three ponds have similar chemical and physical characteristics. One pond was a reference pond, the other two were watersheds treated with Thimet 20G. Significant rainfall events did not occur until 10-14 days after treatment. Reductions to invertebrate populations, fish growth and bluegill fecundity were apparent in ponds adjacent to the treated field. Most of the population reductions noted in the study were as a result of exposure to the metabolites of phorate, phorate sulfone and sulfoxide. Both metabolites were found when the pond water was analyzed. Despite several factors that compromised comparisons between treated and untreated areas, the study provided valuable data concerning phorate behavior in the environment. The authors of the study suggest that phorate may significantly decrease diversity in natural ecosystem. (MRID No.42227101).

A mesocosms study in South Dakota investigated the effects of phorate to wetlands macroinvertebrates. Each wetland had a reference and 3 treated mesocosms with application rates of 1.2, 2.4, and 4.8 kg/ha (1, .2, and 4.3 lbs/A), respectively. For one month all rates resulted in mortality to all amphipods and chironomids (Dieter et al.,1995; MRID No. 43957801).

In addition, several incidents involving freshwater fish have been reported to the Agency and are summarized below:

The EPA has received several reports of field incidents involving phorate products through the Pesticide Incident Monitoring System (PIMS). Three fish kills were reported in Illinois involving phorate combined with propachlor, atrazine, EPTC**,** or esters of 2,4-D. As phorate is considered more toxic than the other chemicals the Agency believes that phorate was primarily responsible for the mortalities.

In May l970, fish kills were reported involving three ponds following the use of phorate, propachlor, EPTC, atrazine, or the isooctyl ester of 2,4-D on corn fields. Phorate residues were measured in the three ponds. Two ponds were measured two weeks post-application and reported residues of 8.3 and 32.3 ppb. The third pond was measured 37 days post-application and revealed concentrations as high as 12.1 ppb. The effects for the three ponds varied from 30 to 50 dead bluegill and bass for one pond and about 2,000 to 3,000 bluegill, bass, greengills, silver minnows, catfish and crappies, a water snake, and fox squirrels for the second pond, approximately three to four days postapplication. In the third pond phorate, atrazine, and propachlor probably caused the death of bass and bluegill 7 to 14 days post-application (B000150-001,002,003).

Since the RED, no aquatic incidents from the use of phorate have been reported to the Agency.

The incidences and field studies support the conclusion that there is potential risk to freshwater fish (and aquatic phase amphibians as a surrogate) from the registered use of phorate. Therefore, the RQ analysis together with the presence of past incidences and the field studies that associated fish mortality with phorate use support the conclusion that there is a potential for direct effects to the aquatic-phase of the CRLF.

Terrestrial-Phase CRLF, Direct Effects

Birds are surrogates for terrestrial-phase CRLF and therefore direct effects to birds would imply direct effects to the terrestrial-phase CRLF. LD_{50}/ft^2 was calculated as RQs since all formulations for phorate are granular. Acute RQs exceeded the listed species LOC (0.1) for all uses and the RQs ranged from 11.0 to 5580.0. Based on the exceedance of the listed species LOC and the acute LOC for all uses, it is concluded that phorate exposure is likely to adversely affect the CRLF for all uses.

The dietary sub-acute LC_{50} toxicity data indicate that phorate is highly toxic to mallard duck, bobwhite quail and ring-necked pheasant. The toxicity ranges from 240 ppm ai (mallard duck) to 441 ppm ai (ring-necked pheasant).

The risk estimation was based on the most sensitive species tested (mallard duck). However, a number of avian species have been tested and are included in Table 33. Some species have shown similar sensitivity to mallard duck; however, other species tested have shown lower sensitivity (**Table 33**). RQs would remain above listed species LOC for all uses if the CRLF is as sensitive as the least sensitive bird, chukar.

Table 33 Range of Acute Avian LD_{50}s for Phorate.

Avian Species	LD_{50} mg/kg-bw (ppb ai)	Toxicity Category	Source of Data
Mallard duck	0.62 to 2.55	very highly toxic	00160000
Ring-necked pheasant	7.12	very highly toxic	00160000
Starlings	7.5	Very highly toxic	00020560
Redwing blackbird	1.0	very highly toxic	00020560
Grackle	1.3	Very highly toxic	00020560
Chukar	12.8	very highly toxic	00160000

There are no toxicity data or information on terrestrial organisms for phorate degradates. The aquatic toxicity information on the phorate degradates indicate that the sulfone degradate is similar in toxicity to the parent phorate. The phorate degradate, sulfoxide, is less toxic than the parent phorate.

An acute oral toxicity study for bullfrog resulted in an LD_{50} of 85.2 mg ai/kg-bw (MRID 00016000). The 95% confidence interval is 59.3-122. The bullfrog is less sensitive than most of the birds tested. The TREX model was used to calculate the RQs for the frog (LD_{50}/ft^2). The Mineau Scaling Factor for birds was reset to be 1.0 so that there would not be any adjustment. The results of the calculation are below in Table 34.

Table 34. RQ for Frog from Frog LD_{50} of 85.2 mg ai/kg-bw

Use site	Application rate (lb ai/A)	Application Type	RQ (20 g wt. class) (LD_{50} /ft^2)	RQ (100 g wt. class) (LD_{50} /ft^2)
Wheat and corn	1	broadcast	6.11	1.22
beet	1.5	broadcast	9.17	1.83
sorghum	1.3125	broadcast	8.02	1.60
Potato	3.45	broadcast	21.08	4.22
Peanut	1.6	In-furrow	8.8	1.76
Ornamentals	8.0	In-furrow	3.67	0.73
cotton	2.18	broadcast	13.32	2.66
Sweet corn	1.3	broadcast	7.94	1.59
Beans	1.52	broadcast	9.29	1.86

From the above results, the LOC is exceeded at all rates of application.

Phorate residues can persist in the terrestrial environment, with a field dissipation half life of up to 173 days. Therefore, for many days post-application, there is potential for runoff to non-target terrestrial and aquatic systems, as well as on-site terrestrial exposure risk. Once within the aquatic environment, however, phorate is subject to hydrolysis and aqueous metabolism and is thus less persistent. Phorate residues may, therefore, present a longer-term exposure risk in the terrestrial environment – particularly within or adjacent to application areas. The terrestrial EECs used in this assessment reflect total toxic residues (parent phorate and its degradates of concern). Exposure may be to parent, sulfoxide, sulfone, or all three. Given this uncertainty, it is most conservative to assume exposure to the most toxic of these compounds for any given species.

Chronic risk to the terrestrial phase of the CRLF could not be assessed quantitatively via the LD_{50}/sq ft method. However, the following qualitative statement can be made regarding chronic risk from phorate exposure to the adult phase of the CRLF. Because the acute oral toxicity of frog is considered to be very highly toxic and the estimated avian NOAEL (5 ppm ai) suggests birds to be chronically very sensitive to phorate, it would appear that if an adult CRLF experiences acute exposure to phorate (avian LD_{50} = 0.6 mg/kg-bw) and survives the initial acute exposure, later chronic reproductive effects can also have an adverse affect on the organism.

The incidences in section 4.4 and a field study in section 4.2.5 support the conclusion that birds (and terrestrial phase amphibians as a surrogate) may be affected by labeled uses of phorate. Therefore, the RQ analysis together with the presence of several incidences and a field study that associated bird mortality with phorate exposure supports the conclusion that there is a potential for direct effects to the terrestrial-phase of the CRLF.

5.2.1.2 Indirect Effects

Potential Loss of Prey

As discussed in Section 2.5.3, the diet of aquatic-phase CRLF tadpoles is composed primarily of unicellular aquatic plants (*i.e*., algae and diatoms) and detritus. The diet of terrestrial-phase CRLF includes terrestrial and aquatic invertebrates, mammals, frogs and fish.

Aquatic-Phase CRLF

Fish and Aquatic-Phase Amphibians

Results from the pre-May 2008 labels indicate that acute RQs exceeded the acute LOC (0.5) for all uses except peanut and the RQ ranged from 0.8 to 14.3. Based on the exceedance of the acute LOC for all uses but peanut, it is concluded that phorate use has the potential to likely adversely affect the CRLF indirectly by reduction of aquatic food items.

Results from the pre-May 2008 labels indicate that the chronic RQs also exceed the LOC (1.0) for wheat and sorghum (RQ = 2.4), sugarbeet (1.2), sorghum at 1.3 lb ai/A (3.1), cotton (3.1), and sweet corn (1.4). Risk to fish and aquatic-phase amphibian from phorate used on potato (0.4), corn (0.6), beans (0.6), ornamentals (0.9), and peanut (0.2) will be below the chronic LOC. The chronic effect observed from the early-life stage of fish was based on reduction of the length of fish. Based on the chronic RQs, it is anticipated that there is a potential for phorate to adversely affect CRLF indirectly on a chronic basis by reduction of aquatic food items. Formulated products containing phorate were tested on rainbow trout, bluegill sunfish, and channel catfish. The results indicate that the range of phorate 20G products have LC_{50} from 2.2 ppb product (catfish) to 45 ppb product (trout). Phorate 20G formulation is also considered to be very highly toxic to fish and aquatic-phase amphibian.

Aquatic Invertebrates

Acute RQs (0.6 to 26.5) exceeded the acute LOC (0.5) for all uses. Based on the exceedance of the acute LOC for all uses, it is concluded that phorate exposure has the potential to likely adversely affect the CRLF indirectly on an acute basis.

The chronic RQs (0.3 – 14.3) also exceed the LOC (1.0) for all uses except peanut (0.3). The chronic effect from the life cycle of *Daphnis magna* life cycle study was based on number of offspring per female, growth of parental Daphnids, survival of adults and production of young. Based on the exceedance of the chronic LOC for all uses but peanut, it is concluded that phorate exposure has the potential to likely adversely affect the CRLF indirectly on a chronic basis.

Formulated products containing phorate were tested on waterflea, midge larvae, and mayfly nymphs. The results indicate that phorate 20G product ranges have LC_{50} from 37 ppb product (waterflea) to 65 ppb product (mayfly nymphs). The phorate 20G formulation is considered to be very highly toxic to aquatic invertebrates.

Therefore, based on numerous lines of evidence, the RQ analysis, and together with the field studies that associated aquatic invertebrate mortality with phorate use; the lines of evidence support the conclusion that there is a potential for indirect effects to the aquatic-phase of the CRLF.

Aquatic Plants

The only data available on effects to unicellular aquatic plants (*i.e.*, algae and diatoms) are for marine diatom. The RQ (0.08) is below the Agency's LOC (1.0). Therefore, there appears to be no indirect effect to CRLF from reduction in algal food items.

Terrestrial-Phase CRLF

Terrestrial-Phase Amphibians

Birds are surrogates for terrestrial-phase amphibian. LD_{50}/ft^2 was calculated as RQs since all formulations for phorate are granular. RQs exceeded the acute LOC (0.5) for all uses and the RQs ranged from 11.0 to 5580.0.

The dietary sub-acute LC_{50} toxicity data indicate that phorate is highly toxic to mallard duck, bobwhite quail and ring-necked pheasant. The toxicity ranges from 240 ppm ai (mallard duck) to 441 ppm ai (ring-necked pheasant).

The LD_{50} was based on the most sensitive species tested (mallard duck). However, a number of avian species have been tested and are included in **Table 35**. Some species have shown similar sensitivity to mallard duck; however, other species tested have shown lower sensitivity (**Table 35**). RQs would remain above acute LOC for all uses if the least sensitive bird, chukar, was used instead of the mallard.

Table 35. Range of Acute Avian LD_{50}s for Phorate.

Avian Species	LD_{50} mg/kg-bw (ppb ai)	Toxicity Category	Source of Data
Mallard duck	0.62 to 2.55	very highly toxic	00160000
Ring-necked pheasant	7.12	very highly toxic	00160000
Starlings	7.5	Very highly toxic	00020560
Redwing blackbird	1.0	very highly toxic	00020560
Grackle	1.3	Very highly toxic	00020560
Chukar	12.8	very highly toxic	00160000

There are no toxicity data or information on terrestrial organisms for phorate degradates. The aquatic toxicity information on the phorate degradates indicate that the sulfone degradate is similar in toxicity to the parent phorate. The phorate degradate, sulfoxide, is less toxic than the parent phorate.

Acute oral toxicity study for bullfrog resulted in LD_{50} of 85.2 mg ai/kg-bw. The 95% confidence interval is 59.3-122. The bullfrog is less sensitive than most of the birds tested. The TREX model was used to calculate the RQs for the frog (LD_{50}/ft^2) since the T-HERPS does not provide for granular formulations. The Mineau Scaling Factor for birds was reset to be 1.0 so that there would not be any adjustment for the bullfrog. The results of the calculation are below in Table 36.

Table 36. RQ for Frog from Frog LD_{50} of 85.2 mg ai/kg-bw

Use site	Application rate (lb ai/A)	Application Type	RQ (20 g wt. class) (LD_{50} /ft^2)	RQ (100 g wt. class) (LD_{50} /ft^2)
Wheat and corn	1	broadcast	6.11	1.22
Beet	1.5	broadcast	9.17	1.83
sorghum	1.3125	broadcast	8.02	1.60
Potato	3.45	broadcast	21.08	4.22
Peanut	1.6	In-furrow	8.8	1.76
Ornamentals	8.0	In-furrow	3.67	0.73
cotton	2.18	broadcast	13.32	2.66
Sweet corn	1.3	broadcast	7.94	1.59
Beans	1.52	broadcast	9.29	1.86

From the above lower RQ results, the acute LOC (0.5) is exceeded at all rates of application.

Therefore, the RQ analysis together with the presence of several incidences and a field study that associated bird mortality with phorate exposure supports the conclusion that there is a potential for indirect effects to the CRLF via reduction in the amphibian as prey.

Mammals

Mammalian LD_{50}/ft^2 was calculated as RQs since all formulations for phorate are granular. RQs exceeded the acute LOC (0.5) for all uses and the RQs ranged from 6 to

778. Additional toxicity data suggest that phorate is very toxic to mammals (rat dermal toxicity LD_{50} = 9.3 mg/kg (male) and 3.9 mg/kg (female); and inhalation toxicity LD_{50} = 0.06 mg/kg (male) and 0.011 mg/kg (female)).

Chronic risk to mammals could not be assessed quantitatively via the LD_{50}/sq ft method. However, the following qualitative statement can be made regarding chronic risk from phorate exposure to mammals. Because the acute oral toxicity of the rat is considered to be very highly toxic and the estimated mammalian NOAEL (2 ppm ai) suggests mammals to be chronically very sensitive to phorate, it would appear that if a mammal experiences acute exposure to phorate (mammalian LD_{50} = 1.4 mg/kg-bw) and survives the initial acute exposure, later chronic reproductive effects can also have an adverse affect on the organism.

Therefore, the RQ analysis together with the incident (skunk and two opossums during one incident) that associated mammalian mortality with phorate use supports the conclusion that there is a potential for indirect effects to CRLF via reduction in mammal prey.

Insects

Toxicity data on the honey bee suggests that phorate is highly toxic to insects. An additional study showed 100% mortality to various carabid beetles at 1.12 kg ai/ha. Acute risk to the insects could not be assessed quantitatively via the LD_{50}/sq ft method. The following qualitative statements can be made regarding phorate’s potential to affect non-target insects. Phorate is a systemic insecticide that is highly toxic to several insects. Since it is applied as a granular, there may be minimal direct contact with phorate. However, runoff containing phorate residues may go to non-target plants near CRLF habitats. These plants will take up the phorate residues via its vascular pathways and phorate becomes available to non-target insects feeding on the plants. Since phorate is very highly toxic to insects (Honey bee LD_{50} = 0.32 µg/bee), it is assumed that insect mortality will increase. A reduction in insect prey items may result from phorate exposure to non-target plants. Therefore, there is potential for CRLF to be impacted indirectly via reduction in insect prey base.

5.2.1.3 Modification of Designated Critical Habitat

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

The available toxicity data on unicellular plants indicate no effects to aquatic plants. However, there is only data on a marine diatom. Such a limited amount of data on aquatic plants creates uncertainty in the toxicity of phorate to aquatic habitats. Other information on organophosphate insecticides suggests that phorate may not be very phytotoxic to algae or vascular aquatic plants.

If such exposure to aquatic vascular plants would occur from spray drift, there may occur some leaf injury in which the plants may be recover from injury. However, since phorate is a granular insecticide, spray drift is not expected. Any exposure to aquatic vascular plants is likely to occur from runoff and thus may not be of significant exposure as to cause injury to plants. Thus there is considered to be no habitat modification relative to aquatic plants.

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

There is no current terrestrial phytotoxicity data on phorate. Label warnings indicate that there may be some injury to plants from application of phorate to crops but such injury is expected to be short lived. Phorate is an organophosphate insecticide and not a herbicide. Information on other organophosphate insecticides indicate that the chemical can cause leaf burns from direct contact from which plants usually recover. Phorate is only used as a granular formulation and therefore does not result in spray drift from application. There appears to be minimal potential to cause terrestrial habitat modification of the CRLF and if any injury to habitat does occur, it would be insignificant and discountable.

5.2.2 Bay Checkerspot Butterfly (BCB)

All BCB habitat includes shallow, serpentine-derived (or similar)) soils that support larval food plants and adult nectar sources (USFWS 1998). The primary larval host plant for the BCB is the dwarf plantain (*Plantago erecta*). In many drier years, BCB larvae also rely on secondary host plant species [primarily purple owl's-clover (*Castilleja densiflora*) or exserted paintbrush (*Castilleja exserta*)] that are used when the plantain dries up while the larvae are still feeding. Adults most commonly feed on the nectar of desertparsley (*Lomatium* spp.), California goldfields (*Lasthenia californica*) and tidy-tips (*Layia platyglossa*) (USFWS 1998).

Topography can also influence habitat quality for the BCB. South-facing slopes are warmer and drier than north-facing slopes, which can affect the timing of the development of the butterfly and its host plants. Larvae on south-facing slopes develop faster and emerge (a month or more) earlier than larvae on north-facing slopes and host plants on warmer slopes flower and senesce three to four weeks before those on cooler slopes. Either south- and north-facing slopes are beneficial in different years, depending on the weather conditions. Therefore, a serpentine habitat area having a range of slopes and exposures can reduce the chances of population-wide reproductive failure in years with extreme weather (USFWS 1998).

The BCB's life cycle is closely tied with the biology of its host plants. Phorate is used only on agricultural land that has row crops and on wheat. These crops are usually not grown on serpentine soils due to slope of land, no irrigation, and poor soil quality for agricultural crops. In addition, phorate is only used as a granular and therefore spray drift would be minimal.

BCB is closely tied to the host species and the host species are closely tied to the serpentine soils. If agricultural production was occurring above slopes inhabited by the host plants, the runoff from the agricultural fields would have added moisture and nutrients to the serpentine soils. This would provide an avenue for non-native grass species to invade the otherwise drier areas and crowd out the native host plants to the BCB. If the agricultural crops were grown below the serpentine soils, the runoff from the fields would not be able to travel up the slopes with phorate residues. Furthermore, spray drift carrying phorate residues would not travel to the serpentine slopes due to the granular nature of phorate. Therefore, it is unlikely that BCB host plants would be affected by the registered uses of phorate.

While BCB is a meta-population species and as such will travel from one population area to another resting on a variety of plants, the scenario resulting in effects to the BCB is not reasonably likely to occur. In this case, phorate runoff residues would need to be taken up by plants and translocated to the leaves. The BCB on its travel would need to rest on a plant that had taken up and translocated phorate to its leaves and while resting, the BCB would then have to feed on the leaves of this plant. However, there is some uncertainty in this analysis in that there is a potential for phorate to be exposed to BCB during the traveling from one population to another. Therefore, an LAA will be made due to the uncertainty.

5.2.2.1 Direct Effects

BCB does not feed on aquatic organisms or on terrestrial animals. Athough phorate is a systemic insecticide, it is not expected that phorate will be deposited on host plants or systemically taken up by obligate host plants due to lack of exposure. Spray drift containing phorate residues to BCB or its host plants from agriculture applications is not anticipated from a granular chemical that is not applied on BCB habitats or obligate host plants.

It is concluded that phorate exposure to BCB and to BCB host plants would be very little if any, however with traveling between populations, BCB may alight upon a plant that is exposed to phorate runoff residues. Because of this traveling between populations and that phorate is toxic to insects, there is a potential for adverse effect to BCB.

5.2.2.2 Indirect Effects

Indirect effects to host plants are not anticipated because phorate is not very toxic to plants and exposure to host plants is either not anticipated or very limited. In addition, BCB does not feed on any aquatic or terrestrial animals. Therefore the conclusion is that there will be no indirect effects to the BCB from the use of phorate.

5.2.2.3 Modification of Designated Critical Habitat

Indirect effects to host plants are not anticipated because phorate is not very toxic to plants and exposure to host plants is either not anticipated or very limited. In addition, BCB does not feed on any aquatic or terrestrial animals. Furthermore, phorate is not expected to significantly modify any plant community since any plant damage is insignificant.

5.2.3 Valley Elderberry Longhorn Beetle (VELB)

The VELB feeds only on elderberry bush/tree. It burrows into the woody stems and subsists on it. The elderberry thus becomes an obligate host to the VELB. In California, the habitat for the VELB and the native species of elderberry species are along riparian areas. The VELB is "endemic to the Central Valley of California (USFWS, 2006). "Historically the beetle ranged throughout the Valley" and could be found "in elderberry thickets in moist valley oak woodland along the margins of the Sacramento and San Joaquin Rivers" (California's Endangered Insects and USFWS, 1980). "Potential VELB habitat is defined by the presence of mature and immature elderberry shrubs (*Sambucus* spp.)" (Barr, 1991). Elderberries are typically "associated with riparian forests which occur along rivers and streams" in California's Central Valley "and in the surrounding foothills up to 3,000 feet in elevation in the east and the entire watershed to the west (Jones & Stokes, 2004; and California's Endangered Insects). "Elderberry is a common component of the remaining riparian forests and adjacent grasslands of the Central Valley" (Barr, 1991).

5.2.3.1 Direct Effects

Since VELB does not feed on aquatic organisms, there will be no aquatic direct effects. The only terrestrial organisms that VELB will feed on are the elderberry plant species; therefore, no RQs will be calculated for terrestrial animals. Due to lack of terrestrial plant studies no EC25 toxicity value can be used for RQ calculation.

Spray drift to elderberry plants is not anticipated since phorate is applied only as a granular.

Phorate runs off from agricultural fields into riparian areas where the elderberry plants inhabit. Since phorate is a systemic insecticide, it is assumed that the insecticide will be taken up by the elderberry plants where it would be exposed to the VELB feeding on the elderberry plants. Phorate is considered to be very highly toxic to honey bee and by extension, to the VELB. Under this scenario, phorate can adversely impact the VELB.

5.2.3.2. Indirect Effects

Indirect effects to host plants are not anticipated because phorate is not very toxic to plants. Since the food supply is not reduced from the use of phorate, there are no anticipated indirect effects.

5.2.3.3. Modification of Designated Critical Habitat

Phorate residues from runoff may be available to native plant community which obligate host plants inhabit. In the absence of phytotoxicity data, the effects to non-target plants that BCB and VELB depend on will depend on whether the plants are exposed to phorate residues from runoff. If the plants are exposed to phorate, an assumption will be made that plants may potentially have a reduction in biomass and there may be an effect on the plants; thereby indirectly having an effect on the listed insect species. Although it appears that the effects to the plants may be insignificant, there is an uncertainty as to the effects of phorate on plants because of a lack of phytotoxicity data.

5.2.4. San Joaquin Kit Fox

Habitat for SJKF

"Kit foxes use some types of agricultural land where uncultivated land is maintained, allowing for denning sites and a suitable prey base. Kit foxes also den on small parcels of native habitat surrounded by intensively maintained agricultural lands and adjacent to dryland farms" (USFWS, 1998). "Other habitats in which kit foxes are currently found have been extensively modified by humans" (USFWS, 1998). Kit foxes are "found in grassland and scrubland communities with active oil fields, wind turbines, and an agricultural matrix of row crops, irrigated pasture, orchards, vineyards, and grazed annual grasslands (non-irrigated pasture)" (USFWS, 1998 and 2008).

Diet of SJKF

The SJKF diet consists of poaceae (grasses), "forb leaves/stems, reptiles, birds, carrion, arthropods, and mammals" (VT, 1996). SJKF are predominantly carnivorous; "however, they also consume invertebrates and vegetation. Pups apparently nurse for one to two months. Following weaning they are fed primarily kangaroo rats (*Dipodomys* sp.) by their parents until they are about three or four months old. An adult pair will feed about 98 pounds of meat to five pups in two months. Sub-adults will consume about three ounces of meat per day and adults consume about twice that" (VT, 1996). SJKF are supposedly opportunistic feeders. However, some believe that kangaroo rats are a staple in their diet because "kangaroo rat remains can be found in kit fox scats year-round in the San Joaquin Valley" (VT, 1996). Lagomorph remains are found mostly in scat in the spring and summer (VT, 1996). Desert cottontail rabbits (*Sylvilagus auduboni*) comprise the majority of the kit fox diet in agricultural areas (VT, 1996). It is thought that "kit foxes obtain moisture from their prey. However, a mostly protein diet would create a water deficiency" (VT, 1996). As a result, it is unclear how they maintain their water balance (VT, 1996). It is thought that these animals are "physiologically adapted to desert-like conditions" and also restrict their "water loss by denning during the heat of the day, hunting at night, and excreting highly concentrated urine" (Bell, 1995).

A list of species contained in the SJKF diet based on scat analysis and remains found near dens includes: "kangaroo rats (*Dipodomys ingens*, *D. nitratoides*, and *D. heermanni*), cottontail rabbits (*S. auduboni*), black-tailed hares (*L. californicus*), California ground squirrels (*S. beecheyi*)" (VT, 1996). "Also occurring frequently in scats are insects, and vegetation seeds and stems, including "scorpions (Scorpionidae), Jerusalem crickets (*Stemopelmatus longispinus*), ants (Formicidae), grasshoppers (*Oedaleonotus enigma*), grasses (Bromus sp.), and filaree (*Erodium cicutarium*)" (VT, 1996). "Incidentally consumed are other small mammals including: pocket mice (*Perognathus inornatus*, *P. flauus*), deer mice (*Peromyscus maniculatus*), harvest mice (*Reithrodontomys megalotis*), San Joaquin antelope squirrels (*A. nelsoni*), and gophers (*Thomomys bottae*); other insects (Insecta) and spiders (Arachnida); seeds and stems of other grasses and annual flowering plants; birds, including western medowlark (*Sturnella neglecta*) and California quail (*Lophortyx californicus*); and lizards" (VT, 1996). "They are also known to eat old, decaying meat and carrion from road-kills caused by motor vehicles" (VT, 1996).

5.2.4.1 Direct Effects

The rat is used as a surrogate for SJKF. Mammalian LD_{50}/ft^2 was calculated as RQs since all formulations for phorate are granular. RQs exceeded the acute listed species LOC (0.1) for all uses and the RQs ranged from 6.0 to 778.0. The listed species LOC is exceeded from 60X to 7780X. Additional toxicity data suggest that phorate is very toxic to mammals (rat dermal toxicity LD_{50} = 9.3 mg/kg (male) and 3.9 mg/kg (female); and inhalation toxicity LD_{50} = 0.06 mg/kg (male) and 0.011 mg/kg (female)).

Chronic risk to the terrestrial phase of the CRLF could not be assessed quantitatively via the LD_{50}/sq ft method. However, the following qualitative statement can be made regarding chronic risk from phorate exposure to the adult phase of the CRLF. Because the acute oral toxicity of frog is considered to be very highly toxic and the estimated avian NOAEL (5 ppm ai) suggests birds to be chronically very sensitive to phorate, it would appear that if an adult CRLF experiences acute exposure to phorate (avian LD_{50} = 0.6 mg/kg-bw) and survives the initial acute exposure, later chronic reproductive effects can also have an adverse affect on the organism.

Therefore, the RQ analysis together with the incident (skunk and two opossums during one incident) that associated mammalian mortality with phorate use supports the conclusion that there is a potential for direct effects to SJKF.

5.2.4.2. Indirect Effects

Birds as Prey Items

LD_{50}/ft^2 was calculated as RQs since all formulations for phorate are granular. RQs exceeded the acute LOC (0.5) for all use and the acute RQs for birds ranged from 11.0 to 5580.0.

The dietary sub-acute LC_{50} toxicity data indicate that phorate is highly toxic to mallard duck, bobwhite quail and ring-necked pheasant. The toxicity ranges from 240 ppm ai (mallard duck) to 441 ppm ai (ring-necked pheasant).

The LD_{50} was based on the most sensitive species tested (mallard duck). However, a number of avian species have been tested and are included in Table 37. Some species have shown similar sensitivity to mallard duck; however, other species tested have shown less sensitivity (**Table 37**). RQs would remain above acute LOC for all uses if the least sensitive bird, chukar, was used instead of the mallard. Therefore, it is expected that phorate affects a wide range of avian species.

Table 37. Range of Acute Avian LD_{50}s for Phorate.

Avian Species	LD_{50} mg/kg-bw (ppb ai)	Toxicity Category	Source of Data
Mallard duck	0.62 to 2.55	very highly toxic	00160000
Ring-necked pheasant	7.12	very highly toxic	00160000
Starlings	7.5	Very highly toxic	00020560
Redwing blackbird	1.0	very highly toxic	00020560
Grackle	1.3	Very highly toxic	00020560
Chukar	12.8	very highly toxic	00160000

There are no toxicity data or information on terrestrial organisms for phorate degradates. The aquatic toxicity information on the phorate degradates indicate that the sulfone degradate is similar in toxicity to the parent phorate. The phorate degradate, sulfoxide, is less toxic than the parent phorate.

Therefore, the RQ analysis together with the presence of several incidences and a field study that associated bird mortality with phorate exposure supports the conclusion that there is a potential for indirect effects to the SJKF via reduction in avian prey.

Mammals as Prey Items

Mammalian LD_{50}/ft^2 was calculated as RQs since all formulations for phorate are granular. RQs exceeded the acute listed species LOC (0.1) for all uses and the RQs ranged from 6.0 to 778.0. The listed species LOC is exceeded from 60X to 7780X. Additional toxicity data suggest that phorate is very toxic to mammals (rat dermal toxicity LD_{50} = 9.3 mg/kg (male) and 3.9 mg/kg (female); and inhalation toxicity LD_{50} =

0.06 mg/kg (male) and 0.011 mg/kg (female)).

Chronic risk to the terrestrial phase of the CRLF could not be assessed quantitatively via the LD_{50}/sq ft method. However, the following qualitative statement can be made regarding chronic risk from phorate exposure to the adult phase of the CRLF. Because the acute oral toxicity of frog is considered to be very highly toxic and the estimated avian NOAEL (5 ppm ai) suggests birds to be chronically very sensitive to phorate, it would appear that if an adult CRLF experiences acute exposure to phorate (avian LD_{50} = 0.6 mg/kg-bw) and survives the initial acute exposure, later chronic reproductive effects can also have an adverse affect on the organism.

Therefore, the RQ analysis together with the incident (skunk and two opossums during one incident) that associated mammalian mortality with phorate use supports the conclusion that there is a potential for indirect effects to SJKF via reduction in mammal prey.

Insects as Prey Items

Toxicity data on the honey bee suggests that phorate is highly toxic to insects. An additional study showed 100% mortality to various carabid beetles at 1.12 kg ai/ha. Acute risk to the insects could not be assessed quantitatively via the LD_{50}/sq ft method. The following qualitative statements can be made regarding phorate's potential to affect non-target insects. Phorate is a systemic insecticide that is highly toxic to several insects. Since it is applied as a granular, there may be minimal direct contact with phorate. However, runoff containing phorate residues may go to non-target plants. These plants will take up the phorate residues via its vascular pathways and phorate becomes available to non-target insects feeding on the plants. Since phorate is very highly toxic to insects (Honey bee LD_{50} = 0.32 µg/bee), it is assumed that insect mortality will increase. A reduction in insect prey items may result from phorate exposure to non-target plants. Therefore, there is potential for SJKF to be impacted indirectly via reduction in insect prey base.

Terrestrial Plants

SJKF depends on plant cover for its den and protection from predators. Phorate is not expected to significantly modify any plant community since any plant damage is insignificant.

However, plants may take up phorate residues from runoff. SJKF may eat plant items containing phorate residues. SJKF will then have exposure to phorate residues via consumption of plants. There is potential for SJKF to be impacted from consumption of contaminated plant items.

6.0 Uncertainties

6.1 Exposure Assessment Uncertainties

6.1.1 Maximum Use Scenario

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

6.1.2 Aquatic Exposure Modeling of Phorate

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

The Agency acknowledges that there are some unique aquatic habitats that are not accurately captured by this modeling scenario and modeling results may, therefore, under- or over-estimate exposure, depending on a number of variables. For example, some organisms may inhabit water bodies of different size and depth and/or are located adjacent to larger or smaller drainage areas than the EXAMS pond. In addition, the Services agree that the existing EXAMS pond represents the best currently available approach for estimating aquatic exposure to pesticides (USFWS/NMFS 2004).

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

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

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

6.1.3 Action Area Uncertainties

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

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

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

6.1.4 Usage Uncertainties

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

6.1.5 Terrestrial Exposure Modeling of Phorate

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

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

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

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

6.2 Effects Assessment Uncertainties

6.2.1 Age Class and Sensitivity of Effects Thresholds

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

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

6.2.2 Use of Surrogate Species Effects Data

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

Although no aquatic-phase amphibian data are available for Phorate, freshwater fish data will be used as surrogate for the aquatic-phase amphibian. Therefore, endpoints based on freshwater fish ecotoxicity data are assumed to be protective of potential direct effects to aquatic-phase amphibians including the CRLF, and extrapolation of the risk conclusions from the most sensitive tested species to the aquatic-phase CRLF is likely to overestimate the potential risks to those species. Efforts are made to select the organisms most likely to be affected by the type of compound and usage pattern; however, there is an inherent uncertainty in extrapolating across phyla. In addition, the Agency's LOCs are intentionally set very low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

Toxicity tests on phorate are available for the laboratory rat but are not for the kit fox. Therefore, the rat is used as surrogate species for kit fox. Therefore, endpoints based on mammalian ecotoxicity data are assumed to be protective of potential direct effects to kit fox including the SJKF, and extrapolation of the risk conclusions from the tested species to the SJKF is likely to overestimate the potential risks to those species. Efforts are made to select the organisms most likely to be affected by the type of compound and usage pattern; however, there is an inherent uncertainty in extrapolating across phyla. In addition, the Agency's LOCs are intentionally set very low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

Toxicity tests on phorate are available for the honey bee but are not for the BCB or the VELB. Therefore, the honey bee is used as surrogate species for BCB and VELB. Therefore, endpoints based on bee ecotoxicity data are assumed to be protective of potential direct effects to BCB and VELB, and extrapolation of the risk conclusions from the tested species to BCB and VELB is likely to overestimate the potential risks to those species. Efforts are made to select the organisms most likely to be affected by the type of compound and usage pattern; however, there is an inherent uncertainty in extrapolating across phyla. In addition, the Agency's LOCs are intentionally set very low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

6.2.3 Sublethal Effects

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

To the extent to which sublethal effects are not considered in this assessment, the potential direct and indirect effects of Phorate on listed species may be underestimated.

6.2.4 Chronic Endpoint for Terrestrial Species

Phorate is applied only as a granular formulation. There is no current methodology to determine exposure to CRLF, BCB, VELB, or SJKF from granular applications. Birds (surrogate for CRLF and terrestrial-phase amphibians) and mammals experience chronic effects when exposed to phorate residues as low as 5 ppm for birds and 2 ppm for mammals. Although these terrestrial animals are considered to be very sensistive to phorate on a chronic basis, there is no valid method to compare the exposure of granular formulations to chronic toxicity.

6.2.5. Chronic Toxicity for Bluegill Sunfish

There is some uncertainty in the bluegill chronic value. There was no available data for bluegill chronic endpoint. Bluegill acute value is similar to the trout chronic endpoint value. There is uncertainty in using ACR derived chronic value in that the comparison of acute and chronic data between two different species should be a least 3X instead of being similar. The ACR is a mathematical calculation that was used to estimate a chronic value for bluegill.

6.2.6. Acute Toxicity to Bluegill Sunfish

The bluegill study was done with different weight groups (0.6 gm, 1.0 gm, 1.22 gm, and 1.6 gm). The lowest LC_{50} value of 1.4 ppb was not chosen since this value is an extrapolated value of which the lowest dose concentration tested is 2.1 ppb ai which has 60% mortality. The 95% confidence interval is 0.01-2.2 ppb and the slope is 3.2. There is much uncertainty in this value in that the LC_{50} value may be more or less sensitive and that there was no 50% mortality found within the dose concentrations tested. This may indicate that the LC_{50} could be lower than 2.1 ppb ai. The value used in this assessment is 2.35 ppb which comes from the 1.6 gram group of test species. Therefore, the freshwater fish LC_{50} may be underestimated.

6.2.7 Location of Wildlife Species

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

7. Risk Conclusions

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

Based on the best available information, the Agency makes a Likely to Adversely Affect determination for the CRLF, SJKF, BCB, and VELB from the use of phorate. Additionally, the Agency has determined that there is not the potential for modification of the designated critical habitat for the BCB from the use of phorate and there is a potential for modification of the designated critical habitat for the CRLF and VELB. The SJKF has no critical habitat.

The determinations below are based upon phorate application information derived from approved (marketed) labels prior to May 2008. Since that time, all phorate labels have required that all applications include soil-incorporation (for which the Agency assumes an incorporation efficiency of 85%) – leaving 15% of total applied a.i. available at the surface. Although both sets of exposure and risk data (85% soil-incorporated vs. non-soil-incorporated) are presented in this document, the risk conclusions are based solely upon the pre-May 2008 labels. As a result, exposure estimates, associated potential risks, and the final determinations are higher than would be expected if only the post-May 2008 labels had been used – the exceptions being peanut and ornamental uses, which already required soil-incorporation. Mitigation strategies, initially required in 1996 but not fully implemented until 2008 are thus considered in this assessment as a means of comparison but are not used in the final determination.

A summary of the risk conclusions and effects determinations for the CRLF, VELB, BCB, and SJKF and their critical habitats, given the uncertainties discussed in Section 6, is presented in **Tables 38** and **39**.

Table 38 Effects Determination Summary for Effects of Phorate on the CRLF, BCB, VELB, and SJKF

Species	Effects Determination [1]	Basis for Determination
California red-legged frog (*Rana aurora draytonii*)	**LAA**[1]	**Potential for Direct Effects**
		Aquatic-phase (Eggs, Larvae, and Adults): freshwater fish (as a surrogate to the aquatic-phase amphibian). Listed species LOC (0.05) was exceeded for all uses; chronic LOC (1.0) was exceeded for all uses except peanut (0.1), corn (0.6) , beans (0.6), ornamentals (0.9), and potato (0.4). Potential acute and chronic effects were not considered discountable or insignificant.
		Terrestrial-phase (Juveniles and Adults): birds (as a surrogate to the terrestrial-phase frog). Listed species LOC (0.05) was exceeded for all uses; chronic LOC was not calculated. However, with chronic effects (Reduction in number of eggs laid, viable embryos, and normal hatchlings) to birds measured as low 5 ppm, the potential for chronic effects to CRLF can not be ruled out. Potential chronic and acute effect was not considered discountable or insignificant.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover and/or primary productivity: Aquatic invertebrates: RQs exceed acute LOC (0.5) for all uses. RQs exceed Chronic LOC (1.0) for all uses except peanut (0.3). Acute RQs ranged from 0.6 to 26.5 and chronic RQs ranged from 0.3 to 14.2. Potential acute and chronic effects were not considered discountable or insignificant. Fish and frogs: RQs exceed acute LOC (0.5) for all uses except peanut (0.1). Chronic LOC (1.0) was exceeded for all uses, except peanut (0.1), corn (0.6), beans (0.6), ornamentals (0.9), and potato (0.4). Acute RQs ranged from 0.1 to 6.2 and chronic RQs ranged from 0.1 to 3.1. Potential acute and chronic effects were not considered discountable or insignificant. Aquatic Plants: RQs below LOC.
		Terrestrial prey items, riparian habitat Birds and frogs: RQs exceed acute LOC (0.5) for all uses. Acute RQs ranged from 11 to 5,580. The potential magnitude of effect could be sufficient to result in potential indirect effects to the CRLF. Chronic LOC was not calculated. However, with chronic effects (Reduction in number of eggs laid, viable embryos, and normal hatchlings) to birds measured as low 5 ppm, the potential for chronic effects to CRLF can not be ruled out. Terrestrial invertebrates: RQs were not calculated for insects due to granular formulation. Phorate is very highly toxic to honey bee (surrogate for insects).

		Phorate is systemic in plants where insects feeding on plants will be exposed to phorate. Potential risk to insect prey items is expected. Potential acute and chronic effects were not considered discountable or insignificant. Small mammals: RQs exceeded the acute LOC (0.5) for all uses and the RQs ranged from 6 to 778. In addition, phorate is very toxic to small mammals via dermal and inhalation. Chronic RQs are not calculated due to granular formulation. Mammalian reproductive data show phorate to have reproductive effects at very low levels of exposure. Potential acute and chronic effects were not considered discountable or insignificant. Terrestrial plants: Leaf injury may occur and plant may recover.
Bay checkerspot butterfly (*Euphydryas editha bayensis*)	**LAA**[1]	**Potential for Direct Effects**
		Phorate is highly toxic to insects. Exposure to insects would be through systemic activity of the plants on which they feed. Potential for phorate exposure to BCB is minimal. However, since BCB has metapopulation characteristics, there is some uncertainty of phorate exposure to BCB traveling from one population to another population. The longest distance known for BCB to travel is 7.6 Km. BCB may travel from one population to another and land on a plant that has phorate residues. If such conditions occur, BCB may be adversely impacted.
		Potential for Indirect Effects
		Host plants are not expected to be exposed to phorate.
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	**LAA**[1]	**Potential for Direct Effects**
		Honey bee is surrogate for VELB. Runoff from use sites may move to riparian areas inhabited by host plants. Host plant takes up phorate residues and the VELB could then be exposed. Phorate is considered to be very highly toxic to honey bee and by extension, to the VELB. Due to granular nature of phorate, RQs are not calculated. Potential effect was not considered discountable or insignificant.
		Potential for Indirect Effects
		In the absence of phytotoxicity data, it is assumed that the effects to non-target plants that VELB depend on may potentially have a small reduction in biomass; thereby indirectly having an effect on the listed insect species. Although it appears that the effects to the plants may be insignificant, there is an uncertainty as to the effects of phorate on plants because of a lack of phytotoxicity data. Therefore, VELB may be indirectly affected from reduction in food supply.
San Joaquin kit fox (*Vulpes macrotis mutica*)	**LAA**[1]	**Potential for Direct Effects**
		Rat is surrogate for SJKF. Rat RQs exceeded the acute listed species LOC (0.1) for all uses. RQs ranged from 6 to 778. The listed species LOC is exceeded from 60X to 7780X. In addition, phorate is very toxic to small mammals via dermal and inhalation routes of exposure. Chronic RQs are not calculated due to granular formulation. However, with chronic effects (decreased pup survival and pup body weight) to rats measured as low as 2 ppm, the potential for chronic effects to SJKF can not be ruled out. Potential effect was not considered discountable or insignificant.
		Potential for Indirect Effects
		Reduction in Prey Birds. RQs exceed acute LOC (0.5) for all uses. Chronic LOC was not calculated due to granular formulation. Birds are very sensitive to chronic endpoints. If birds survive acute risk, they may still have chronic risk. Acute RQs ranged from 11 to 5,580. The potential magnitude of effect could be sufficient to result in potential indirect effects to the SJKF. Small mammals: RQs exceeded the acute LOC (0.5) for all use and the RQs

		ranged from 6 to 778. In addition, phorate is very toxic to small mammals via dermal and inhalation routes of exposure. Chronic RQs are not calculated due to granular formulation. However, with chronic effects (decreased pup survival and pup body weight) to rats measured as low as 2 ppm, the potential for chronic effects to CRLF can not be ruled out. The potential magnitude of effect could be sufficient to result in potential indirect effects to the SJKF. *Terrestrial insects*: Honey bee is surrogate for insects. Runoff from use sites go to plants. Plants take up phorate residues and insects are exposed to phorate. Phorate is considered to be very highly toxic to honey bee and by extension, to insects. Due to granular nature of phorate, RQ are not calculated. Insect prey base may be reduced. Reduction of prey items may result in a potential for indirect effects to the SJKF. *Terrestrial plants*: No RQs are calculated for non-target plants due to lack of plant toxicity data. Plants may take up phorate residues from runoff. SJKF may eat plant items containing phorate residues. SJKF will then have exposure to phorate residues via consumption of plants. The amount of plant items in diet, the toxicity of phorate to mammals, and incidents reported of swift fox mortality from phorate may result in a potential for indirect effects to the SJKF.

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

Table 39 Effects Determination Summary for the Critical Habitat Impact Analysis		
Designated Critical Habitat for:	**Effects Determination [1]**	**Basis for Determination**
California red-legged frog (*Rana aurora raytonii*)	**HM[1]**	PCE - Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond.
		PCE - Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.
		PCE - Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source. – **Phorate potentially reduces aquatic invertebrate population which is food source for aquatic-phase CRLF.**
		PCE - Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)
		PCE - Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance. **Insects feed off of plant leaves will be exposed to phorate residues from phorate being translocated to plant leaves from runoff to riparian areas. This may potentially reduce insect prey population for CRLF.**
		PCE - 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.
		PCE - Reduction and/or modification of food sources for terrestrial phase juveniles and adults. **Insects feed off of plant leaves will be exposed to phorate residues from phorate being translocated to plant leaves from runoff to riparian areas. This may potentially reduce insect prey population for CRLF.**
		PCE - Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source. **Insects feed off of plant leaves will be exposed to phorate residues from phorate being translocated to plant leaves from runoff to riparian areas. This may potentially reduce insect prey population for CRLF.**
Bay checkerspot butterfly (*Euphydryas editha bayensis*)	**NE[1]**	**There is no exposure to BCB critical habitat from registered use of phorate.**
		PCE - The presence of annual or perennial grasslands with little to no overstory that provide north/south and east/west slopes with a tilt of more than 7 degrees for larval host plant survival during periods of atypical weather (e.g., drought).
		PCE - The presence of the primary larval host plant, dwarf plantain (*Plantago erecta*) (a dicot) and at least one of the secondary host plants, purple owl's-clover or exserted paintbrush, are required for reproduction, feeding, and larval development.
		PCE - The presence of adult nectar sources for feeding.
		PCE - Aquatic features such as wetlands, springs, seeps, streams, lakes, and ponds and their associated banks, that provide moisture during periods of spring drought; these features can be ephemeral, seasonal, or permanent.
		PCE - Soils derived from serpentinite ultramafic rock (Montara, Climara, Henneke, Hentine, and Obispo soil series) or similar soils (Inks, Candlestick, Los Gatos, Fagan, and Barnabe soil series) that provide areas with fewer aggressive, nonnative plant species for larval host plant and adult nectar plant survival and reproduction.[2]
		PCE - The presence of stable holes and cracks in the soil, and surface rock outcrops that provide shelter for the larval stage of the bay checkerspot butterfly during summer diapause.[2]
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	**HM[1]**	PCE - Areas that contain the host plant of this species [*i.e.*, elderberry trees (*Sambucus* sp.)] (a dicot). **The host plants inhabit riparian areas. Runoff from agricultural fields containing phorate may come to these riparian areas. In the absence of phytotoxicity data, it is assumed that the effects to non-target plants that VELB depend on may potentially have a small reduction in biomass; thereby indirectly having an effect on the listed insect species. Although it appears that the effects to the plants may be insignificant, there is an uncertainty as to the effects of phorate on**

		plants because of a lack of phytotoxicity data. Therefore, VELB may be indirectly affected from reduction in food supply.

[1] Habitat Modification (HM) or No effect (NE). These PCEs are in addition to more general requirements for habitat areas that provide essential life cycle needs of the species such as, 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.
[2] PCEs that are abiotic, including, 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.

Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated to seek concurrence with the Likely to Adversely Affect (LAA) determination for California red-legged frog (*Rana aurora draytonii*), Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), Bay checkerspot butterfly (*Euphydryas editha bayensis*), and San Joaquin kit fox (*Vulpes macrotis mutica*) and to determine whether there are reasonable and prudent alternatives and/or measures to reduce and/or eliminate potential incidental take.

Given the LAA determination for the CRLF, VELB, BCB, and SJKF and potential modification of designated critical habitat for CRLF and VELB, a description of the baseline status and cumulative effects for the CRLF is provided in **Attachment 2** and the baseline status and cumulative effects for the VELB, BCB, and SJKF are provided in **Attachment 4**.

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

- Enhanced information on the density and distribution of CRLF, and VELB, BCB and SJKF, life stages within the action area and/or applicable designated critical habitat. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the assessed species.

- Quantitative information on prey base requirements for the assessed species. While existing information provides a preliminary picture of the types of food sources utilized by the assessed species, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.
- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual species and potential modification to critical habitat.

8. References

Altig, R. and R.W. McDiarmid. 1999. Body Plan: Development and Morphology. In R.W. McDiarmid and R. Altig (Eds.), Tadpoles: The Biology of Anuran Larvae.University of Chicago Press, Chicago. pp. 24-51.

Alvarez, J. 2000. Letter to the U.S. Fish and Wildlife Service providing comments on the Draft California Red-legged Frog Recovery Plan.

Atkins. E.L., E.A. Greywood, and R.L. MacDonald. 1975. Toxicity of pesticides and other agricultural chemicals to honey bees. Laboratory studies. Univ. of Calif., Div. Agric. Sci. Leaflet 2287. 38 pp. (MRID# 000369-35).

Burns, L.A. 1997. Exposure Analysis Modeling System (EXAMSII) Users Guide for Version 2.97.5, Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

Carsel, R.F. , J.C. Imhoff, P.R. Hummel, J.M. Cheplick and J.S. Donigian, Jr. 1997. PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.0; Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

Crawshaw, G.J. 2000. Diseases and Pathology of Amphibians and Reptiles *in:* Ecotoxicology of Amphibians and Reptiles; ed: Sparling, D.W., G. Linder, and C.A. Bishop. SETAC Publication Series, Columbia, MO.

Fellers, G. M., et al. 2001. Overwintering tadpoles in the California red-legged frog (*Rana aurora draytonii*). Herpetological Review, 32(3): 156-157.

Fellers, G.M, L.L. McConnell, D. Pratt, S. Datta. 2004. Pesticides in Mountain Yellow-Legged Frogs (Rana Mucosa) from the Sierra Nevada Mountains of California, USA. Environmental Toxicology & Chemistry 23 (9):2170-2177.

Fellers, Gary M. 2005a. *Rana draytonii* Baird and Girard 1852. California Red-legged Frog. Pages 552-554. *In*: M. Lannoo (ed.) Amphibian Declines: The Conservation Status of United States Species, Vol. 2: Species Accounts. University of California Press, Berkeley, California. xxi+1094 pp. (http://www.werc.usgs.gov/pt-reyes/pdfs/Rana%20draytonii.PDF)

Fellers, Gary M. 2005b. California red-legged frog, *Rana draytonii* Baird and Girard. Pages 198-201. *In*: L.L.C. Jones, et al (eds.) Amphibians of the Pacific Northwest. xxi+227.

Fernandez, S., C. Santin, J. Marquinez, and M.A. Alvarez. 2005. Changes in soils due to polderization in coastal plain estuaries. Geophysical Research Abstracts 7, 3pp.

Fletcher, J.S., J.E. Nellessen, and T.G. Pfleeger. 1994. Literature review and evaluation of the EPA food-chain (Kenaga) nomogram, and instrument for estimating pesticide residues on plants. Environmental Toxicology and Chemistry 13 (9):1383-1391.

Hayes, M.P. and M.R. Jennings. 1988. Habitat correlates of distribution of the California red-legged frog (Rana aurora draytonii) and the foothill yellow-legged frog (Rana boylii): Implications for management. Pp. 144-158. In Proceedings of the symposium on the management of amphibians, reptiles, and small mammals in North America. R. Sarzo, K.E. Severson, and D.R. Patton (technical coordinators). USDA Forest Service General Technical Report RM-166.

Hayes, M.P. and M.M. Miyamoto. 1984. Biochemical, behavioral and body size differences between *Rana aurora aurora* and *R. a. draytonii*. Copeia 1984(4): 1018-22.

Hayes and Tennant. 1985. Diet and feeding behavior of the California red-legged frog. The Southwestern Naturalist 30(4): 601-605.

Hoerger, F., and E.E. Kenaga. 1972. Pesticide residues on plants: Correlation of representative data as a basis for estimation of their magnitude in the environment. In F. Coulston and F. Korte, *eds*., Environmental Quality and Safety: Chemistry, Toxicology, and Technology, Georg Thieme Publ, Stuttgart, West Germany, pp. 9-28.

Hoheisel, C., J. Karrie, S. Lees, L. Davies-Hilliard, P. Hannon, R. Bingham, E. Behl, D. Wells, and E. Waldman. 1992. Pesticides in Ground Water Database. A compilation of monitoring studies: 1971 - 1991 National Summary. EPA 734-12-92-001. U. S. Environmental Protection Agency: Arlington, VA.

Jennings, M.R. and M.P. Hayes. 1985. Pre-1900 overharvest of California red-legged frogs (*Rana aurora draytonii*): The inducement for bullfrog (*Rana catesbeiana*) introduction. Herpetological Review 31(1): 94-103.

Jennings, M.R. and M.P. Hayes. 1994. Amphibian and reptile species of special concern in California. Report prepared for the California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California. 255 pp.

Jennings, M.R., S. Townsend, and R.R. Duke. 1997. Santa Clara Valley Water District California red-legged frog distribution and status – 1997. Final Report prepared by H.T. Harvey & Associates, Alviso, California. 22 pp.

Jordan, T.E., J.C. Cornwell, R.B. Walter, and J.T. Anderson. 2008. Changes in phosphorus biogeochemistry along an estuarine salinity gradient. Limnology and Oceanography 53(1): 172-184.

Karvonen, T., Koivusalo, H., Jauhiainen, M., Palko, J. and Weppling, K. 1999. A hydrological model for predicting runoff from different land use areas, Journal of Hydrology, 217(3-4): 253-265.

Kuhn, J.O. 1991. Acute Oral Toxicity Study in Rats. CIBA-GEIGY Corporation, Agricultural Division, Greensboro, NC. Study Number 7803-91.

Kupferberg, S. 1997. Facilitation of periphyton production by tadpole grazing: Functional differences between species. Freshwater Biology 37:427-439.

Kupferberg, S.J., J.C. Marks and M.E. Power. 1994. Effects of variation in natural algal and detrital diets on larval anuran (*Hyla regilla*) life-history traits. Copeia 1994:446-457.

LeNoir, J.S., L.L. McConnell, G.M. Fellers, T.M. Cahill, J.N. Seiber. 1999. Summertime Transport of Current-use pesticides from California's Central Valley to the Sierra Nevada Mountain Range,USA. Environmental Toxicology & Chemistry 18(12): 2715-2722.

Majewski , M.S. and P.D. Capel. 1995. Pesticides in the atmosphere: distribution, trends, and governing factors. Ann Arbor Press, Inc. Chelsea, MI.

McConnell, L.L., J.S. LeNoir, S. Datta, J.N. Seiber. 1998. Wet deposition of current-use pesticides in the Sierra Nevada mountain range, California, USA. Environmental Toxicology & Chemistry 17(10):1908-1916.

McDonald M.A.1; Healey J.R.; Stevens P.A. 2002. The effects of secondary forest clearance and subsequent land-use on erosion losses and soil properties in the Blue Mountains of Jamaica. Agriculture, Ecosystems & Environment, Volume 92, Number 1: 1-19.

Means, J.C. 1995. Influence of salinity upon sediment-water partitioning of aromatic hydrocarbons. Marine Chemistry 51(1): 3-16.

Okisaka S.; Murakami A.; Mizukawa A.; Ito J.; Vakulenko S.A.; Molotkov I.A.; Corbett C.W.; Wahl M.; Porter D.E.; Edwards D.; Moise C. 1997. Nonpoint source runoff modeling: A comparison of a forested watershed and an urban watershed on the South Carolina coast. Journal of Experimental Marine Biology and Ecology, Volume 213, Number 1: 133-149.

Parikh S.J., J. Chorover, and W.D Burgos. 2004. Interaction of phenanthrene and its primary metabolite (1-hydroxy-2-naphthoic acid) with estuarine sediments and humic fractions. Journal of Contaminant Hydrology 72(1-4): 1-22.

Phuong V.T. and van Dam J. Linkages between forests and water: A review of research evidence in Vietnam. ***In***: Forests, Water and Livelihoods European Tropical Forest Research Network. ETFRN NEWS (3pp).

Rathburn, G.B. 1998. *Rana aurora draytonii* egg predation. Herpetological Review, 29(3): 165.

Reis, D.K. Habitat characteristics of California red-legged frogs (*Rana aurora draytonii*): Ecological differences between eggs, tadpoles, and adults in a coastal brackish and freshwater system. M.S. Thesis. San Jose State University. 58 pp.

Seale, D.B. and N. Beckvar. 1980. The comparative ability of anuran larvae (genera: *Hyla*, *Bufo* and *Rana*) to ingest suspended blue-green algae. Copeia 1980:495-503.

Sparling, D.W., G.M. Fellers, L.L. McConnell. 2001. Pesticides and amphibian population declines in California, USA. Environmental Toxicology & Chemistry 20(7): 1591-1595.

Swarzenski, P.W., D. Porcelli, P.S. Andersson, and J.M Smoak. 2003. The behavior of U- and Th-series nuclides in the estuarine environment. Reviews in Mineralogy and Geochemistry 52(1): 577-606.

Teske, Milton E., and Thomas B. Curbishley. 2003. *AgDisp ver 8.07 Users Manual*. USDA Forest Service, Morgantown, WV.

U.S. Environmental Protection Agency (U.S. EPA). 1998. Guidance for Ecological Risk Assessment. Risk Assessment Forum. EPA/630/R-95/002F, April 1998.

U.S. EPA. 2004. Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs. Office of Prevention, Pesticides, and Toxic Substances. Office of Pesticide Programs. Washington, D.C. January 23, 2004.

U.S. Fish and Wildlife Service (USFWS). 1996. Endangered and threatened wildlife and plants: determination of threatened status for the California red-legged frog. Federal Register 61(101):25813-25833.

USFWS. 2002. Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*). Region 1, USFWS, Portland, Oregon. (http://ecos.fws.gov/doc/recovery_plans/2002/020528.pdf)

USFWS. 2006. Endangered and threatened wildlife and plants: determination of critical habitat for the California red-legged frog. 71 FR 19244-19346.

USFWS. Website accessed: 30 December 2006. http://www.fws.gov/endangered/features/rl_frog/rlfrog.html#where

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1998. Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. Final Draft. March 1998.

USFWS/NMFS. 2004. 50 CFR Part 402. Joint Counterpart Endangered Species Act Section 7 Consultation Regulations; Final Rule. FR 47732-47762.

Velde B. and T. Church. 1999. Rapid clay transformations in Delaware salt marshes. Applied Geochemistry 14(5): 559-568

Wassersug, R. 1984. Why tadpoles love fast food. Natural History 4/84.

Willis, G.H. and L.L. McDowell. 1987. Pesticide Persistence on Foilage in Reviews of Environmental Contamination and Toxicology. 100:23-73.

Wood, T.M. and A.M. Baptista. 1993. A model for diagnostic analysis of estuarine geochemistry. Water Resources Research 29(1): 51–71.