Risks of Acephate Use to the Federally Threatened

Bay Checkerspot Butterfly (*Euphydryas editha bayensis*), Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*), and California Tiger Salamander (*Ambystoma californiense*), Central California Distinct Population Segment

And the Federally Endangered

California Clapper Rail (*Rallus longirostris obsoletus*), California Freshwater Shrimp (*Syncaris pacifica*), California Tiger Salamander (*Ambystoma californiense*) Sonoma County Distinct Population Segment and Santa Barbara County Distinct Population Segment, Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*), San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*), and San Joaquin Kit Fox (*Vulpes macrotis mutica*)

Pesticide Effects Determinations
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List of Commonly Used Abbreviations and Nomenclature

µg/kg	Symbol for "micrograms per kilogram"
µg/L	Symbol for "micrograms per liter"
ºC	Symbol for "degrees Celsius"
AAPCO	Association of American Pesticide Control Officials
a.i.	Active Ingredient
AIMS	Avian Monitoring Information System
Acc#	Accession Number
amu	Atomic Mass Unit
BCB	Bay Checkerspot Butterfly
BCF	Bioconcentration Factor
BEAD	Biological and Economic Analysis Division
bw	Body Weight
CAM	Chemical Application Method
CARB	California Air Resources Board
AW	Alameda Whipsnake
CBD	Center for Biological Diversity
CCR	California Clapper Rail
CDPR	California Department of Pesticide Regulation
CDPR-PUR	California Department of Pesticide Regulation Pesticide Use Reporting Database
CFWS	California Freshwater Shrimp
CI	Confidence Interval
CL	Confidence Limit
CTS	California Tiger Salamander
CTS-CC	California Tiger Salamander Central California Distinct Population Segment
CTS-SB	California Tiger Salamander Santa Barbara County Distinct Population Segment
CTS-SC	California Tiger Salamander Sonoma County Distinct Population Segment
DS	Delta Smelt
EC	Emulsifiable Concentrate
EC_{05}	5% Effect Concentration
EC_{25}	25% Effect Concentration
EC_{50}	50% (or Median) Effect Concentration

ECOTOX	EPA managed database of Ecotoxicology data
EEC	Estimated Environmental Concentration
EFED	Environmental Fate and Effects Division
e.g.	Latin *exempli gratia* ("for example")
EIM	Environmental Information Management System
EPI	Estimation Programs Interface
ESU	Evolutionarily significant unit
et al.	Latin *et alii* ("and others")
etc.	Latin *et cetera* ("and the rest" or "and so forth")
EXAMS	Exposure Analysis Modeling System
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
FQPA	Food Quality Protection Act
ft	Feet
GENEEC	Generic Estimated Exposure Concentration model
HPLC	High Pressure Liquid Chromatography
IC_{05}	5% Inhibition Concentration
IC_{50}	50% (or median) Inhibition Concentration
i.e.	Latin for *id est* ("that is")
IECV1.1	Individual Effect Chance Model Version 1.1
KABAM	K_{OW} (based) Aquatic BioAccumulation Model
kg	Kilogram(s)
kJ/mole	Kilojoules per mole
km	Kilometer(s)
K_{AW}	Air-water Partition Coefficient
K_d	Soil-water Distribution Coefficient
K_f	Freundlich Soil-Water Distribution Coefficient
K_{OC}	Organic-carbon Partition Coefficient
K_{OW}	Octanol–water Partition Coefficient
LAA	Likely to Adversely Affect
lb a.i./A	Pound(s) of active ingredient per acre
LC_{50}	50% (or Median) Lethal Concentration
LD_{50}	50% (or Median) Lethal Dose
LOAEC	Lowest Observable Adverse Effect Concentration
LOAEL	Lowest Observable Adverse Effect Level
LOC	Level of Concern
LOD	Level of Detection

LOEC	Lowest Observable Effect Concentration
LOQ	Level of Quantitation
m	Meter(s)
MA	May Affect
MATC	Maximum Acceptable Toxicant Concentration
m^2/day	Square Meters per Days
ME	Microencapsulated
mg	Milligram(s)
mg/kg	Milligrams per kilogram (equivalent to ppm)
mg/L	Milligrams per liter (equivalent to ppm)
mi	Mile(s)
mmHg	Millimeter of mercury
MRID	Master Record Identification Number
MW	Molecular Weight
n/a	Not applicable
NASS	National Agricultural Statistics Service
NAWQA	National Water Quality Assessment
NCOD	National Contaminant Occurrence Database
NE	No Effect
NLAA	Not Likely to Adversely Affect
NLCD	National Land Cover Dataset
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAEC	No Observable Adverse Effect Concentration
NOAEL	No Observable Adverse Effect Level
NOEC	No Observable Effect Concentration
NRCS	Natural Resources Conservation Service
OPP	Office of Pesticide Programs
OPPTS	Office of Prevention, Pesticides and Toxic Substances
ORD	Office of Research and Development
PCE	Primary Constituent Element
pH	Symbol for the negative logarithm of the hydrogen ion activity in an aqueous solution, dimensionless
pKa	Symbol for the negative logarithm of the acid dissociation constant, dimensionless
ppb	Parts per Billion (equivalent to µg/L or µg/kg)

ppm	Parts per Million (equivalent to mg/L or mg/kg)
PRD	Pesticide Re-Evaluation Division
PRZM	Pesticide Root Zone Model
ROW	Right of Way
RQ	Risk Quotient
SFGS	San Francisco Garter Snake
SJKF	San Joaquin Kit Fox
SLN	Special Local Need
SMHM	Salt Marsh Harvest Mouse
TG	Tidewater Goby
T-HERPS	Terrestrial Herpetofaunal Exposure Residue Program Simulation
T-REX	Terrestrial Residue Exposure Model
UCL	Upper Confidence Limit
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VELB	Valley Elderberry Longhorn Beetle
WP	Wettable Powder
wt	Weight

1. Executive Summary

1.1. Purpose of Assessment

The purpose of this assessment is to evaluate potential direct and indirect effects of acephate (PC code: 103301) on the bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB), California tiger salamander (*Ambystoma californiense*) Central California Distinct Population Segment (CTS-CC), Sonoma County Distinct Population Segment (CTS-SC) and Santa Barbara County Distinct Population Segment (CTS-SB), California clapper rail (*Rallus longirostris obsoletus*) (CCR), California freshwater shrimp (*Syncaris pacificus*) (CFWS), salt marsh harvest mouse (*Reithrodontomys raviventris*) (SMHM), San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) (SFGS), and the San Joaquin kit fox (*Vulpes macrotis mutica*) (SJKF) arising from FIFRA regulatory actions regarding use of acephate on agricultural and non-agricultural sites. In addition, this assessment evaluates whether these actions can be expected to result in modification of designated critical habitat for the BCB, VELB, CTS-CC, and CTS-SB; the other assessed species do not have designated critical habitats. 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), procedures outlined in the Agency's Overview Document (USEPA, 2004), and consistent with a suit in which acephate was alleged to be of concern to the BCB, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SMHM, SFGS, and SJKF (*Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS).

Below are brief descriptions of when each San Francisco Bay species being assessed was listed and a short description of their associated Primary Constituent Element (PCEs) (when applicable).

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 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 PCEs 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 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. The PCEs for the VELBs include areas that contain its host plant (*i.e.*, elderberry trees).

There are currently three CTS Distinct Population Segments (DPSs): the Sonoma County (SC) DPS, the Santa Barbara (SB) DPS, and the Central California (CC) DPS. Each DPS is considered separately in the risk assessment as they occupy different geographic areas. The main difference in the assessment will be in the spatial analysis. The CTS-SB was listed by the USFWS as endangered in 2000, the CTS-SC in 2002, and the CTS-CC as threatened in 2004. The CTS-SB and CTS-SC were downlisted from endangered to threatened in 2004 by the

USFWS, however, the downlisting was vacated by the U.S. District Court. Therefore, the Sonoma and Santa Barbara DPSs are currently listed as endangered while the CTS-CC is listed as threatened. All CTS populations utilize vernal pools, semi-permanent ponds, and permanent ponds, and the terrestrial environment in California. The aquatic environment is essential for breeding and reproduction and mammal burrows are also important habitat for aestivation. The PCEs for the CTS are standing bodies of freshwater sufficient for the species to complete the aquatic portion of its life cycle that are adjacent to barrier-free uplands that contain small mammal burrows. An additional PCE is upland areas between sites (as described above) that allow for dispersal of the species.

The CCR was listed by the USFWS as an endangered species in 1970. The species is found only in California in coastal wetlands along the San Francisco estuary and Suisun Bay.

The CFWS was listed as endangered in 1988 by the USFWS. The CFWS inhabits freshwater streams in Central California in the lower Russian River drainage and westward to the Pacific Ocean and coastal streams draining into Tomales Bay and southward into the San Pablo Bay.

The SMHM was listed by the USFWS as an endangered species in 1970. The species is found in tidal and non-tidal salt marshes along the San Francisco, San Pablo, and Suisun Bays in California.

The SFGS was listed as endangered in 1967 by the USFWS. The species is endemic to the San Francisco Peninsula and San Mateo County in California in densely vegetated areas near marshes and standing open water.

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.

1.2. Scope of Assessment

1.2.1. Uses Assessed

Acephate (O, S-dimethyl acetylphosphoramidothioate) is a systemic, organophosphate insecticide currently registered for use on a variety of field, fruit, and vegetable crops; in food handling establishments; on ornamental plants both in greenhouses and outdoors (including lawns, turf, and cut flowers); and in and around the home. Acephate was first registered in 1973 for ornamental uses and in 1974 for food uses (agricultural crops). Formulation types registered include wettable powders, soluble powders, soluble extruded pellets, granular, and liquid. Target pests include armyworms, aphids, beetles, bollworms, borers, budworms, cankerworms, crickets, cutworms, fire ants, fleas, grasshoppers, leafhoppers, loopers, mealy bugs, mites, moths, roaches, spiders, thrips, wasps, weevils, and whiteflies. Although current registrations of acephate allow for use nationwide, this ecological risk assessment and effects determination addresses currently registered uses of acephate in California only. Uses in California comprise the full range of agricultural and non-agricultural registrations and all types of formulations for acephate. Applications to crops can be made aerially, by ground spray, or by air blast sprayer for orchard crops.

1.2.2. Environmental Fate Properties of Acephate

Aerobic soil metabolism is the main degradation process for acephate. Observed half-lives are less than 3 days for most soils, producing the intermediate degradate methamidophos, which was also a registered pesticide until it was voluntarily cancelled by the registrants in 2009. Methamidophos is itself rapidly metabolized by soil microorganisms to carbon dioxide and microbial biomass (half-lives of < 10 days). Acephate degrades very slowly by hydrolysis except at high pHs (half-life at pH 9 of 18 days) and does not photodegrade. Acephate is not persistent in anaerobic clay sediment with a half-life of 6.6 days. The major degradates under anaerobic conditions are carbon dioxide and methane.

Acephate and methamidophos are likely to be very mobile in soils. Because acephate is not persistent under aerobic conditions, acephate is not expected to leach to groundwater. If any acephate were to reach ground water, it would not be expected to persist, due to its short metabolic half-life.

Acephate and its degradate methamidophos are not expected to persist in the field. Field studies conducted in Mississippi (tobacco on silt loam soil), California (bell peppers on silt loam soil), Florida (cauliflower on sand soil) and Iowa (soybeans on loam soil) found half-lives of 2 days or less with no detections of parent or the degradate methamidophos below a depth of 50 cm. Based on the vapor pressures and solubilities of acephate and methamidophos, the Agency does not expect that volatilization from soil or water is a route of dissipation for either the parent or the degradate.

Section 2.4 describes the fate properties of acephate in greater detail.

1.2.3. Evaluation of Degradates and Stressors of Concern

The major degradate of acephate in aerobic soil metabolism studies is methamidophos (up to 23%), which also has insecticidal properties and was a registered insecticide until 2009. Methamidophos is four to 42 times more acutely toxic than acephate, depending on the specific taxa, and its effects are considered quantitatively in this risk assessment. Separate assessments of risk due to acephate and to methamidophos as a degradate of acephate are provided to assess the overall risk to the environment from acephate applications.

Section 2.2.1 describes the quantitative assessment of methamidophos exposure in greater detail.

1.3. Assessment Procedures

A description of routine procedures for evaluating risk to the San Francisco Bay Species is provided in Attachment I.

1.3.1. Exposure Assessment

1.3.1.a. Aquatic Exposures

Tier-II aquatic exposure models are used to estimate high-end exposures of acephate in aquatic habitats resulting from runoff and spray drift from different uses. The models used to predict aquatic estimated environmental concentrations (EECs) are the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). The AgDRIFT model is also used to estimate deposition of acephate on aquatic habitats from spray drift. Peak model-EECs resulting from different acephate uses range from 0.09 to 2456 µg/L. No useful surface water monitoring data were found for acephate.

1.3.1.b. Terrestrial Exposures

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

1.3.2. Toxicity Assessment

The assessment endpoints include direct toxic effects on survival, reproduction, and growth of individuals, as well as indirect effects, such as reduction of the food source and/or modification of habitat. Federally-designated critical habitat has been established for the BCB, VELB, CTS-CC, and CTS-SB. Primary constituent elements (PCEs) were used to evaluate whether acephate has the potential to modify designated critical habitat. The Agency evaluated registrant-submitted studies and data from the open literature to characterize toxicity of acephate and its degradate, methamidophos. The most sensitive toxicity value available from acceptable or supplemental studies for each taxon relevant for estimating potential risks to the assessed species and/or their designated critical habitat was used.

Section 4 summarizes the ecotoxicity data available on acephate and its degradate, methamidophos. Acephate is moderately toxic to freshwater and estuarine/marine invertebrates, practically nontoxic to freshwater fish (surrogate for aquatic-phase amphibians), and slightly toxic to estuarine/marine fish on an acute exposure basis. The reproductive NOAECs for freshwater and estuarine/marine invertebrates are 0.15 mg a.i./L and 0.58 mg a.i./L, respectively. The chronic NOAEC for freshwater fish, calculated using an acute to chronic ratio, is 5.9 mg a.i./L. There is no data available with which to determine a chronic NOAEC for estuarine/marine fish.

Methamidophos is very highly toxic to freshwater invertebrates, slightly toxic to freshwater fish, and moderately toxic to estuarine/marine invertebrates and fish on an acute exposure basis. The reproductive NOAECs for freshwater and estuarine/marine invertebrates are 0.0045 mg a.i./L and 0.174 mg a.i./L, respectively. The chronic NOAEC for freshwater fish, calculated using an acute to chronic ratio, is 0.174 mg a.i./L. There is no data available with which to determine a chronic NOAEC for estuarine/marine fish.

Acephate is moderately toxic to avian species (surrogate for terrestrial-phase amphibians and reptiles) on an acute oral and subacute dietary exposure basis, and moderately toxic to mammals on an acute oral exposure basis. Acephate is classified as highly toxic to terrestrial invertebrates on an acute contact exposure basis. The avian reproductive NOAEL for acephate is 5 ppm a.i. and the mammalian 3-generation reproductive NOAEL is 50 mg a.i./kg bw-day diet.

Methamidophos is very highly toxic to avian species on an acute oral and subacute dietary exposure basis, and highly toxic to mammals on an acute oral exposure basis. Methamidophos is classified as highly toxic to terrestrial invertebrates on an acute contact exposure basis. The avian reproductive NOAEL for methamidophos is 3 ppm a.i. and the mammalian 2-generation reproductive NOAEL is 0.5 mg a.i./kg body weight.

Aquatic plants exposed to acephate have a 5-day EC_{50} of >50 mg a.i./L; no NOAEC has been established. There are no data available with which to assess the toxicity of methamidophos to aquatic plants. Terrestrial plants exposed to acephate have an EC_{25} of >3.96 lb a.i./A for both seedling emergence and vegetative vigor. The NOAEC for both these effects is 3.96 lb a.i./A. Terrestrial plants exposed to methamidophos have an EC_{25} of >4.0 lb a.i./A for both seedling emergence and vegetative vigor. The NOAEC for both these effects is 4.0 lb a.i./A.

1.3.3. Measures of Risk

Risk quotients (RQs) are calculated by dividing the lowest acute and chronic taxon-specific effects concentration by the appropriate expected environmental concentration (EEC) for each use scenario. Acute and chronic RQs are compared to the Agency’s Levels of Concern (LOCs) to identify instances where acephate use has the potential to adversely affect the assessed species or adversely modify their designated critical habitat. When RQs for a particular type of effect are below LOCs, the pesticide is considered to have “no effect” on the species and its designated critical habitat. Where RQs exceed LOCs, a potential to cause adverse effects or habitat modification is identified, leading to a conclusion of “may affect”. If acephate use “may affect” the assessed species, and/or may cause effects to designated critical habitat, the best available additional information is considered to refine the potential for exposure and effects, and distinguish actions that are Not Likely to Adversely Affect (NLAA) from those that are Likely to Adversely Affect (LAA).

1.4. Summary of Conclusions

Based on the best available information, the Agency makes a May Affect, and Likely to Adversely Affect determination for the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF from the use of acephate. Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, VELB, CTS-CC, and CTS-SB from the use of the chemical. A summary of the risk conclusions and effects determinations for each listed species assessed here and their designated critical habitat is presented in Table 1-1 and Table 1-2. Use-specific determinations are provided in Table 1-3 and Table 1-4. 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 BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and potential modification of designated critical habitat for BCB, VELB, CTS-CC, and CTS-SB, a description of the baseline status and cumulative effects for the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF is provided in Attachment III.

Table 1-1. Effects Determination Summary for Effects of Acephate on the BCB, VELB, CTS-CC, CTS-SC, CTS-SB, CCR, CFWS, SMHM, SFGS, and SJKF

Species	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial
		All acute and chronic RQs are above the listed species LOC (0.05) for Lepidoptera species. Probability of individual effect is between 40% (1 in 2.4) and 100% (1 in 1.0). Direct effects to the BCB are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Terrestrial food items, habitat
		The BCB relies on terrestrial plants exclusively for both food and habitat and has an obligate relationship with dicots. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use rate scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). The BCB habitat does not include wetland areas. While terrestrial plant incidents with acephate have been reported, all incidents where details are available involved the direct application of acephate products to ornamental plants and most involved multi-a.i. formulations that have since been voluntarily cancelled by the registrants. Acephate's neurotoxic mode of action does not apply to plant physiology. Additionally, acephate has been used as an agricultural insecticide on a wide variety of crops for decades, indicating its absence of negative effect on these crops. Therefore, effects to non-target plants are not expected to result in indirect effects to the BCB.
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial
		All acute and chronic RQs are above the listed species LOC (0.05) for terrestrial invertebrate species. Probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. Direct effects to the VELB are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Terrestrial food items, habitat
		The VELB relies on elderberry trees exclusively for both food and habitat in an obligate relationship. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use rate scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). The

Species	Effects Determination	Basis for Determination
		VELB habitat does not include wetland areas. While terrestrial plant incidents with acephate have been reported, all incidents where details are available involved the direct application of acephate products to ornamental plants and most involved multi-a.i. formulations that have since been voluntarily cancelled by the registrants. Acephate's neurotoxic mode of action does not apply to plant physiology. Additionally, acephate has been used as an agricultural insecticide on a wide variety of crops for decades, indicating its absence of negative effect on these crops. Therefore, effects to non-target plants are not expected to result in indirect effects to the VELB.
California Tiger Salamander (All 3 DPS) (*Ambystoma californiense)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic-phase (Eggs, Larvae, and Adults) Acute and chronic RQs exceed the listed species LOCs (0.05 and 1.0, respectively) for freshwater fish (as a surrogate species to the aquatic-phase amphibian) only for the single highest use rate of acephate (commercial lawn areas) when assuming complete transformation to the degradate, methamidophos. No RQs exceed the listed species acute LOC (0.05) for aquatic-phase amphibian toxicity data. Probability of individual effect does not exceed 1 in 2.0E+44. Direct effects to the aquatic-phase CTS are not likely.
		Terrestrial-phase (Juveniles and Adults) All acute and chronic RQs are above the listed species LOCs (0.1 and 1.0, respectively) for birds (as a surrogate species to the terrestrial-phase amphibian) and remain above these LOCs after refinement using T-HERPS. Probability of individual effect is between 2.4% (1 in 42) and 100% (1 in 1.0). Direct effects to the terrestrial-phase CTS are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity For freshwater fish and frogs the chronic RQ exceeds the LOC (1.0) for only the highest use rate (commercial lawn areas). Acute and chronic RQs for freshwater invertebrate prey are above the non-listed species LOC (0.5) for a majority of acephate uses and probability of individual effect can be as high as 100% (1 in 1.0). RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is likely to indirectly affect the aquatic-phase CTS via effects on freshwater invertebrate prey under exposure scenarios evaluated in this assessment.
		Terrestrial prey items, habitat Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) when not accounting for the degradate, methamidophos, and for all use scenarios when assuming complete transformation to methamidophos. Probability of individual effect to a small mammal can be as high as 100% (1 in 1.0). All

Species	Effects Determination	Basis for Determination
		acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the terrestrial-phase CTS via terrestrial invertebrate and small mammal prey as well as habitat in small mammal burrows.
California Clapper Rail (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial All acute and chronic RQs are above the listed species LOCs (0.1 and 1.0, respectively) for birds. Probability of individual effect is between 2.4% (1 in 42) and 100% (1 in 1.0). Direct effects to the CCR are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity For both freshwater and estuarine/marine fish, no acute or chronic RQs exceed the non-listed species LOCs (0.5 and 1.0, respectively) with the exception of the chronic RQ for freshwater fish for the highest use scenario (commercial lawn areas). Acute and chronic RQs for freshwater invertebrate prey are above non-listed species LOC (0.5) for a majority of acephate uses and probability of individual effect can be as high as 100% (1 in 1.0). Acute and chronic RQ values exceed the non-listed species LOC (0.5 and 1.0, respectively) for estuarine/marine invertebrates only for the highest use rate scenarios. Probability of individual effect varies from 1 in 6.3E+95 to 1 in 4.0 (25%). RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is likely to indirectly affect the CCR via freshwater and estuarine/marine invertebrate prey under exposure scenarios evaluated in this assessment.
		Terrestrial prey items, riparian habitat All acute and chronic RQs are above the non-listed species LOCs (0.5 and 1.0, respectively) for birds except for the lowest use rate (fallow land) when not accounting for toxicity of the degradate, methamidophos. All LOCs for birds are exceeded when assuming complete transformation to methamidophos. The probability of individual effect associated with these RQs to a bird is close to 100% (1 in 1.0) for nearly all uses. Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) for acephate and probability of individual effect can be as high as 100% (1 in 1.0). All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for

Species	Effects Determination	Basis for Determination
		semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the CCR via bird, mammal, and invertebrate prey under exposure scenarios evaluated in this assessment.
California Freshwater Shrimp (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic
		Acute RQs for aquatic invertebrates exceed the listed species LOC for 27 of the 30 uses assessed when assuming complete transformation to the degradate, methamidophos (11 of 30 when not accounting for methamidophos). Chronic RQs exceed the LOC for 21 of the 30 uses assessed when the degradate is taken into account (1 of 30 when it is not). Probability of an individual effect associated with the RQs is between 1in 9.7E+39 and 1 in 1.0 (100%). Direct effects to the CFWS are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity
		Acute and chronic RQs for freshwater invertebrate prey are above non-listed species LOC (0.5) for a majority of acephate uses and probability of individual effect can be as high as 100% (1 in 1.0). RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is likely to indirectly affect the CFWS via freshwater invertebrate prey under exposure scenarios evaluated in this assessment.
		Terrestrial prey items, riparian habitat
		RQs exceed the LOC (1.0) for terrestrial plants only for the highest use rate scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Acephate is not likely to indirectly affect the CFWS via terrestrial plant food and habitat.
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial
		Acute and chronic RQs for small mammals exceed the listed LOCs (0.1 and 1.0, respectively) for all but the lowest use rate scenario (fallow land) when not accounting for the degradate, methamidophos and for all use scenarios when assuming complete transformation to methamidophos. Probability of individual effect to a small mammal associated with the RQs is between 1 in 9.1E+08 and 1 in 1.0 (100%). Direct effects to the SMHM are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects

Species	Effects Determination	Basis for Determination
		Aquatic habitat, cover, and primary productivity RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is not likely to indirectly affect the SMHM via aquatic plant habitat.
		Terrestrial prey items, habitat All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. All acute and chronic RQs are above the non-listed species LOCs (0.5 and 1.0, respectively) for birds and the probability of individual effect is close to 100% (1 in 1.0) for nearly all uses. Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) when not accounting for the degradate, methamidophos, and for all use scenarios when assuming complete transformation to methamidophos. Probability of individual effect to a small mammal can be as high as 100% (1 in 1.0). RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the SMHM via terrestrial invertebrate prey and rearing sites built on bird and small mammal nests.
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Terrestrial*** All acute and chronic RQs are above the listed species LOCs (0.1 and 1.0, respectively) for birds (as a surrogate species to the reptile) and remain above the LOCs after refinement using T-HERPS. Probability of individual effect associated with the RQs is between 2.4% (1 in 42) and 100% (1 in 1.0). Direct effects to the SFGS are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects ***Aquatic prey items, aquatic habitat, cover, and primary productivity*** For freshwater fish the chronic RQ exceeds the LOC (1.0) for only the highest use rate (commercial lawn areas). The acute RQ does not exceed the non-listed LOC (0.5) for any uses. Acute and chronic RQs for freshwater invertebrate prey are above non-listed species LOC (0.5) for a majority of acephate uses and probability of individual effect can be as high as 100% (1 in 1.0). RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is likely to indirectly affect the SFGS via freshwater invertebrate prey under exposure scenarios evaluated

Species	Effects Determination	Basis for Determination
		in this assessment. ***Terrestrial prey items, riparian habitat*** All acute and chronic RQs are above the non-listed species LOCs (0.5 and 1.0, respectively) for birds, terrestrial-phase amphibians, and reptiles except for the lowest use rate (fallow land) when not accounting for toxicity of the degradate, methamidophos. All LOCs for birds are exceeded when assuming complete transformation to methamidophos. The probability of individual effect to a bird is close to 100% for nearly all uses. Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) when not accounting for the degradate, methamidophos, and all LOCs are exceeded when assuming complete transformation to methamidophos. The probability of individual effect to a small mammal can be as high as 100% (1 in 1.0). All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the SFGS via bird, mammal, and invertebrate prey as well as the mammal burrow component of habitat.
San Joaquin Kit Fox (*Vulpes macrotis mutica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Terrestrial*** Acute and chronic RQs for large mammals exceed the listed species LOCs (0.1 and 1.0, respectively) for all but the lowest use rate scenario when not accounting for toxicity of the degradate, methamidophos, and for all use scenarios when assuming complete transformation to methamidophos. Probability of individual effect associated with the acute RQs is between 1 in 6.5E+14 and 1 in 1.0 (100%). Direct effects to the SJKF are likely under exposure scenarios evaluated in this assessment. **Potential for Indirect Effects** ***Terrestrial prey items, riparian habitat*** All acute and chronic RQs are above the non-listed species LOCs (0.5 and 1.0, respectively) for birds except for the lowest use rate (fallow land) when not accounting for toxicity of the degradate, methamidophos. All LOCs for birds are exceeded when assuming complete transformation to methamidophos. The probability of individual effect to a bird is close to 100% for nearly all uses. Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) when not accounting for the degradate, methamidophos, and all LOCs are exceeded when assuming complete transformation to methamidophos. The probability of individual effect to a small mammal can be as high as 100% (1 in 1.0). All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario

Species	Effects Determination	Basis for Determination
		assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the SJKF via bird, mammal, and invertebrate prey under exposure scenarios evaluated in this assessment.

Table 1-2. Effects Determination Summary for the Critical Habitat Impact Analysis

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly	Habitat Modification	All acute and chronic RQs are above the listed species LOC (0.05) for Lepidoptera species. Probability of individual effect is between 40% (1 in 2.4) and 100% (1 in 1.0). Direct effects to the BCB are likely under exposure scenarios evaluated in this assessment.
Valley Elderberry Longhorn Beetle	Habitat Modification	All acute and chronic RQs are above the listed species LOC (0.05) for terrestrial invertebrate species. Probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. Direct effects to the VELB are likely under exposure scenarios evaluated in this assessment.
California Tiger Salamander Central California Distinct Population Segment	Habitat Modification	Acute and chronic RQs for small mammals exceed the non-listed LOCs for all but the lowest use rate scenario (fallow land) for acephate and probability of individual effect can be as high as 100%. Small mammals are essential in creating the underground habitat that juvenile and adult California tiger salamanders depend upon for food, shelter, and protection from the elements and predation.
California Tiger Salamander Santa Barbara County Distinct Population Segment	Habitat Modification	Acute and chronic RQs for small mammals exceed the non-listed LOCs for all but the lowest use rate scenario for acephate (fallow land) and probability of individual effect can be as high as 100%. Small mammals are essential in creating the underground habitat that juvenile and adult California tiger salamanders depend upon for food, shelter, and protection from the elements and predation.

Table 1-3. Use Specific Summary of the Potential for Adverse Effects to Aquatic Taxa

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment:									
	Estuarine/Marine Vertebrates[1]		CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Estuarine/Marine Invertebrates[4]		Vascular Plants[5]	Non-vascular Plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic		
Cotton seed treatment	No	--	No	No	No	No	No	No	No	No
Fallow land	No	--	No	No	No	No	No	No	No	No
Tomatoes	No	--	No	No	No	No	No	No	No	No
Beans	No	--	No	No	**Yes***	No	No	No	No	No
Peanuts	No	--	No	No	**Yes***	No	No	No	No	No
Mint	No	--	No	No	**Yes***	No	No	No	No	No
Cotton	No	--	No	No	**Yes***	No	No	No	No	No
Peppers	No	--	No	No	**Yes***	No	No	No	No	No
Grapes 2	No	--	No	No	**Yes***	No	No	No	No	No
Celery	No	--	No	No	**Yes***	**Yes**	No	No	No	No
Grapes 1	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Almonds, non-bearing	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Drainage systems	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Rights-of-way	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Bermuda grass	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Apples, non-bearing	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Citrus 2	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Cauliflower	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Alfalfa	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Christmas trees	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Paved areas	No	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Lettuce	No	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Fire ants	No	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Citrus 1	No	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Golf courses	**Yes***	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Sod farms	**Yes***	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Roses	**Yes***	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Ornamentals	**Yes***	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Ornamental shrub & vines	**Yes***	--	No	No	**Yes**	**Yes**	**Yes**	**Yes**	No	No
Commercial lawns	**Yes***	--	**Yes***	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No

[1] A yes in this column indicates a potential for indirect effects to CCR.

[2] A yes in this column indicates a potential for indirect effects to SFGS and CCR. A yes also indicates a potential for direct and indirect effects for the CTS-CC, CTS-SC, and CTS-SB.
[3] A yes in this column indicates a potential for direct effects to the CFWS and indirect effects to the CFWS, SFGS, CCR, CTS-CC, CTS-SB, and CTS-SC.
[4] A yes in this column indicates a potential for indirect effects to CCR.
[5] A yes in this column indicates a potential for indirect effects to SFGS, CCR, SMHM, CTS-CC, CTS-SC, CTS-SB, and CFWS.
* RQ exceeds the LOC for listed species (potential for direct effects) but not for non-listed species (no potential for indirect effects). LOCs are 0.05 for acute risk to listed aquatic species, 0.5 for acute risk to non-listed aquatic species, 1.0 for chronic risk to all aquatic species, and 1.0 for risk to aquatic plants.
NOTE: This table counts a potential for effect based on the toxicity of the major degradate, methamidophos, assuming 100% conversion. Methamidophos is more toxic than the parent, acephate.

Table 1-4. Use Specific Summary of the Potential for Adverse Effects to Terrestrial Taxa

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment:												
	SMHM and Small Mammals[1]		SJKF and Large Mammals[2]		CCR and Small Birds[3]		CTS-CC, CTS-SC, CTS-SB and Amphibians[4]		SFGS and Reptiles[5]		BCB, VELB, and Invertebrates (Acute)[6]	Dicots[7]	Monocots[7]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
All Uses	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No

[1] A yes in this column indicates a potential for direct effects to SMHM and indirect effects to SFGS, CCR, SMHM, SJKF, CTS-CC, CTS-SC, CTS, and CTS-SB.
[2] A yes in this column indicates a potential for direct and indirect effects to SJKF. The only exception to the potential for effects to large mammals is for acute effects for the fallow land use for an indirect effects assessment (not applicable in this assessment because there are no indirect effects based on large mammals).
[3] A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, SMHM, SJKF, CTS-CC, CTS-SC, and CTS-SB.
[4] A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS-CC, CTS-SC, CTS-SB, SFGS, and CCR.
[5] A yes in this column indicates the potential for direct and indirect effects to SFGS and other reptiles.
[6] A yes in this column indicates a potential for direct effect to BCB and VELB and indirect effects to SFGS, CCR, SMHM, SJKF, CTS-CC, CTS-SC, and CTS-SB.
[7] A yes in this column indicates a potential for indirect effects to BCB, VELB, SFGS, CCR, SMHM, CTS-CC, CTS-SC, CTS-SB, and CFWS. For the BCB and VELB this is based on the listed species LOC because of the obligate relationship with terrestrial monocots and dicots. For other species, the LOC exceedances are evaluated based on the LOC for non-listed species.
*LOCs are 0.05 for acute risk to listed terrestrial invertebrates, 0.1 for acute risk to other listed terrestrial species, 0.5 for acute risk to non-listed terrestrial species, 1.0 for chronic risk to all terrestrial species, and 1.0 for risk to terrestrial plants.
NOTE: This table counts a potential for effect based on the toxicity of the major degradate, methamidophos, assuming 100% conversion. Methamidophos is more toxic than the parent, acephate.

Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated.

When evaluating the significance of this risk assessment's direct/indirect and adverse habitat modification effects determinations, it is important to note that pesticide exposures and predicted risks to the assessed listed species and their 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 BCB, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SMHM, SFGS, 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.

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* (USEPA, 1998), the Services' *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998) and is consistent with procedures and methodology outlined in the Overview Document (USEPA, 2004) and reviewed by the U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS/NMFS/NOAA, 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 BCB, VELB, and CTS-CC, and federally endangered CCR, CFWS, CTS-SC, CTS-SB, SMHM, SFGS, and SJKF arising from FIFRA regulatory actions regarding agricultural and non-agricultural uses of acephate. This ecological risk assessment has been prepared consistent with a stipulated injunction in the case *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS) entered in Federal District Court for the Northern District of California on May 17, 2010.

In this assessment, direct and indirect effects to the BCB, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SMHM, SFGS, and SJKF and potential modification to designated critical habitat for the BCB, VELB, CTS-CC DPS, and CTS-SB are evaluated in accordance with the methods described in the Agency's Overview Document (USEPA, 2004).

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 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 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. The PCEs for the VELBs include areas that contain its host plant (*i.e.*, elderberry trees).

There are currently three CTS Distinct Population Segments (DPSs): the Sonoma County (SC) DPS, the Santa Barbara (SB) DPS, and the Central California (CC) DPS. Each DPS is considered separately in the risk assessment as they occupy different geographic areas. The main difference in the assessment will be in the spatial analysis. The CTS-SB was listed by the USFWS as endangered in 2000, the CTS-SC in 2002, and the CTS-CC as threatened in 2004. The CTS-SB and CTS-SC were downlisted from endangered to threatened in 2004 by the USFWS, however, the downlisting was vacated by the U.S. District Court. Therefore, the Sonoma and Santa Barbara DPSs are currently listed as endangered while the CTS-CC is listed as threatened. All CTS populations utilize vernal pools, semi-permanent ponds, and permanent ponds, and the terrestrial environment in California. The aquatic environment is essential for breeding and reproduction and mammal burrows are also important habitat for aestivation. The PCEs for CTSs are standing bodies of freshwater sufficient for the species to complete the aquatic portion of its life cycle that are adjacent to barrier-free uplands that contain small mammal burrows. An additional PCE is upland areas between sites (as described above) that allow for dispersal of the species.

The CCR was listed by the USFWS as an endangered species in 1970. The species is found only in California in coastal wetlands along the San Francisco estuary and Suisun Bay.

The CFWS was listed as endangered in 1988 by the USFWS. The CFWS inhabits freshwater streams in Central California in the lower Russian River drainage and westward to the Pacific Ocean and coastal streams draining into Tomales Bay and southward into the San Pablo Bay.

The SMHM was listed by the USFWS as an endangered species in 1970. The species is found in tidal and non-tidal salt marshes along the San Francisco, San Pablo, and Suisun Bays in California.

The SFGS was listed as endangered in 1967 by the USFWS. The species is endemic to the San Francisco Peninsula and San Mateo County in California in densely vegetated areas near marshes and standing open water.

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.

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 acephate 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 acephate 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 BCB, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SMHM, SFGS, and SJKF 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 acephate in accordance with current labels:

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

Additionally, for habitat and PCEs, a "No Effect" or a "Habitat Modification" determination is made.

A description of routine procedures for evaluating risk to the San Francisco Bay Species is provided in Attachment I.

2.2. Scope

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 acephate in accordance with the approved product labels for California is "the action" relevant to this ecological risk assessment.

Acephate is a systemic, organophosphate insecticide with commercial and residential uses. Currently registrations of acephate in California include both agricultural and non-agricultural uses. These include aerial applications to food and non-food crops, airblast applications to citrus trees, ground sprays to tomatoes and golf courses, ground application to ornamentals, sod, and roses, seed treatments for cotton and peanuts, aerial application to rights-of-way and paved areas, and perimeter and spot treatments for lawns.

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

2.2.1. Evaluation of Degradates

The major degradate of acephate in aerobic soil metabolism studies is methamidophos, (up to 23%), which also has insecticidal properties and was a registered insecticide until 2009. Methamidophos was also found in the aqueous photolysis study (maximum formation of 1.6% of the applied amount), the soil photolysis study (5.3 to 8.4% in both irradiated and control), the anaerobic aquatic metabolism study (5% at 7 days), and the aerobic aquatic metabolism study (<1.6%). Methamidophos is four to 42 times more acutely toxic than acephate, depending on the taxa, so its effects are considered quantitatively for both aquatic and terrestrial exposures in the risk assessment. Acephate and methamidophos are assessed separately. Methamidophos is considered by assuming that there is 100% conversion of acephate to methamidophos at application. While the amount of methamidophos detected in degradation studies reached only 23% of the total applied acephate at any given time point, this number does not accurately represent the total amount of acephate that is cumulatively converted to methamidophos. As acephate degrades to methamidophos over time, methamidophos subsequently degrades to its transformation products, limiting the amount that is measured in a degradation study at one time point.

For both aquatic and terrestrial exposure assessment, methamidophos application rates were calculated by applying a correction factor of 0.77 to the acephate application rates, to account for molecular weight difference. A total toxic residues approach was not used because the degradate methamidophos is known to be more toxic than the parent.

For the terrestrial exposure assessment, in the absence of a degradation study of acephate on foliage, the breakdown of acephate to methamidophos on foliage is assumed. Metabolism of acephate on foliage is expected to be similar to aerobic soil metabolism, in which the rapid and complete breakdown of acephate to methamidophos is observed.

An analysis accounting for the formation and decline of the parent and degradate over time would provide more accurate aquatic and terrestrial EECs. However the current aquatic and terrestrial exposure models (PRZM-EXAMS and T-REX) do not allow for analysis of the formation and decline of degradates. Further, additional analyses on the exposure potential of the degradate would have little impact on the risk conclusions reached in this assessment.

2.2.2. Evaluation of Mixtures

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 (USEPA, 2004; USFWS/NMFS/NOAA, 2004).

Acephate has one active registered product and three recently cancelled products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in Appendix A. This data set is limited and a qualitative analysis does not support any broad conclusions about the interactive nature of acephate in combination with other pesticides. Given that the active and inert ingredients would not be expected to have similar mechanisms of action, metabolites or toxicokinetic behavior, it is reasonable to conclude that an assumption of dose-addition would be inappropriate. Consequently, an assessment based on the toxicity of the single active ingredient of acephate is appropriate.

2.3. Previous Assessments

The Agency published an Interim Reregistration Eligibility Decision for Acephate in September 2001 which identified numerous human health and ecological risks associated with the labeled uses (USEPA, 2006). Upon completion of the assessment, the Agency decided on a number of label amendments to address the worker, residential, and ecological concerns. Acephate and its degradate methamidophos are highly toxic to honey bees and beneficial predatory insects on an acute contact basis. Acute and chronic risks to birds and chronic risk to mammals were also of concern. The document was finalized in July, 2006 when all the organophosphate IREDs were completed and is available on the web, at:
http://www.epa.gov/oppsrrd1/REDs/acephate_ired.pdf. Numerous mitigation requirements (label amendments) resulted from the IRED assessment. Some changes include requiring labeling to protect honeybees and to reduce the potential for spray drift. Also, aerial applications

to turf have been deleted as have residential indoor uses. Product reregistration is complete but there appear to be some discrepancies between the IRED and the current labels. These discrepancies will be resolved during Registration Review (see Appendix B).

On March 31, 2004, EPA released an assessment of the potential effects of acephate to 26 listed Environmentally Significant Units (ESUs) of Pacific salmon and steelhead. That assessment concluded that acephate would have no effect on the species under consideration. While acephate was noted to have significant toxicity to aquatic invertebrates, as does this assessment, the minimal usage, the size of the watersheds under consideration and the volume of the water bodies serving as habitat to these species taken together, resulted in the determination of no effect to the listed salmon and steelhead.

On July 22, 2007 EPA released an assessment of potential effects of acephate to the federally threatened California red-legged frog (CRLF). That assessment concluded that acephate has no direct effect on the aquatic phase CRLF or its habitat, and is not likely to indirectly adversely affect the aquatic phase CRLF as a result of acephate's toxicity to aquatic invertebrates. The present assessment reaches the same conclusion regarding direct effect to freshwater vertebrates but a different conclusion regarding indirect effects via aquatic invertebrate prey. The CRLF assessment stated: "the acute LOC is exceeded for aquatic invertebrates, however effect is considered discountable based on low likelihood of individual effect." A different conclusion is reached here due to the assessment of higher use rate scenarios not included in the CRLF assessment as well as the assumption of complete transformation to methamidophos

Acephate was found to be likely to adversely affect the terrestrial phase CRLF both directly and indirectly through toxicity to the terrestrial CRLF prey base. Modification of terrestrial critical habitat was concluded based on adverse modification of terrestrial food resources. The document is available on the web, at: http://www.epa.gov/espp/litstatus/effects/redleg-frog/acephate/analysis_acephate.pdf.

EPA completed the acephate Problem Formulation for Registration Review on January 5, 2009. No new data has been received and reviewed between the effects assessment for the CRLF and the problem formulation, or since the problem formulation was completed. The problem formulation requested the submission of additional toxicity data for registration review, including avian oral toxicity for a passerine species and aquatic plant acute toxicity studies with a freshwater diatom, green algae (*Selenastrum capricornutum*), duckweed (*Lemna gibba*), and cyanobacteria (*Anabaena flos-aquae*). Additional environmental fate data were also requested, including an anaerobic soil metabolism study and an aerobic aquatic metabolism study.

2.4. Environmental Fate Properties

Based on acceptable and supplemental data, acephate is not persistent under aerobic conditions, and is not expected to be persistent in anaerobic aquatic environments where it will be associated with the aqueous phase due to its short anaerobic half-life. Table 2-1 lists the physical-chemical and fate properties of acephate.

Table 2-1. Physicochemical and Fate Properties of Acephate

Fate Property	Value	Source
Molecular Weight	183.16 g/mol	Product Chemistry
Henry's Law constant	5.1 X 10^{-13} atm-m^3/mole	Calculated from vapor pressure and solubility
Vapor Pressure	1.7 X 10^{-6}torr at 24°C 3.0 X 10^{-7} torr (gas saturation method)	MRID 40390601 MRID 40645901
Aqueous Solubility	801 g/L to 835 g/L	MRID 40390601
Aqueous Photolysis	163 days	MRID 41081603
Aerobic Soil Metabolism	0.5 to 1.5 days for clay 1.5 to 3.0 days for loam 1.0 days for loamy sand 0.5 to 1.0 for sandy clay 2.0 for silty clay 6.0 to 13.0 for muck	MRID 00014991
Hydrolysis	325 days at pH 5 169 days at pH 7 18 days at pH 9	MRID 41081604
Anaerobic Aquatic Metabolism	6.6 days	MRID 43971601
K_{OC}	2.7 ml/g	MRID 40504811

Aerobic soil metabolism is the main degradation process for acephate. Observed half-lives are less than two days under the nominal or expected use conditions, producing the intermediate degradate methamidophos, which is also an insecticidal compound. Acephate is stable to hydrolysis except at high pH (half-life at pH 9 of 18 days) and does not photodegrade. Acephate is not persistent in anaerobic clay sediment: creek water systems in the laboratory, with a half-life of 6.6 days. The major degradates under anaerobic conditions were carbon dioxide and methane, comprising > 60% of the applied acephate after 20 days of anaerobic incubation. No other anaerobic degradates were present at > 10% during the incubation. There are no acceptable data for the aerobic aquatic metabolism of acephate; supplemental information indicates that acephate degrades more rapidly in aquatic systems when sediment is present.

Acephate is very soluble (801-835g/L) and very mobile (K_{oc} = 2.7) in the laboratory. Only one K_{oc} value is available, because acephate was adsorbed in only one of the five soils (a clay loam) used in the batch equilibrium studies. Because acephate is not persistent under aerobic conditions, very little acephate is expected to leach to groundwater. If any acephate does reach ground water, it would not be expected to persist, due to its short anaerobic half-life.

Based on the vapor pressure of acephate (pure active: 1.7 x 10^{-6} torr [MRID 40390601]) and its calculated Henry's Law constant (5.1 x 10^{-13} atm mole / m^3), it is not expected to volatilize from either soil or water in significant quantities. The California Department of Pesticide Regulation (CDPR) has concurred with this judgment (Fan and Walters, 2002).

Field studies conducted in Mississippi (tobacco on a silt loam soil), California (bell peppers on a silt loam soil), Florida (cauliflower on a sand soil) and Iowa (soybeans on a loam soil) produced dissipation half-lives of 2 days or less with no detections of acephate below a depth of 50 cm.

Laboratory studies showed that bioaccumulation of acephate in bluegill sunfish was insignificant. A maximum bioaccumulation factor of 10x occurred after 14 days' exposure to acephate at 0.007 and 0.7 ppm.

Batch equilibrium studies using acephate and methamidophos were conducted using four soils ranging in texture from sand to clay loam. In three of the soils, acephate and methamidophos were not adsorbed in sufficient quantities to permit the calculation of Freundlich adsorption coefficients (Freundlich K_{ads}). For the clay loam soil, the reported adsorption values for parent acephate and its degradate, methamidophos, are listed in the following table:

Table 2-2. Adsorption Values for Acephate and Methamidophos

Soil	pH	CEC (meq/100g)	% Clay	% Organic Matter	Acephate			Methamidophos		
					K	1/n	r^2	K	1/n	r^2
Clay loam	5.8	20.2	32	3.3	0.090	1.06	0.96	0.029	0.64	0.93

Calculated K_{oc} for acephate and methamidophos in this clay loam soil were 2.7 and 0.9, respectively. Because of the minimal adsorption of the chemicals in the adsorption phase of the study, it was not possible to determine desorption values in the soils. Based on the values listed above, it appears that acephate and methamidophos are very mobile in soils

Based on acceptable and supplemental data, methamidophos is not persistent in aerobic environments, but may be more persistent in anaerobic aquatic environments where it will be associated with the aqueous phase. A summary of the environmental fate properties of methamidophos is found in Table 2-3 below.

Table 2-3. Physical-chemical and Fate Properties of Methamidophos

Fate Property	Value	Source
Molecular Weight	141.2 g /mol	Calculated
Henry's Law constant	1.62×10^{-11} atm m^3 /mol	MRID 43661003
Vapor Pressure	1.73×10^{-5} torr	MRID 43661003
Aqueous Solubility	200,000 mg/l	MRID 43661003
Aqueous Photolysis	200 days	MRID 00150610
Aerobic Soil Metabolism	14 hours	MRID 41372201
Hydrolysis	309 days at pH 5 27 days at pH 7 3 days at pH 9	MRID 00150609
Aerobic Aquatic Metabolism (water column)	No Data	Not Applicable
Anaerobic Aquatic Metabolism (benthic)	19.4 days	MRID 46934002
K_{OC}	0.9 ml/g	MRID 40504811

Aerobic soil metabolism is the main degradation process for methamidophos. Methamidophos degraded with a calculated half-life of 14 hours in a sandy loam soil at an application rate (6.5 ppm) greater than the currently registered application rate (0.5 ppm from the maximum label rate of 1 lb a.i./A), producing the intermediate degradate S-methyl phosphoramidothioate, which also is rapidly metabolized by soil microorganisms to carbon dioxide and microbial biomass (half-life of < 5 days). Supplemental information also identifies O, S-dimethyl phosphorothioate (DMPT) as a major degradate which is also rapidly degraded in soil (half-life < 4 days). In sterile aqueous solutions, methamidophos photodegrades slowly (dark control-corrected half-life > 200 days) and there is no evidence of hydrolysis at acid pHs. Hydrolysis degradates at neutral and alkaline pHs include O-*des*-methyl, DMPT, and the volatile degradate dimethyl disulfide.

Supplemental information, provided from a laboratory pond water systems study, showed that methamidophos degraded in anaerobic sandy loam sediment with a DT_{50} (degradation time in which 50% degrades) of 41 days. The observed major degradates in the same study were DMPT and O-*des*-methyl methamidophos, but their persistence could not be determined due to incomplete material balances after 3 months of anaerobic incubation. Radiolabeled residues were distributed between the water and sediment fractions with the majority of residues observed in the water phase in a ratio of approximately 10 to 1. This study was repeated with silty clay sediment and depicted the following results: DT_{50} 7-14 days, and DT_{90} 58-93 days; the calculated half-life was 19.4 days. However, due to the loss of methane the mass accounted for was incomplete. Therefore, in order to use the calculated half-life from the anaerobic aquatic study (MRID 46934002) for future assessments, it is assumed that the missing mass was methane that had escaped the system due to volatilization and an inadequate ability to capture it. There are no acceptable data for the aerobic aquatic metabolism of methamidophos.

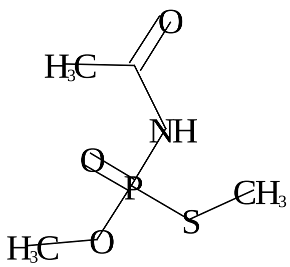
Soil dissipation of methamidophos (O, S-dimethyl phosphoramidothioate) was conducted under U.S. field conditions in four replicate bare plots of loamy sand soil from Washington. In this study, the dissipation of methamidophos was rapid yielding a half-life of 0.49 days in soil. The observed DT_{50} of methamidophos was 0.33 days to 1 day. No major transformation products were identified. In the 0-15 centimeter (cm) soil layer, two minor transformation products were identified: S-methyl phosphoramidothioate (O-*des*-methyl methamidophos) was a maximum average of 27.1 ppb and O,S-dimethyl phosphorothioate was a maximum average of 14.3 ppb each at day zero. In the 0-15 cm soil layer, no transformation products were detected after 1 day. In the 15-30 cm soil layer, dimethyl phosphorothiate was detected once at 3.7 ppb at 3 days (single replicate). No transformation products were detected in the 30-46 cm soil layer. The average measured time zero concentration was 332 parts per billion (ppb).

Laboratory studies showed that bioaccumulation of methamidophos in largemouth bass was insignificant; the maximum bioconcentration factor of 0.09 in whole fish occurred on day 28 and decreased to <0.014 ppm in the fish (quantification limit) after one day depuration.

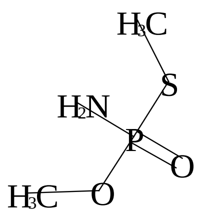
Potential transport mechanisms include pesticide surface water runoff and spray drift. Methamidophos is very soluble (>200 grams per liter (g/L) and very mobile (K_{OC} = 0.9). The methamidophos degradate DMPT is also very mobile (K_{oc} = 1.6); no data are available for O-*des*-methyl methamidophos, but it is expected to have similar mobility as its parent compound. Because methamidophos and its degradates are not persistent under aerobic conditions, little methamidophos residue is expected to leach to groundwater. If any methamidophos residues did reach ground water, they might persist based on an observed anaerobic aquatic DT_{50} of 41 days for methamidophos and undetermined persistence for DMPT and O-*des*-methyl methamidophos.

Volatilization from soil or water is not expected to be a major route of dissipation for methamidophos because of its rapid metabolism in soil and its calculated Henry's law constant (1.6 x 10^{-11} atm-m^3/mole); CDPR has concurred with this judgment (Fan and Walters, 2002).

Chemical Structure of Acephate



Chemical Structure of Methamidophos



2.4.1. Environmental Transport Mechanisms

Potential transport mechanisms include pesticide surface water and sediment runoff, spray drift, and secondary drift of soil-bound residues leading to deposition onto nearby or more distant ecosystems. Surface water and sediment runoff and spray drift are expected to be the major routes of exposure for acephate. Based on the vapor pressure of acephate and its calculated Henry's Law constant, it is not expected that volatilization will be a significant route of dissipation for acephate.

In general, deposition of drifting pesticides is expected to be greatest close to the site of application. Computer models of spray drift (AgDRIFT) are used to determine potential exposures to aquatic and terrestrial organisms via spray drift. The distance of potential impact away from the use sites is determined by the distance required to fall below the LOC for the taxonomic group that has the largest RQ to LOC ratio, which is the invertebrate in both terrestrial and aquatic systems. Due to model limitations, it may not be possible to provide a quantitative estimate of exposure with known uncertainty beyond the range of AgDRIFT (see Section 6.1.3).

2.4.2. Mechanism of Action

Organophosphate insecticides (such as acephate) act upon target pests through a neurotoxic action, which affects the central nervous system. Specifically, the mechanism of action is known to be acetylcholinesterase inhibition. The transmission of nerve impulses across synapses and the junctions between nerve and an organ (gland, muscle, nerve) is accomplished by the release of a chemical agent, acetylcholine. Acetylcholine must be rapidly destroyed or inactivated at or near the site of its release to continue transmission of new impulses. The destruction of acetylcholine at such sites is accomplished by an enzyme, acetylcholinesterase. Acetylcholinesterase is located at the neurosynaptic junctions and breaks the acetylcholine into acetyl and choline fragments. Acetylcholinesterase functions to increase the precision of nerve firing, enabling some nerve cells to fire as rapidly as 1,000 times per second without overlap of the of the neural impulses. Acetylcholinesterase inhibitors prevent the acetylcholinesterase from removing the acetylcholine and thereby causing disruption to the central nervous system. At a high enough concentration of the inhibitors, the muscles may not contract the diaphragm and breathing ceases and death results (Davies *et al*., 1981).

Depending on the organophosphate involved, the dose received, and the duration of exposure; the period for regeneration of acetylcholinesterase to occur varies among organisms.

2.4.3. Use Characterization

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

Acephate is an organophosphate insecticide currently registered for use on a variety of field, fruit, and vegetable crops; in food handling establishments; on ornamental plants both in greenhouses and outdoors (including lawns, turf, and cut flowers); and in and around the home. Acephate was first registered in 1973 for ornamental uses, and in 1974 for food uses (agricultural crops). The use profile is based on the current, federally registered uses (Section 3 and 24c for California). There are well over 100 registered labels for acephate, with products ranging from 1.0% to 98.9% a.i. Section 3 (nation-wide) and section 24(c) (California) registered uses for acephate were reviewed, including the label maximum one time application, number of applications allowed per year, the minimum time between treatments, and the application type (see Appendix B). Letter codes before the crop entry in Table 2-4 group together crops with similar use patterns to facilitate the assessment (see Section 3.1 for more details).

Table 2-4. Use patterns for the assessment of aquatic exposure from acephate for crops with potential exposure to San Francisco Bay endangered species

Crop	Max. App. Rate (lb acre^{-1})	Max Seasonal Rate (lb acre^{-1})	No. of Apps.	Application Intervals (days)	Application Method
A) fallow land[1]	0.1245	NS	1	NA	aerial, ground
B) alfalfa	0.974	1.948	2	NS	aerial, ground
C1) almond, non-bearing	0.97	NS	NS	NS	aerial, ground
C2) apple, non-bearing	0.97	NS	NS	NS	aerial, ground
C2) apricot, non-bearing	0.97	NS	NS	NS	aerial, ground
D) beans, dry	1	2.07	NS	7	aerial, ground
D) beans, succulent[2]	1	2.07	NS	7	aerial, ground

Crop	Max. App. Rate (lb $acre^{-1}$)	Max Seasonal Rate (lb $acre^{-1}$)	No. of Apps.	Application Intervals (days)	Application Method
D) lima, beans, dry & succulent	1	2.07	NS	7	aerial, ground
F4) bell peppers	1	2.07	NS	7	aerial, ground
E) Bermuda grass	0.99	NS	NS	7	aerial, ground
F1) Brussels sprouts	1	2	NS	NS	aerial, ground
F1) cauliflower	1	2	NS	NS	aerial, ground
F2) celery	1	2	NS	3	aerial, ground
C2) cherry, non-bearing	1	2.07	NS	NS	aerial, ground
H) Christmas trees	1.725	NS	NS	NS	aerial, ground
I) citrus, non-bearing	4	NS	NS	7	ground
J) citrus, non-bearing	0.75	NS	NS	7	aircraft
K) citrus, non-bearing, fire ant control	0.0094 lb/mound	NS	NS	7	mound drench
Z) commercial/industrial lawns	0.0094 lb/mound	NS	NS	7	mound drench
L) cotton	1	6	NS	7	aerial, ground
M) cotton seed treatment	1.6 lb/500 lb-seed	NS	NS	NA	seed treatment
C2) crabapple	0.25	NS	3	28	airblast
C2) deciduous fruit trees, non-bearing	0.97	NS	NS	7	aerial, ground
O) fruiting vegetables	0.374	0.374	NA	NA	ground
P) golf course turf	4.77	NS	NS	NS	granular, ground
K) golf course turf	0.009 lb/mound	NS	NS	NS	mound drench
Q) grapes 1, non-bearing	0.73	NS	NS	NS	aerial, airblast
R) grapes 2, non-bearing	0.974	NS	NS	7	aerial, airblast
K) household/domestic dwelling	0.0063 lb/mound	NS	NS	NS	mound treatment
C2) kiwi fruit	0.97	NS	NS	NS	aerial, ground
S) lettuce, crisphead types	1	5	NS	NS	aerial, ground
S) lettuce, head	1	2	NS	NS	aerial, ground
G) mint/peppermint/spearmint	1	2	NS	NS	aerial, ground
K) ornamental trees/shrubs	.0019513 gal/mound	NS	NS	NS	mound drench
T) nursery stock[4]	16	NS	NS	NS	ground
T) ornamental/shade trees[3, 4]	20.8	NS	NS	NS	broadcast, unincorporated
T) ornamental ground cover[4]	20.8	NS	NS	NS	ground spray
T) herbaceous ornamental plants[4]	20.8	NS	NS	NS	ground spray
K) ornamental lawns	0.0124 lb/mound	NS	NS	NS	mound treatment
T) ornamental non-flowering plants[4]	20.8	NS	NS	NS	ground spray
V) sod	4.8	NS	NS	NS	ground spray

Crop	Max. App. Rate (lb acre^{-1})	Max Seasonal Rate (lb acre^{-1})	No. of Apps.	Application Intervals (days)	Application Method
U) ornamental woody shrubs and vines	32	NS	NS	NS	ground spray
W) paved areas	.25	NS	AN	NS	aerial/ground spray
X) peanuts	1	4	NS	7	aerial/ground spray
Y) peanuts	0.197 lb/100 lb seed	NA	NA	NA	seed treatment
C2) pear, non-bearing	0.97	NS	NS	NS	aerial/ground
C1) pecan	0.99	NS	NS	7 d	aerial/ground
F4) pepper	.9975	1.995	NS	NS	aerial/ground
C1) pistachio	0.97	NS	NS	NS	aerial/ground
C2) plum, non-bearing	0.97	NS	NS	NS	aerial/ground
C2) prune, non-bearing	0.97	NS	NS	NS	aerial/ground
Z) recreational area lawns	156	NS	NS	NS	perimeter/spot ground spray
K) recreational area lawns	.0094 lb/mound	NS	NS	NS	fire ant mound treatment
K) residential lawns	.0094 lb/mound	NS	NS	NS	fire ant mound treatment
AA) rights-of-way	0.252	NS	NS	NS	aerial
AB) roses[4]	15.6	Ns	NS	NS	ground spray
C1) tree nut, non-bearing	0.97	NS	NS	NS	aerial/ground
C1) walnut	0.97	NS	NS	NS	aerial/ground

[1] Includes idle agricultural land and land in the Conservation Reserve Program.
[2] Includes snap beans, green beans, and wax beans.
[3] Includes containerized nursery stock in lathhouses and shadehouses.
[4] Label rate in lb of pesticide per volume of spray. Calculation of area based rate is described in the text.
NA – not applicable; NS – not specified

Food: Acephate is registered for use on beans (green and lima), Brussels sprouts, cauliflower, celery, cottonseed, cranberries, lettuce, peanuts, peppermint, peppers (bell and non-bell), citrus, fruit trees, nut trees, soybeans, and spearmint.

Other Agriculture, Non-food: Acephate is also registered for use on cotton, and as seed treatment on cotton and peanuts (seed for planting), on non-bearing fruit trees, such as ornamentals, citrus, and on tobacco.

Residential: Acephate is registered for use outdoors around residential buildings, homes, and apartments, for the control of roaches, wasps, fire ants, and crickets, among other pests. It is also registered for outdoor use on home lawns, trees, shrubs and ornamentals.

Public Health: Acephate is registered for use in and around industrial, institutional and commercial buildings, including restaurants, food handling establishments, warehouses, stores, hotels, manufacturing plants, and ships for the control of roaches and fire ants.

Other Nonfood: Acephate is registered for use on sod, golf course turf, field borders, fence rows, roadsides, ditch banks, borrow pits, wasteland, and greenhouse and horticultural nursery floral and foliage plants.

Target pests include: Armyworms, aphids, beetles, bollworms, borers, budworms, cankerworms, crickets, cutworms, fire ants, fleas, grasshoppers, leafhoppers, loopers, mealybugs, mites, moths, roaches, spiders, thrips, wasps, weevils, whiteflies, and others (USEPA, 2006).

Formulation types: Wettable powder, soluble powder, soluble extruded pellets, granular, and liquid. All forms, except for granular, are mixed with water prior to application and are applied in a liquid form.

Equipment for agriculture, greenhouse, nursery, and turf uses: Granular acephate can be applied by belly grinder, hand, tractor-drawn spreader, push-type spreader, and shaker can. Liquid acephate (formulated from soluble powders or soluble extruded pellets) may be applied by aircraft, airblast sprayer, backpack sprayer, chemigation, hydraulic sprayers, ground boom spray, handgun, high pressure sprayer, hopper box (seed treatment), low-pressure hand wand, slurry (seed treatment), sprinkler can, transplanting in water (tobacco), or by an aerosol generator (greenhouses).

Equipment for residential and public health uses: Residential applications can be made by aerosol can, backpack sprayer, hose-end sprayer, and low-pressure handwand. Residential granular applications can be made by shaker can or by hand. Residential soluble powder applications may be made by sprinkler can or compressed air sprayers.

Method: Acephate may be applied on seed before planting, in-furrow at planting, or as a foliar spray, it may be applied to flower beds, plant beds, or as a transplant (tobacco) treatment. For use against fire ants it may be applied directly on their soil mound (drench and dry methods). Acephate is also used indoors as spot, crack and crevice, and bait treatments.

In addition to the uses listed above, there are other uses which are not being considered in this assessment (Table 2-5). These uses have excluded because no outdoor exposure is expected that could impact listed (threatened or endangered) species.

Table 2-5. Acephate use sites for which no risk assessment will be performed

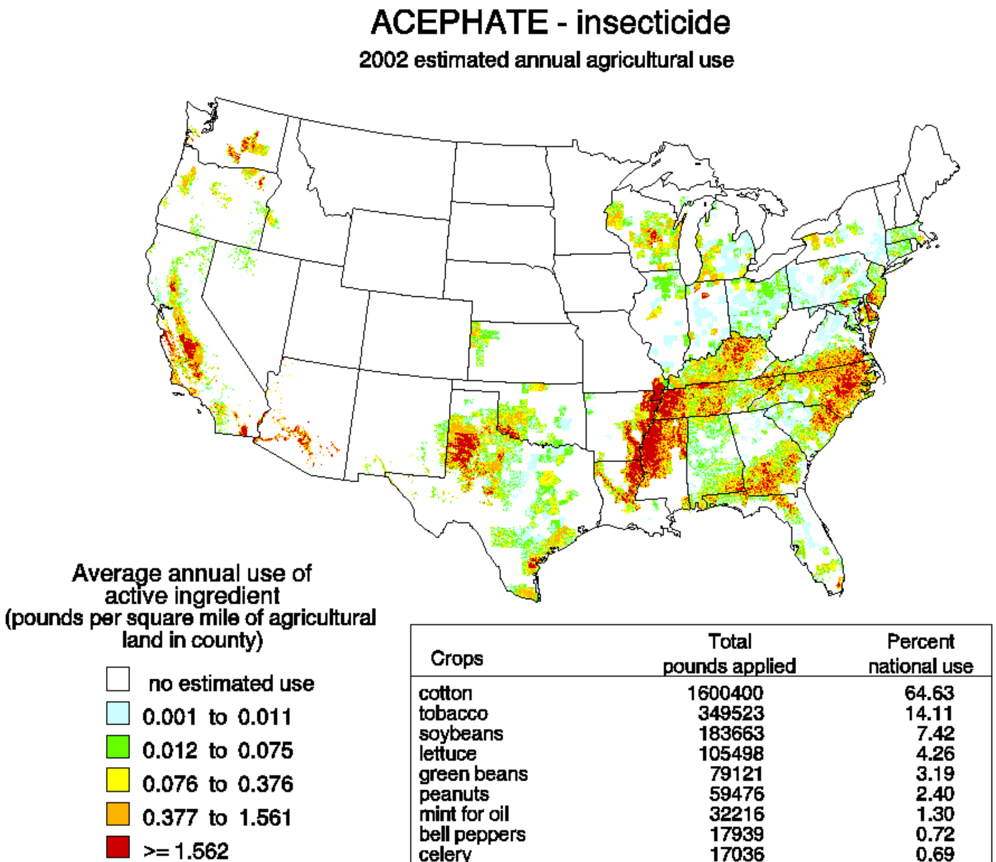
Use Site	Justification
bathroom premises	indoor use
commercial/institutional/industrial premises	indoor use
commercial storage/premises	indoor use
Christmas trees	tree injection
conifer release	tree injection
cranberry	not grown in California
eating establishments	indoor use
food stores/markets/supermarkets	indoor use
forest nursery plantings	tree injection
forest trees	tree injection

hospital/medical institutions	indoor use
household/domestic dwelling	indoor use
meat processing plant/premises	indoor use/crack and crevice treatment
non-agricultural outdoor buildings	bee nests only
greenhouse container ornamentals	indoor use
poultry processing plant premises	indoor use
recreational areas	tree injection
garbage cans	minimal outdoor exposure
indoor refuse containers	indoor use
seed orchard trees	tree injection
shelter belt plantings	tree injection
ships and boats	no outdoor exposure
southern pine seed orchard	not grown in California
soybeans	not grown in California
tobacco	not grown in California

Most acephate product labels specify application rates on a per crop cycle basis (not on a per year basis). Information from the Agency's Biological and Economic Analysis Division (BEAD) indicates that many crops can be grown more than one time/year in California (USEPA, 2007c). Since standard PRZM scenarios consist of only one crop per year, applications to one crop per year were modeled. The crops that may be grown multiple times in a calendar year that can be treated by acephate include cauliflower, celery, and lettuce. The cropping seasons range between two and four cycles per year. If acephate is applied for multiple cropping cycles within a year, EECs presented in this assessment may under-predict exposures. However, in California, rain dominantly falls in the winter season and the exposure is dominated by cropping cycles planted during the winter season. For pesticides with short environmental persistence like acephate, contributions to the estimated risk from other cropping seasons is small. For all other labeled uses, it was assumed that a maximum seasonal application specified on the label was equivalent to a maximum annual application.

According to the United States Geological Survey's (USGS) national pesticide usage data (based on information from 1999 to 2004), an average of 2.46 million lbs of acephate is applied nationally to agricultural use sites in the U.S. (non-agricultural uses are not included) (Figure 2-1). Of this, about 65% of the total usage was on cotton followed by 14% on tobacco and 7% on soybeans.

Figure 2-1. Acephate Use in Total Pounds per County.
(from http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=02&map=m6002)[1]



Crops	Total pounds applied	Percent national use
cotton	1600400	64.63
tobacco	349523	14.11
soybeans	183663	7.42
lettuce	105498	4.26
green beans	79121	3.19
peanuts	59476	2.40
mint for oil	32216	1.30
bell peppers	17939	0.72
celery	17036	0.69
dry beans	15932	0.64

BEAD provided an analysis of both national- and county-level usage information (USEPA, 2011a) using state-level usage data obtained from USDA-NASS[2], Doane (www.doane.com; the full dataset is not provided due to its proprietary nature) and the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database.[3] CDPR PUR is considered a more comprehensive source of usage data than USDA-NASS or EPA proprietary databases, and thus the usage data reported for acephate by county in this California-specific

[1] The pesticide use maps available from this site show the average annual pesticide use intensity expressed as average weight (in pounds) of a pesticide applied to each square mile of agricultural land in a county. The area of each map is based on state-level estimates of pesticide use rates for individual crops that were compiled by the CropLife Foundation, Crop Protection Research Institute based on information collected during 1999 through 2004 and on 2002 Census of Agriculture county crop acreage. The maps do not represent a specific year, but rather show typical use patterns over the five year period 1999 through 2004.
[2] United States Depart of Agriculture (USDA), National Agricultural Statistics Service (NASS) Chemical Use Reports provide summary pesticide usage statistics for select agricultural use sites by chemical, crop and state. See http://www.pestmanagement.info/nass/app_usage.cfm.
[3] The California Department of Pesticide Regulation's Pesticide Use Reporting database provides a census of pesticide applications in the state. See http://www.cdpr.ca.gov/docs/pur/purmain.htm.

assessment were generated using CDPR PUR data. Eleven years (1999-2009) of usage data were included in this analysis. Data from CDPR PUR were obtained for every agricultural pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system.[4] BEAD summarized these data to the county level by site, pesticide, and unit treated. Calculating county-level usage involved summarizing across all applications made within a section and then across all sections within a county for each use site and for each pesticide. The county level usage data that were calculated include: average annual pounds applied, average annual area treated, and average and maximum application rate across all eleven years. The units of area treated are also provided where available. Between 1999 and 2009, annual use of acephate in California ranged from approximately 112,000 to 307,000 pounds a.i. There is a generally decreasing trend in use over this time period.

A summary of acephate usage for all California use sites is provided below in Table 2-6**.**

Table 2-6. Summary of California Department of Pesticide Registration (CDPR) Pesticide Use Reporting (PUR) Data from 1999 to 2009 for Currently Registered Acephate Uses[1]

Site Name	Average Application Rate (lbs a.i./A)	Maximum Application Rate (lbs a.i./A)
ALMOND	0.8	1.0
APPLE	0.2	0.2
BEAN, DRIED	0.9	56.3
BEAN, SUCCULENT	0.9	10.1
BEAN, UNSPECIFIED	0.8	8.3
BERMUDAGRASS	0.9	1.0
BRUSSELS SPROUT	0.9	1.0
CAULIFLOWER	0.9	3.8
CELERY	0.9	16.0
CHERRY	0.8	0.8
CHRISTMAS TREE	0.4	0.8
CITRUS	0.7	0.8
COMMODITY FUMIGATION	NA	NA
COTTON	0.7	49.7
DITCH BANK	0.0	0.0
FOREST, TIMBERLAND	0.4	0.8
FUMIGATION, OTHER	0.4	0.5
GRAPE	1.0	1.0
GRAPE, WINE	0.8	2.0
GRAPEFRUIT	0.5	3.0
GREENHOUSE FUMIGATION	<0.1	0.1
LANDSCAPE MAINTENANCE	0.5	2.0
LEMON	0.6	14.7

[4] Most pesticide applications to parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights of way, and postharvest treatments of agricultural commodities are reported in the database. The primary exceptions to the reporting requirement are home-and-garden use and most industrial and institutional uses (http://www.cdpr.ca.gov/docs/pur/purmain.htm).

Site Name	Average Application Rate (lbs a.i./A)	Maximum Application Rate (lbs a.i./A)
LETTUCE, HEAD	0.9	10.1
LETTUCE, LEAF	0.8	3.0
MINT	0.9	1.5
N-GRNHS FLOWER	1.4	24.4
N-GRNHS PLANTS IN CONTAINERS	1.5	50.4
N-GRNHS TRANSPLANTS	0.8	12.0
N-OUTDR FLOWER	0.7	56.6
N-OUTDR PLANTS IN CONTAINERS	1.3	62.4
N-OUTDR TRANSPLANTS	0.9	20.1
ORANGE	0.4	3.9
PASTURELAND	0.4	1.0
PEPPER, FRUITING	0.8	10.5
PEPPER, SPICE	2.1	60.0
PISTACHIO	0.8	1.1
PLUM	0.3	0.3
PUBLIC HEALTH	NA	NA
RANGELAND	0.2	0.2
REGULATORY PEST CONTROL	NA	NA
RESEARCH COMMODITY	1.2	14.1
RIGHTS OF WAY	0.8	1.5
SOIL FUMIGATION/PREPLANT	0.6	1.0
STRUCTURAL PEST CONTROL	NA	NA
TANGELO	0.4	0.8
TANGERINE	0.5	0.9
TOMATO	0.5	0.8
TURF/SOD	1.0	1.9
UNCULTIVATED AG	2.7	67.2
UNCULTIVATED NON-AG	0.7	11.6
VERTEBRATE CONTROL	0.6	1.0
WALNUT	1.2	2.1

[1] Based on data supplied by BEAD (USEPA, 2011a)

2.5. Assessed Species

Table 2-7 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 II. See Figure 2-2, Figure 2-3, Figure 2-4, Figure 2-5, Figure 2-6, Figure 2-7, Figure 2-8, and Figure 2-9 for maps of the current range and designated critical habitat, if applicable, of the assessed listed species. See Section 2.1 for information on when each species was listed and a general description of their ranges.

Table 2-7. 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
San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*)	Adult (46-131 cm in length), Females – 227 g, Males – 113 g; Juveniles – 2 g (Cover Jr. and Boyer, 1988) (18–20 cm in length)	San Mateo County	Densely vegetated freshwater ponds near open grassy hillsides; emergent vegetation; rodent burrows	No	Oviparous Reproduction[2] Breeding: Spring (Mar. and Apr.) and Fall (Sept. to Nov.) Ovulation and Pregnancy: Late spring and early summer Young: Born 3-4 months after mating	Juveniles: frogs (Pacific tree frog, CRLF, and bullfrogs depending on size) and insects Adults: primarily frogs (mainly CRLFs; also bullfrogs, toads); to a lesser extent newts; freshwater fish and invertebrates; insects and small mammals
California Clapper Rail (CCR) (*Rallus longirostris obsoletus)*	250 - 350 g Juveniles ~50 g[3]	Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties	Tidal marsh habitat	No	Breeding: Feb. - August Nesting: mid-March-Aug. Lay Eggs: March - July Incubation: 23 to 29 days; Leave nest: 35 to 42 days after hatch; Juveniles fledge at ten weeks and can breed during the spring after they hatch	Opportunistic feeders: freshwater and estuarine invertebrates, seeds, worms, mussels, snails, clams, crabs, insects, and spiders; occasionally consume small birds and mammals, dead fish, up to 15% plant material
Salt Marsh Harvest Mouse (SMHM) (*Reithrodontomys raviventris*)	Adult 8 – 14 g	Northern subspecies can be found in Marin, Sonoma, Napa, Solano, and northern Contra Costa counties. The southern subspecies occurs in San Mateo, Alameda, and Santa Clara counties with some isolation populations in Marin and Contra Costa counties.	Dense, perennial cover with preference for habitat in the middle and upper parts of the marsh dominated by pickleweed and peripheral halophytes as well	No	Breeding: March – November Gestation period: 21 – 24 days	Leaves, seeds, and plant stems; may eat insects; prefers "fresh green grasses" in the winter and pickleweed and saltgrass during the rest of the year; drinks both salt and fresh water

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
			as similar vegetation in diked wetlands adjacent to the Bay			
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 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	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
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	Males: 1.25–2.5 cm length Females: 1.9–2.5 cm length	Central Valley of California (from Shasta County to Fresno County in the San Joaquin Valley)	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 pupal 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.

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
San Joaquin Kit Fox (SJKF) (*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 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)	No, but has designated core areas	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.
California Tiger Salamander (CTS)	Adult 14.2-80.5 g[4]	CTS-SC are primarily found on the Santa Rosa Plain in Sonoma County.	Freshwater pools or ponds (natural or man-made, vernal	Yes	Emerge from burrows and breed: fall and winter rains	Aquatic Phase: algae, snails, zooplankton, small crustaceans, and

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
(*Ambystoma californiense*)		CTS-CC occupies the Bay Area (central and southern Alameda, Santa Clara, western Stanislaus, western Merced, and the majority of San Benito Counties), Central Valley (Yolo, Sacramento, Solano, eastern Contra Costa, northeast Alameda, San Joaquin, Stanislaus, Merced, and northwestern Madera Counties), southern San Joaquin Valley (portions of Madera, central Fresno, and northern Tulare and Kings Counties), and the Central Coast Range (southern Santa Cruz, Monterey, northern San Luis Obispo, and portions of western San Benito, Fresno, and Kern Counties). CTS-SB are found in Santa Barbara County.	pools, ranch stock ponds, other fishless ponds); Grassland or oak savannah communities, in low foothill regions; Small mammal burrows		Eggs: laid in pond Dec. – Feb., hatch: after 10 to 14 days Larval stage: 3-6 months, until the ponds dry out, metamorphose late spring or early summer, migrate to small mammal burrows	aquatic larvae and invertebrates, smaller tadpoles of Pacific tree frogs, CRLF, toads; Terrestrial Phase: terrestrial invertebrates, insects, frogs, and worms
California Freshwater Shrimp (CFWS) (*Syncaris pacifica*)	Up to 50 mm postorbital length (from the eye orbit to tip of tail)	Marin, Napa, and Sonoma Counties, CA	Freshwater, perennial streams; they prefer quiet portions of tree-lined streams with underwater vegetation and exposed tree roots	No	Breed once a year, typically in Sept. Eggs adhere to the pleopods and are cared for for 8 – 9 months; embryos emerge during May or early June.	Feed on detritus (algae, aquatic macrophyte fragments, zooplankton, and aufwuchs)

[1] For more detailed information on the distribution, habitat requirements, and life history information of the assessed listed species, see Attachment II.
[2] Oviparous = eggs hatch within the female's body and young are born live.
[3] No data on juvenile CCR body weights are available at this time. As a surrogate for CCR juveniles, data on captive 21-day king rails were averaged for the juvenile body weight. King rails make an appropriate proxy for the CCR in the absence of information. The birds were once considered the same species by taxonomists, are members of the same genus (*Rallus*), and occasionally interbreed where habitats overlap.
[4] See Page 369 of Trenham *et al.* (Trenham *et al.*, 2000).

Figure 2-2. Bay Checkerspot Butterfly Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

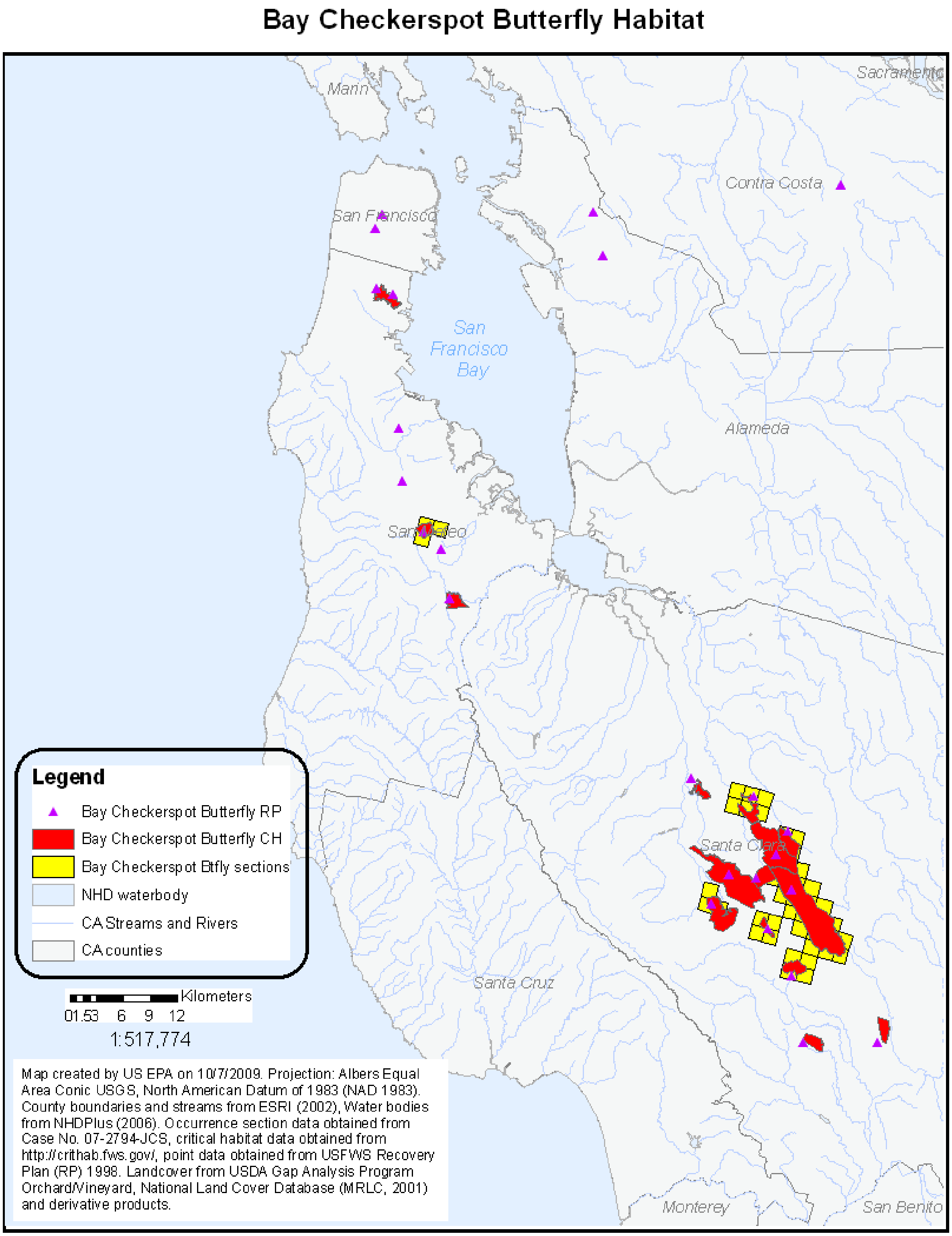


Figure 2-3. Valley Elderberry Longhorn Beetle Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

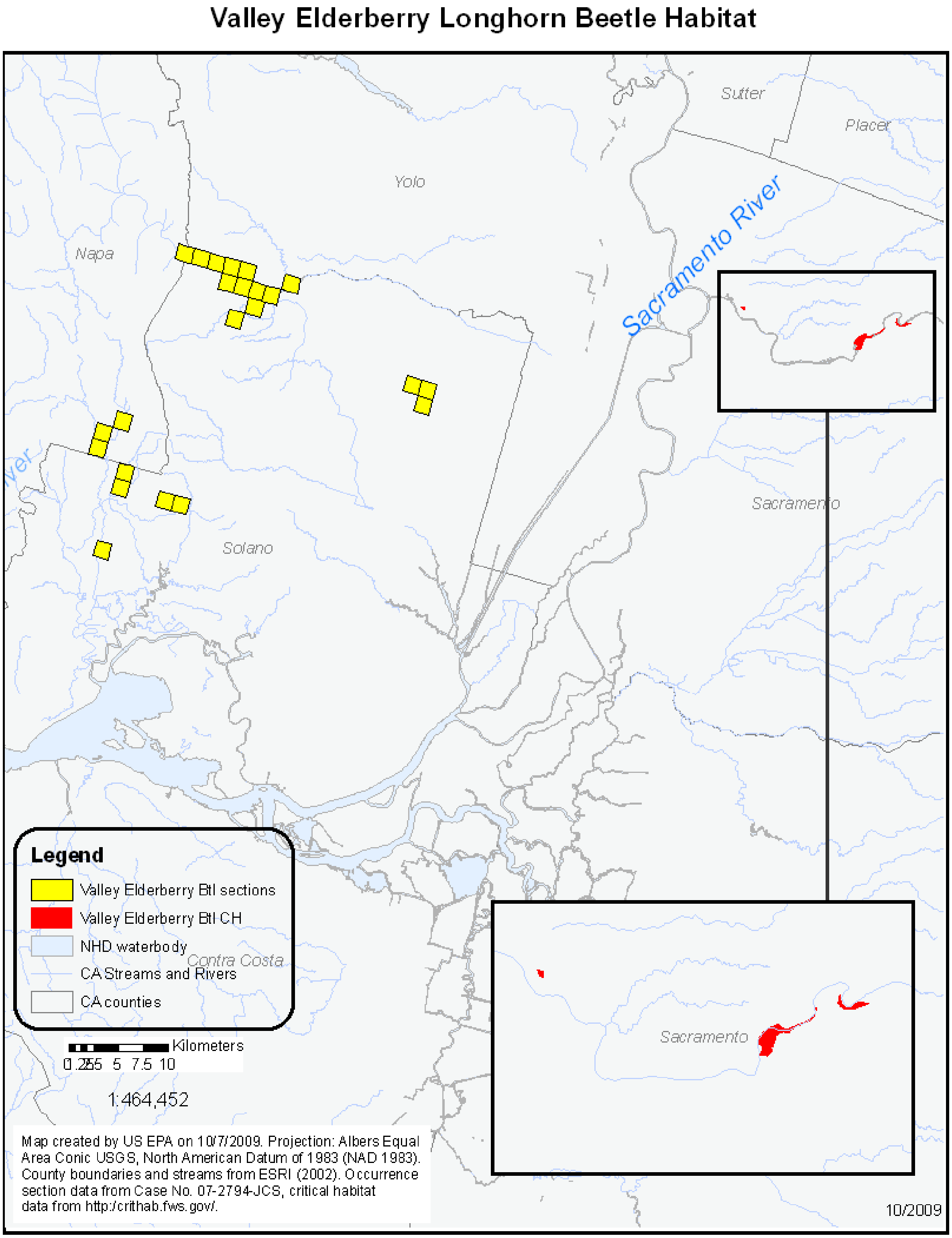


Figure 2-4. California Clapper Rail Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

California Clapper Rail Habitat

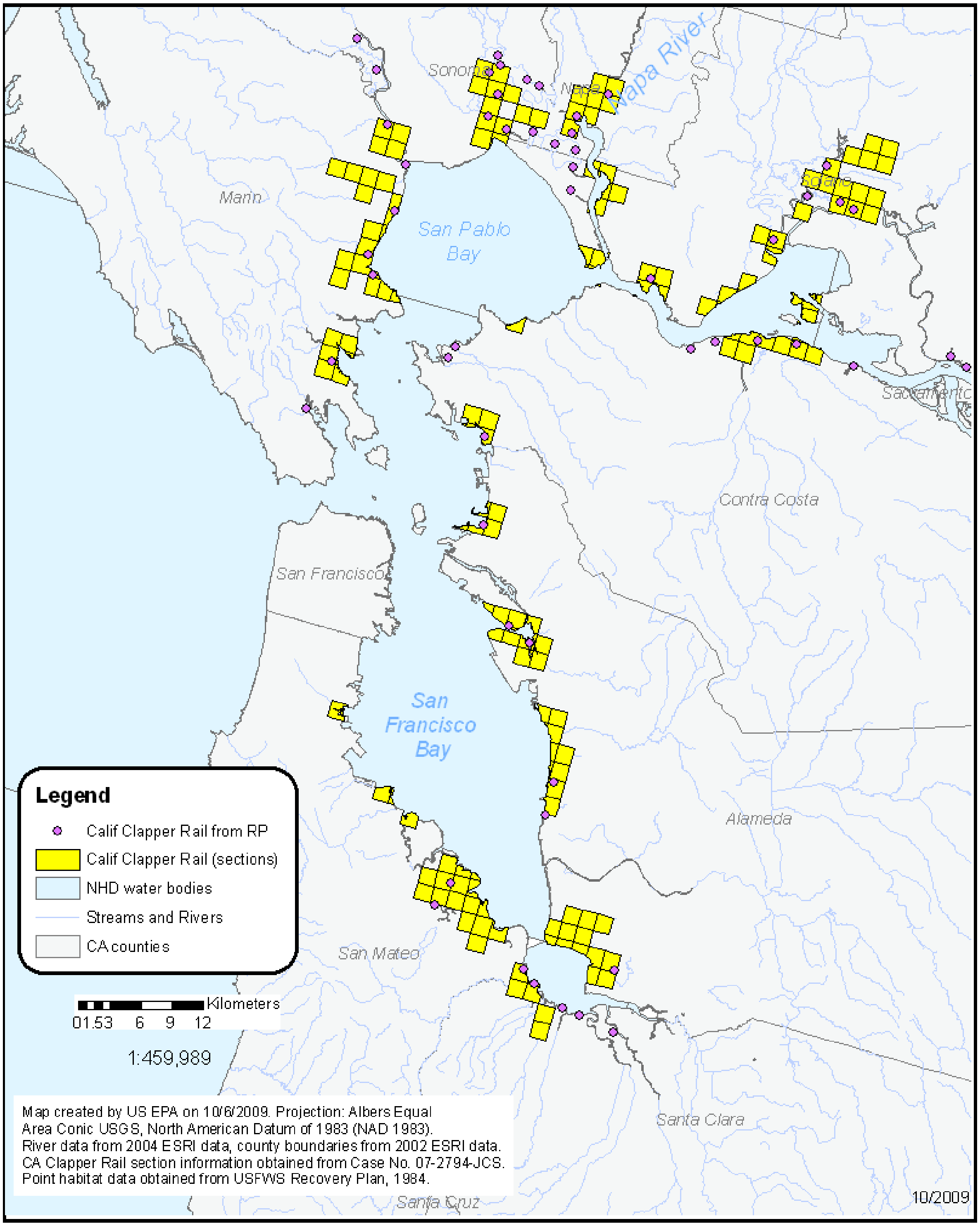


Figure 2-5. California Freshwater Shrimp Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

California Freshwater Shrimp Habitat

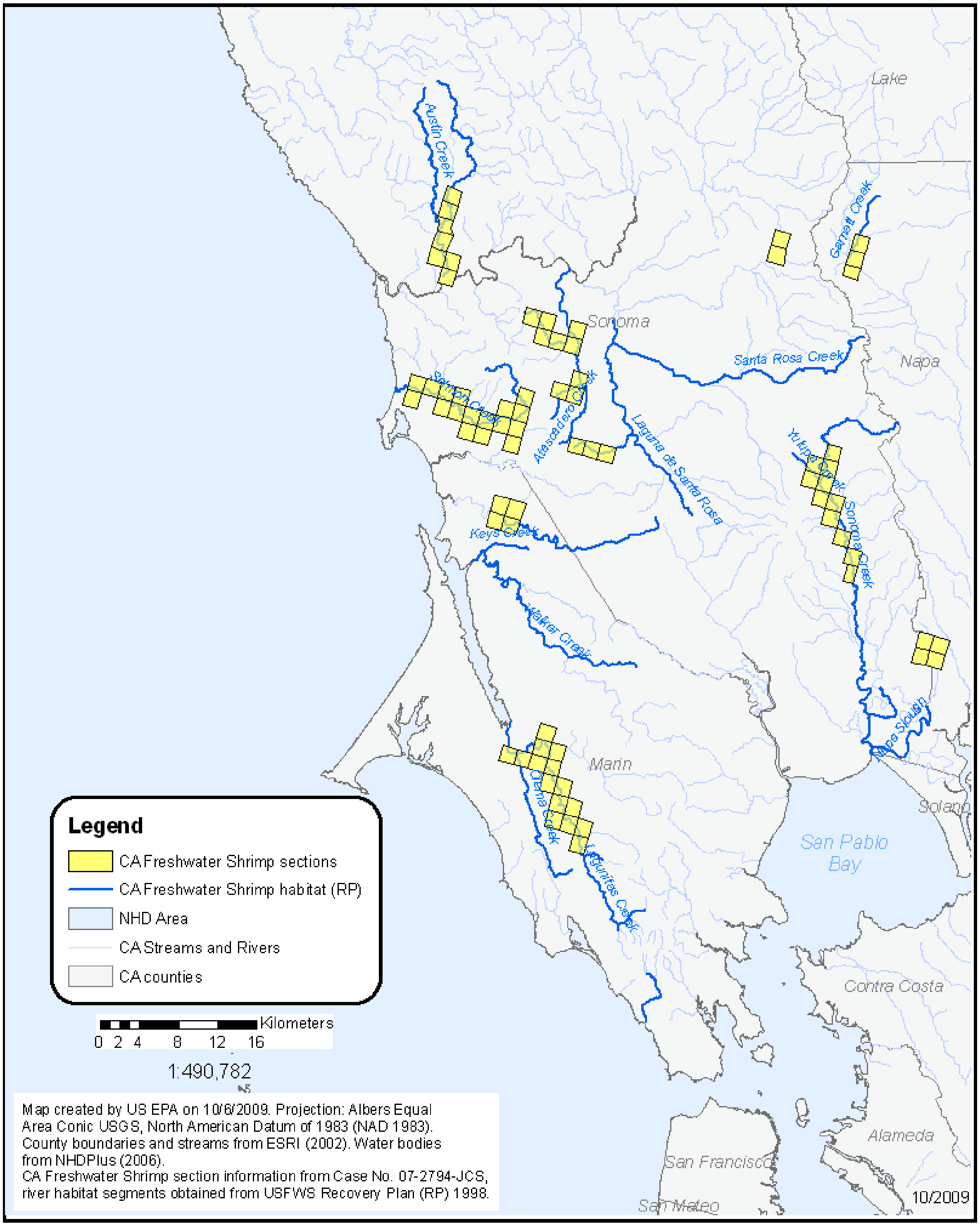


Figure 2-6. California Tiger Salamander Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

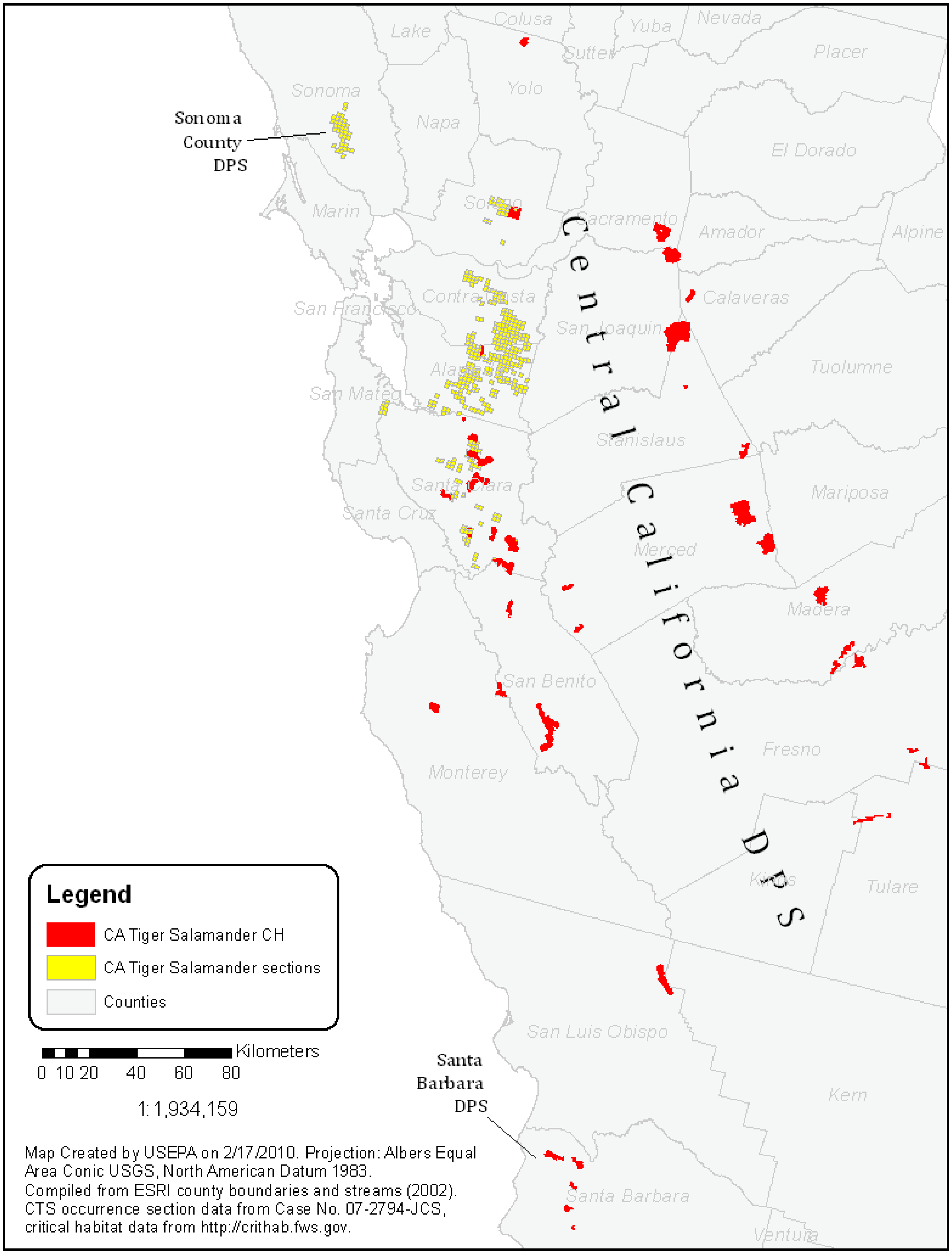


Figure 2-7. San Francisco Garter Snake Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

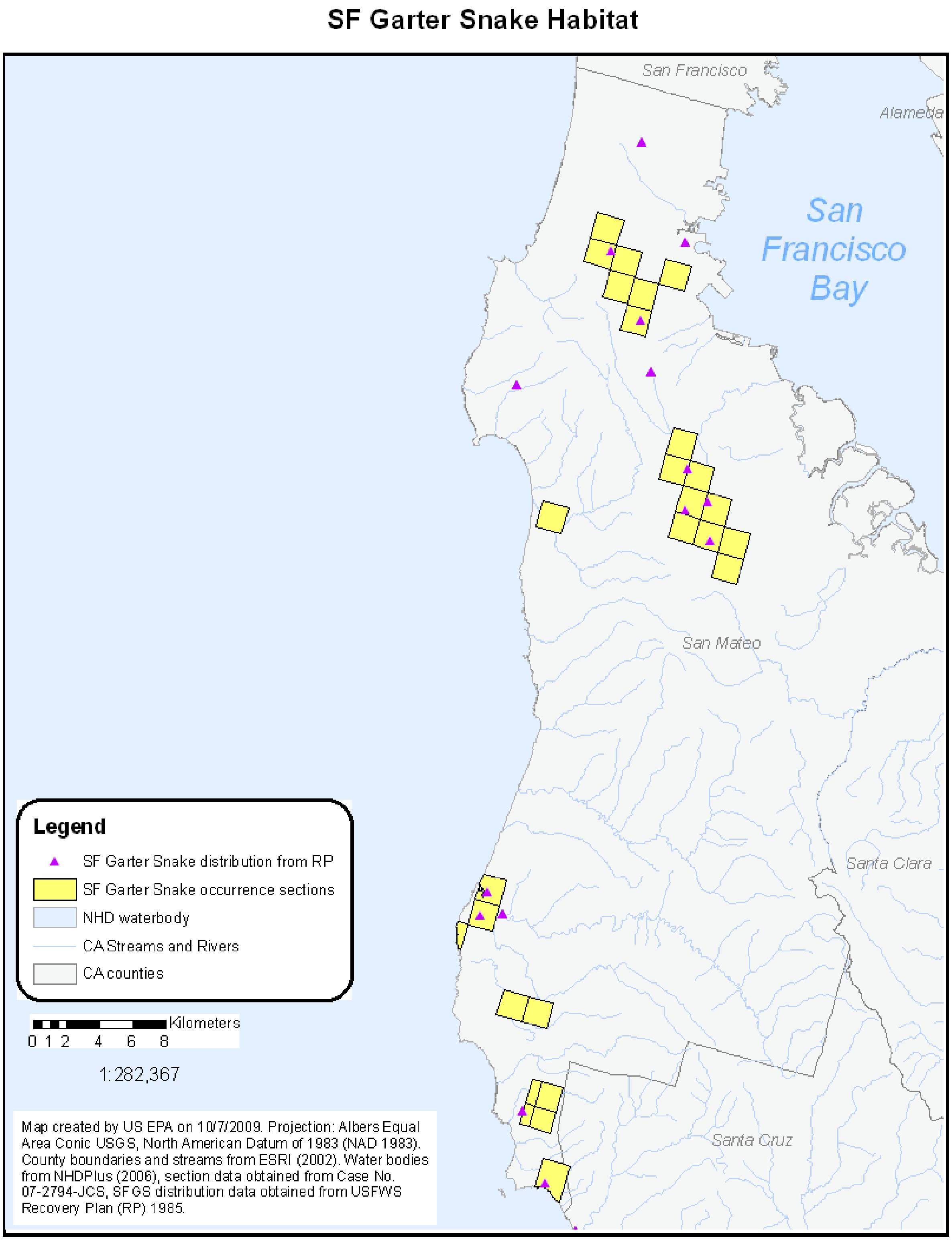


Figure 2-8. San Joaquin Kit Fox Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

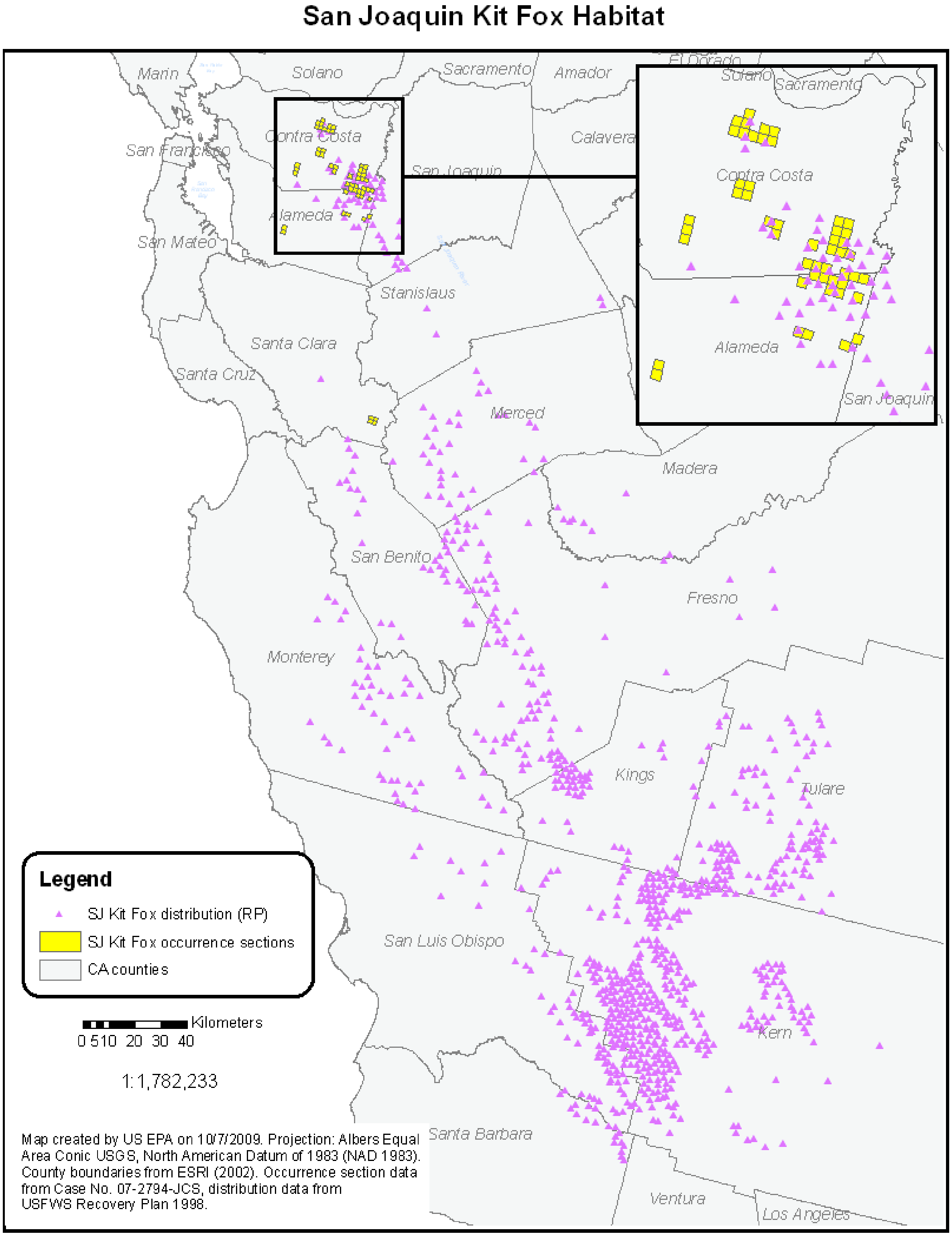
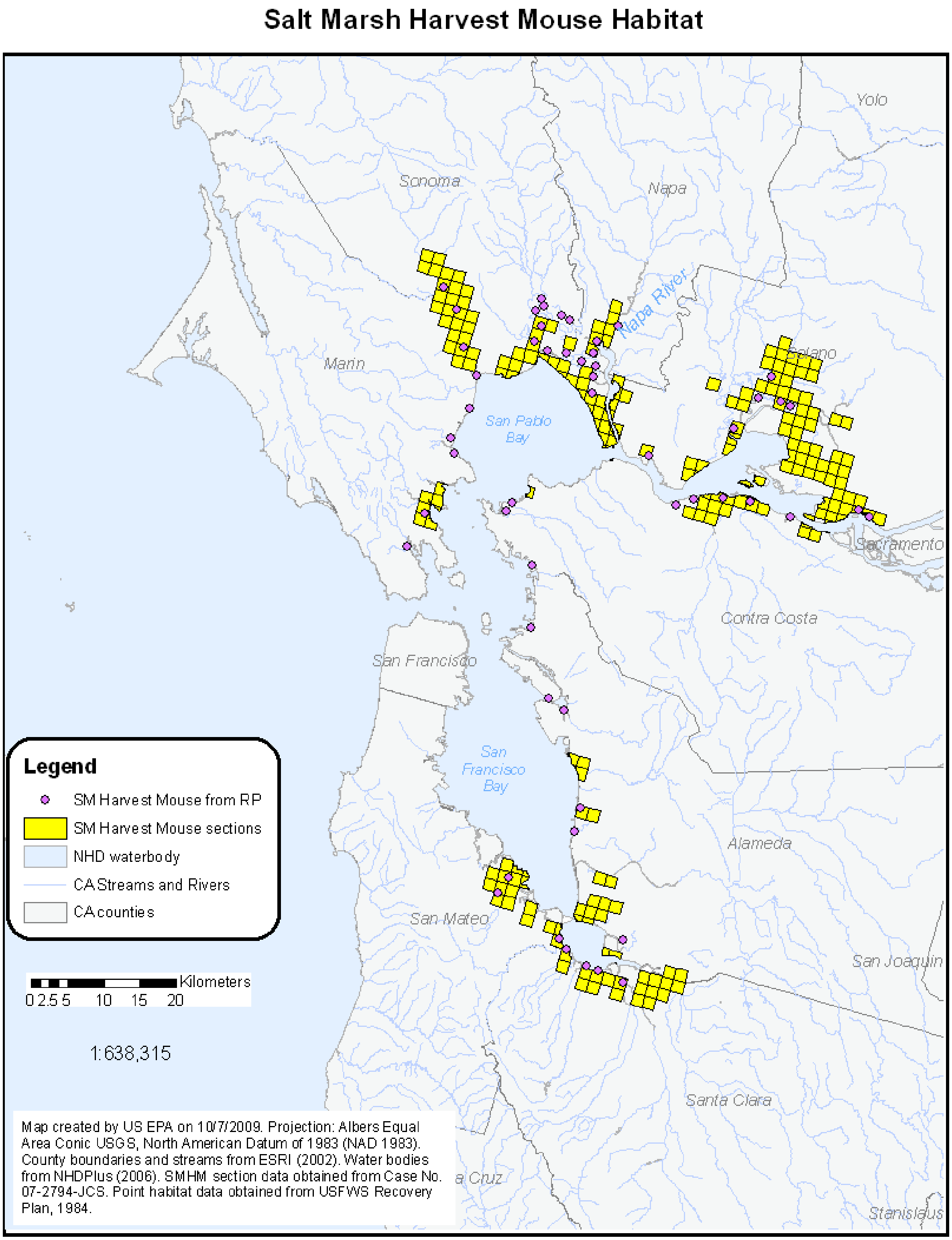


Figure 2-9. Salt Marsh Harvest Mouse Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.



2.6. Designated Critical Habitat

Critical habitat has been designated for the BCB, VELB, CTS-CC, and CTS-SB. Risk to critical habitat is evaluated separately from risk to effects on the species. '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 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)). Table 2-8 describes the PCEs for the critical habitats designated for the BCB, VELB, CTS-CC, and CTS-SB.

Table 2-8. Designated Critical Habitat PCEs for the Bay Checkerspot Butterfly, Valley Elderberry Longhorn Beetle, and California Tiger Salamander, Central California and Santa Barbara Distinct Population Segments[1]

Species	PCEs	Reference
California tiger salamander	Standing bodies of fresh water, including natural and man-made (*e.g.*, stock) ponds, vernal pools, and dune ponds, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a sufficient length of time (*i.e.*, 12 weeks) necessary for the species to complete the aquatic (egg and larval) portion of its life cycle[2] Barrier-free uplands adjacent to breeding ponds that contain small mammal burrows. Small mammals are essential in creating the underground habitat that juvenile and adult California tiger salamanders depend upon for food, shelter, and protection from the elements and predation Upland areas between breeding locations (PCE 1) and areas with small mammal burrows (PCE 2) that allow for dispersal among such sites	FR Vol. 69 No. 226 CTS, 68584, 2004
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). 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)	66 FR 21449 21489, 2001

Species	PCEs	Reference
	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, physical-chemical water quality parameters such as salinity, pH, and hardness are not evaluated.

More detail on the designated critical habitat applicable to this assessment can be found in Attachment II. 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 acephate that may alter the PCEs of the designated critical habitat for the BCB, VELB, CTS-CC, and CTS-SB 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 acephate is expected to directly impact living organisms within the action area, critical habitat analysis for acephate 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 and LAA Effects Determination Area

2.7.1. Action Area

The action area is used to identify areas that could be affected by the Federal action. The Federal action is the authorization or registration of pesticide use or uses as described on the label(s) of pesticide products containing a particular active ingredient. The action area is defined by the Endangered Species Act as, “all areas to be affected directly or indirectly by the Federal action and not merely the immediate are involved in the action” (50 CFR §402.2). Based on an analysis of the Federal action, the action area is defined by the actual and potential use of the pesticide and areas where that use could result in effects. 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. It is recognized that the overall action area for the national registration of acephate is likely to encompass considerable portions of the United States based on the large array of agricultural and non-agricultural uses. However, the scope of this assessment limits consideration of the overall action area to those portions that may be applicable to the protection of the BCB, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SMHM, SFGS, and SJKF and their designated critical habitat within the state of California. For this assessment, the entire state of California is considered the action area. The purpose of defining the action area as the entire state of California is to ensure that the initial area of consideration encompasses all areas where the pesticide may be used now and in the future, including the potential for off-site transport via spray drift and downstream dilution that could influence the San Francisco Bay Species. Additionally, the concept of a state-wide action area takes into account the potential for direct and indirect effects and any potential modification to critical habitat based on ecological effect measures associated with reduction in survival, growth, and reproduction, as well as the full suite of sublethal effects available in the effects literature.

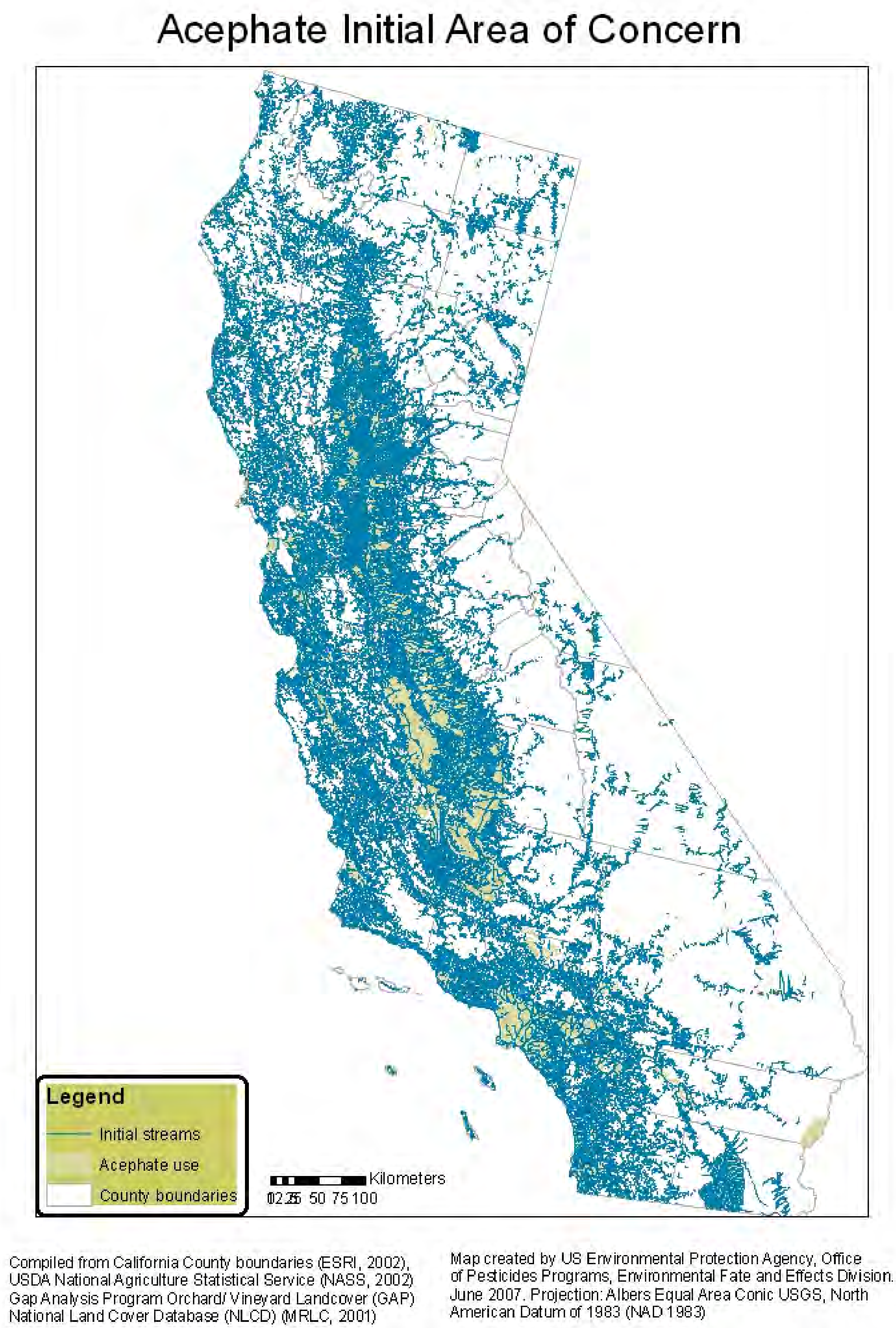
It is important to note that the state-wide action area does not imply that direct and/or indirect effects and/or critical habitat modification are expected to or are likely to occur over the full extent of the action area, but rather to identify all areas that may potentially be affected by the action. The Agency uses more rigorous analysis including consideration of available land cover data, toxicity data, and exposure information to determine areas where BCB, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SMHM, SFGS, and SJKF and designated critical habitat may be affected or modified via endpoints associated with reduced survival, growth, or reproduction.

2.7.2. LAA Effects Determination Area

A stepwise approach is used to define the Likely to Adversely Affect (LAA) Effects Determination Area. An LAA effects determination applies to those areas where it is expected that the pesticide's use will directly or indirectly affect the species and/or modify its designated critical habitat using EFED's standard assessment procedures (see Attachment I) and effects endpoints related to survival, growth, and reproduction. This is the area where the "Potential Area of LAA Effects" (initial area of concern + drift distance or downstream dilution distance) overlaps with the range and/or designated critical habitat for the species being assessed. If there is no overlap between the potential area of LAA effects and the habitat or occurrence areas, a no effect determination is made. The first step in defining the LAA Effects Determination Area is to understand the federal action. The federal action is defined by the currently labeled uses for acephate. An analysis of labeled uses and review of available product labels was completed. Several of the currently labeled uses are special local needs (SLN) uses not specified for use in California or are restricted to specific states and are excluded from this assessment. In addition, a distinction has been made between food use crops and those that are non-food/non-agricultural uses. For those uses relevant to the assessed species, the analysis indicates that, for acephate, the following agricultural uses are considered as part of the federal action evaluated in this assessment: fallow land, turf, food crops, non-food crops, ornamentals, and seed treatments. In addition, the following non-food and non-agricultural uses are considered: fire ant control, drainage systems, golf courses, paved areas, recreational area lawns, and rights-of-way. For a detailed list of both agricultural and non-agricultural uses, see Table 2-4.

Following a determination of the assessed uses, an evaluation of the potential "footprint" of acephate use patterns (*i.e.*, the area where pesticide application may occur) is determined. This "footprint" represents the initial area of concern, based on an analysis of available land cover data for the state of California. The initial area of concern is defined as all land cover types and the stream reaches within the land cover areas that represent the labeled uses described above. A map representing all the land cover types that make up the initial area of concern for acephate is presented in Figure 2-10.

Figure 2-10. Initial Area of Concern, or "Footprint" of Potential Use, for Acephate.



Once the initial area of concern is defined, the next step is to define the potential boundaries of the Potential Area of LAA Effects by determining the extent of offsite transport via spray drift and runoff where exposure of one or more taxonomic groups to the pesticide will result in exceedances of the listed species LOCs.

The AgDRIFT model (Version 2.01) is used to define how far from the initial area of concern an effect to a given species may be expected via spray drift (*e.g.*, the drift distance). The spray drift analysis for acephate uses the most sensitive endpoint of invertebrates in both terrestrial and aquatic systems. Further detail on the spray drift analysis is provided in Section 5.2.9.a.

In addition to the buffered area from the spray drift analysis, the Potential Area of LAA Effects area also considers the downstream extent of acephate that exceeds the LOC based on downstream dilution analysis (discussed in Section 5.2.9.b).

An evaluation of usage information was conducted to determine the area where use of acephate 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 acephate has historically been used on a wide variety of agricultural and non-agricultural uses.

2.8. Assessment Endpoints and Measures of Ecological Effect

For more information on the assessment endpoints, measures of ecological effect, see Attachment I.

2.8.1. Assessment Endpoints

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. Table 2-9 identifies the taxa used to assess the potential for direct and indirect effects from the uses of acephate 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 2-10.

Table 2-9. Taxa Used in the Analyses of Direct and Indirect Effects for the Assessed Listed Species.

Listed Species	Birds	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Aquatic Phase Amphibians	Estuarine /Marine Fish	Estuarine /Marine Inverts.	Aquatic Plants
San Francisco garter snake**	Direct Indirect (prey)	Indirect (prey/ habitat)	Indirect (habitat)	Indirect (prey)	Indirect (prey)	Indirect (prey)	Indirect (prey)	N/A	N/A	Indirect (habitat)
California clapper rail**	Direct Indirect (prey)	Indirect (prey)	Indirect (food/ habitat)	Indirect (prey)	Indirect (prey)	Indirect (prey)	N/A	Indirect (prey)	Indirect (prey)	Indirect (food/ habitat)
Salt marsh harvest mouse	Indirect (rearing sites)	Direct Indirect (rearing sites)	Indirect (food, habitat)	Indirect (prey)	N/A	N/A	N/A	N/A	N/A	Indirect (habitat)
Bay checkerspot butterfly	N/A	N/A	Indirect (food/ habitat) *	Direct	N/A	N/A	N/A	N/A	N/A	N/A
Valley elderberry longhorn beetle	N/A	N/A	Indirect (food/ habitat) *	Direct	N/A	N/A	N/A	N/A	N/A	N/A
San Joaquin kit fox	Indirect (prey)	Direct Indirect (prey)	Indirect (food/ habitat)	Indirect (prey)	N/A	N/A	N/A	N/A	N/A	N/A
California tiger salamander	Direct	Indirect (prey/ habitat)	Indirect (habitat)	Indirect (prey)	Direct Indirect (prey)	Indirect (prey)	Direct	N/A	N/A	Indirect (food/ habitat)
California freshwater shrimp	N/A	N/A	Indirect (food/ habitat)	N/A	N/A	Direct Indirect (prey)	N/A	N/A	N/A	Indirect (food/ habitat)

Abbreviations: n/a = Not applicable; Terr. = Terrestrial; Invert. = Invertebrate; FW = Freshwater
* obligate relationship
** Consumption of residues of acephate in aquatic organisms may result in direct effects to the San Francisco Garter Snake and the Clapper Rail.

Table 2-10. Taxa and Assessment Endpoints Used to Evaluate the Potential for Use of Acephate to Result in Direct and Indirect Effects to the Assessed Listed Species or Modification of Critical Habitat

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
1. Freshwater Fish and Aquatic-Phase Amphibians	Direct Effect – -CA Tiger Salamander	Survival, growth, and reproduction of individuals via direct effects	1a. Most sensitive fish acute LC_{50} (guideline or ECOTOX) 1b. Most sensitive fish chronic NOAEC (guideline or ECOTOX) 1c. Most sensitive aquatic-phase amphibian acute LC_{50} (guideline or ECOTOX)
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail	Survival, growth, and reproduction of individuals or modification of habitat via indirect effects on aquatic prey food supply (*i.e.*, fish and aquatic-phase amphibians)	
2. Freshwater Invertebrates	Direct Effect – -CA FW Shrimp	Survival, growth, and reproduction of individuals via direct effects	2a. Most sensitive freshwater invertebrate EC_{50} (guideline or ECOTOX) 2b. Most sensitive freshwater invertebrate chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -CA FW shrimp -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on aquatic prey food supply (*i.e.*, freshwater invertebrates)	
3. Estuarine/Marine Fish	Direct Effect – -none	NA	3a. Most sensitive estuarine/marine fish EC_{50} (guideline or ECOTOX) 3b. Most sensitive estuarine/marine fish chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -CA Clapper Rail	Survival, growth, and reproduction of individuals or modification of habitat via indirect effects on aquatic prey food supply (*i.e.*, estuarine/marine fish)	
4. Estuarine/Marine Invertebrates	Indirect Effect (prey) -CA Clapper Rail	Survival, growth, and reproduction of individuals or modification of habitat via indirect effects on aquatic prey food supply (*i.e.*, estuarine/marine invertebrates)	4a. Most sensitive estuarine/marine invertebrate EC_{50} (guideline or ECOTOX) 4b. Most sensitive estuarine/marine invertebrate chronic NOAEC (guideline or ECOTOX)
5. Aquatic Plants	Indirect Effect	Survival, growth, and	5a. Vascular plant acute EC_{50}

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
(freshwater/marine)	<u>(food/habitat)</u> -SF Garter Snake -CA Clapper Rail -Salt Marsh Harvest Mouse -CA Tiger Salamander -CA FW Shrimp	reproduction of individuals or modification of critical habitat/habitat via indirect effects on habitat, cover, food supply, and/or primary productivity (*i.e.*, aquatic plant community)	(duckweed guideline test or ECOTOX vascular plant) 5b. Non-vascular plant acute EC_{50} (freshwater algae or diatom, or ECOTOX non-vascular)
6. Birds	<u>Direct Effect</u> -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals via direct effects	6a. Most sensitive bird* or terrestrial-phase amphibian acute LC_{50} or LD_{50} (guideline or ECOTOX) 6b. Most sensitive bird* or terrestrial-phase amphibian chronic NOAEC (guideline or ECOTOX)
	<u>Indirect Effect (prey/rearing sites)</u> -SF Garter Snake -CA Clapper Rail -Salt Marsh Harvest Mouse - San Joaquin Kit Fox	Survival, growth, and reproduction of individuals or modification of habitat via indirect effects on terrestrial prey (birds)	
7. Mammals	<u>Direct Effect</u> -Salt Marsh Harvest Mouse -San Joaquin Kit Fox	Survival, growth, and reproduction of individuals via direct effects	7a. Most sensitive laboratory mammalian acute LC_{50} or LD_{50} (guideline or ECOTOX) 7b. Most sensitive laboratory mammalian chronic NOAEC (guideline or ECOTOX)
	<u>Indirect Effect (prey/habitat from burrows/rearing sites)</u> -SF Garter Snake -CA Clapper Rail -Salt Marsh Harvest Mouse -San Joaquin Kit Fox -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on terrestrial prey (mammals) and/or burrows/rearing sites	
8. Terrestrial Invertebrates	<u>Direct Effect</u> -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) 8b. Most sensitive terrestrial invertebrate chronic NOAEC (guideline or ECOTOX)
	<u>Indirect Effect (prey)</u> -SF Garter Snake -CA Clapper Rail -Salt Marsh Harvest Mouse -San Joaquin Kit Fox -CA Tiger	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on terrestrial prey (terrestrial	

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
	Salamander	invertebrates)	
9. Terrestrial Plants	Indirect Effect (food/habitat) (non-obligate relationship) -SF Garter Snake -CA Clapper Rail -Salt Marsh Harvest Mouse -SF Garter Snake -San Joaquin Kit Fox -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat 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 BCB and the VELB) for dicots (seedling emergence, vegetative vigor, or ECOTOX)
	Indirect Effect (food/habitat) (obligate relationship) -Bay Checkerspot Butterfly -Valley Elderberry Longhorn Beetle		

Abbreviations: SF=San Francisco; NA=Not Applicable
* Birds are used as a surrogate for terrestrial-phase amphibians and reptiles. Fish are used as a surrogate for aquatic-phase amphibians.

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 acephate 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 acephate effects data are available.

Assessment endpoints used to evaluate potential for direct and indirect effects are equivalent to the assessment endpoints used to evaluate potential effects to designated critical habitat. If a potential for direct or indirect effects is found, then there is also a potential for effects to critical habitat. Some components of these PCEs are associated with physical abiotic features (*e.g.*, presence and/or depth of a water body, or distance between two sites), which are not expected to be measurably altered by use of pesticides.

2.9. 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 (USEPA, 1998). For this assessment, the risk is stressor-linked, where the stressor is the release of acephate to the environment. The following risk hypotheses are presumed in this assessment:

The labeled use of acephate within the action area may:

- directly affect BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and/or modify their designated critical habitat by reducing or changing the composition of food supply;
- indirectly affect CTS (all DPS), CCR, CFWS, SMHM, and SFGS 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 BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF 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 CTS (all DPS) and CFWS 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);
- indirectly affect CTS (all DPS) and/or modify their designated critical habitat by reducing or changing terrestrial habitat in their current range (via reduction in small burrowing mammals leading to reduction in underground refugia/cover).

2.9.2. Diagram

The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the acephate release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in Figure 2-11 and Figure 2-12 . 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 BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and modification to designated critical habitat is expected to be negligible.

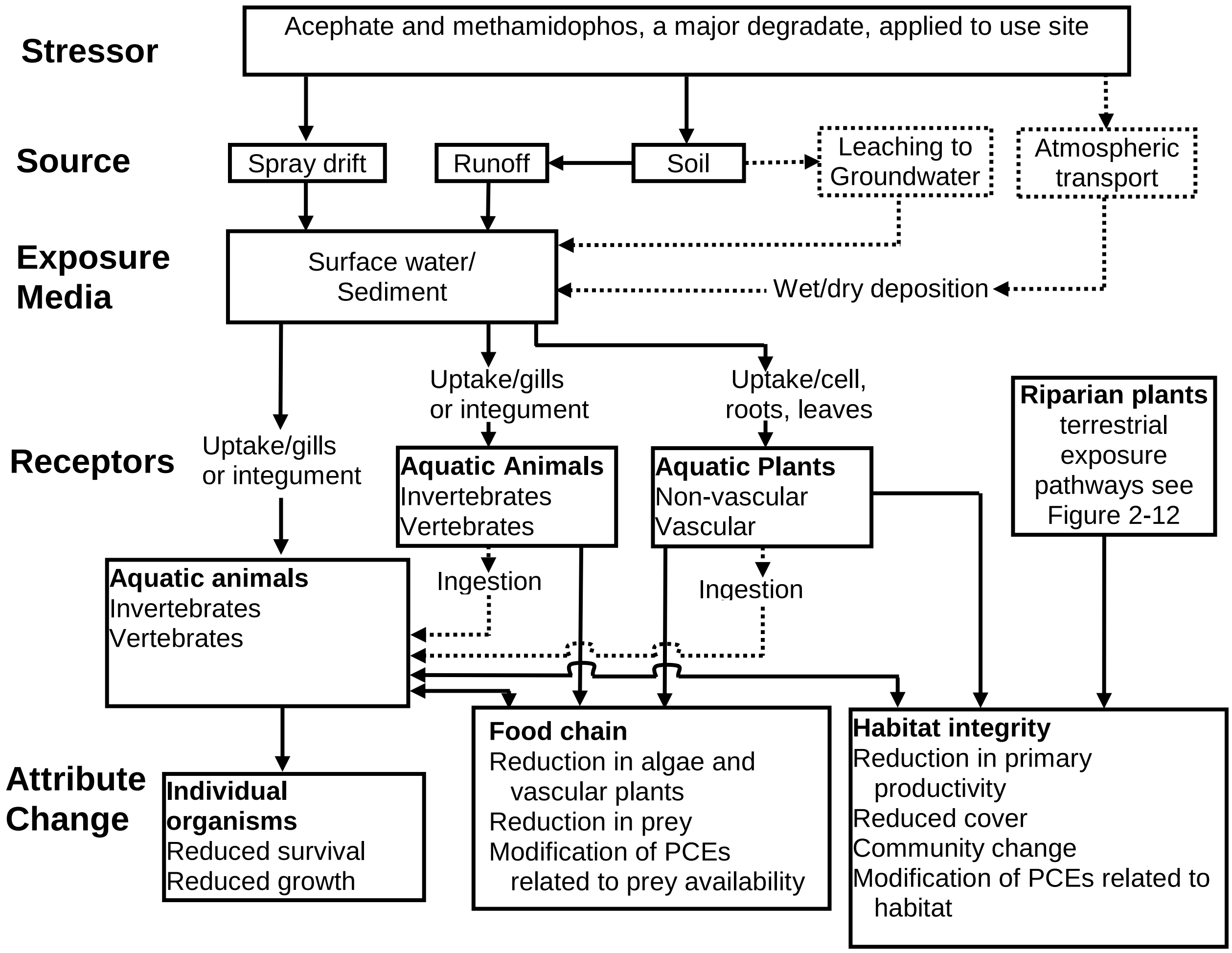


Figure 2-11. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Aquatic Organisms from the Use of Acephate.
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

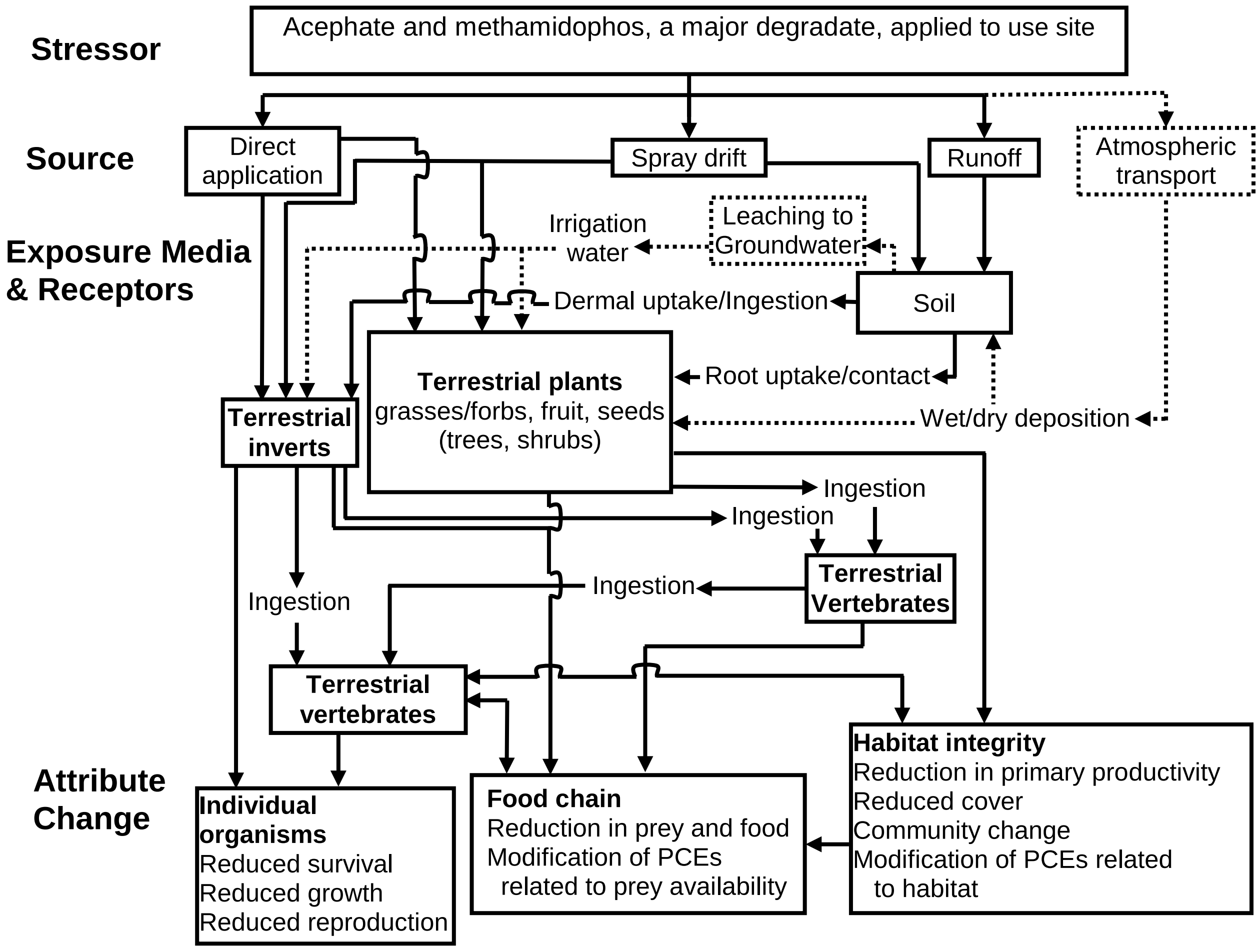


Figure 2-12. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Terrestrial Organisms from the Use of Acephate.
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

2.10. Analysis Plan

In order to address the risk hypothesis, the potential for direct and indirect effects to the assessed species, prey items, and habitat is estimated based on a taxon-level approach. In the following sections, the use, environmental fate, and ecological effects of acephate 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 (USEPA, 2004), the likelihood of effects to individual organisms from particular uses of acephate is estimated using the probit dose-response slope and either the level of concern (discussed below) or actual calculated risk quotient value.

Descriptions of routine procedures for evaluating risk to the San Francisco Bay Species are provided in Attachment I.

2.10.1. Measures of Exposure

The environmental fate properties of acephate along with available monitoring data indicate that water and sediment runoff and spray drift are the principle potential transport mechanisms of acephate to the aquatic and terrestrial habitats. In this assessment, transport of acephate through runoff and spray drift is considered in deriving quantitative estimates of acephate exposure to BCB, VELB, CTS, CCR, CFWS, SMHM, SFGS, and SJKF, their prey, and their habitats. Based on chemical properties and the results of laboratory studies, volatilization, groundwater, and bioaccumulation are not considered likely routes of exposure for acephate.

Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EECs) of acephate 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 Terrestrial Residue Exposure (T-REX) model. The T-HERPS model is used to allow for further characterization of dietary exposures of terrestrial-phase amphibians relative to birds. The model used to derive EECs relevant to terrestrial and wetland plants is TerrPlant. The AgDRIFT model is also used to estimate deposition of acephate on aquatic and terrestrial habitats from spray drift. These models are parameterized using relevant reviewed registrant-submitted environmental fate data. More information on these models is available in Attachment I.

2.10.2. Measures of Effect

Data identified in Section 2.8 are used as measures of effect for direct and indirect effects. Data were obtained from registrant submitted studies or from literature studies identified by ECOTOX. More information on the ECOTOXicology (ECOTOX) database and how toxicological data is used in assessments is available in Attachment I.

2.10.3. 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 acephate, and the likelihood of direct and indirect effects to the assessed species 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. 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). More information on standard assessment procedures is available in Attachment I.

2.10.4. Data Gaps

The only significant data gap, for both acephate and methamidophos is the aerobic aquatic metabolism rate. In both cases, the assessment was completed using a value of twice the aerobic soil metabolism rate which will be a conservative estimate most of the time. The toxicity data requirements for acephate are complete with the exception of an aquatic plant study using the degradate methamidophos and chronic fish studies. The aquatic plant data gap is not expected to impact the conclusions of this assessment. The lack of chronic freshwater fish studies is addressed by using a conservative acute-to-chronic ratio derived from other organophosphate insecticide data. The lack of estuarine/marine chronic fish data impacts the assessment of indirect effects to the CCR, but is not expected to change the conclusions of this assessment. As stated in Section 2.3, four aquatic plant toxicity studies, one avian oral toxicity study for a passerine species, an anaerobic soil metabolism study, and an aerobic aquatic metabolism study have been requested for acephate as part of the registration review process.

Studies from the open literature provide quantitative data on aquatic-phase amphibians and Lepidoptera species that are used in this assessment for the relevant species. No data are available in the open literature on terrestrial-phase amphibians or reptiles, and EPA does not require registrants to submit data on these species. Therefore, birds are used as a surrogate species for terrestrial-phase amphibians and reptiles.

3. Exposure Assessment

Acephate formulations include wettable powder, soluble powder, soluble extruded pellets, granular, and liquid. Granular acephate can be applied by belly grinder, hand, tractor-drawn spreader, push-type spreader, and shaker can. Liquid acephate (formulated from soluble powders or soluble extruded pellets) may be applied by aircraft, airblast sprayer, backpack sprayer, chemigation, hydraulic sprayers, ground boom spray, handgun, high-pressure sprayer, hopper box (seed treatment), low-pressure hand wand, seed slurry treatment, sprinkler can, transplanting in water (tobacco), or by an aerosol generator (greenhouses). Residential applications can be made by aerosol can, backpack sprayer, hose-end sprayer, and low-pressure handwand. Residential granular applications can be made by shaker can or by hand. Residential soluble powder applications may be made by sprinkler can or compressed air sprayers.

Risks from ground boom and aerial applications are considered in this assessment because they are expected to result in the highest off-target levels of acephate due to generally higher spray drift levels. Ground boom and aerial modes of application tend to use lower volumes applied in finer sprays than applications coincident with sprayers and spreaders and thus have a higher potential for off-target movement via spray drift.

3.1. Label Application Rates and Intervals

The registered uses of acephate in California include cotton, lettuce, citrus, celery, peppers, beans, mint, Bermuda grass for seed, landscape maintenance, pistachio, structural pest control, greenhouses, plants in containers, transplants, flowers, and others (see Table 2-6).

The use patterns assessed for risk assessment are in Table 3-1. As noted above, crops with similar use patterns have been grouped together with one crop chosen as a surrogate for the group. In some cases, a group was assessed singly for terrestrial assessment, but separated into two or more subgroups for aquatic assessment because different scenarios were appropriate for the assessing aquatic exposure for the subgroups. Subgroups are denoted with a numeral following the letter, *e.g.* 'C1', 'C2'. When neither a maximum seasonal application rate nor a maximum number of applications per year was specified, 26 applications were assumed as this is the maximum number of applications per year that can be simulated with PRZM. If no minimum application interval was specified, a 3 day application interval was assumed. A three day application interval is, in most cases, the minimum interval which would be used to reapply a chemical. The three day window allows two days for scouting to determine efficacy with the sequential application occurring on the third day if the initial application has not suppressed the pest. It should be noted that for alfalfa, the label specifies a 2-day reapplication interval. Note that these numbers of applications or minimum intervals are not expected to be used frequently, if ever, for acephate. However, at least for some uses (*e.g.* ornamentals), applications of acephate exceed 50 lb·acre^{-1}.

In cases when both aerial applications as well as air blast or ground spray applications are allowed on the label, the aerial application was simulated as the off-site drift from aerial applications is greater. A discussion of application rates and surrogacy groups for some groups follows.

Table 3-1. Label Use Rates for Acephate in California

Use	Application Rate (lb a.i./acre)	Number of applications[1]	Application Interval[1] (days)	Application Type
A) fallow land	0.1245	1	NA	aerial
B) alfalfa	0.974	26	2	aerial
C1) almonds, non-bearing	0.97	26	3	aerial
C2) apples, non-bearing	0.97	26	3	aerial
D) beans	1	2	7	aerial
E) Bermuda grass	0.99	26	7	aerial
F1) cauliflower	1	2	3	aerial
F2) celery	1	2	3	aerial
F3) mint	1	2	3	aerial
F4) peppers	1	2	3	aerial
G) Christmas trees	1.725	26	3	aerial
H) citrus 1	4	26	7	airblast
I) citrus 2	0.75	26	7	aerial
J) fire ants	6.84	26	3	ground spray
K) cotton	1	6	7	aerial
L) cotton seed treatment	0.06	1	NA	incorporated with seed
M) drainage systems	0.25	26	3	aerial
N) tomatoes	0.374	1	NA	ground spray
O) golf courses	4.77	26	3	ground spray
P) grapes 1	0.73	26	3	aerial
Q) grapes 2	0.974	26	7	aerial
R) lettuce	1	5	3	aerial
S) ornamentals	20.8	26	3	ground
T) ornamental shrub & vines	32	26	3	ground

Use	Application Rate (lb a.i./acre)	Number of applications[1]	Application Interval[1] (days)	Application Type
U) sod farms	4.8	26	3	ground
V) paved areas	0.25	26	3	aerial
W) peanuts	1	4	7	aerial
X) peanuts seed treatment	0.45	1	NA	at plant with seed
Y) commercial lawns	156	26	3	perimeter/spot treatment
Z) rights-of-way	0.252	26	3	aerial
AB) roses	15.6	26	3	ground

[1] The largest number of applications with the shortest interval between applications is used whenever the label does not specify the number of applications or application interval.
NA: not applicable

Fallow land. Fallow land is agricultural land that is not currently in production. While fallow land is being modeled as a separate agricultural practice, fallow land will eventually be planted with a crop and can be potentially treated with acephate according to the label application practices for that crop.

Nut trees. Almonds serve a surrogate for nut tree crops in this assessment including pecans, pistachio and walnut. There is also a generic tree nut use pattern that is being represented by this crop. Only non-bearing nut trees can be treated with acephate. For terrestrial assessments, almonds also serve as a surrogate for deciduous fruit tree crops including apples.

Deciduous fruit trees. Apples serve as a surrogate crop for deciduous fruit trees including apricots, cherries, pears, plum, and prunes. For terrestrial assessments, almonds are used as a surrogate for this group of crops since tree nut crops and deciduous fruit trees have the same use pattern. For the aquatic assessment, separate assessments will be performed since different scenarios are used to assess these two crop groups. Crabapples have use patterns specific to the crop of 0.25 $lb \cdot acre^{-1}$, but can be treated under the non-bearing deciduous fruit tree use pattern at the same rate as other deciduous fruit trees and are not being considered separately in this assessment.

Beans. Acephate is registered for both dry and succulent bean crops including lima beans, green beans, wax beans, and common dry beans. Acephate is registered for soybeans but this use pattern is not being considered for this assessment since this crop is not grown in California. Beans are used as a surrogate for peppers as they have the same use pattern and are simulated for the aquatic exposure assessment using the same scenario.

Cauliflower. Cauliflower is used as a surrogate for Brussels sprouts. For terrestrial assessments, cauliflower is also used as a surrogate for celery and mint.

Fire ants. Applications to control fire ants are made in a number of specific use sites including non-bearing citrus, commercial and industrial lawns, golf courses, household & domestic dwelling premises, ornamental trees and shrubs, ornamental lawns, recreational area lawns, and residential lawns. Use rates may be specified in mass per unit area or mass of pesticide per mound. The rates per mound are generally higher for fire ant infestations. For fire ants in polygynous colonies, mound densities can be as high as 1880 mounds per hectare or 760 mounds per acre (Vogt *et al*., 2003). Since the highest application rate per mound is 0.009 lb a.i. per mound. The maximum application rate assessed for use on fire ants is 6.84 $lb \cdot acre^{-1}$. This application rate is expected to be conservative because it is based on the highest documented fire ant density in the United States.

Cotton. The application rate for the seed treatment use for peanuts is based on an application rate per 100 lb of seed, specifically, 1.6 lb a.i./500 of seed. Based on a review of planting practices from the BEAD (Becker and Ratnayake, 2011), the maximum planting rate for peanuts is 18.9 pounds per acre. Based on this planting rate, the resulting application rate of acephate for this use is 0.06 $lb \cdot acre^{-1}$.

Commercial & Industrial Lawns. Most applications for commercial and industrial lawns are expressed as a mass of acephate per gallon of spray. In order to use these rates in a risk assessment, an aerial application rate must be estimated. If it is assumed that 2 mm of water is required to wet the grass, then 20,000 liters per hectare (0.002 m x 10,000 m^2/ha x 1000 L/m^3) or 2183 gal/acre are required wet a lawn. For commercial and industrial lawns, this is equivalent to 156 $lb \cdot acre^{-1}$. Commercial and industrial lawns are used as a surrogate for recreational lawns. Application rates for these sites are for around the perimeters of structures and spot treatments. Applications made to urban areas can have substantial incidental application to impervious surfaces which have high runoff potential. A commercial industrial watershed with a high proportion of impervious surface was developed to assess this use. A description of this scenario is in Appendix L. The output from the California turf and impervious scenarios were combined according to percentages described in the Appendix to estimate the aquatic exposure from this use.

Tomatoes. Tomatoes have been chosen to represent the 'fruiting vegetables' use pattern. Note that peppers can be considered a fruiting vegetable but have a separate higher application rate and are being simulated for aquatic exposure assessment using the 'row crop scenario' rather than the California tomato scenario.

Lettuce. There are two lettuce use patterns, one for 'crisphead' lettuce types, and one for all other head lettuces. The crisphead use pattern allows five applications compared to two applications for other lettuce. Only the crisphead lettuce use pattern is being assessed.

Mint. Cauliflower is being used as a surrogate for mint in the terrestrial assessment as they have the same use patterns. Separate aquatic exposure assessments will be performed as the two use patterns are simulated with different scenarios.

Ornamentals. This use pattern includes nursery stock, ornamental trees, shade trees, ground covers, and non-flowering plants. Ornamental woody vines and shrubs have a higher use rate and are being assessed separately.

Peppers. Cauliflower is being used as a surrogate of peppers for the terrestrial assessment as they have the same use pattern. They are being assessed separately for aquatic assessment since a different scenario that cauliflower is used for peppers.

Peanuts. The application rate for the seed treatment use for peanuts is based on an application rate per 100 lb of seed, specifically, 0.197 lb a.i./100 of seed. Based on a review of planting practices from BEAD (Becker and Ratnayake, 2011), the maximum planting rate for peanuts is 228 pounds per acre. Based on this planting rate, the resulting application rate of acephate for this use is 0.45 $lb \cdot acre^{-1}$.

3.2. Aquatic Exposure Assessment

3.2.1. Conceptual Model of Exposure

Aquatic exposure to the assessed species within the action area is estimated with the PRZM and EXAMS models (USEPA, 2004). Screening-level exposures (EECs) are produced using the standard farm pond of 20,000 cubic meters volume. Watersheds where acephate is used are assumed to have 100% cropped area. The downstream extent of streams with exposures above the Level of Concern (LOC) is estimated (using GIS methods) by expanding the watershed considered until uncontaminated stream flow dilutes the initial pond concentration to below the LOC.

Standard assumptions of 1% spray drift for ground application and 5% drift for aerial application are used. If the pond concentration from PRZM-EXAMS exceeds the LOC, a spray drift buffer can be calculated (using AgDRIFT model) that will reduce the pond concentration to below the LOC. If a spray drift buffer cannot be used to reduce the pond concentration to below the LOC, then a separate spray drift buffer (neglecting run-off) is calculated with AgDRIFT to ensure that pond concentrations are below the LOC (see Section 2.10.3 above).

3.2.2. Modeling Approach

Use sites and the PRZM scenarios used to represent them are given in Table 3-2. Scenarios were chosen in accordance with current guidance for scenario selection or previous California endangered species assessments. In general, a first application date of March 15 was chosen since it corresponds to the beginning of spring growing season in central California. In cases where specific information for a crop was available, a more appropriate date was selected. A justification for the scenario selection and any use specific rationales for application date selections are provided below.

Risk quotients (RQs) were initially based on EECs derived using the Pesticide Root Zone Model/Exposure Analysis Modeling System (PRZM/EXAMS) standard ecological pond scenario according to the methodology specified in the Overview Document (USEPA, 2004).

Table 3-2. PRZM Scenario Assignments and First Application Dates for the Acephate Uses Simulated for the Aquatic Exposure Assessment for the Endangered Species Assessment

Crop group	Scenario	First Application Date
A) fallow land	CARowCropRLF_V2	Jan 15
B) alfalfa	CAAlfalfa_wIrrigOP	April 15
C1) almonds, non-bearing	CAAlmonds_wIrrigSTD	March 15
C2) apples, non-bearing	CAFruit_wIrrigSTD	March 15
D) beans	CARowCropRLF_V2	May 15
E) Bermuda grass	CATurfRLF	March 15
F1) cauliflower	CAColeCropRLF_V2	January 15
F2) celery	CARowCropRLF_V2	January 15
F3) mint	ORMintSTD	March 15
F4) peppers	CATomato_wIrrigV2	May 1
G) Christmas trees	ORXmasSTD	January 15
H) citrus 1	CAcitrus_NirrigSTD	April 1
I) citrus 2	CAcitrus_NirrigSTD	April 1
J) fire ants	CATurfRLF	January 15
K) cotton	CAcotton_wIrrig	May 15
L) cotton seed treatment	CAcotton_wIrrig	April 15
M) drainage systems	CARightOfWayRLF_V2	January 15
N) tomatoes	CARowCropRLF_V2	March 15
O) golf courses	CATurfRLF_V2	January 15
P) grapes 1	CAWineGrapesRLF_V2	March 15
Q) grapes 2	CAWineGrapesRLF_V2	March 15
R) lettuce	CAlettuceSTD	January 15
S) ornamentals	CANurserySTD_V2	January 15
T) ornamental shrub & vines	CANurserySTD_V2	January 15
U) sod farms	CATurfRLF_V2	January 15
V) paved areas	CAImperviousRLF	January 15
W) peanuts	CARowCropRLF_V2	May 15
X) peanuts seed treatment	CARowCropRLF_V2	Apr 15
Y) commercial lawns	CATurfRLF CAImperviousRLF	January 15
Z) rights-of-way	CARightOfWayRLF_V2	January 15
AA) roses	CANurserySTD_V2	March 15

NA = not applicable

The initial condition of the agricultural field (PRZM variable INICROP) was set to “fallow” for all scenarios.

The general conceptual model of exposure for this assessment is that the highest exposures are expected to occur in the headwater streams adjacent to agricultural fields. Many of the streams and rivers within the action area defined for this assessment are in close proximity to agricultural use sites.

Twenty-six California scenarios were developed for the SF Bay assessment. Each scenario is intended to represent a high-end exposure setting for a particular crop. Each scenario location is selected based on various factors including crop acreage, runoff and erosion potential, climate, and agronomic practices. Once a location is selected, a scenario is developed using locally specific soil, climatic, and agronomic data. Each PRZM scenario is assigned a specific climatic weather station providing 30 years of daily weather values.

Specific California PRZM scenarios were chosen for this assessment, including citrus, lettuce, row crop (representing beans, celery, and peppers), cotton, turf (representing Bermuda grass for seed and landscape maintenance), almond (representing nut trees), fruit (representing various fruit trees) and cole crops (broccoli, cauliflower). Non-crop areas were not modeled because the application rates are lower than the agricultural uses, and agricultural scenarios are believed to represent non-agricultural exposures adequately. Structural pest control was not modeled due to lack of an appropriate PRZM scenario, and the low likelihood of exposure. All scenarios were used within the standard framework of PRZM/EXAMS modeling using the standard graphical user interface (GUI) shell, PE5v01.pl.

Citrus (Groups I & J): The California citrus scenario is a standard scenario that was specifically designed to represent citrus in that state. The use pattern that would produce the greatest EECs for citrus could not be determined from the label and was modeled two ways: with applications of 4 lb $acre^{-1}$ applied by ground spray and 0.75 lb $acre^{-1}$ applied aerially. The ground spray use pattern gave the highest EECs. April 1 represents an early season application of acephate to citrus crops and was the value used in the previous aquatic exposure assessment (Jones 2003).

Commercial lawns (Group Y). Commercial lawns are used as a surrogate for industrial lawns and recreational lawns. These are urban use patterns in which there is a potential for application to impervious surfaces adjacent to the treated turf. To model this use pattern , applications were made to both California turf and impervious scenarios, and the EECs were combined according to the percentage of the standard pond watershed that which might be applied to as both turf and impervious surface. The development of these percentiles is in Appendix L. Based on the analysis in this appendix, 14.8% of the watershed is treated turf, and 2.7% of the watershed is incidentally treated turf.

Cotton. The first application date for the aerial application was chosen to be 2 weeks after emergence on May 15. The application date for the seed treatment was at planting on April 15. The crop application method was set to incorporate at a specific depth as with the planted seed. (PRZM variable CAM = 8). The incorporation depth was 0.5 inches.

Mint. The Oregon mint scenario is used to represent mint and other herbs grown in California for California endangered species assessments. An application date of May 1 was chosen as it is early in the growing season (2 weeks after crop emergence) for the scenario. Rainfall is likely to be higher at this time than later in the spring and summer.

Fire ants. The crop application method was set to ‘broadcast’ (PRZM variable CAM = 1) for this use to simulate application to the soil surface.

Peanuts. The seed treatment use for peanuts was not simulated because the seeds are planted at 5 cm below the surface extraction zone (4 cm) and consequently there will be no runoff and hence no aquatic exposure from this use.

3.2.3. Model Inputs

The estimated water concentrations from surface water sources were calculated using the Tier 2 PRZM/ EXAMS model. PRZM is used to simulate pesticide transport as a result of runoff and erosion from a standardized watershed, and EXAMS estimates environmental fate and transport of pesticides in surface waters. The linkage program shell (PE5v01.pl) that incorporates the site-specific scenarios was used to run these models. The input parameters were selected based on current guidance input parameter guidance.

The PRZM/EXAMS model was used to calculate concentrations using the standard ecological water body scenario in EXAMS. Weather and agricultural practices were simulated over 30 years so that the 1 in 10 year exceedance probability at the site was estimated for the standard ecological water body.

The appropriate PRZM input parameters were selected from the environmental fate data submitted by the registrant and in accordance with US EPA-OPP EFED water model parameter selection guidelines, Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides, Version 2.1, October 22, 2009. Exposures for the toxic degradate methamidophos were calculated by applying a correction factor: 0.77 for the molecular weight difference (141.13/183.16 = 0.77). The total toxic residue approach was not used for methamidophos because it is known to be more toxic than the parent, so the assumption of equal toxicity needed for that approach is not valid.

The chemistry parameters for simulating acephate are in Table 3-3 and for methamidophos in Table 3-4. These parameters are essentially the same as used in the previous CRLF assessment with exception of the aerobic soil metabolism, which was changed to a value of 2.05 d based on a reanalysis of the aerobic soil metabolism data. Since no studies of aerobic aquatic metabolism are available, the aerobic aquatic metabolism input parameter is estimated as twice the aerobic soil metabolism value, or 4.1 d. The value used in the previous assessment was 19.8 d. The origin of the previous value could not be identified. The foliar degradation half-life for the aquatic exposure assessment was assumed to be zero. Using the values from the terrestrial assessment would result in somewhat lower EECs, but as these half-lives (8.2 d and 6.5 d for acephate and methamidophos respectively) are slower than the aerobic soil rate, they are unlikely to have a substantial impact on the aquatic EECs.

Table 3-3. Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs for Acephate Endangered Species Assessment[1]

Property	Surface Water Modeling Parameter Value	Source
Molecular Wt ($g \cdot mol^{-1}$)	183.16	calculated
Aqueous Solubility ($mg\ L^{-1}$)	801,000	MRID 40390601
Vapor pressure (torr)	1.7×10^{-7}	MRIDs 40390601, 40645901
Henry's Law Constant	$1.62 \times 10^{-13}\ atm \cdot m^3 \cdot mol^{-1}$	calculated
Hydrolysis half-life, pH 7(days)	pH 5: 325 pH 7: 169 pH 9: 18	MRID 41081603

Aqueous Photolysis half-life (days)	163	MRID 41081603
Aerobic Soil Metabolism half-life (days)	2.05 d	MRID 00014991 Upper 90% confidence bound on the mean
Anaerobic Aquatic Metabolism $T_{1/2}$	19.8 d	MRID 43971601
Aerobic Aquatic Metabolism half-life (days)	4.1 d	2x aerobic soil
Foliar Degradation Rate	0 d^{-1}	default
Foliar Washoff Rate	0.5 cm^{-1}	default
K_{oc}	2.7 $l \cdot kg^{-1}$	MRID 40504811

[1] Inputs determined in accordance with EFED "*Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1*" dated October 22, 2009.

Table 3-4. Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs for Methamidophos Endangered Species Assessment[1]

Property	Surface Water Modeling Parameter Value	Source
Molecular Wt	141.13 $g \cdot mol^{-1}$	calculated
Aqueous Solubility	200,000 mg L^{-1}	MRID 43661003
Vapor pressure	1.73 x 10^{-5} torr	MRID 43661003
Henry's Law Constant	5.1 x 10^{-13} $atm \cdot m^3 \cdot mol^{-1}$	calculated
Hydrolysis $T_{1/2}$	pH 5: 309 d pH 7: 27 d pH 9: 3 d	MRID 00150609
Aqueous Photolysis $T_{1/2}$	200 d	MRID 00150610
Aerobic Soil Metabolism $T_{1/2}$	1.75 d	MRID 41372201 3x single value
Aerobic Aquatic Metabolism $T_{1/2}$	3.5	2x aerobic soil
Anaerobic Aquatic Metabolism $T_{1/2}$	58.2 d	MRID 46934002
Foliar Degradation Rate	0 d^{-1}	default
Foliar Washoff Rate	0.5 cm^{-1}	default
K_{oc}	0.9 $l \cdot kg^{-1}$	MRID 40504811

[1] Inputs determined in accordance with EFED "*Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1*" dated October 22, 2009.

3.2.4. Aquatic EEC Results

Table 3-5and Table 3-6 below present the results of the PRZM-EXAMS modeling. An example of the full output from PRZM-EXAMS can be found in Appendix D.

Table 3-5. One-in-ten-Year Acephate EECs for Aquatic Environments from the Application of Acephate Uses in California

Crop Group[1]	Peak (µg/L)	21 Day EEC (µg/L)	60 Day EEC (µg/L)
A) fallow land	0.572	0.371	0.190
B) alfalfa	55.2	6.34	3.11
C1) almonds, non-bearing	15.4	3.45	2.75
C2) apples, non-bearing	36.4	5.37	3.21
D) beans	2.96	0.65	0.23
E) Bermuda grass	9.04	2.85	1.78
F1) cauliflower	39.0	7.70	2.71
F2) celery	11.4	2.6	0.91
F3) mint	4.44	1.08	0.38
F4) peppers	6.61	4.46	2.42
G) Christmas trees	42.7	13.8	8.96
H) citrus 1	239.5	22.1	8.34
I) citrus 2	43.1	4.01	1.60
J) fire ants	136	35.3	17.5
K) cotton	14.1	2.07	1.16
L) cotton seed treatment	0.09	0.01	0.003
N) tomatoes	2.35	0.51	0.18
O) golf courses	345	58.2	26.1
P) grapes 1	15.2	3.53	2.41
Q) grapes 2	6.75	1.84	1.32
R) lettuce	35.3	6.98	2.71
S) ornamentals	589	64.1	33.6
T) ornamental shrub & vines	907	98.7	51.8
U) sod farms	158	20.2	9.40
V) paved areas	46.0	14.0	9.95
W) peanuts	3.39	1.17	0.52
Y) commercial lawns	2456	544	300
Z) rights-of-way	19.4	4.22	2.96
AA) roses	707	128	70.0

Table 3-6. One-in-ten-year Methamidophos EECs for Aquatic Environments from the Application of Acephate Uses in California

Crop Group	Peak (µg/L)	21 Day EEC (µg/L)	60 Day EEC (µg/L)
A) fallow land	0.43	0.20	0.08
B) alfalfa	35.3	20.6	11.6
C1) almonds, non-bearing	16.8	8.42	7.03
C2) apples, non-bearing	31.8	13.6	8.75
D) beans	3.14	1.57	0.63
E) Bermuda grass	28.0	17.0	11.2

F1) cauliflower	35.0	16.8	6.92
F2) celery	10.7	5.28	2.26
F3) mint	4.32	2.22	0.92
F4) peppers	6.16	2.96	1.18
G) Christmas trees	39.6	27.8	21.6
H) citrus 1	184	65.1	24.8
I) citrus 2	34.6	10.4	4.30
J) fire ants	126	70.4	47.1
K) cotton	5.34	2.27	1.25
L) cotton seed treatment	0.05	0.02	0.01
M) drainage systems	20.9	10.6	7.76
N) tomatoes	0.83	0.36	0.14
O) golf courses	296	144	76.9
P) grapes 1	14.4	8.58	6.56
Q) grapes 2	7.30	4.43	3.53
R) lettuce	65.7	33.8	13.9
S) ornamentals	487	170	94.4
T) ornamental shrub & vines	746	260	144
U) sod farms	313	164	100
V) paved areas	53.4	28.6	23.8
W) peanuts	3.74	2.41	1.23
Y) commercial lawns	1291	688	540
Z) rights-of-way	20.9	10.6	7.77
AA) roses	365	128	70.8

3.2.5. Existing Monitoring Data

There is very little useful water monitoring data for acephate, due to its non-persistent nature. There were no data for acephate or methamidophos in the California surface water database or in the USGS NAWQA surface water monitoring program.

In July and August of 2002, the California Air Resources Board (ARB) conducted ambient air monitoring for acephate and methamidophos in highly populated areas of Fresno County (CARB, 2003). Acephate was detected in seven out of 210 samples and measurements were below the limit of quantitation (LOQ) in six of these. There were measurements of methamidophos above the LOQ in 12 samples and detections below the LOQ in seven of 210 samples, however at that time methamidophos was used as an insecticide in the area so it is not possible to discern whether the methamidophos detected was from methamidophos applications or a degradate from acephate applications.

Due to the lack of substantial monitoring data, this assessment is based on modeled concentrations as described in Section 3.2.1.

3.3. Terrestrial Animal Exposure Assessment

3.3.1. Exposure to Residues in Terrestrial Food Items: Model Scenarios

T-REX (Version 1.4.1) is used to calculate dietary and dose-based EECs of acephate and methamidophos for birds (including terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. T-REX simulates a 1-year time period. T-HERPS may be used as a refinement of dietary and dose-based EECs for snakes and amphibians when risk quotients from T-REX are higher than LOCs. T-HERPS was also set up to simulate a 1-year time period. For this assessment, spray and granular applications of acephate are considered. Terrestrial EECs were derived for the uses previously summarized in Table 3-1. Crops with similar use patterns were grouped together with one crop chosen as a surrogate for the group for the purpose of data presentation. Exposure estimates generated using T-REX and T-HERPS are for both the parent chemical, acephate, and its major degradate, methamidophos. The methamidophos EECs apply under the conservative scenario where 100% of the applied acephate has degraded to methamidophos. Exposures for methamidophos were calculated by applying a correction factor: 0.77 for the molecular weight difference (141.13/183.16 = 0.77). See Section 2.2.1 for a discussion of this approach.

Terrestrial EECs for foliar formulations of acephate were derived for the uses summarized in Table 3-7. Use specific input values, including number of applications, application rate, foliar half-life and application interval are provided in Table 3-7. These inputs represent the lowest, highest, and two mid-range application scenarios for acephate. These uses were chosen to illustrate the effects of acephate and methamidophos on terrestrial species over the full range of uses while minimizing redundancy in the results. Because of the high toxicity of acephate and methamidophos to terrestrial organisms, expanding these tables to include all uses does not add useful information in the context of this assessment. Note that the commercial lawn area use has a higher lb a.i./A application rate than ornamental shrub and vines, however because this is a perimeter/spot treatment it is not modeled in T-REX for this assessment. T-REX is designed to model agricultural uses and is not optimized for use with perimeter/spot treatment applications. Given the high application rate for commercial lawn areas and the sensitivity of terrestrial species to acephate and methamidophos, RQs from commercial lawn area applications modeled at the 156 lb a.i./A application rate (Table 3-1) would exceed listed and non-listed species acute and chronic LOCs for all taxa. An example output from T-REX and T-HERPS is available in Appendix E.

Willis and McDowell (1987) was consulted for data on acephate persistence on foliage to replace the default value of 35 days in the T-REX and T-HERPS models. The default value was not believed to be reasonable for a non-persistent pesticide like acephate. Table III (p. 35) of this reference gives eight values for acephate, five of which are for dislodgeable residues (range 0.7 to 8.2 days), and three of which are for total residues (range 2.8 to 3.5 days). Normally, total residue values would be used for acephate, since it has a low K_{OC} and is taken up through the roots (i.e., acts systemically). This rule is applied because it is believed that residues will be higher and more persistent if the pesticide is taken up into the plant, rather than just being on the surface of the foliage (which is measured by dislodgeable residue). Of the eight values, only one was measured on a crop in California (lemons), and it was measured as dislodgeable residue.

This value was also the longest, and therefore most conservative of the values, at 8.2 days. The next longest value was 3.5 days (total residue) on citrus in Florida. Since the crops are similar (lemon and citrus) and the dislodgeable value exceeds the total value, the value of 8.2 days was selected as the input to T-REX and T-HERPS.

Willis and McDowell (1987) was similarly consulted for data on methamidophos persistence on foliage. The longest half-life reported was 6.5 days, which was therefore selected as the input to T-REX and T-HERPS for methamidophos modeling (Willis & McDowell, 1987, p. 45).

Table 3-7. Input Parameters for Foliar Applications Used to Derive Terrestrial EECs for Acephate and Methamidophos with T-REX and T-HERPS

Use (Application method)	Application Rate (lbs a.i./A)		Number of Applications	Application Interval	Foliar Dissipation Half-Life	
	Acephate	Methami-dophos			Acephate	Methami-dophos
Fallow land (aerial)	0.1245	0.096	1	NA	8.2 days	6.5 days
Cauliflower/celery/mint /peppers (aerial)	1	0.77	2	3	8.2 days	6.5 days
Citrus (airblast)	4	3.08	26	7	8.2 days	6.5 days
Ornamental shrub & vines (ground)	32	24.64	26	3	8.2 days	6.5 days

n/a = Not applicable

Organisms consume a variety of dietary items and may exist in a variety of sizes at different life stages. T-REX estimates exposure for the following dietary items: short grass, tall grass, broadleaf plants/small insects, and fruits/pods/seeds/large insects, and seeds for granivores. Birds, including the CCR, and mammals, including the SJKF and SMHM, consume all of these items. The size classes of birds represented in T-REX are small (20 g), medium (100 g), and large (1000 g). The size classes for mammals are small (15 g), medium (35 g), and large (1000 g). EECs are calculated for the most sensitive dietary item and size class for birds (surrogate for amphibians and reptiles) and mammals. For mammals and birds, the most sensitive EECs are for the smallest size class consuming short grass. The percentages of the EECs for the different dietary items are discussed in the discussion on uncertainties (Section 6.1.1.a).

For foliar applications of liquid formulations, T-HERPS estimates exposure for the following dietary items: broadleaf plants/small insects, fruits/pods/seeds/large insects, small herbivore mammals, small insectivore mammals, and small amphibians. Snakes and amphibians may consume all of these items. The default size classes of amphibians represented in T-HERPS are small (2 g), medium (20 g), and large (200 g). The default vertebrate prey size that the medium and large amphibians can consume is 13 g and 133 g, respectively (small amphibians are not expected to eat vertebrate prey). The default size classes for snakes are small (2 g), medium (20 g), and large (800 g). The default vertebrate prey size that medium and large snakes can consume is 25 g and 1286 g, respectively (small snakes are not expected to eat vertebrate prey). EECs are calculated for the most sensitive dietary item and size class for amphibians and snakes. For both amphibians and reptiles, the most sensitive EECs and RQs are for a 20-gram animal that consumes small herbivore mammals. If dietary RQs are more sensitive than acute dose based RQs for acute exposures they are shown as well. Dietary based EECs and RQs are used to characterize risk from chronic exposure. The percentages of the EECs for the different dietary items are discussed in the discussion on uncertainties (Section 6.1.1.b).

T-REX also includes the capability to calculate LD_{50}/ft^2 risk values and specialized risk analyses for granular and seed treatment applications. Conceptually, an LD_{50}/ft^2 is the amount of a pesticide estimated to kill 50% of exposed animals in each square foot of applied area. Although a square foot does not have defined ecological relevance, and any unit area could be used, risk presumably increases as the number of $LD_{50}s/ft^2$ increases. The LD_{50}/ft^2 is used to estimate risk for liquid or granular formulations and broadcast, row, banded, and in-furrow applications. The LD_{50}/ft^2 is calculated using a toxicity value (adjusted LD_{50}) and the EEC (mg a.i./ft^2) and is directly compared with the Agency's LOCs. LD_{50}/ft^2 risk values were calculated for the uses summarized in Table 3-8. These uses represent the maximum application rates for each application type as well as an additional moderate level for broadcast applications. Like for the foliar uses analyzed, these uses were chosen to illustrate the effects of acephate and methamidophos on terrestrial species over the full range of uses while minimizing redundancy in the results.

Table 3-8. Input Parameters for Applications Used to Derive LD_{50}/ft^2 Risk Values for Acephate and Methamidophos with T- REX

Use	Application Type	Application Media	Application Rate (lbs a.i./A)		Row Spacing (in)	Bandwidth (in)	% Incorp-oration
			Acephate	Methami-dophos			
Cotton	Soil in-furrow	Liquid	1.00	0.77	30	6	0
Golf Course Turf	Broadcast	Granular	4.95	3.81	NA	NA	0
Beans / peppers / brussels sprouts / cauliflower / celery / citrus / lettuce / mint / peanuts	Broadcast	Liquid	1.00	0.77	NA	NA	0

The granular analysis calculates the number of granules needed to be consumed by a bird or mammal to achieve a dose that would exceed the adjusted LD_{50} and trigger the acute or endangered species LOC. In addition, the minimum foraging area with sufficient number of granules to achieve a dose that exceeds the adjusted LD_{50} or 1/10th the adjusted LD_{50} is estimated by assuming that a bird consumes 100%, 50%, and 10% of the available granules. This analysis is based on the size and percent a.i. of the granule application assessed as well as acute toxicity data. At this time a granule analysis cannot be completed because granule size for acephate products is not available. The seed treatment analysis provides a conservative estimate of exposure from granular applications.

The seed treatment analysis calculates acute and chronic RQs for birds and mammals based on dose (mg a.i./bw/day) and available pesticide (mg a.i./ft^2). The inputs include maximum seeding rates for the treated seeds and the maximum application rate of the pesticide to the seeds. The crops with approved acephate seed treatment uses in California and their maximum application rates are summarized in Table 3-9.

Table 3-9. Input Parameters for Seed Treatment Applications

Crop	Maximum Seeding Rate (lbs/A)[1]	Application Rate (lbs a.i./cwt)	
		Acephate	Methamidophos
Cotton	18.9	0.320	0.246
Peanuts	228	0.197	0.152

[1] Becker and Ratnayake, 2011

3.3.1.a. Dietary Exposure to Mammals, Birds, and Amphibians Derived Using T-REX

Upper-bound Kenaga nomogram values reported by T-REX are used for derivation of dietary EECs for the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and their potential prey (Table 3-10).

EECs in T-REX that are applicable to direct effects to the CCR are for small (20 g, juveniles) and medium (100 g, adult) birds consuming a variety of dietary items. The most sensitive EEC for the CCR is for the small bird consuming short grass. EECs in T-REX that are applicable to assess direct effect to the terrestrial-phase CTS and SFGS are for small birds (20g) consuming short grass[5]. EECs in T-REX applicable to assess direct effects the SMHM are for small (15 g) mammals consuming a variety of dietary items (Table 3-10). The most sensitive EEC for the SMHM is for a small mammal consuming short grass. EECs in T-REX that are applicable to assess direct effects to the SJKF are for large (1,000 g) mammals consuming a variety of dietary items (Table 3-10). The most sensitive EEC for the SJKF is for the large mammal consuming short grass. For birds (surrogates for terrestrial-phase amphibians and reptiles), EECs and RQs for acute dose-based and chronic dietary-based exposure are calculated as these are the most sensitive values. If the LC_{50} is lower than the LD_{50}, the highest acute dietary EEC and RQ are shown as well. For mammals, EECs and RQs for acute dose based and chronic dose based exposure are calculated as these are typically the most sensitive values. If the dietary assessment results in higher RQs than the dose-based assessment, the highest dietary RQs are shown as well.

Table 3-10. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Birds and Mammals Derived Using T-REX for Acephate

Use(s), Type of Application	App Rate (lb a.i./A, # Apps, Interval (days)	EECs for SJKF (large mammals [1000 g] consuming short grass)		EECs for CCR, CTS (all DPS), SFGS and Birds (small birds [20 g] consuming short grass)		EECs for SMHM and Mammals (small mammals [15 g] consuming short grass)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Fallow land	0.1245, 1,	30	4.6	30	34.03	30	28

[5] The short grass EECs and RQs are used for reptiles and amphibians to represent a conservative screen. It is not being assumed that amphibians and snakes eat short grass, the result of modeling the 20 gram bird consuming short grass is more conservative than modeling an alternative diet for amphibians and snakes and is therefore, a valid conservative screen and is protective of these species. If the short grass assessment does not result in LOC exceedances, there is a high confidence that effects are unlikely to occur.

(aerial)	N/A						
Cauliflower/celery/ mint/peppers (aerial)	1, 2, 3	426	65	426	485	426	406
Citrus (airblast)	4, 26, 7	2,149	328	2,149	2,448	2,149	2,049
Ornamental shrub & vines (ground)	32, 26, 3	34,240	5,231	34,240	38,996	34,240	32,645

N/A = not applicable; App = Application

Table 3-11. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Birds and Mammals Derived Using T-REX for Methamidophos

Use(s), Type of Application	App Rate (lb a.i./A, # Apps, Interval (days)	EECs for SJKF (large mammals [1000 g] consuming short grass)		EECs for CCR, CTS (all DPS), SFGS and Birds (small birds [20 g] consuming short grass)		EECs for SMHM and Mammals (small mammals [15 g] consuming short grass)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Fallow land (aerial)	0.096, 1, N/A	23	3.5	23	26	23	22
Cauliflower/celery/ mint/peppers (aerial)	0.77, 2, 3	319	49	319	363	319	304
Citrus (airblast)	3.1, 26, 7	1,405	215	1,405	1,601	1,405	1,340
Ornamental shrub & vines (ground)	25, 26, 3	21,594	3,299	21,594	24,593	21,594	20,588

N/A = not applicable; App = Application

3.3.1.b. Dietary Exposure to Amphibians and Reptiles Derived Using T-HERPS

Birds were used as surrogate species for terrestrial-phase CTS and SFGS. Terrestrial-phase amphibians and reptiles are poikilotherms indicating that their body temperature varies with environmental temperature. Birds are homeotherms indicating that their temperature is regulated, constant, and largely independent of environmental temperatures). As a consequence, the caloric requirements of terrestrial-phase amphibians and reptiles are markedly lower than birds. Therefore, on a daily dietary intake basis, birds consume more food than terrestrial-phase amphibians. This can be seen when comparing the caloric requirements for free living iguanid lizards (used in this case as a surrogate for terrestrial phase amphibians) to song birds (USEPA, 1993):

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

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

With relatively comparable slopes to the allometric functions, one can see that, given a comparable body weight, the free-living metabolic rate (FMR) of birds can be 40 times higher than reptiles, though the requirement differences narrow with high body weights.

Because the existing risk assessment process is driven by the dietary route of exposure, a finding of safety for birds, with their much higher feeding rates and, therefore, higher potential dietary exposure is reasoned to be protective of terrestrial-phase amphibians consuming similar dietary items. For this not to be the case, terrestrial-phase amphibians would have to be 40 times more sensitive than birds for the differences in dietary uptake to be negated. However, existing dietary toxicity studies in terrestrial-phase amphibians for acephate are lacking. To quantify the potential differences in food intake between birds and terrestrial-phase CTS and amphibians, food intake equations for the iguanid lizard were used to replace the food intake equation in T-REX for birds, and additional food items of the CTS and amphibians were evaluated. These functions were encompassed in a model called T-HERPS. T-HERPS is available at: http://www.epa.gov/oppefed1/models/terrestrial/index.htm. EECs calculated using T-HERPS are shown in this Section and potential risk is further discussed in the risk characterization.

EECs in T-HERPS that are applicable to the CTS are small (2 g, juveniles) amphibians consuming small and large insects and medium (20 g) amphibians consuming small and large insects, small herbivorous and insectivorous mammals, and amphibians. The dietary item that results in the highest EEC for CTS (all DPS) is the small herbivore mammal. EECs calculated using T-HERPS for the CTS are shown in Table 3-12.

Table 3-12. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians Derived Using T-HERPS for Acephate

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium birds [20 g] consuming herbivorous mammals [13 g])	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Fallow land (aerial)	0.1245, 1, N/A	30	20
Cauliflower/celery/ mint/peppers (aerial)	1, 2, 3	428	285
Citrus (airblast)	4, 26, 7	2,157	1,438
Ornamental shrub & vines (ground)	32, 26, 3	34,366	22,910

N/A = not applicable; App = Application

Table 3-13. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians Derived Using T-HERPS for Methamidophos

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium birds [20 g] consuming herbivorous mammals [13 g])	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Fallow land (aerial)	0.096, 1, N/A	23	15
Cauliflower/celery/ mint/peppers (aerial)	0.77, 2, 3	320	213
Citrus (airblast)	3.1, 26, 7	1411	940
Ornamental shrub &	25, 26, 3	21673	14449

vines (ground)			

N/A = not applicable; App = Application

T-REX may underestimate exposure to snakes when birds are used as a surrogate and are assumed to eat similar dietary items because of the large meal size a snake may consume on a single day.[6] That is why birds consuming short grass in T-REX are used as the screen to determine whether further refinement in T-HERPS is needed for snakes. T-HERPS was modified (version 1.1) to estimate exposure to snakes based on the maximum size prey item they could consume and is used to refine a risk estimate when LOCs are exceeded for small birds consuming short grass based on RQs estimated in T-REX. The following allometric equation developed by King 2002 was used to estimate the maximum size prey items for snakes (King, 2002).

$$\text{Prey Size} = \text{Snake Mass}^{1.015}$$

The 95% confidence limits on the coefficient are 0.959 and 1.071 (King, 2002). The upper limit was used in T-HERPS to estimate exposure to snakes.

EECs in T-HERPS that are applicable to the SFGS are small (2 g, juveniles) snakes consuming small and large insects and medium (20 g) snakes consuming small and large insects, small herbivorous and insectivorous mammals, and amphibians. The most sensitive EECs and RQs for SFGS are for the medium animal consuming small herbivorous mammals. EECs calculated using T-HERPS for the SFGS are shown in Table 3-14.

Table 3-14. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Reptiles Derived Using T-HERPS for Acephate

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small bird [2 g] consuming small insects)		EEC for Medium SFGS (medium birds [20 g] consuming herbivorous mammals [25 g])	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Fallow land (aerial)	0.1245, 1, N/A	17	0.93	23	28
Cauliflower/celery/ mint/peppers (aerial)	1, 2, 3	240	13	327	404
Citrus (airblast)	4, 26, 7	1209	67	1648	2038
Ornamental shrub & vines (ground)	32, 26, 3	19260	1070	26247	32467

N/A = not applicable; App = Application

[6] When examining the same application rates and types, RQs calculated in T-REX for small birds consuming short grass are higher than or equal to the highest RQs estimated in T-HERPs for medium snakes consuming small herbivore mammals. Therefore, RQs calculated in T-REX for the small birds consuming short grass may be used as a screen for examining risk to snakes.

Table 3-15. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Reptiles Derived Using T-HERPS for Methamidophos

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small bird [2 g] consuming small insects)		EEC for Medium SFGS (medium birds [20 g] consuming herbivorous mammals [25 g])	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Fallow land (aerial)	0.096, 1, N/A	13	0.72	18	22
Cauliflower/celery/ mint/peppers (aerial)	0.77, 2, 3	179	10	245	302
Citrus (airblast)	3.1, 26, 7	791	44	1077	1333
Ornamental shrub & vines (ground)	25, 26, 3	12147	675	16553	20476

N/A = not applicable; App = Application

3.3.2. Exposure to Terrestrial Invertebrates Derived Using T-REX

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

Both small and large insects are applicable to the VELB and BCB and in estimating indirect effects based on reduction in prey to the CCR, SMHM, SJKF, and CTS. The most sensitive insect is the small insect. An example output from T-REX v. 1.4.1 is available in Appendix E.

Table 3-16. Summary EECs Used for Estimating Risk to Terrestrial Invertebrates and Derived Using T-REX for Acephate (Liquid Formulations)

Use, Method of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	Small Insect EEC (µg a.i./g)
Fallow land (aerial)	0.1245, 1, N/A	17
Cauliflower/celery/ mint/peppers (aerial)	1, 2, 3	240
Citrus (airblast)	4, 26, 7	1,209
Ornamental shrub & vines (ground)	32, 26, 3	19,260

N/A = not applicable; App = Application

Table 3-17. Summary EECs Used for Estimating Risk to Terrestrial Invertebrates and Derived Using T-REX for Methamidophos (Liquid Formulations)

Use, Method of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	Small Insect EEC (µg a.i./g)
Fallow land (aerial)	0.096, 1, N/A	13
Cauliflower/celery/ mint/peppers (aerial)	0.77, 2, 3	179
Citrus (airblast)	3.1, 26, 7	791
Ornamental shrub & vines (ground)	25, 26, 3	12147

N/A = not applicable; App = Application

3.4. Terrestrial Plant Exposure Assessment

TerrPlant (Version 1.2.2) is used to calculate EECs for non-target plant species inhabiting dry and semi-aquatic areas. TerrPlant is not used for methamidophos due to a lack of tier II terrestrial plant toxicity data. Parameter values for application rate, drift assumption, and incorporation depth are based on the use and related application method (Table 3-7). A runoff value of 0.05 is utilized based on acephate's solubility, which is classified by TerrPlant as >100 mg/L. For aerial and ground application methods, drift is assumed to be 5% and 1%, respectively. EECs relevant to terrestrial plants consider pesticide concentrations in drift and in runoff. These EECs are listed by use in Table 3-18. An example output from TerrPlant v.1.2.2 is available in Appendix F. TerrPlant does not account for degradation; therefore, the results obtained from the TerrPlant analysis are likely conservative for acephate given its relatively rapid degradation profile. However, TerrPlant also models only a single application while many acephate products may be applied multiple times with varying intervals between applications.

Table 3-18. TerrPlant Inputs and Resulting EECs for Plants Inhabiting Dry and Semi-aquatic Areas Exposed to Acephate via Runoff and Drift

Use	Application rate (lbs a.i./A)	Application method (Incorporation [in])	Runoff Fraction (solubility >100 ppm)	Drift Value (%)	Spray drift EEC (lbs a.i./A)	Dry area EEC (lbs a.i./A)	Semi-aquatic area EEC (lbs a.i./A)
Fallow land	0.1245	Aerial (1)	0.05	5	0.006225	0.01245	0.068475
Cauliflower/celery/ mint/peppers	1	Aerial (1)	0.05	5	0.05	0.1	0.55
Citrus	4	Airblast (1)	0.05	5	0.2	0.4	2.2
Ornamental shrub & vines	32	Ground (1)	0.05	1	0.32	1.92	16.32

4. Effects Assessment

This assessment evaluates the potential for acephate to directly or indirectly affect the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF or modify their designated critical habitat. 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 CTS are based on toxicity information for aquatic-phase amphibians, while terrestrial-phase amphibian (CTS) and reptile (SFGS) effects 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 (USEPA, 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include freshwater fish, aquatic-phase amphibians, freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrates, aquatic plants, birds (used as a surrogate for terrestrial-phase amphibians and reptiles), 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 acephate and the degradate methamidophos.

4.1. Ecotoxicity Study Data Sources

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) (USEPA, 2004). Open literature data presented in this assessment were obtained from previous acephate and methamidophos assessments as well as ECOTOX information obtained on August 17, 2011 (USEPA, 2006; USEPA, 2007a; USEPA, 2007b). 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.

Open literature toxicity data for other 'target' insect species (not including bees, butterflies, beetles, and non-insect invertebrates including soil arthropods and worms), which include efficacy studies, are not currently considered in deriving the most sensitive endpoint for terrestrial insects. Efficacy studies do not typically provide endpoint values that are useful for risk assessment (*e.g.*, NOAEC, EC_{50}, *etc.*), but rather are intended to identify a dose that maximizes a particular effect (*e.g.*, EC_{100}). Therefore, efficacy data and non-efficacy toxicological target insect data are not included in the ECOTOX open literature summary table provided in Appendix I. For the purposes of this assessment, 'target' insect species are defined as all terrestrial insects with the exception of bees, butterflies, beetles, and non-insect invertebrates (*i.e.*, soil arthropods, worms, *etc*.) which are included in the ECOTOX data presented in Appendix I. The list of citations including toxicological and/or efficacy data on target insect species not considered in this assessment is provided in Appendix H.

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, as specified by the Agency's guidance on the evaluation of open literature (USEPA, 2011b). 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, as they are relevant to the understanding of the area with potential effects, as defined for the action area.

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 I. Appendix J includes a summary of the human health effects data for acephate.

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 ecological incident data, are considered to further refine the characterization of potential ecological effects associated with exposure to acephate. A summary of the available aquatic and terrestrial ecotoxicity information and the incident information for acephate are provided in Sections 4.2 through 4.5.

Available toxicity of degradates and other stressors of concern are summarized for each taxa in the appropriate sections for the taxa. A detailed summary of the available ecotoxicity information for all acephate degradates and formulated products can be found Appendix G.

4.2. Toxicity of Acephate to Aquatic Organisms

Table 4-1 and Table 4-2 summarize the most sensitive aquatic toxicity endpoints for acephate and its degradate methamidophos, respectively, based on an evaluation of both the submitted studies and the available open literature data, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the BCB, VELB, CTS, CCR, CFWS, SMHM, SFGS, and SJKF is presented below. Additional information is provided in Appendix G. All endpoints are expressed in terms of the active ingredient (a.i.), for both acephate and methamidophos, unless otherwise specified.

Acephate is moderately toxic to freshwater and estuarine/marine invertebrates, practically nontoxic to freshwater fish, and slightly toxic to estuarine/marine fish on an acute exposure basis. The reproductive NOAECs for freshwater and estuarine/marine invertebrates are 0.15 mg a.i./L and 0.58 mg a.i./L, respectively. The chronic NOAEC for freshwater fish, calculated using an acute to chronic ratio, is 5.9 mg a.i./L. There are no data available with which to determine a chronic NOAEC for estuarine/marine fish. Aquatic plants exposed to acephate have a 5-day EC_{50} of >50 mg a.i./L; a NOAEC has not been established.

Methamidophos is very highly toxic to freshwater invertebrates, slightly toxic to freshwater fish, and moderately toxic to estuarine/marine invertebrates and fish on an acute exposure basis. The reproductive NOAECs for freshwater and estuarine/marine invertebrates are 0.0045 mg a.i./L and 0.174 mg a.i./L, respectively. The chronic NOAEC for freshwater fish, calculated using an acute to chronic ratio, is 0.174 mg a.i./L. There are no data available with which to determine a chronic NOAEC for estuarine/marine fish. Toxicity data of methamidophos to aquatic plants are also not available.

Table 4-1. Aquatic Toxicity Profile for Acephate

Assessment Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Study Classification and Comments
Freshwater fish (surrogate for aquatic-phase amphibians for chronic toxicity)	Acute	Rainbow Trout (*Oncorhynchus mykiss*)	96-hr LC_{50} = 852 mg a.i./L slope = no data	48650401 (Duangsawasdi, 1977)	Supplemental
	Chronic	Rainbow Trout (*Oncorhynchus mykiss*)	NOAEC = 5.9 mg a.i./L	See section 4.2.1.b	Extrapolated using most sensitive acute 96-h LC_{50} for Rainbow trout (852 mg a.i./L) divided by 144 (highest rainbow trout acute to chronic ratio for organophosphates)
Aquatic-phase amphibians	Acute	Green frog larvae/tadpole (*Raai clamitans*)	24-hr LC_{50} = 6433 mg a.i./L slope = no data	MRIDs 00093943, 05019255 (Lyons, 1976)	Supplemental
Freshwater invertebrates	Acute	Water flea (*Daphnia magna*)	48-hr EC_{50} = 1.1 mg a.i./L slope = 1.6	MRID 47116601 (Thompson, 1978)	Acceptable
	Chronic	Water flea (*Daphnia magna*)	NOAEC = 0.15 mg a.i./L LOAEC = 0.375 mg a.i./L	MRID 44466601 (McCann, 1978)	Supplemental Based on average # young per female per day
Estuarine/ marine fish	Acute	Pin Fish (*Lagodon rhomboides*)	96-hr LC_{50} = 85 mg a.i./L slope = no data	MRID 40228401 (Mayer, 1986)	Supplemental
	Chronic	No data	No data	No data	No data

Assessment Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Study Classification and Comments
Estuarine/ marine invertebrates	Acute	Pink Shrimp (*Penaeus durorarum*)	96-hr LC_{50} = 3.8 mg a.i./L slope = no data	MRID 40228401 (Mayer, 1986)	Supplemental
	Chronic	Mysid Shrimp (*Americanysis bahia*)	NOAEC = 0.58 mg a.i./L LOAEC = 0.62 mg a.i./L	MRID 00066341	Supplemental Based on survival
Aquatic plants	Vascular	No data	No data	No data	No data
	Non-vascular	Diatom (*Skeletonema costatum*)	5-day EC_{50} >50 mg a.i./L	MRID 40228401 (Mayer, 1986)	Supplemental No NOAEC value provided

[1] ECOTOX references are designated with an E followed by the ECOTOX reference number.

Table 4-2. Aquatic Toxicity Profile for Methamidophos

Assessment Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)	Study Classification and Comments
Freshwater fish (surrogate for aquatic-phase amphibians)[1]	Acute	Rainbow Trout (*Oncorhynchus mykiss*)	96-hr LC_{50} = 25 mg a.i./L slope = 9.2	MRID 00041312 (Nelson & Roney, 1979)	Supplemental
	Chronic	Rainbow Trout (*Oncorhynchus mykiss*)	NOAEC = 0.17 mg a.i./L	See section 4.2.1.b	Extrapolated using most sensitive acute 96-h LC_{50} for Rainbow trout (25 mg a.i./L) divided by 144 (highest rainbow trout acute to chronic ratio for organophosphates)
Freshwater invertebrates	Acute	Water flea (*Daphnia magna*)	48-hr EC_{50} = 0.026 mg a.i./L slope = 4.9	MRID 00041311 (Nelson & Roney 1979)	Supplemental
	Chronic	Water flea (*Daphnia magna*)	NOAEC = 0.0045 mg a.i./L LOAEC = 0.0053 mg a.i./L	MRID 46554501 (Kern & Lam, 2005)	Supplemental Based on adult dry weight
Estuarine/ marine fish	Acute	Sheepshead Minnow (*Cyprinodon variegates*)	96-hr LC_{50} = 5.63 mg a.i./L slope = no data	MRID 00144431 (Larkin, 1983)	Acceptable
	Chronic	No data	No data	No data	No data
Estuarine/ marine invertebrates	Acute	Mysid Shrimp (*Americanysis bahia*)	96-hr LC_{50} = 1.054 mg a.i./L slope = no data	MRID 00144430 (Larkin, 1983)	Acceptable
	Chronic	Mysid Shrimp	NOAEC = 0.174	MRID	Acceptable

Assessment Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)	Study Classification and Comments
		(*Americanysis bahia*)	mg a.i./L LOAEC = 0.360 mg a.i./L	46646001 (Blankinship *et al*., 2005)	Based on average # young per reproductive day and adult length.
Aquatic plants[2]	Vascular	No data	No data	No data	No data
	Non-vascular	No data	No data	No data	No data

[1] No aquatic-phase amphibian studies for methamidophos have been submitted to US EPA or identified in the open literature.
[2] The diatom (*Skeletonema costatum*) endpoint for acephate (EC_{50} > 50 mg a.i./L, MRID 40228401 (Mayer, 1986)) has been used in previous methamidophos assessments as a representative value. No aquatic plant studies for methamidophos have been submitted to US EPA or identified in the open literature.

Toxicity to fish and aquatic invertebrates is categorized using the system shown in Table 4-3 (USEPA, 2004). Toxicity categories for aquatic plants have not been defined.

Table 4-3. Categories of Acute Toxicity for Fish and Aquatic Invertebrates

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

4.2.1. Toxicity to Freshwater Fish and Aquatic-Phase Amphibians

Freshwater fish toxicity data were used to assess potential indirect effects of acephate to the SFGS, CCR, and CTS (all DPS) via effects on prey. Aquatic-phase amphibian data were used to assess potential direct effects of acephate to the aquatic-phase CTS (all DPS) and potential indirect effects to the SFGS via effects on prey.

A summary of acute and chronic freshwater fish and aquatic-phase amphibian data, including data from the open literature, is provided below in Sections 4.2.1.a through 4.2.1.c.

4.2.1.a. Freshwater Fish: Acute Exposure (Mortality) Studies

Acephate

Acephate technical grade active ingredient (TGAI) acute toxicity data exist for several cold water and warm water freshwater fish species, including rainbow trout (*Oncorhynchus mykiss*), bluegill sunfish (*Lepomis macrochirus*), brook trout (*Salvelinus fontinalis*), Atlantic salmon (*Salmo salar*), cutthroat trout (*Salmo clarki*), yellow perch (*Perca flavescens*), channel catfish (*Ictalurus punctatus*), and fathead minnow (*Pimephales promelas*). A complete list of all the acute freshwater fish toxicity data for acephate is provided in Appendix G. In 32 studies, the acute freshwater fish 96-h LC_{50} values for technical grade acephate range from >50 to >1,000 ppm a.i. and of these studies only two have definitive 96-h LC_{50} values.

The most sensitive **LC_{50}** value suitable for use in RQ calculations is **852 ppm a.i.** for the rainbow trout (MRID 48650401, ECOTOX 7317, Duangsawasdi, 1977). This study used a 93% technical grade soluble powder and tested 10 concentrations with 10 fish at each test level. The study species were larger than recommended by the US EPA guideline and the study was conducted at 15±1°C, warmer than the recommended 12±2°C. However, the study experienced very low pre-test and control mortality indicating that the temperature did not cause stress to the fish.

There is one lower freshwater fish 96-h LC_{50} value – 832 ppm a.i. with rainbow trout (MRID 40098001, Mayer and Ellersieck, 1986). Raw data from this study were reviewed and the LC_{50} was calculated. This study is considered to be supplemental and not suitable for use in RQ calculations because of a lack of replicates, the use of only 5 fish per treatment level, the use of only nominal test concentrations, and a lack of chemical, water, and environmental data provided. Further, mortality was only seen at the highest test concentration, resulting in significant uncertainty of the LC_{50} calculation.

There is another more sensitive rainbow trout LC_{50} calculated by Mayer and Ellersieck, but this data is not considered scientifically sound because mortality of <50% was not achieved at any test concentration (Appendix G). Based on this data, acephate is categorized as slightly toxic to practically non-toxic to freshwater fish on an acute exposure basis (Table 4-3). A complete list of all the acute freshwater fish toxicity data for acephate is provided in Appendix G.

Acephate formulation (75% wettable powder) acute toxicity test results were also available for several cold water and warm water freshwater species including rainbow trout (*Oncorhynchus mykiss*), bluegill sunfish (*Lepomis macrochirus*), brook trout (*Salvelinus fontinalis*), largemouth bass (*Micropterus salmoides*), cutthroat trout (*Salmo clarki*), goldfish (*Carassius auratus*), yellow perch (*Perca flavescens*), channel catfish (*Ictalurus punctatus*), fathead minnow (*Pimephales promelas*), and mosquito fish (*Gambusia affinis)* (Appendix G). For these 25 studies the 96-h LC_{50} values range from >100 to 6,000 ppm a.i. Like the studies with acephate TGAI, most of these LC_{50} values were non-definitive values. However, based on the limited data it does not appear that acephate as the 75% wettable powder formulation is more toxic than the TGAI.

Methamidophos, major degradate

There is only one acute 96-h LC_{50} study with a freshwater fish and the major degradate, methamidophos TGAI, which was with a warm water carp (*Cyprinus carpio*) (Appendix G). The 96-h **LC_{50}** is **68 ppm a.i**. methamidophos for the carp. In this study, brain and liver acetylcholinesterase activities were depressed at 20 ppm concentrations for 48 hours. Methamidophos TGAI toxicity to the carp is higher than the 96-h LC_{50} value observed for acephate with rainbow trout (852 ppm a.i.). Acute test results of formulations with methamidophos are also more toxic than acephate TGAI or acephate formulations. Methamidophos 96-h LC_{50} values for formulations ranged from 25 to 51 ppm a.i. for two species, rainbow trout and bluegill sunfish, whereas for these same species the acephate TGAI results ranged from >50 to >1,000 ppm a.i. and for acephate formulations >200 to 2,740 ppm a.i.

Based on this data, methamidophos is categorized as slightly toxic to freshwater fish on an acute exposure basis (Table 4-3). A complete list of all the acute freshwater fish toxicity data for methamidophos is provided in Appendix G.

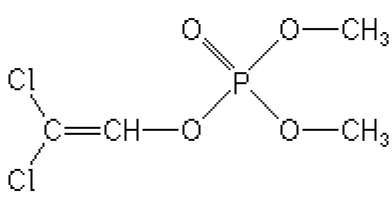
4.2.1.b. Freshwater Fish: Chronic Exposure (Growth/Reproduction) Studies

Acephate

Chronic freshwater fish toxicity studies are used to assess potential direct effects to the aquatic-phase CTS because direct chronic toxicity guideline data for amphibians were not found. Since there are no chronic data for freshwater fish with survival, growth, or reproductive endpoints submitted to US EPA or located in the open literature, an acute to chronic ratio (ACR) was determined using other organophosphate insecticide data. The estimated chronic **NOAEC** for rainbow trout as derived from an ACR of 144 and a LC_{50} of 852 ppm is **5.9 ppm**. The following paragraph presents the methodology used to derive this ACR and chronic fish NOAEC for acephate. The freshwater fish early life stage NOAEC endpoint was used as a surrogate for the aquatic-phase amphibian (U.S. EPA 2006).

The EFED toxicity database was accessed to derive an acute to chronic ratio for all organophosphate insecticides that have an acute LC_{50} for rainbow trout, an early life stage fish study for rainbow trout, and have been reviewed previously for scientific soundness (acceptable and supplemental studies). Twelve organophosphates met these criteria. Rainbow trout is typically the most sensitive fish species to pesticides and is the most sensitive fish acute endpoint for acephate. The ACR ranged from 5.4 for terbufos to 144.0 for dichlorvos (Table 4-4). In order to provide the most conservative estimate for the chronic freshwater fish NOEAC for acephate, the ACR of 144 is used. Further discussion of the uncertainty involved in this approach can be found in Section 6.2.1. The calculation is as follows:

<u>Dichlorvos (DDVP) Chemical Structure</u>



ACR for Dichlorvos: 750 ppb a.i. (acute LC_{50}) / 5.2 ppb a.i. (chronic NOAEC) = 144

$$\text{Estimated NOAEC for acephate} = \frac{LC_{50}}{NOAEC} = \frac{852 \text{ ppm a.i.}}{NOAEC} = 144$$

Estimated NOAEC for acephate = 852/144 = **5.9 ppm a.i.**

Methamidophos, major degradate

As with acephate, no chronic freshwater fish studies have been submitted to EPA or identified in the open literature for methamidophos. Therefore, an ACR (utilizing the same methods as described above) was used to estimate a methamidophos NOAEC for freshwater fish. The same data and procedure was used as described above. The calculation is as follows:

$$\text{Estimated NOAEC for methamidophos} = \frac{LC_{50}}{NOAEC} = \frac{25 \text{ ppm a.i.}}{NOAEC} = 144$$

Estimated Trout NOAEC for methamidophos = 25/144 = **0.17 ppm a.i.**

Table 4-4. Acephate Acute-to-Chronic Ratio for Rainbow Trout NOAEC

Chemical	96-hr LC_{50} (ppm a.i.)	MRID	NOAEC (ppm a.i.)	MRID	ACR	Acephate NOAEC (ppm a.i.)	Methamidophos NOAEC (ppm a.i.)
Azinphos methyl	0.0088	03125193	0.00029	00145592	30.34	28.08	0.82
Coumaphos	0.890	40098001	0.0117	43066301	76.07	11.20	0.33
Dichlorvos	0.750	43284702	0.0052	43788001	144.23	5.91	0.17
Dimethoate	7.500	TN 1069[1]	0.430	43106303	17.44	48.85	1.43
Disulfoton	1.850	40098001	0.220	41935801	8.41	101.32	2.97
Fenamiphos	0.068	40799701	0.0038	41064301	17.89	47.61	1.40
Fenitrothion	2.000	40098001	0.046	40891201	43.48	19.60	0.58
Fenthion	0.830	40214201	0.0075	40564102	110.66	7.70	0.23
Fonofos	0.050	00090820	0.0047	40375001	10.64	80.09	2.35
Isofenphos	1.800	00096659	0.153	00126777	11.76	72.42	2.13
Phosmet	0.105	40098001	0.0032	40938701	32.81	25.97	0.76
Terbufos	0.0076	40098001	0.0014	41475801	5.43	156.95	4.61

[1] TN 1069 is test number for EPA's Animal Biology Lab, McCann, 1977

4.2.1.c. Freshwater Fish: Sublethal Effects and Additional Open Literature Information

Sublethal effects of acephate and methamidophos exposure to freshwater fish are reported in open literature studies.

One study (Zinkl, 1987) found that >70% cholinesterase (ChE) inhibition is needed to achieve poisoning by acephate or methamidophos to rainbow trout, as brain ChE inhibition was as high as 70% in trout that survived exposure. Persistent ChE depression was evident (brain ChE activity remains depressed 8 days after a 24-hour exposure to 25 mg/L of methamidophos and 15 days after exposure to 400 mg/L of acephate), which suggests sublethal effects such as inability to sustain physical activity in search of food, eluding predators, and maintaining position in flowing water would occur. However, additional studies are needed to conclude whether these sublethal effects do occur.

Several studies (Boscor, 1975, MRID 14637; Geen, 1981; Rabeni, 1979, MRID 14547; Schoettger, 1976, MRID 14861) indicate no significant adverse effects on fish and benthic invertebrates from acephate applications.

4.2.1.d. Aquatic-phase Amphibians: Open Literature Studies

The most sensitive acephate amphibian study calculated a 24 hr **LC_{50}** for green frog larvae/tadpoles at **6433 ppm** (95% CI: 5857-6775) (MRIDs 00093943, 05019255, Lyons, 1976). This study is classified as supplemental and has been deemed suitable for quantitative use in risk assessments. Note that there is no EPA guideline for amphibian studies. The study does not provide raw data, uses only ten tadpoles per treatment level, and lacks replicates. Although the study was run for 96 hrs, only a 24 hr toxicity endpoint was derived because a linear dose-response pattern was not obtained. A behavior bioassay suggested that concentrations up to 500 ppm produced no observable differences between the treatment and control groups.

Another study tested green frog larvae/tadpoles with acephate up to 5 ppm for bio-concentration (MRID 44042901, Hall, 1980). Neither bio-accumulation nor toxicity was noted at 5 ppm.

A salamander acephate study found a 96 hr LC_{50} of 8816 ppm (ECOTOX 11134, Geen, 1984). Exposure of egg masses to acephate concentrations of 798 ppm did not show any significant differences from the control to the time of hatching. This study is classified as supplemental and appropriate for qualitative use only.

Using the acute aquatic organism ecotoxicity categories (Table 4-3), acephate is classified as practically non-toxic to aquatic-phase amphibians on an acute basis.

4.2.2. Toxicity to Freshwater Invertebrates

Freshwater aquatic invertebrate toxicity data were used to assess potential direct effects of acephate to the CFWS and indirect effects of acephate to the SFGS, CCR, CTS (all DPS), and CFWS via effects on prey.

A summary of acute and chronic freshwater invertebrate data, including data published in the open literature, is provided below in Sections 4.2.2.a through 4.2.2.c.

4.2.2.a. Freshwater Invertebrates: Acute Exposure Studies

Acephate

The most sensitive acephate freshwater invertebrate study found the 48 hr **EC_{50}** for *D. magna* to be **1.11 ppm a.i.** (95% CI: 0.65-1.88) (MRID 47116601, Thompson, 1978). The probit slope was 1.62. The range of EC_{50} toxicity for freshwater invertebrates in 24 studies using both acephate TGAI and formulations is 1.11 to >1,000 ppm. Only one other study used *D. magna*; this study found a 48 hr EC_{50} of 71.8 ppm. Other studies on freshwater invertebrates use species including mayfly (Ephemerida), stonefly (Plecoptera), scud (*Gammarus pseudolimneaus*), midge (*Chironomus plumosus*), damselfly (*Zygoptera*), and crayfish (*Procamborus clarki*).

Acephate classification ranges from moderately toxic to practically non-toxic to freshwater invertebrates on an acute basis. A complete list of all the acute freshwater invertebrate toxicity data for acephate is provided in Appendix G.

Methamidophos, major degradate

The most sensitive methamidophos freshwater invertebrate study found the 48 hr **EC_{50}** for *D. magna* to be **0.026 ppm a.i.** (95% CI: 0.20-0.034) (MRID 41311, Nelson and Roney, 1977). The range of EC_{50} toxicity for freshwater invertebrates in four studies is 0.026 to 0.050 ppm. All four studies used *D. magna*.

Methamidophos classification is very highly toxic to freshwater invertebrates on an acute basis. A complete list of all the acute freshwater invertebrate toxicity data for methamidophos is provided in Appendix G.

4.2.2.b. Freshwater Invertebrates: Chronic Exposure Studies

One freshwater invertebrate life-cycle study using acephate was submitted to EPA (MRID 44466601, McCann, 1978) and none were identified in the open literature. The study used *D. magna* and found a **NOAEC** of **0.150 ppm** in a 21 day test based on reduction in numbers of young. The LOAEC was 0.375 ppm. This study is classified supplemental because the control had 35% mortality of the adults and the treatments ranged from 10% to 35% mortality for adults with the highest concentration level having 10% mortality. There is a dose response trend of offspring per adult per day. This dose response trend and the more sensitive methamidophos *D. magna* life-cycle **NOAEC** of **0.0045 ppm** (MRID 46554501, Kern & Lam, 2005) led to the conclusion that the NOAEC of 0.150 ppm contained useful information despite the high control mortality.

4.2.2.c. Freshwater Invertebrates: Open Literature Data

Data were located in the open literature that report lethal and sublethal effect levels to freshwater invertebrates. However, these studies reported endpoints that were less toxic than the studies described in Sections 4.2.2.a and 4.2.2.b.

In one study, backswimmer (Notonectidae) ChE exposed to a 0.08 M methamidophos solution *in vitro* remained inhibited in a phosphorylated state for at least 4 hours (ECOTOX 37219, Hussain *et al*., 1985). A previous study demonstrated the rapid conversion of acephate to methamidophos in the backswimmer (ECOTOX 11371, Hussain *et al*., 1984). The authors suggested that aquatic insects and fish that are exposed to acephate or methamidophos may not recover by spontaneous reactivation of acetylcholinesterase (AChE) and may therefore be stressed for some time because of physiological effects caused by inhibition of AChE.

4.2.3. Toxicity to Estuarine/Marine Fish

Estuarine/marine fish toxicity data were used to assess potential indirect effects of acephate to the CCR via effects on prey.

A summary of acute and chronic estuarine/marine fish data, including data published in the open literature is provided below in Sections 4.2.3.a through 4.2.3.b.

4.2.3.a. Estuarine/Marine Fish: Acute Exposure Studies

Acephate

Acephate acute toxicity data exist for multiple estuarine/marine fish including sheepshead minnow (*Cyprinodon variegatus*), mummichog (*Fundulus heteroclitus*), pin fish (*Lagodon rhomboides*), and spot (*Leinstomus xanthurns*). A complete list of all the acute estuarine/marine fish toxicity data for acephate is provided in Appendix G. In five studies, the acute estuarine/marine fish 96-h LC_{50} values for acephate range from 85 to >3200 ppm a.i., and of these studies, three had definitive 96-h LC_{50} values. One study used a 75% acephate formulation and the remainder used technical grade acephate. Based on this data, acephate is categorized as practically non-toxic to slightly toxic to estuarine/marine fish on an acute exposure basis (Table 4-3). The most sensitive study was on the pin fish (*Lagodon rhomboides*) with a 96-h **LC_{50}** of **85 ppm a.i.** (MRID 40228401, Mayer, 1986). No sublethal effects were reported as part of this study. The data is recorded as part of a larger report and is classified as supplemental because of a lack of raw data and study specific details.

Methamidophos, major degradate

There is only one acute methamidophos 96-h LC_{50} study with an estuarine/marine fish, the sheepshead minnow (MRID 144431, Larkin, 1983). The 96-h **LC_{50}** value of **5.63 ppm** (95% CI: 4.13-6.89) methamidophos for the sheepshead minnow is more toxic than the most sensitive 96-h LC_{50} value observed for acephate (pin fish, 85 ppm a.i.). Based on this study, methamidophos is classified as moderately toxic to estuarine/marine fish on an acute exposure basis (Table 4-3).

4.2.3.b. Estuarine/Marine Fish: Chronic Exposure Studies

No chronic toxicity studies for estuarine/marine fish for either acephate or methamidophos have been submitted by registrants or identified in the ECOTOX database.

If the same acute-to-chronic ratio used for freshwater fish, 144 (Section 4.2.1.b), is applied to estuarine/marine fish, the estimated chronic toxicity value would be 0.59 mg/L for acephate and 0.039 mg/L for methamidophos. This approach involves a great deal of uncertainty due to the extrapolation from one chemical to a different chemical and from freshwater fish to estuarine/marine fish. Therefore, these values are not used to quantitatively estimate risk in this assessment.

4.2.4. Toxicity to Estuarine/Marine Invertebrates

Estuarine/marine aquatic invertebrate toxicity data were used to assess potential indirect effects of acephate to the CCR via effects on prey.

A summary of acute and chronic estuarine/marine invertebrate data, including data published in the open literature, is provided below in Sections 4.2.4.a through 4.2.4.b.

4.2.4.a. Estuarine/Marine Invertebrates: Acute Exposure Studies

Acephate

The most sensitive acephate estuarine/marine invertebrate study found the 96 hr **LC_{50}** for the pink shrimp (*Penaeus durorarum*) to be **3.8 ppm** (MRID 40228401, Mayer, 1986). The range of acephate LC_{50} toxicity for estuarine/marine invertebrates in six studies was 3.8 to 150 ppm. Only one other study used pink shrimp; this study found a non-definitive 96 hr LC_{50} of >10 ppm (MRID 40228401, Mayer, 1986). Two other shrimp studies used mysid (*Americamysis bahia*) and brown shrimp (*Penaeus aztecus*) and found LC_{50}s of 7.3 ppm (96 hr) and 22.9 ppm (48 hr), respectively (MRID 40228401, Mayer, 1986; MRID 00014711, Sleight, 1970). Two studies on the eastern oyster larvae (*Crassostrea virginica*) found LC_{50}s of 5.41 ppm (48 hr) and 150 ppm (96 hr) (MRID 40228401, Mayer, 1986; MRID 00014713, Sleight, 1970).

Acephate classification ranges from practically non-toxic to moderately toxic to estuarine/marine invertebrates on an acute exposure basis. A complete list of all the acute estuarine/marine invertebrate toxicity data for acephate is provided in Appendix G.

Methamidophos, major degradate

The most sensitive methamidophos estuarine/marine invertebrate study found the 96 hr **LC_{50}** for the mysid shrimp (*Americamysis bahia)* to be **1.054 ppm** (MRID 144430, Larkin, 1983). The range of methamidophos LC_{50} toxicity for estuarine/marine invertebrates in three studies was 1.054 to 36 ppm. One other study used the white shrimp (*Litopenaeus vannamei*); this study found a 96 hr LC_{50} of 1.46 ppm (ECOTOX #88461, Garcia-de la Parra et al. 2006). An oyster shell deposition study found a 96 hr LC_{50} of 36 ppm (MRIDs 40088601, 40074701, Surprenant, 1987).

Methamidophos ranges from slightly toxic to moderately toxic to estuarine/marine invertebrates on an acute basis. A complete list of all the acute estuarine/marine invertebrate toxicity data for methamidophos is provided in Appendix G.

4.2.4.b. Estuarine/Marine Invertebrates: Chronic Exposure Studies

Acephate

There is only one chronic estuarine/marine invertebrate study with acephate. This life cycle study on the mysid shrimp (*Americamysis bahia*) found a 21-day **NOAEC** of **0.58 ppm** and a LOAEC of 1.4 ppm (MIRDs 66341, 40228401, Mayer, 1986). The NOAEC and LOAEC are derived from the most sensitive endpoint, adult mortality; the survival of progeny was not affected.

Methamidophos, major degradate

There is only one chronic estuarine/marine invertebrate study with methamidophos. This life cycle study on the mysid shrimp (*Americamysis bahia*) found a 21-day **NOAEC** of **0.174 ppm** and a LOAEC of 0.360 ppm (MRID 46646001, Blankinship *et al.,* 2005). The NOAEC and LOAEC are derived from the most sensitive endpoint, dry weight of the adult mysids. Other endpoints in this study were offspring per reproductive day (NOAEC 0.360 ppm, LOAEC 0.669 ppm), larvae survival (NOAEC 0.669 ppm, LOAEC 1.35 ppm), and length of adult mysids (NOAEC 0.360 ppm, LOAEC 0.669 ppm).

4.2.5. Toxicity to Aquatic Plants

Aquatic plant toxicity studies are used as one of the measures of effect to evaluate whether acephate may affect primary production. Aquatic plants may also serve as dietary items of CCR, CTS (all DPS), and CFWS and habitat components for the SFGS, CCR, SMHM, CTS (all DPS), and CFWS. In addition, freshwater vascular and non-vascular plant data are used to evaluate a number of the PCEs associated with the critical habitat impact analysis for the CTS-CC and CTS-SB.

There is only one non-vascular aquatic plant study and no vascular aquatic plant studies for acephate. The non-vascular aquatic plant study found the EC_{50} for a diatom (*Skeletonema costatum*) to be >50 mg/L (MRID 40228401, Mayer, 1986). This study is recorded as part of a larger report and is classified as supplemental because of a lack of raw data and study specific details. No NOAEC is reported and the lack of raw data prevents the use of additional statistical analysis to determine this endpoint.

This acephate non-vascular aquatic plant endpoint has been used for methamidophos assessments in the past due to a lack of aquatic plant data for methamidophos. The neurotoxic mode of action of both acephate and methamidophos, like other organophosphate insecticides, is not applicable to plant physiology. Overall, the weight of evidence suggests that the risk to aquatic plants from exposure to methamidophos is unlikely. No open literature studies have been located for either acephate or methamidophos toxicity to aquatic plants.

4.3. Toxicity of Acephate to Terrestrial Organisms

Table 4-5 summarizes the most sensitive terrestrial toxicity endpoints for acephate, based on an evaluation of both the submitted studies and the open literature. Table 4-6 summarizes the most sensitive terrestrial toxicity endpoints for the degradate methamidophos. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment is presented below. Additional information is provided in Appendix G.

Acephate is moderately toxic to avian species on an acute oral and subacute dietary exposure basis, and moderately toxic to mammals on an acute oral exposure basis. Acephate is classified as highly toxic to terrestrial invertebrates on an acute contact exposure basis. The avian reproductive NOAEL for acephate is 5 ppm a.i. and the mammalian 3-generation reproductive NOAEL is 50 mg a.i./kg body weight. Terrestrial plants exposed to acephate have an EC_{25} of >3.96 lb a.i./A for both seedling emergence and vegetative vigor. The NOAEC for both these effects is 3.96 lb a.i./A.

Methamidophos is very highly toxic to avian species on an acute oral and subacute dietary exposure basis, and highly toxic to mammals on an acute oral exposure basis. Methamidophos is classified as highly toxic to terrestrial invertebrates on an acute contact exposure basis. The avian reproductive NOAEL for methamidophos is 3 ppm a.i. and the mammalian 2-generation reproductive NOAEL is 0.5 mg a.i./kg body weight. Terrestrial plants exposed to methamidophos showed no significant effects on seedling emergence or vegetative vigor at the maximum dose tested, 4.0 lb a.i./A.

Table 4-5. Terrestrial Toxicity Profile for Acephate

Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Study Classification and Comments
Birds (surrogate for terrestrial-phase amphibians and reptiles)	Acute	Bobwhite quail (*Colinus virginianus*)	LD_{50} = 109 mg a.i./kg bw slope = 5.4	43939301 (Campbell, 1992)	Acceptable
	Subacute Dietary	Japanese quail (*Coturnix japonica*)	LC_{50} = 718 mg a.i./kg diet	MRID 40910905 (Hill & Camardese, 1986)	Supplemental
	Chronic	Mallard duck (*Anas platyrhynchos*)	NOAEC = 5 mg a.i./kg diet LOAEC = 20 mg a.i./kg diet	MRID 00029691 (Beavers, 1979)	Acceptable Based on reduced # viable embryos and live embryos at 3-weeks
Mammals	Acute	Meadow vole (*Microtus pennsylvanicus*)	LD_{50} = 321mg a.i./kg bw slope = 5.18	E038448 (Rattner & Hoffman, 1984)	Acceptable
	Chronic	Rat (*Rattus norvegicus*)	3- generation reproductive study NOAEC = 50 mg a.i./kg diet LOAEC = 500 mg a.i./kg diet	MRID 40323401, 40605701 (Hoberman, 1987)	Acceptable Based on parental and pup weight, food consumption, litter size, mating performance and viability
Terrestrial invertebrates	Acute Contact	Honey bee (*Apis mellifera*)	LD_{50} = 1.20 µg a.i./bee = 9.4 µg a.i./g [2] slope = 8.26	MRID 00014714, 44038201 (Atkins et al., 1971)	Acceptable
		Soybean looper larvae (*Pseudoplusia includes*)	72-hr LD_{50} = 0.66 µg a.i./larvae = 20.34 µg a.i./g slope = 2.4	48650402 (Ottens et al., 1984)	Supplemental
Terrestrial plants	n/a	<u>Seedling Emergence</u> Monocots	EC_{25} >3.96 lb a.i./A NOAEC = 3.96 lb a.i./A	MRID 46173203 (Porch, 2003)	Acceptable
	n/a	<u>Seedling Emergence</u> Dicots	EC_{25} >3.96 lb a.i./A NOAEC = 3.96 lb a.i./A	MRID 46173203 (Porch, 2003)	Acceptable

Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Study Classification and Comments
	n/a	Vegetative Vigor Monocots	EC_{25} >3.96 lb a.i./A NOAEC = 3.96 lb a.i./A	MRID 46173204 (Porch, 2003)	Acceptable
	n/a	Vegetative Vigor Dicots	EC_{25} >3.96 lb a.i./A NOAEC = 3.96 lb a.i./A	MRID 46173204 (Porch, 2003)	Acceptable

[1] ECOTOX references are designated with an E followed by the ECOTOX reference number.
[2] Using the average adult honey bee weight of 0.128 g.

Table 4-6. Terrestrial Toxicity Profile for Methamidophos

Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Study Classification and Comments
Birds (surrogate for terrestrial-phase amphibians and reptiles)	Acute	Common grackle (*Quiscalus quiscula*)	LD_{50} = 6.7 mg a.i./kg bw slope = 4.6	MRID 00144428 (Lamb, 1972)	Supplemental
	Subacute Dietary	Bobwhite quail (*Colinus virginianus*)	LC_{50} = 42 mg a.i./kg diet	MRID 00093904 (Beavers & Fink, 1979)	Supplemental
	Chronic	Mallard duck (*Anas platyrhynchos*)	NOAEC = 3 mg a.i./kg diet LOAEC = 5 mg a.i./kg diet	MRID 00014114 (Beavers & Fink, 1978)	Acceptable Based on egg thickness, viable embryos, embryo survival, and 14-day old chick survival.
Mammals	Acute	Rat (*Rattus norvegicus*)	LD_{50} = 15.6 a.i./kg body weight slope = 13	MRID 00014044 (Cavalli & Hallesy, 1968)	Acceptable
	Chronic	Rat (*Rattus norvegicus*)	3- generation reproductive study NOAEL = 0.5 mg a.i./kg bw/day (10 mg a.i./kg diet) LOAEL = 1.65 mg/kg bw/day (33 mg a.i./kg diet)	MRID 00148455, 41234301 (1984)	Acceptable Based on decrease in number of births, pup viability and body weight.
Terrestrial invertebrates	Acute Contact	Honey bee (*Apis mellifera*)	LD_{50} = 1.37 µg a.i./bee = 10.7 µg/g [2] slope = 10.32	MRID 00036935 (Atkins et al, 1975)	Acceptable
		Western spruce budworm larvae *(Choristoneura occidentalis)*	24-hr LD_{50} = 7.45 µg a.i./g slope = 3.37	48650403 (Mohamad & Oloffs, 1987)	Supplemental
Terrestrial plants	n/a	Seedling Emergence	EC_{25} >4.0 lb a.i./A	MRID 46655802	Acceptable

Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Study Classification and Comments
		Monocots	NOAEC = 4.0 lb a.i./A	(Christ and Lam, 2005)	
	n/a	Seedling Emergence Dicots	EC_{25} >4.0 lb a.i./A NOAEC = 4.0 lb a.i./A	MRID 46655802 (Christ and Lam, 2005)	Acceptable
	n/a	Vegetative Vigor Monocots	EC_{25} >4.0 lb a.i./A NOAEC = 4.0 lb a.i./A	MRID 46655802 (Christ and Lam, 2005)	Acceptable
	n/a	Vegetative Vigor Dicots	EC_{25} >4.0 lb a.i./A NOAEC = 4.0 lb a.i./A	MRID 46655802 (Christ and Lam, 2005)	Acceptable

[1] ECOTOX references are designated with an E followed by the ECOTOX reference number.
[2] Using the average adult honey bee weight of 0.128 g.

Acute toxicity to terrestrial animals is categorized using the classification system shown in Table 4-7 (USEPA, 2004). Toxicity categories for terrestrial plants have not been defined.

Table 4-7. Categories of Acute Toxicity for Avian and Mammalian Studies

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

4.3.1. Toxicity to Birds, Reptiles, and Terrestrial-Phase Amphibians

Avian toxicity data were used to assess potential direct effects of acephate to the SFGS, CCR, and terrestrial-phase CTS (all DPS) as well as indirect effects of acephate to the SFGS, CCR, and SJKF via effects on prey and to the SMHM via effects on rearing sites. As specified in the Overview Document, the Agency uses birds as a surrogate for reptiles and terrestrial-phase amphibians when toxicity data for each specific taxon are not available (USEPA, 2004). The available open literature has no information on acephate toxicity to reptiles or terrestrial-phase amphibians. Avian toxicity endpoints from open literature are generally less sensitive than those from the registrant submitted avian studies.

A summary of acute and chronic avian data, including sublethal effects, is provided below in Sections 4.3.1.a through 4.3.1.c.

4.3.1.a. Birds: Acute Exposure (Mortality) Studies

Acephate

Acephate toxicity has been evaluated in multiple avian species including mallard duck (*Anas platyrhynchos*), bobwhite quail (*Colinus virginianus*), dark-eyed junco (*Junco hyemalis*), pheasant (*Phasianus colchicus*), and Japanese quail (*Coturnix japonica*). Acute oral LD_{50} values for acephate range from 106 mg a.i./kg bw to 350 mg a.i./kg bw. The range of subacute dietary LC_{50} values is 718 ppm a.i. to >5000 ppm a.i.

The most sensitive **LD_{50}** value suitable for use in RQ calculations is **109 mg a.i./kg bw** (86-139 mg a.i./kg bw) for the bobwhite quail (MRID 43939301, Campbell, 1992). This study was conducted with a granular formulation (15% a.i.). The probit slope is 5.4. The formulation LD_{50} = 734 mg/kg (86-139 mg/kg formulation). This study followed EPA guidelines and is an acceptable study for the formulation. The LD_{50} value (109 mg/kg bw) from this bobwhite study was used in the T-REX model to quantitatively estimate risk to SFGS, CCR, and terrestrial-phase CTS (all DPS).

One study had a lower acute oral LD_{50} value – 106 mg/kg bw for the dark eyed junco (MRID 93911, Zinkl, 1981). However, this study had significant uncertainty based on study design and therefore this value is not used quantitatively in this assessment. There were 5 dose groups with a geometric progression of 1.4x (EPA recommends 2x). Only 4 birds were tested in each dose group (EPA recommends 10). The 106 mg/kg bw dose group mortality was 2/4 (50%). No confidence interval and no probit slope were calculated. This study compared the LD_{50} value of birds fed larvae laced with acephate with birds that were given acephate by gavage. The birds initially refused to ingest larvae that contained 16 µg acephate; however, the birds were willing to consume larvae containing 5 µg acephate.

The most sensitive **LC_{50}** value is **718 ppm a.i.** for the Japanese quail (*Coturnix japonica*) (MRID 40910905, Hill & Camardese, 1986). This study is classified as supplemental due to a lack of raw data and study-specific information. The endpoint is reported as part of a larger report on avian toxicity of multiple chemicals.

Acephate is categorized as moderately toxic to avian species on an acute oral basis and practically non-toxic to moderately toxic to avian species on a subacute-dietary basis. A complete list of all the acute avian toxicity data for acephate is provided in Appendix G.

Methamidophos, major degradate

Methamidophos toxicity has been evaluated in multiple avian species including mallard duck (*Anas platyrhynchos*), bobwhite quail (*Colinus virginianus*), Japanese quail (*Coturnix japonica*), dark eyed junco (*Junco hyemalis*), common grackle (*Quiscalur quiscula*), starling (Sturnidae), and redwing blackbird (*Agelaius phoeniceus*). Acute oral LD_{50} values for methamidophos range from 1.78 mg a.i./kg bw to 29.5 mg a.i./kg bw. The range of subacute dietary LC_{50} values is 42 ppm a.i. to 1650 ppm a.i.

The most sensitive acute oral LD_{50} value is 1.78 mg/kg bw for the redwing blackbird (MRID 146286, Schafer, 1984). However, this value is not used for this risk assessment. This study is an "up/down" test, which does not comply with the current EPA guidelines. Only two doses were used (3.16 and 1.0 mg/kg) with resulting mortality 2/2 birds tested and 0/2 birds tested, respectively. The next lowest **LD_{50}** value is **6.7 mg a.i./kg bw** (4.1-10.9 mg a.i./kg bw) for the common grackle (MRID 144428, Lamb, 1972). This study is classified as supplemental due to the use of only 5 birds per treatment level, including the control (EPA recommends 10). However, the study is considered scientifically sound and the endpoint was used in the T-REX model. The most sensitive dietary **LC_{50}** value is **42 ppm a.i.** for the bobwhite quail (MRID 00093904 (Beavers & Fink, 1979).

Methamidophos is categorized as highly to very highly toxic to avian species on an acute oral basis and slightly to very highly toxic to avian species on a subacute dietary basis. A complete list of all the acute avian toxicity data for methamidophos is provided in Appendix G.

4.3.1.b. Birds: Chronic Exposure (Growth, Reproduction) Studies

Acephate

The most sensitive avian reproduction study with acephate showed that when mallard duck parents are fed between 5 and 20 ppm technical grade acephate, the survival of embryos is adversely affected. The effects seen at 20 ppm included a reduced number of viable embryos and live 3 week embryos. The **NOAEC** for the mallard is **5 ppm** and the LOAEC is 20 ppm (MRID 29691, Beavers, 1979).

Reproductive effects seen in a study on northern bobwhite quail at 80 ppm acephate included reduced body weight, number of eggs laid, eggs set, viable embryos, number of embryos alive at 3 weeks, number of normal hatchlings, and 14-day old survivors. The NOAEC is 20 ppm for the bobwhite quail and the LOAEC is 80 ppm (MRID 29692, Beavers, 1979).

Methamidophos, major degradate

Avian reproduction studies with methamidophos indicate that when bobwhite quail parents are fed between 3 and 5 ppm methamidophos, the survival of embryos and chicks are adversely affected. The effects seen at 5 ppm included reduced eggshell thickness, embryo viability, embryo development, hatchability, and survival of hatchlings. The **NOAEL** for the bobwhite quail is **3 ppm** (MRID 14114, Beavers & Fink, 1978).

One other bobwhite quail study found a NOAEC of 5 ppm and a LOAEC of 7.8 ppm based on egg production (MRID 14113, Fink, 1977). No reproductive effects were observed in a study using mallard duck and methamidophos concentrations up to 15 ppm (ECOTOX 40022, Stromberg et al., 1986).

4.3.1.c. Birds: Sublethal Effects and Additional Open Literature Information

Studies of sublethal effects of acephate exposure to avian species focus largely on cholinesterase (ChE) inhibition and behaviors surrounding this mode of action. Findings of these studies, including laboratory and field studies, are summarized below. Five field studies described below report ChE inhibition in birds following applications rates of 0.5-2.0 lb a.i./A, within the range of labeled acephate application rates. A dietary study demonstrates ChE inhibition as low as 0.5 ppm a.i. and irreversibly so above 16 ppm a.i. This study shows toxicity below the reproductive NOAEC of 5 ppm a.i. and far below the acephate dietary LC_{50} of 718 ppm a.i.

The acute oral dark eyed junco study found that the higher the dose, the greater the ChE inhibition in birds (MRID 93911, Zinkl, 1981). Increased exposure time also prolonged the recovery time for ChE inhibition. Feeding the birds larvae containing acephate decreased the activity of the acephate when compared to the gavage method. The birds fed for five days recovered in 12 to 22 days.

Vyas (ECOTOX 40313, 1995) reported that acephate affected adult migratory white-throated sparrows (*Zonotrichia albicollis*). Adult birds exposed to 256 ppm acephate a.i. were not able to establish a preferred migratory orientation and exhibited random activity. All juvenile treatment groups displayed a seasonally correct southward migratory orientation. The author hypothesized that acephate may have produced aberrant migratory behavior by affecting the memory of the adult's migratory route and wintering ground. The "experiment reveals that an environmentally relevant concentration" (similar to 0.5 lb a.i./A application) of an OP such as acephate "can alter migratory orientation, but its effect is markedly different between adult and juvenile sparrows. Results suggest that the survival of free-flying adult passerine migrants may be compromised following organophosphate pesticide exposure."

Another study by Vyas (ECOTOX 40343, 1996) reported the effects of a 14-day dietary exposure of acephate on ChE activity in three regions; basal ganglia, hippocampus, and hypothamulus were examined in the brain of the white-throated sparrow, *Zonotrichia albicollis*. All three regions experienced depressed ChE activity between 0.5-2 ppm a.i. acephate. The regions exhibited ChE recovery at 2-16 ppm a.i. acephate; however, ChE activity dropped and showed no recovery at higher dietary levels (>16 ppm acephate). Each region of the brain is responsible for different survival areas such as a foraging and escaping predators, memory and spatial orientation, food and water intake, reproduction and several others. Data indicated that the recovery is determined by the magnitude of ChE depression, not the duration. In general, as acephate concentration increased, depression in ChE activity among brain regions increased and differences of ChE activity among the three brain regions decreased. The pattern of ChE depression in different regions of the brain following low level exposure may be a critical factor in the survival of the bird. The authors hypothesized that adverse effects to birds in the field may occur at pesticide exposure levels considered negligible.

Zinkl (1978) studied several large acreages of forest that were sprayed with acephate at 0.5, 1.0 or 2.0 lb. a.i./A application rates. There was no brain ChE inhibition on day zero after application. Birds collected from the 2 lb a.i./A plots from day one through six post-spray showed ChE inhibition. Brain ChE inhibition was shown in birds 33 days after treatment but not 89 days after treatment. Birds had more inhibition of ChE in summer application when compared to the fall application in the 1 lb a.i./A plots (30-50% and 25-40% depression, respectively). The greatest ChE inhibition occurred in dark-eyed juncos (65%) collected 15 days after treatment. In the 2 lb a.i./A plots, dark-eyed juncos and golden-crowned kinglets had 54% ChE inhibition. Of the 14 species collected, only pine siskins *(Siinus pinus)* did not show any ChE inhibition. Symptoms of organophosate poisoning were observed such as profuse salivation of a warbling vireo, difficulty maintaining perching position of an American robin, and visible tremors in a mountain chickadee. All of these observations were made in the 1 lb a.i./A plots. The authors concluded that since marked ChE inhibition did not occur on day zero, but was evident up to 33 days after application, there was either an accumulative effect that was detected later or acephate was converted to a more potent ChE inhibitor such as methamidophos. Spraying the forest with 0.5, 1.0, or 2.0 lb. a.i./A caused marked and widespread, and prolonged ChE depression in passerine birds.

Two additional studies by Zinkl (ECOTOX 39518, 1980, MRID 40329701, 1979) looked at results of acephate sprayed in a forest at 0.5 lb a.i./A. Eleven species of birds had ChE inhibition ranging from 20 to 40%. The maximum depression of ChE found in chipping sparrows was 57% at day six. Western tanagers were found to have significant inhibition up to 26 days after application. Brain residue analysis of a western tanager collected on day three contained 0.318 ppm of acephate and 0.055 ppm of methamidophos.

In a study by Bart (MRIDs 163173, 5014922, 1979), acephate was applied in this study in the month of June at 0.55 kg/ha (0.5 lb a.i./A) on two 200 hectare plots. Authors measured the presence of the red-eyed vireos by the number of their particular songs. Significant ($P<0.05$) decline in number of red-eyed vireos was observed. The decline was concentrated in the interior of the treated plots rather than spread throughout. The study did not determine whether the decline was due to direct or indirect effects on vireos.

In a lab study, Rudolph (MRID 141694, 1984) dosed kestrels with 50 mg/kg of 75% acephate formulation. Serum ChE was 37% inhibited and returned to predosed levels eight days later. The birds were then dosed again and serum ChE activity was inhibited 42% while brain ChE was inhibited 26%. Prey-catching activity was not altered.

A study in the Oregon Wallowa-Whitman National Forest by Richmond (MRID 40644802, 1979) used applications of 1.12 (1.0 lb a.i./A) and 2.24 (2.0 lb a.i./A) kg/ha on forest plots. Extensive inhibition of brain ChE activity (30-50%) was observed for up to 33 days for 11 of the 12 species of birds collected. The highest frequency of ChE inhibition was observed on day two post-spray. Some birds on the plots treated with 1.12 kg/ha had 65% ChE inhibition, which is known to be fatal. At both plots, birds were found with coordination problems, salivating profusely, and unable to fly. These behaviors were observed up to 20 days after application in the 2.24 kg/ha plot. It was also observed that breeding pairs for the warbling vireo and yellow-rumpled warbler decreased. The authors concluded that application of acephate at rates of 1.12 and 2.24 kg/ha can cause sickness and death to forest birds.

A study by McEwen (MRID 93909, 1981) in WY, UT, and AZ rangeland found that birds collected in 1979 and 1980 up to 24 days after acephate application at 0.0938 lb ai/A had reduced ChE activity. Reduction of 20% or more is indicative of brain exposure to a ChE inhibitor. Of the birds collected in AZ, 24.5% had reduced ChE activity >20%. The birds with the greatest ChE inhibition were the last ones collected (21-24 days post treatment). In 1981, horned larks and lark buntings were collected in WY on a 12,000 acre plot that was treated with acephate at the same rate of 0.0938 lb ai/A. More than 20% ChE inhibition was found in 19% of the horned larks and 25% of the lark buntings.

4.3.2. Toxicity to Mammals

Mammalian toxicity data were used to assess potential direct effects of acephate to the SMHM and SJKF as well as indirect effects of acephate to the SFGS, CCR, CTS (all DPS), and SJKF via effects on prey and to the SFGS, SMHM, and CTS (all DPS) via effects on habitat or rearing sites.

A summary of acute and chronic mammalian data, including data published in the open literature, is provided below in Sections 4.3.2.a through 4.3.2.c. A more complete analysis of toxicity data to mammals is available in Appendix J, which is a copy of the Health Effects Division (HED) chapter prepared in support of the re-registration eligibility decision (RED) finalized in 2006.

4.3.2.a. Mammals: Acute Exposure (Mortality) Studies

Acephate

Mammalian acephate toxicity studies indicate that the toxicity ranges from slightly to moderately toxic to small mammals on an acute oral basis. Acephate oral toxicity to small mammals was tested on multiple species including the laboratory rat (*Rattus norvegicus*), white-footed mouse (*Peromyscus leucopus noveboracensis*), laboratory mouse (*Mus musculus*), meadow vole (*Microtus pennsylvanicus*), and brown bat (*Myotis lucifugus*). LD_{50} values ranged from 321 mg/kg bw to >1500 mg/kg bw over eight studies. The most sensitive acute oral **LD_{50}** was **321 mg/kg bw** for the meadow vole (ECOTOX 38448, Rattner and Hoffman, 1984). LD_{50}s reported for mice were similar to the meadow vole at 351 and 380 mg/kg (one study reported 720 mg/kg) while toxicity values reported for rats were higher at 739, 866, and 970 mg/kg (see Appendix G) (ECOTOX 38448, Rattner and Hoffman, 1984; ECOTOX 39704, Clark and Rattner, 1987; MRID 237487; MRIDs 236863, 236864; MRID 00014675).

Acephate is categorized as moderately toxic to small mammals on an acute oral basis. A complete list of all the oral acute mammalian toxicity data for acephate is provided in Appendix G.

Methamidophos, major degradate

Mammalian methamidophos toxicity studies indicate that methamidophos is highly toxic to small mammals on an acute oral basis. Methamidophos oral toxicity was tested on the laboratory rat (*Rattus norvegicus*) and laboratory mouse (*Mus musculus*). LD_{50} values ranged from 13.0 mg/kg bw to 18 mg/kg bw. The most sensitive acute oral LD_{50} was 13.0 mg/kg bw for the female laboratory rat (MRID 14044, Cavalli and Hallesy, 1968). However, the data in this study for the female rats indicates missing data for the two lowest test concentrations. Therefore, the **LD_{50}** value used for risk assessment is **15.6 mg/kg bw** for male rats, which had a complete data set, from the same study (MRID 14044, Cavalli and Hallesy, 1968).

Methamidophos is categorized as highly toxic to small mammals on an acute oral basis. A complete list of all the oral acute mammalian toxicity data for methamidophos is provided in Appendix G.

4.3.2.b. Mammals: Chronic Exposure (Growth, Reproduction) Studies

Acephate

Laboratory data indicate that acephate and its degradate, methamidophos, may pose chronic risk to mammals by affecting reproductive capacity. A 3-generation study on Charles River rats (*Rattus norvegicus*) found that when female rats were fed acephate at 500 ppm, the LOAEC, they exhibited significant adverse effects on parental and pup body weight, food consumption, litter size, mating performance, and viability. The **NOAEC** was **50 ppm** acephate, the level at which rats showed no effects (MRIDs 40323401, 40605701).

Methamidophos, major degradate

A 2-generation study on laboratory rats showed that 33 ppm methamidophos, the LOAEC, in food adversely affected the survival of embryos and pups. This equated to 1.65 mg/kg bw/day. The **NOAEC** was **10 ppm** methamidophos, equivalent to 0.5 mg/kg bw/day, the level at which rats showed no effects (MIRDs 148455, 41234301).

4.3.2.c. Mammals: Sublethal Effects and Additional Open Literature Information

Studies from the open literature of sublethal effects to mammals as a result of acephate exposure are summarized below. Two field studies described below report ChE inhibition in small mammals following applications rates of 0.5-1.0 lb a.i./A, within the range of labeled acephate application rates. Reproductive toxicity studies reported effects on male mice at 14 mg/kg/day and on female mice at 28 mg/kg/day, lower than the guideline study value of 50 mg/kg/day for acephate.

Zinkl (MRID 40329701, ECOTOX 39518, 1980) found a marked inhibition of brain ChE activity in squirrels but no mortality after aerial acephate treatment of forests at 0.57 kg/ha (0.51 lb/A).

McEwen (MRID 93909, 1981) collected small samples of deer mice in 1980 and 1981 in WY up to 12-14 days after an acephate application of 0.0938 lb ai/A. They were found to have ChE inhibition from 12.7% to 14.6%. The potential populations effects of these levels of inhibition were not well understood.

A study by Stehn (ECOTOX 35459, 1976) reported increased ingestion of arthropods by insectivorous mammals following acephate application. This signified a direct pathway for substantial exposure to acephate due to consumption of dead and dying insects.

Farag (ECOTOX 87471, 2000) studied the reproductive toxicity of acephate to male mice. Adult male mice were treated by gavage with acephate at doses of 0, 7, 14, and 28 mg/kg/day for 4 weeks before mating with untreated females. Signs of cholinergic effects were observed in the 28 mg/kg/day group. Brain and skeletal muscle AchE activity was inhibited only in this group. Acephate treatment was associated with a decreased number of implantations and live fetuses, and an increased number of early resorptions at 28 mg/kg/day. The percent morphologically normal spermatozoa were unaffected in all dose groups; however, sperm motility and count were decreased in the 14 and 28 mg/kg/day groups compared to the control. Histological examination of brain did not reveal any abnormalities. Dose related histological changes, including degeneration of muscle fibers, were observed in the muscles of male mice treated with any of the doses of acephate. The study demonstrated adverse effects of male acephate exposure on pregnancy outcome with effects on sperm parameters at 14 and 28 mg/kg/day.

A second study by Farag (ECOTOX 87472, 2000) evaluated acephate for its potential to produce developmental toxicity in mice after oral administration to females. Pregnant mice were given sublethal doses of 0, 7, 14, and 28 mg/kg/day acephate by gavage on gestation days 6 through 15. Maternal effects in the 28 mg/kg/day dose group included cholinergic signs, decreased body weight at 15 and 18 days of gestation, and decreased absolute and relative brain weight. Placental weight was also decreased and liver weight was increased in the high dose group. Absolute and relative brain weight was decreased in the 14 mg/kg/day group. No maternal effects were apparent in the 7 mg/kg/day dose group. Maternal exposure to acephate during organogenesis significantly affected the number of implantations, number of live fetuses, number of early resorptions, mean fetal weight, and the incidence of external and skeletal malformations in the 28 mg/kg/day dose group. No visceral malformations were observed. Acephate showed maternal and developmental toxicity at 28 mg/kg/day.

4.3.3. Toxicity to Terrestrial Invertebrates

Terrestrial invertebrate toxicity data were used to assess potential direct effects of acephate to the BCB and VELB as well as indirect effects of acephate to the SFGS, CCR, SMHM, SJKF, and CTS (all DPS) via effects on prey.

A summary of acute terrestrial invertebrate data, including data published in the open literature, is provided below in Sections 4.3.3.a through 4.3.3.b.

4.3.3.a. Terrestrial Invertebrates: Acute Exposure (Mortality) Studies

Acephate

A honey bee acute contact study indicated that acephate is highly toxic to honey bees on an acute contact basis with an **LD_{50}** of **1.20 µg a.i./bee** (MRIDs 14714, 44038201, Atkins, 1971). Using an average adult honey bee weight of 0.128 g, this equates to 9.4 µg a.i./g bw. Multiple foliar residue studies showed that acephate caused bee mortality from 0 to 96 hours after foliar application at rates from 0.48 to 1.0 lb a.i./A. These studies were preformed on multiple bee species as well as one species of spider (Appendix G).

EPA also reviewed a study (MRID 5004012, Plapp, 1978) that determined toxicity ratios for acephate. By comparing the sensitivity of a beneficial predator insect to that of the pest tobacco budworm, the study determined the relative toxicity to the beneficial insect versus the pest insect. The ratio was calculated using the LC_{50} values for each species. The ratios were 6.4 and 10.0 for the green lacewing and the parasitic wasp, respectively. The ratios of >1 indicate that acephate is more toxic to these two beneficial predators than it is to the pest.

A complete list of all the contact, oral, and foliar residue terrestrial invertebrate toxicity data for acephate is provided in Appendix G.

Methamidophos, major degradate

A honey bee acute contact toxicity study indicated that methamidophos is highly toxic to bees on an acute contact basis with an **LD_{50}** of **1.37 µg a.i./bee** (MRID 36935, Atkins, 1975). Using an average adult honey bee weight of 0.128 g, this equates to 10.7 µg a.i./g bw.

A complete list of all the terrestrial invertebrate toxicity data for methamidophos is provided in Appendix G.

4.3.3.b. Terrestrial Invertebrates: Sublethal Effects and Additional Open Literature Information

Target insect studies are not typically used in assessments of the risks to non-target species. However, this endangered species assessment includes a Lepidoptera species (BCB) and a Coleoptera species (VELB) and studies on insects in these orders, which are nearly all focused on target species, were therefore considered.

A complete list of all the Lepidoptera and Coleoptera toxicity data for acephate and methamidophos is provided in Appendix G. Other terrestrial invertebrate open literature studies are summarized below as well as in Appendix G.

Lepidoptera studies

Eleven acute Lepidoptera acephate studies with comparable LD_{50} endpoints were identified in the open literature. The species in these studies included cotton bollworm (*Helicoverpa* *armigera*), diamondback moth (*Plutella xylostella*), Douglas-fir tussock moth (*Hemerocampa pseudotsugata*), gypsy moth (*Lymantria dispar*), Mediterranean flour moth (*Anagasta kuehniella*), oriental fruit moth (*Grapholita molesta*), soybean looper (*Pseudoplusia includes*), tobacco budworm (*Heliothis virescens*), and Western spruce budworm (*Choristoneura occidentalis*). All species were tested in their larval stage in a laboratory setting. Nine of the studies tested acute contact toxicity using a direct topical application to the larvae. The most sensitive species tested was the soybean looper (*P. includes*) with a 72-hr LD_{50} of 20.34 µg/g bw (MRID 48650402, ECOTOX 73702, Ottens et al., 1984). This equates to 0.66 µg/larvae, calculated based on the weight range of larvae provided in the study. This value will be used quantitatively to assess acute risk of acephate exposure to the BCB.

Five acute Lepidoptera methamidophos studies with comparable LD_{50} endpoints were identified in the open literature. The species in these studies included diamondback moth (*Plutella xylostella)*, Douglas-fir tussock moth (*Hemerocampa pseudotsugata*), oriental fruit moth (*Grapholita molesta*), tobacco budworm (*Heliothis virescens*), and Western spruce budworm (*Choristoneura occidentalis*). All species were tested in their larval stage in a laboratory setting. The most sensitive species tested was the Western spruce budworm (*C. occidentalis*) with a 24 hr LD_{50} of 7.45 µg/g bw. The larval weight was not provided in the study. This value will be used quantitatively to assess acute risk of methamidophos exposure to the BCB.

Coleoptera studies

Three acute Coleoptera acephate studies were identified using adult boll weevils (*Anthonomus grandis grandis*), adult coffee bean weevils (*Araecerus fasciculatus*), and adult mealybug destroyers (*Cryptolaemus montrouzieri*) (a beneficial insect, not a target species). The first two studies tested acute contact toxicity using a direct topical application and found LD_{50}s of >5700 µg/g bw (72 hr) and >300 µg/g bw (24 hr), respectively. The mealybug destroyer study used a foliar residue design and found a 48 hr LD_{50} of 988 mg/l (MRID 48650403, ECOTOX 153300, Mohamad and Oloffs, 1987).

One acute Coleoptera methamidophos study was identified using the adult boll weevil (*Anthonomus grandis grandis*). This study tested acute contact toxicity using a direct topical application and found an LD_{50} of 128.6 µg/g bw (72 hr). This equates to 2.3 µg/weevil.

Because the collection of Coleoptera studies with usable, definitive acute toxicity endpoints is small, all studies are on adult insects, and there is no EPA guideline to serve as a standard, these endpoints will not be used to quantitatively assess toxicity of acephate and methamidophos to the VELB. However, the studies will be used qualitatively to characterize hazard. In the absence of Coleoptera data, to evaluate direct risk to the VELB the honeybee toxicity data described above will be used.

Other terrestrial invertebrate studies

Roberts and Dorough studied the effects of acephate on two species of earthworms (ECOTOX 40531, 1983). The earthworm species (*Eisenia foetida* and *Lumbricus rubellus*) were exposed to technical grade acephate on filter paper in vials for 48 hrs. The LC_{50} for *E. foetida* was 851.0

μg/cm^2 (95% CI 525.0-1378.0) and the LC_{50} for *L. rubellus* was 692.0 μg/cm^2 (95% CI 424.0-1127.0). Acephate was classified as moderately toxic (LC_{50} = 100-1000 μg/cm^2) to both species on an acute basis. Acephate was the least toxic of five organophosphate pesticides (fonofos, malathion, parathion, chlorpyrifos, and acephate) tested on these two species of earthworms by an order of magnitude.

Acephate effects on bee colonies were studied by Stoner (ECOTOX 35475, 1985). All bee colonies that were fed 10 ppm acephate lost queens early in the study and were unable to rear new queens. Acephate was systemic in nurse bees, causing toxicity from glandular secretions fed to queens. Concentrations of 1 ppm or less were harmless to the worker bees, but exposure to just 0.1 ppm resulted in significant reduction of the surviving brood. The study concluded that infrequent encounters by honey bee foragers with acephate on crops at levels of 1 ppm (the NOAEC) or less could be harmless. However, foragers may encounter levels greater than 1 ppm in the field because of 6-9 day residue persistence and residual systemic activity of acephate in plants for up to 15 days.

Another study also investigated the effects of acephate on bee colonies (MRID 99762, Johansen, 1977). After exposure to acephate, brood cycles of some colonies were found to be permanently broken, and all of the bees were dead within 45-48 days. Depression in the numbers of wild foraging bees at all treated plots was apparent. Measured seed and fruit production of northern bluebells (*Mertensia paniculata*) were significantly reduced from lack of pollination.

Severe impacts to yellow jacket wasps and ants were measured at 1 and 2 lb a.i./A acephate sprayed on forest (MRID 99763, Johansen, 1977). Temperature affected the exposure of wasps; wasps do not forage in cooler temperatures (39^{o}F), whereas warmer temperatures (59^{o}F) increase their activity out of the nest.

4.3.4. Toxicity to Terrestrial Plants

Terrestrial plants may serve as dietary items of CCR, SMHM, BCB, VELB, SJKF, and CFWS and habitat components for the SFGS, CCR, SMHM, BCB, VELB, SJKF, CTS (all DPS), and CFWS. In addition, terrestrial dicot plant data are used to evaluate a number of the PCEs associated with the critical habitat impact analysis for the BCB, VELB, CTS-CC, and CTS-SB. The BCB and VELB have obligate relationships with dicot plants. A complete list of terrestrial plant toxicity data for acephate and methamidophos is provided in Appendix G.

4.3.4.a. Terrestrial Plants: Guideline Studies

Plant toxicity data from both registrant-submitted studies and studies in the scientific literature were reviewed for this assessment. Registrant-submitted studies are conducted under conditions and with species defined in EPA toxicity test guidelines. Sublethal endpoints such as plant growth, dry weight, and biomass are evaluated for both monocots and dicots, and effects are evaluated at both seedling emergence and vegetative life stages. Guideline studies generally evaluate toxicity to ten crop species. These tests 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 acephate, is largely unknown. Homogenous test plant seed lots also lack the genetic variation that occurs in natural populations, so the range of effects seen from tests is likely to be smaller than would be expected from wild populations.

The results of the Tier II seedling emergence and vegetative vigor toxicity tests with acephate on non-target plants are summarized below in Table 4-8 (MRIDs 46173203, 46173204, Porch et al., 2003). Tier I seedling emergence and vegetative vigor toxicity tests using 4.0 lb a.i./A methamidophos found no significant effects (MRID 46655802, Christ and Lam, 2005). Acephate's neurotoxic mode of action does not apply to plant physiology so effects on plants would not be expected, though data are still needed to confirm this. Additionally, acephate has been used as an agricultural insecticide on a wide variety of crops for decades, indicating its absence of negative effect on these crops.

Table 4-8. Non-target Terrestrial Plant Seedling Emergence and Vegetative Vigor Toxicity (Tier II) for Acephate

Crop	Type of Study Species	NOAEC (lb a.i./A)	EC_{25} (lb a.i./A)	Most sensitive parameter
		Seedling Emergence		
Monocots	Corn	3.96	>3.96	None
	Onion	3.96	<3.96	Dry weight[1]
	Ryegrass	3.96	>3.96	None
	Wheat	3.96	>3.96	None
Dicots	Buckwheat	<3.96	>3.96	Plant height[2]
	Flax	3.96	>3.96	None
	Lettuce	3.96	>3.96	None
	Radish	3.96	>3.96	None
	Soybean	3.96	>3.96	None
	Tomato	3.96	>3.96	None
		Vegetative Vigor		
Monocots	Corn	3.96	>3.96	None
	Onion	3.96	>3.96	None
	Ryegrass	3.96	>3.96	None
	Wheat	3.96	>3.96	None
Dicots	Buckwheat	3.96	>3.96	None
	Flax	3.96	>3.96	None
	Lettuce	3.96	>3.96	None
	Radish	3.96	>3.96	None
	Soybean	3.96	>3.96	None
	Tomato	3.96	>3.96	None

[1] The study author discounted the >25% inhibition exhibited by onion height and biomass because these responses did not follow a clear dose-dependent pattern.
[2] The 7% inhibition exhibited by buckwheat height did not follow a clear dose-dependent pattern.

4.3.4.b. Terrestrial Plants: Open Literature

Three open literature studies testing the effects of acephate products on plants were identified. A study using a 0.75 lb/100 gal insect spray formulation (a typical concentration for acephate products) with methyl cellosolve, with up to three applications, recorded foliar distortion, marginal leaf necrosis, and slight leaf chlorosis on multiple ornamental plants (MRID 00014623, Davis, 1977). However, tests in this study with technical grade acephate did not cause any leaf damage. A second study using a formulation found marginal necrosis and slight stunting on *Viburnum suspensum* from two applications of 1 lb/100 gal solution but did not see any effects on 14 other species of nursery plants (MRID 00014928, Shaefer, 1975). A third study, using an unknown formulation of acephate, observed slight to mild phytotoxicity symptoms on leaves of the Lombardy cottonwood after two applications of 0.5 lb and 1 lb/A (MRID 00014929, Clark, 1975). This study tested 60 other nursery plants with no observed effects. No open literature studies on the effects of methamidophos on plants were available.

4.4. Toxicity of Chemical Mixtures

As previously discussed, the results of available toxicity data for mixtures of acephate with other pesticides are presented in Appendix A. Acephate has only one active registered product that contains multiple active ingredients. Acute mammalian toxicity data are available for that product and three others that were recently cancelled. This data set is limited and a qualitative analysis does not support any broad conclusions about the interactive nature of acephate in combination with other pesticides.

4.5. Incident Database Review

A review of the Ecological Incident Information System (EIIS, version 2.1), the ‘Aggregate Incident Reports’ (v. 1.0) database, and the Avian Monitoring Information System (AIMS) for ecological incidents involving acephate was completed on 23 September 2011. The results of this review for terrestrial, plant, and aquatic incidents are discussed below and in Sections 4.5.1 through 4.5.2. A complete list of the reported incidents involving acephate including associated uncertainties is included as Appendix K. Note that a lack of reported incidents does not imply that no incidents have occurred. Incidents described here are from throughout the U.S., including outside of the action area, as they are not necessarily unique to the location.

Although there are many reported incidents of toxic effects to non-target plants and animals from acephate, the majority of these reports are not clearly documented or report acephate applied in combination with or in the presence of other pesticides. In the latter case, it is not possible to determine which pesticide primarily caused the incident. All reported fish incidents fall under this category. The majority of acephate specific incidents reported were bee kills. Incidents were also reported for bird and fish kills as well as damage to plants. There is no information available with which to ascertain the extent of the damage or the type of damage to plants.

Overall, the EIIS results for acephate included four aquatic incidents, 12 plant incidents, and 12 terrestrial incidents. All incidents were reported as a result of registered uses or unknown uses.

The aquatic incidents varied from “unlikely” to “probable” cause by acephate. The plant incidents were all “possible” or “probable” cause by acephate. The terrestrial incidents were “possible” or “probable” cause by acephate except for one incident that was “highly probable.”

The EIIS results for methamidophos included no aquatic incidents, three plant incidents, and 15 terrestrial incidents. Plant incidents were either “unlikely” or “possible” cause by methamidophos and were the result of either registered or unknown uses. Terrestrial incidents were either “possible” or “probable” cause by methamidophos except for one incident that was “highly probable.” The terrestrial incidents were the result of either registered or unknown uses, with one accidental misuse reported (a “probable” cause incident).

The Aggregate Incident Reports database contained 11 minor fish and wildlife incidents and 453 minor plant incidents for acephate. No detailed information is available for these incidents. There were no incidents in this database for methamidophos.

4.5.1. Terrestrial Incidents

An incident in South Carolina in 1998 involved 24 dead boat-tailed grackles. The birds were collected and methamidophos residues found within them were attributed to acephate use on fire ants. This incident was classified as “probable” cause by acephate. A similar incident also in South Carolina in 2005 involved 50 boat-tailed grackles found dead. Acephate had been used in the area to control fire ants in a legal manner under the label restrictions and acephate residues were found within some of the birds. This incident was classified as “highly probable” cause by acephate.

Washington State reported 4 incidents of bee kills from 1992 to 2002. Forty to 60 colonies were killed off per incident and all were classified as “probable” cause by acephate. Washington also reported 7 incidents of bee kills due to methamidophos during this time period. Between 30 and 500 colonies were killed off per incident. The largest incident, with 500 colonies killed, was classified as “highly probable” that it was caused by methamidophos. Of the remaining bee kills, three were classified as “probable” and three as “possible” cause by methamidophos.

4.5.2. Plant Incidents

The reported plant incidents from acephate applications with information available are listed below. Note that the products used in five of the seven incidents described below have since been voluntarily cancelled by the registrant. The three cancelled products involved in these incidents were all formulated with mixtures of acephate and other insecticides (see Appendix A for product details). All of the incidents described below involved damage to plants sprayed directly with the product rather than as a result of spray drift from a separate target area.

- 1994 in PA - Orthenex Rose and Flower Spray (aerosol) is alleged to have caused damage to ornamentals and/or flowers. “Probable” cause by acephate, registered use.

- 1998 in FL - There was an allegation of plant damage from the use of Ortho Systemic Rose and Floral Spray on ornamentals. "Possible" cause by acephate, unknown use. This product was voluntarily cancelled by the registrant on June 1, 2011.

- 1998 in PA - There was an allegation of plant damage from the use of Ortho Orthenex™ Insect and Disease Control Formula III on ornamentals. "Possible" cause by acephate, unknown use. This product was voluntarily cancelled by the registrant on October 14, 2008.

- 1999 in DC - There was an allegation of plant damage from the use of Isotox Insect Killer Formula IV. Product was sprayed on a dwarf Alberta pine preceding the death of the tree. "Probable" cause by acephate, unknown use. This product was voluntarily cancelled by the registrant on October 14, 2008.

- 1999 in IN - There was an allegation of plant damage from the use of Ortho Orthenex™ Insect and Disease Control Formula III on ornamentals. The report indicated that flowering almond and hibiscus were dying. "Probable" cause by acephate, registered use. This product was voluntarily cancelled by the registrant on October 14, 2008.

- 1999 in TX - There was an allegation of plant damage from the use of Ortho Orthenex™ Insect and Disease Control Formula III on ornamentals. The report indicated that the homeowner applied this product on 40 – 50 bushes used as hedge per recommendation of county extension agent. Approximately 95% of the bushes died. "Probable" cause by acephate, registered use. This product was voluntarily cancelled by the registrant on October 14, 2008.

- 1999 in GA - There was an allegation of plant damage from the use of Ant-Stop Orthene™ Fire Ant Kill. Product was applied on spots of the lawn resulting in "burnt spots." "Probable" cause by acephate, unknown use.

4.6. 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 (USEPA, 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 acephate 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. Results of the IECV1.1 calculations for the individual effect probabilities for a variety of use scenarios based on both acephate and methamidophos toxicity data are presented in Table 4-9.

Table 4-9. Individual Effect Probabilities for Acephate and Methamidophos Exposure

Exposure Scenario	Taxa	Acute RQ		Probit Slope[1]		Chance of Effect (1 in…)	
		Acephate	Methamidophos	Acephate	Methamidophos	Acephate	Methamidophos
Listed Species Threshold	Terrestrial Invertebrate (Honey Bee)	LOC, 0.05		8.26	10.32	3.3E+26	4.7E+40
Fallow land (0.1245 lb a.i./A)		1.8	1.2			1.0	1.2
Cauliflower/celery/mint /peppers (1 lb a.i./A)		26	17			1.0	1.0
Citrus (4 lb a.i./A)		129	74			1.0	1.0
Ornamental shrub & vines (32 lb a.i./A)		2050	1135			1.0	1.0
Listed Species Threshold	Lepidoptera	LOC, 0.05		2.4	3.37	1.12E+3	1.7E+5
Fallow land (0.1245 lb a.i./A)		0.83	1.7			2.4	1.3
Cauliflower/celery/mint /peppers (1 lb a.i./A)		12	24			1.0	1.0
Citrus (4 lb a.i./A)		59	106			1.0	1.0
Ornamental shrub & vines (32 lb a.i./A)		947	1630			1.0	1.0
Listed Species Threshold	Small Bird	LOC, 0.1		5.4	4.6	3.0E+7	4.7E+5
Fallow land (0.1245 lb a.i./A)		0.43	4.9			42	1.0
Cauliflower/celery/mint /peppers (1 lb a.i./A)		6.2	68			1.0	1.0
Citrus (4 lb a.i./A)		31	301			1.0	1.0
Ornamental shrub & vines (32 lb a.i./A)		497	4630			1.0	1.0
Listed Species Threshold	Small Mammal	LOC, 0.1		5.18	13	9.0E+6	1.6E+38
Fallow land (0.1245 lb a.i./A)		0.07	0.73			9.1E+8	26
Cauliflower/celery/mint /peppers (1 lb a.i./A)		1.0	10			1.9	1.0
Citrus (4 lb a.i./A)		5.2	45			1.0	1.0
Ornamental shrub & vines (32 lb a.i./A)		82	684			1.0	1.0

Listed Species Threshold		LOC, 0.1				9.0E+6	1.6E+38
Fallow land (0.1245 lb a.i./A)		0.03	0.33			6.5E+14	4.6E+9
Cauliflower/celery/mint /peppers (1 lb a.i./A)	Large Mammal	0.47	4.6	5.18	13	22	1.0
Citrus (4 lb a.i./A)		2.4	20			1.0	1.0
Ornamental shrub & vines (32 lb a.i./A)		38	313			1.0	1.0
Listed Species Threshold		LOC, 0.05				4.2E+8	3.9E+32
Cotton seed treatment (0.06 lb ai/A)		1.1E-7	2.0E-6			7.9E+215	1.0E+16 [2]
Beans (1 lb ai/A)	FW Fish	3.5E-6	1.3E-4	4.5	9.2	6.9E+132	4.5E+281
Alfalfa (0.974 lb ai/A)		6.5E-5	1.4E-3			6.6E+78	1.3E+151
Roses (15.6 lb ai/A)		8.3E-4	0.015			1.9E+43	3.6E+63
Ornamental shrub & vines (32 lb ai/A)		1.1E-3	0.030			2.5E+40	2.0E+44
Listed Species Threshold		LOC, 0.05				54	1.1E+10
Cotton seed treatment (0.06 lb ai/A)		8.2E-5	1.9E-3			3.2E+10	9.7E+39
Beans (1 lb ai/A)	FW Invertebrate	2.7E-3	0.12	1.6	4.9	5.1E+4	2.9E+5
Alfalfa (0.974 lb ai/A)		0.050	1.4			53	1.4
Roses (15.6 lb ai/A)		0.64	14			2.6	1.0
Ornamental shrub & vines (32 lb ai/A)		0.82	29			2.2	1.0
Listed Species Threshold		LOC, 0.05				4.2E+8	4.2E+8
Cotton seed treatment (0.06 lb ai/A)		1.1E-6	8.9E-6			6.6E+158	9.2E+113
Alfalfa (0.974 lb ai/A)		6.5E-4	6.3E-3			1.7E+46	5.4E+22
Golf courses (4.77 lb ai/A)	SW Fish	4.1E-3	0.053	4.5	4.5	3.9E+26	2.3E+8
Roses (15.6 lb ai/A)		8.3E-3	0.065			2.5E+20	2.2E+7
Ornamental shrub & vines (32 lb ai/A)		0.011	0.13			2.8E+18	2.6E+4
Listed Species Threshold		LOC, 0.05				4.2E+8	4.2E+8
Cotton seed treatment (0.06 lb ai/A)		2.4E-5	4.7E-5			6.3E+95	7.9E+83
Paved areas (0.25 lb ai/A)	SW Invertebrate	0.012	0.051	4.5	4.5	3.2E+17	3.6E+8
Citrus (4 lb ai/A)		0.063	0.17			3.0E+7	3.1E+3
Roses (15.6 lb ai/A)		0.19	0.35			2.0E+3	52
Ornamental shrub & vines (32 lb ai/A)		0.24	0.71			390	4.0
Listed Species Threshold		LOC, 0.05				4.2E+8	--
Cotton seed treatment (0.06 lb ai/A)	Aquatic-phase Amphibians	1.4E-8	--	4.5	--	1.6E+273	--
Alfalfa (0.974 lb ai/A)		8.6E-6	--			4.3E+114	--
Roses (15.6 lb ai/A)		1.1E-4	--			3.7E+70	--

[1] The probit slope is sourced from the study with the most sensitive toxicity endpoint used for the RQ derivation when available. If the slope cannot be obtained from the study, a default slope of 4.5 is used.
[2] 1 in 1.00E+16 is the default minimum individual effect probability used when the z-score probability is too small to calculate in Microsoft Excel.

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 BCB, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SMHM, SFGS, and SJKF or for modification to their designated critical habitat from the use of acephate 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”). In the risk estimation section, risk quotients are calculated using standard EFED procedures and models. In the risk description section, additional analyses may be conducted to help characterize the potential for risk.

5.1. Risk Estimation

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

Acute and chronic risks to aquatic organisms are estimated by calculating the ratio of exposure to toxicity using the 1-in-10 year EECs in Table 3-5 (parent) and Table 3-6 (degradate) based on the label-recommended acephate usage scenarios summarized in Table 3-1 and the appropriate aquatic toxicity endpoint from Table 4-1 (parent) and Table 4-2 (degradate). Each table shows three use scenarios: the lowest EEC, the two highest EECs, and a mid-range EEC. When applicable, the mid-range scenario was specifically chosen to show the lowest EEC for which the Acute RQ becomes greater than the LOC.

Acute and chronic risks to terrestrial animals are estimated based on exposures resulting from applications of acephate (Table 3-10 through Table 3-15) and the appropriate toxicity endpoint from Table 4-5 (parent) and Table 4-6 (degradate). Exposures are also derived for terrestrial plants (Table 3-18). Each table gives RQs for the four use scenarios identified in Table 3-7, including the lowest, highest, and two mid-range application rates for acephate uses in the action area. The LD_{50}/ft^2 and seed treatment analyses are based on the use scenarios identified in Table 3-8 and Table 3-9, respectively. Note that the commercial lawns use has a higher lb a.i./A application rate than ornamental shrub and vines, however because this is a perimeter/spot treatment it is not modeled in T-REX for this assessment. If this scenario was modeled using the 156 lb a.i./A application rate, RQs would be higher than the highest RQs presented here. However, this would not change any of the risk determinations in this assessment.

When the number of applications and/or application interval were not specified on the product label, 26 applications per year and a 3 day minimum period for reapplication were assumed. These are conservative maximum assumptions that result in high EECs and RQs for the highest application rates. While these high numbers of applications and short application intervals are unlikely to represent typical usage, they are possible scenarios under the labeled use and therefore analyzed as such here.

5.1.1. Exposures in the Aquatic Habitat

5.1.1.a. Freshwater Fish and Aquatic-phase Amphibians

Acute risk to fish and aquatic-phase amphibians and reptiles is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value for freshwater fish. Chronic risk is based on the 1 in 10 year 60-day EECs and the lowest chronic toxicity value for freshwater fish. Acephate risk quotients are shown in Table 5-1 for freshwater fish and in Table 5-2 for aquatic-phase amphibians. Risk quotients for freshwater fish based on exposure to the major degradate, methamidophos, are shown in Table 5-3.

No acute or chronic RQs exceed the LOCs for freshwater fish or aquatic-phase amphibians for acephate. Acute and chronic RQs exceed the listed species LOCs for freshwater fish for methamidophos only for the highest use; the chronic LOC also applies to non-listed species. As detailed in Section 4.2.1.b, no chronic toxicity data was available for acephate or methamidophos so an acute-to-chronic ratio was calculated based on other organophosphate insecticide toxicity data and used to estimate chronic toxicity values for acephate and methamidophos. Based on the results below, acephate has minimal potential to directly affect the CTS (all DPS). Additionally, there is even less potential for indirect effects to those listed species that rely on fish or aquatic-phase amphibians during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, and CTS) , since there were no non-listed species LOC (0.5) exceedances for any uses. Prey items of the SFGS, CCR, and CTS (all DPS) would not likely be affected from acephate use.

Table 5-1. Acute and Chronic RQs for Freshwater Fish Exposure to Acephate

Use (Application Rate)	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
M) Cotton seed treatment (0.06 lb a.i./A)	0.09	0.003	1.1×10^{-7}	5.1×10^{-7}
B) Alfalfa (0.974 lb a.i./A)	55.2	3.11	6.5×10^{-5}	5.3×10^{-4}
AA) Roses (15.6 lb a.i./A)	707	70.0	8.3×10^{-4}	0.01
Y) Commercial lawns (156 lb ai./A)	2456	300	0.003	0.05

*LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC/LC_{50} (852000 µg/L). Chronic RQ = use-specific 60-day EEC/estimated NOAEC (5900 µg/L (derived from ACR of OP insecticide Dichlorvos)). Based on acute and chronic toxicity to rainbow trout.

Table 5-2. Acute and Chronic RQs for Aquatic-phase Amphibian Exposure to Acephate

Use (Application Rate)	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
M) Cotton seed treatment (0.06 lb a.i./A)	0.09	0.003	1.4×10^{-8}	--
B) Alfalfa (0.974 lb a.i./A)	55.2	3.11	8.6×10^{-6}	--
AA) Roses (15.6 lb a.i./A)	707	70.0	1.1×10^{-4}	--
Y) Commercial lawns (156 lb ai./A)	2456	300	3.8×10^{-4}	--
*LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC /LC_{50} (6433000 µg/L). Based on acute toxicity to the green frog. Chronic RQ not calculated due to the lack of chronic aquatic-phase amphibian toxicity data.				

Table 5-3. Acute and Chronic RQs for Freshwater Fish Exposure to Methamidophos

Use (Application Rate)	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
M) Cotton seed treatment (0.06 lb a.i./A)	0.05	0.01	2.0×10^{-6}	5.8×10^{-5}
D) Beans (1 lb a.i./A)	3.14	0.63	1.3×10^{-4}	0.0036
T) Ornamental shrub & vines (32 lb a.i./A)	746	144	0.030	0.83
Y) Commercial lawns (156 lb ai./A)	1291	540	**0.052**	**3.2**
*LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC /LC_{50} (25000 µg/L). Chronic RQ = use-specific 60-day EEC/estimated NOAEC (170 µg/L (derived from ACR of OP insecticide Dichlorvos)). Based on acute and chronic toxicity to rainbow trout.				

5.1.1.b. Freshwater Invertebrates

Acute risk to freshwater invertebrates is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value for freshwater invertebrates. Chronic risk is based on 1 in 10 year 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates. Acephate risk quotients for freshwater invertebrates are shown in Table 5-4. Risk quotients for freshwater invertebrates based on exposure to the major degradate, methamidophos, are shown in Table 5-5.

Acute and chronic RQs exceed the listed and non-listed species LOCs (0.05 and 0.5, respectively) for freshwater invertebrates for both acephate and methamidophos at the highest EECs (see Table 3-5 and Table 3-6). Acute RQs for acephate exceed the listed species LOC (0.05) for alfalfa (0.974 lb a.i./A) and all uses with EECs higher than alfalfa. This includes citrus, fire ant uses, golf courses, ornamentals, ornamental shrubs and vines, sod farms, commercial lawns, and roses. Chronic RQs exceed the chronic risk LOC (1.0) only for the commercial lawn use. Acute RQs for methamidophos exceed the listed species LOC (0.05) for beans (1.0 lb a.i./A) and all uses with EECs higher than beans. Only the cotton seed treatment and the fallow land uses have peak EECs for methamidophos less than beans. Chronic RQs for methamidophos are exceeded the chronic risk LOC for all crops with EECs greater than celery. This includes alfalfa, almonds and other nut crops, apples and other deciduous fruit trees, beans, Bermuda grass, cauliflower, Christmas trees, citrus, fire ants, golf courses, grapes, lettuce, ornamentals, ornamental shrubs and vines, sod farms, paved areas, commercial lawns, rights-of way, and roses. Based on these results, acephate does have the potential to directly affect the

CFWS. Additionally, 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.*, SFGS, CCR, CTS (all DPS), and CFWS). Prey items of the SFGS, CCR, CFWS, and CTS (all DPS) would likely be affected from use of acephate.

Table 5-4. Representative Acute and Chronic RQs for Freshwater Invertebrate Exposure to Acephate

Use (Application Rate)	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
M) cotton seed treatment (0.06 lb a.i./A)	0.09	0.01	8.1×10^{-5}	6.7×10^{-5}
B) alfalfa (0.974 lb a.i./A)	55.2	6.34	**0.05**	0.04
AA) roses (15.6 lb a.i./A)	707	128	**0.64**	0.85
Y) commercial lawns (156 lb ai./A)	2456	544	**2.2**	**3.6**
* LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC/EC_{50} (1100 µg/L). Chronic RQ = use-specific 21-day EEC/NOAEC (150 µg/L). Based on acute and chronic toxicity to *Daphnia magna.*				

Table 5-5. Acute and Chronic RQs for Freshwater Invertebrate Exposure to Methamidophos

Use (Application Rate)	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
M) cotton seed treatment (0.06 lb a.i./A)	0.05	0.02	0.0019	0.004
D) beans (1 lb a.i./A)	3.14	1.57	**0.12**	0.35
P) celery (1 lb a.i./A)	10.7	5.28	**0.41**	**1.2**
T) ornamental shrub & vines (32 lb a.i./A)	746	260	**29**	**58**
Y) commercial lawns (156 lb ai./A)	1291	688	**50**	**153**
*LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC /EC_{50} (26 µg/L). Chronic RQ = use-specific 21-day EEC/NOAEC (4.5 µg/L). Based on acute and chronic toxicity to *Daphnia magna.*				

5.1.1.c. Estuarine/Marine Fish

Acute risk to estuarine/marine fish is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine fish. Chronic risk cannot be calculated due to a lack of chronic estuarine/marine fish toxicity data. Acephate risk quotients for estuarine/marine fish are shown in Table 5-6. Risk quotients for estuarine/marine fish based on exposure to the major degradate, methamidophos, are shown in Table 5-7.

Acute RQs exceed the listed species LOC (0.05) only for estuarine/marine fish for methamidophos but not for acephate. Acute RQs for methamidophos exceed the listed species LOC (0.05) for golf courses (4.77 lb a.i./A) and all uses with EECs higher than golf courses. These include ornamental shrubs and vines, commercial lawns and roses. Based on these results, there is a potential for indirect effects to those listed species that rely on estuarine/marine fish during at least some portion of their life-cycle (*i.e.*, CCR). However, the LOC for non-listed species is not exceeded.

Table 5-6. Acute RQs for Estuarine/Marine Fish Exposure to Acephate

Use (Application Rate)	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
M) cotton seed treatment (0.06 lb a.i./A)	0.09	0.003	1.1×10^{-6}	--
B) alfalfa (0.974 lb a.i./A)	55.2	3.11	6.5×10^{-4}	--
AA) roses (15.6 lb a.i./A)	707	70.9	0.008	--
Y) commercial lawns (156 lb a.i./A)	2456	300	0.030	--

*LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC /LC_{50} (85000 µg/L). Chronic RQ not calculated due to the lack of chronic estuarine/marine fish toxicity data. Based on acute toxicity to pin fish.

Table 5-7. Acute RQs for Estuarine/Marine Fish Exposure to Methamidophos

Use (Application Rate)	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
M) cotton seed treatment (0.06 lb a.i./A)	0.05	0.01	8.9×10^{-6}	--
O) golf courses (4.77 lb a.i./A)	296	77	**0.053**	--
T) ornamental shrub & vines (32 lb a.i./A)	746	144	**0.13**	--
Y) commercial lawns (156 lb a.i./A)	1291	540	**0.23**	--

*LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC /LC_{50} (5630 µg/L). Chronic RQ not calculated due to the lack of chronic estuarine/marine fish toxicity data. Based on acute toxicity to sheepshead minnow.

5.1.1.d. Estuarine/Marine Invertebrates

Acute risk to estuarine/marine invertebrates is based on peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine invertebrates. Chronic risk is based on 21-day EECs and the lowest chronic toxicity value for estuarine/marine invertebrates. Acephate risk quotients for estuarine/marine invertebrates are shown in Table 5-8. Risk quotients for estuarine/marine invertebrates based on exposure to the major degradate, methamidophos, are shown in Table 5-9.

Acute RQs exceed the LOCs for estuarine/marine invertebrates for both acephate and methamidophos at the highest EECs. Chronic EECs exceed risk thresholds only for methamidophos. Acute RQs for acephate exceed the LOC for citrus (4.0 lb a.i./A) and all uses with EECs higher than citrus. These uses include golf courses, ornamentals, ornamental shrubs and vines, commercial lawns, and roses. Acute RQs for methamidophos exceed the LOC for paved areas (0.25 lb a.i./A) and all uses with EECs higher than paved areas. This includes golf courses, lettuce, ornamentals, ornamental shrubs and vines, sod farms, commercial lawns, and roses. Chronic EECs exceed the level of concern for ornamental shrubs and vines, and commercial lawns. Based on these results, there is a potential for indirect effects to those listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e.*, CCR). Prey items of the CCR would likely be affected from use of acephate.

Table 5-8. Acute and Chronic RQs for Estuarine/Marine Invertebrate Exposure to Acephate

Use (Application Rate)	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
M) cotton seed treatment (0.06 lb a.i./A)	0.09	0.05	2.4×10^{-5}	8.6×10^{-5}
I) citrus (4 lb a.i./A)	240	22.1	**0.063**	0.04
AA) roses (15.6 lb a.i./A)	708	128	**0.19**	0.22
Y) commercial lawns (156 lb a.i./A)	2456	544	**0.65**	0.93
*LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC /LC_{50} (3800 µg/L). Chronic RQ = use-specific 21-day EEC / NOAEC (580 µg/L). Based on acute toxicity to pink shrimp and chronic toxicity to mysid shrimp				

Table 5-9. Acute and Chronic RQs for Estuarine/Marine Invertebrate Exposure to Methamidophos

Use (Application Rate)	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Cotton seed treatment (0.06 lb a.i./A)	0.05	0.02	4.7×10^{-5}	1.1×10^{-4}
Paved areas (0.25 lb a.i./A)	53.4	28.6	**0.051**	0.16
Ornamental shrub & vines (32 lb a.i./A)	746	260	**0.71**	**1.5**
Y) commercial lawns (156 lb a.i./A)	1291	688	**1.2**	**4.0**
*LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded and shaded. Acute RQ = use-specific peak EEC /LC_{50} (1054 µg/L). Chronic RQ = use-specific 21-day EEC / NOAEC (174 µg/L). Based on acute and chronic toxicity to mysid shrimp.				

5.1.1.e. Aquatic Plants

There are no definitive endpoints for aquatic non-vascular plants and no toxicity data available for aquatic vascular plants for either acephate or methamidophos. Therefore, risk quotients cannot be derived for aquatic plants. There is only one, non-vascular, aquatic plant toxicity value for acephate, EC_{50} > 50 mg/L (MRID 40228401, Mayer, 1986); however a NOAEC was not reported. Acute risk to aquatic non-vascular plants is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value, EC_{50} for non-listed species risk and NOAEC or EC_{05} for listed species risk. No species in this assessment have obligate relationships with aquatic plants, so the listed species risk value is not relevant. The LOC is 1 for both acute risk and acute listed species risk. The highest EEC for acephate is 2456 µg/L (commercial lawns, 156 lb a.i./A annually). Therefore, the toxicity value would have to be 2456 µg/L (2.46 mg/L) or lower for the RQ to exceed the LOC. Given the EC_{50} value of >50,000 µg/L (50 mg/L) for non-vascular aquatic plants, it is not likely that the EC_{50} for vascular aquatic plants NOAEC is <2456 µg/L.

The weight of evidence presented above suggests that risk to aquatic plants from exposure to acephate and its degradate, methamidophos, is unlikely. Therefore, there is not expected to be a potential for indirect effects to those listed species that rely on aquatic plants during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, SMHM, CTS (all DPS), and CFWS).

5.1.2. Exposures in the Terrestrial Habitat

5.1.2.a. Birds (surrogate for Reptiles and Terrestrial-phase Amphibians)

As previously discussed in Section 3.3, potential direct effects to terrestrial species are based on foliar, granular, and in-furrow applications of acephate. Potential direct acute and chronic effects to birds, the CCR, terrestrial-phase CTS (all DPS), and SFGS are evaluated using dose- and dietary-based EECs modeled in T-REX for small (20 g, juveniles) birds consuming short grass (Table 3-10 and Table 3-11) and acute oral, sub-acute dietary, and chronic toxicity endpoints for avian species (Table 4-5 and Table 4-6). Further, potential direct acute and chronic effects to small birds are evaluated for seed treatments (inputs in Table 3-9) and LD_{50}/ft^2 values are calculated for birds of all sizes (inputs in Table 3-8).

T-HERPS is used as a refinement to RQs for snakes and terrestrial-phase amphibians if T-REX indicates potential risk. Small snakes and amphibians only consume insects while medium and large snakes and terrestrial-phase amphibians consume small and large insects, mammals, and amphibians. The most sensitive RQs are for medium reptiles and amphibians consuming small herbivorous mammals. Potential direct acute and chronic effects to the CTS and SFGS are further evaluated by considering dose- and dietary-based EECs modeled in T-HERPS for medium amphibians and snakes, respectively, consuming small herbivorous mammals (Table 3-12 through Table 3-15) and acute oral, sub-acute dietary, and chronic toxicity endpoints for avian species (Table 4-5 and Table 4-6).

Potential for indirect effects to the CCR, SJKF, and SFGS may result from direct acute effects to birds and/or amphibians due to a reduction in prey. Potential indirect effects to the SMHM may result from direct acute effects to birds due to a reduction in rearing sites. RQs for indirect effects are calculated in the same manner as those for direct effects. The most sensitive EECs calculated in T-REX are for small birds consuming short grass.

RQs are calculated in T-REX and T-HERPS for the four use scenarios presented in Table 3-7 and Table 3-8 as well as for seed treatments (Table 3-9). Acute and chronic RQs for birds and the CCR, CTS, and SFGS derived using T-REX for acephate and its major degradate, methamidophos, are shown in Table 5-10 and Table 5-11, respectively. Seed treatment RQs are shown in Table 5-14 and Table 5-15 and LD_{50}/ft^2 values are shown in Table 5-16 and Table 5-17. Acute and chronic RQs for the CTS and SFGS derived using T-HERPS for acephate are shown in Table 5-12. Acute and chronic RQs for the CTS and SFGS derived using T-HERPS for the major degradate, methamidophos, are shown in Table 5-13.

Acute and chronic RQs exceed the listed and non-listed LOCs (0.05 and 0.5, respectively) for birds, terrestrial-phase amphibians, and reptiles for both acephate and methamidophos in nearly every scenario. The only exceptions are the acute dietary-based RQs for acephate for the lowest registered application rate (fallow land) and the LD_{50}/ft^2 value for the liquid broadcast application of acephate for large birds. All RQs exceed the listed and non-listed LOCs for seed treatments; less than one seed needs to be consumed for an exceedance to occur. Based on these results, acephate does have the potential to directly affect the CCR, terrestrial-phase CTS (all DPS), and SFGS. Additionally, there is a potential for indirect effects to those listed species that rely on birds, reptiles, and/or terrestrial-phase amphibians as prey items during at least some portion of their life-cycle (*i.e.*, CCR, SJKF, SFGS, and SMHM).

Table 5-10. Acute and Chronic RQs Derived Using T-REX for Acephate and Birds, Amphibians, and Reptiles

Use (Application Rate)	RQs for Birds and CCR, CTS (all DPS), and SFGS (small bird consuming short grass)*		
	Acute Dose Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]
Fallow land (0.1245 lb a.i./A)	**0.43**	0.040	**6.0**
Cauliflower/celery/mint/peppers (1 lb a.i./A)	**6.2**	**0.59**	**85**
Citrus (4 lb a.i./A)	**31**	**3.0**	**430**
Ornamental shrub & vines (32 lb a.i./A)	**497**	**48**	**6848**

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} = 109 mg/kg-bw
[2] Based on dietary-based EEC and Japanese quail (22.5 g) subacute dietary LC_{50} = 718 mg/kg-diet
[3] Based on dietary-based EEC and Mallard duck NOAEC = 5 mg/kg-diet

Table 5-11. Acute and Chronic RQs Derived Using T-REX for Methamidophos and Birds, Amphibians, and Reptiles

Use (Application Rate)	RQs for Birds and CCR, CTS (all DPS), and SFGS (small bird consuming short grass)*		
	Acute Dose Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]
Fallow land (0.096 lb a.i./A)	**4.9**	**0.55**	**7.7**
Cauliflower/celery/mint/peppers (0.77 lb a.i./A)	**68**	**7.6**	**106**
Citrus (3.0 lb a.i./A)	**301**	**33**	**468**
Ornamental shrub & vines (25 lb a.i./A)	**4630**	**514**	**7198**

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Common grackle (94 g) acute oral LD_{50} = 6.7 mg/kg-bw
[2] Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 42 mg/kg-diet
[3] Based on dietary-based EEC and Mallard duck NOAEC = 3 mg/kg-diet

Table 5-12. Acute and Chronic RQs Derived Using T-HERPS for Acephate and Amphibians and Reptiles

Use (Application Rate)	RQs for CTS (all DPS) (medium birds consuming herbivorous mammals)*			RQs for SFGS (medium birds consuming herbivorous mammals)*		
	Acute Dose Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]	Acute Dose Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]
Fallow land (0.1245 lb a.i./A)	**0.18**	0.040	**6.0**	**0.26**	0.030	**4.6**
Cauliflower/celery/mint/peppers	**2.6**	**0.60**	**86**	**3.7**	**0.46**	**65**

(1 lb a.i./A)						
Citrus (4 lb a.i./A)	**13**	**3.0**	**431**	**19**	**2.3**	**330**
Ornamental shrub & vines (32 lb a.i./A)	**210**	**48**	**6873**	**298**	**37**	**5249**

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} = 109 mg/kg-bw
[2] Based on dietary-based EEC and Japanese quail (22.5 g) subacute dietary LC_{50} = 718 mg/kg-diet
[3] Based on dietary-based EEC and Mallard duck NOAEC = 5 mg/kg-diet

Table 5-13. Acute and Chronic RQs Derived Using T-HERPS for Methamidophos and Amphibians and Reptiles

Use (Application Rate)	RQs for CTS (all DPS) (medium birds consuming herbivorous mammals)*			RQs for SFGS (medium birds consuming herbivorous mammals)*		
	Acute Dose Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]	Acute Dose Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]
Fallow land (0.096 lb a.i./A)	**2.3**	**0.55**	**7.7**	**3.3**	**0.42**	**5.9**
Cauliflower/celery/mint/peppers (0.77 lb a.i./A)	**32**	**7.6**	**107**	**45**	**5.8**	**82**
Citrus (3.0 lb a.i./A)	**140**	**34**	**470**	**199**	**26**	**359**
Ornamental shrub & vines (25 lb a.i./A)	**2157**	**516**	**7224**	**3056**	**394**	**5518**

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Common grackle (94 g) acute oral LD_{50} = 6.7 mg/kg-bw
[2] Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 42 mg/kg-diet
[3] Based on dietary-based EEC and Mallard duck NOAEC = 3 mg/kg-diet

Table 5-14. Acute and Chronic Seed Treatment RQs Derived Using T-REX for Acephate and Birds

Use (Application Rate)	RQs for Small Birds (small birds consuming treated seeds)*			Number of Seeds Consumed Resulting in an Exceedance (small bird)[3]
	Acute Dose Based[1]	Acute based on Available Pesticide/sq. ft[1]	Chronic Dietary Based[2]	
Cotton (0.320 lbs a.i./cwt)	**10**	**0.40**	**640**	<1
Peanuts (0.197 lb a.i./cwt)	**6.4**	**3.0**	**394**	<1

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} = 109 mg/kg-bw
[2] Based on dietary-based EEC and Mallard duck NOAEC = 5 mg/kg-diet
[3] Based on lbs/cwt for seed treatments and Northern bobwhite quail acute oral LD_{50} = 109 mg/kg-bw (adjusted)

Table 5-15. Acute and Chronic Seed Treatment RQs Derived Using T-REX for Methamidophos and Birds

Use (Application Rate)	RQs for Small Birds (small birds consuming treated seeds)*			Number of Seeds Consumed Resulting in an Exceedance (small bird)[3]
	Acute Dose Based[1]	Acute based on Available Pesticide/sq. ft[1]	Chronic Dietary Based[2]	
Cotton (0.246 lbs a.i./cwt)	**117**	**4.6**	**820**	<1

Peanuts (0.152 lb a.i./cwt)	**72**	**34**	**507**	<1

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Common grackle (94 g) acute oral LD_{50} = 6.7 mg/kg-bw
[2] Based on dietary-based EEC and Mallard duck NOAEC = 3 mg/kg-diet
[3] Based on lbs/cwt for seed treatments and Common grackle (94 g) acute oral LD_{50} = 6.7 mg/kg-bw (adjusted)

Table 5-16. LD_{50}/ft^2 Values Derived Using T-REX for Acephate and Birds

Use (Application Rate)	Application Type	RQ (birds at application site)*,1		
		Small (20 g)	Medium (100 g)	Large (1000 g)
Cotton (1 lb a.i./A)	Soil in-furrow, liquid	**33**	**5.2**	**0.37**
Golf Course Turf (4.95 lb a.i./A)	Broadcast, granular	**33**	**5.2**	**0.37**
Beans / peppers / brussels sprouts / cauliflower / celery / citrus / lettuce / mint / peanuts (1 lb a.i./A)	Broadcast, liquid	**6.6**	**1.0**	0.074

* LOC exceedances (acute risk to listed species (0.1)) are bolded and shaded.
[1] Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} = 109 mg/kg-bw

Table 5-17. LD_{50}/ft^2 Values Derived Using T-REX for Methamidophos and Birds

Use (Application Rate)	Application Type	RQ (birds at application site)*,1		
		Small (20 g)	Medium (100 g)	Large (1000 g)
Cotton (1 lb a.i./A)	Soil in-furrow, liquid	**377**	**59**	**4.2**
Golf Course Turf (4.95 lb a.i./A)	Broadcast, granular	**372**	**59**	**4.1**
Beans / peppers / brussels sprouts / cauliflower / celery / citrus / lettuce / mint / peanuts (1 lb a.i./A)	Broadcast, liquid	**75**	**12**	**0.84**

* LOC exceedances (acute risk to listed species (0.1)) are bolded and shaded.
[1] Based on dose-based EEC and Common grackle (94 g) acute oral LD_{50} = 6.7 mg/kg-bw

5.1.2.b. Mammals

Potential direct acute and chronic effects to small mammals and the SMHM are evaluated using dose- and dietary-based EECs modeled in T-REX for a small mammal (15 g) consuming short grass (inputs in Table 3-10 and Table 3-11). Potential direct acute and chronic effects to the SJKF are evaluated using dose- and dietary-based EECs modeled in T-REX for a large mammal (1,000 g) consuming short grass (inputs in Table 3-10 and Table 3-11). Further, potential direct acute and chronic effects to small mammals are evaluated for seed treatments (inputs in Table 3-9) and LD_{50}/ft^2 values are calculated for mammals of all sizes (inputs in Table 3-8). Acute oral and chronic toxicity endpoints for mammals are used for small and large species (Table 4-5 and Table 4-6).

Potential for indirect effects to the SFGS, CCR, SJKF, and CTS (all DPS) may result from direct effects to mammals due to a reduction in prey. Potential indirect effects to the SFGS, SMHM, and CTS (all DPS) may result from direct effects to mammals due to effects on habitat or a reduction in rearing sites. RQs for indirect effects are calculated in the same manner as those for direct effects. The most sensitive EECs calculated in T-REX are for small mammals consuming short grass.

RQs are calculated in T-REX for the use scenarios presented in Table 3-7 and Table 3-8 as well as for seed treatments. Acute and chronic RQs for small mammals and the SMHM and the SJKF derived using T-REX for acephate and its major degradate, methamidophos, are show in Table 5-18 through Table 5-23.

Acute and chronic RQs exceed the listed and non-listed species LOC for mammals for both acephate and methamidophos for nearly every scenario. The only exceptions are the acute and chronic RQs for acephate for the lowest registered application rate (fallow land) and the LD_{50}/ft^2 value for the liquid broadcast application of acephate for large mammals. All RQ values exceed the acute and chronic listed and non-species LOC for seed treatments. Based on these results, acephate does have the potential to directly affect the SMHM and SJKF. Additionally, there is a potential for indirect effects to those listed species that rely on mammals as prey items or for habitat during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, SJKF, CTS (all DPS), and SMHM).

Table 5-18. Acute and Chronic RQs Derived Using T-REX for Acephate and Mammals

Use (Application Rate)	RQs for Small Mammals and SMHM (small mammals consuming short grass)*		RQs for Large Mammals and SJKF (large mammal consuming short grass)*	
	Acute Dose Based[1]	Chronic Dietary Based[2]	Acute Dose Based[1]	Chronic Dietary Based[2]
Fallow land (0.1245 lb a.i./A)	0.070	0.60	0.030	0.60
Cauliflower/celery/mint/ peppers (1 lb a.i./A)	**1.0**	**8.5**	**0.47**	**8.5**
Citrus (4 lb a.i./A)	**5.2**	**43**	**2.4**	**43**
Ornamental shrub & vines (32 lb a.i./A)	**82**	**685**	**38**	**685**

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Meadow vole (35 g) acute oral LD_{50} = 321 mg/kg-bw
[2] Based on dietary-based EEC and Rat NOAEC = 50 mg/kg-diet

Table 5-19. Acute and Chronic RQs Derived Using T-REX for Methamidophos and Mammals

Use (Application Rate)	RQs for Small Mammals and SMHM (small mammals consuming short grass)*		RQs for Large Mammals and SJKF (large mammal consuming short grass)*	
	Acute Dose-Based[1]	Chronic Dietary Based[2]	Acute Dose Based[1]	Chronic Dietary Based[2]
Fallow land (0.096 lb a.i./A)	**0.73**	**2.3**	**0.33**	**2.3**
Cauliflower/celery/mint/ peppers (0.77 lb a.i./A)	**10**	**32**	**4.6**	**32**
Citrus (3.0 lb a.i./A)	**45**	**141**	**20**	**141**
Ornamental shrub & vines (25 lb a.i./A)	**684**	**2159**	**313**	**2159**

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Rat (207.5 g) acute oral LD_{50} = 15.6 mg/kg-bw

[2] Based on dietary-based EEC and Rat NOAEC = 10 mg/kg-diet

Table 5-20. Acute and Chronic Seed Treatment RQs Derived Using T-REX for Acephate and Mammals

Use (Application Rate)	RQs for Small Mammals and SMHM (small mammals consuming treated seeds)*			Number of Seeds Consumed Resulting in an Exceedance (small mammal)[3]
	Acute Dose Based[1]	Acute based on Available Pesticide/sq. ft[1]	Chronic Dietary Based[2]	
Cotton (0.320 lbs a.i./cwt)	**1.7**	**0.11**	**64**	<1
Peanuts (0.197 lb a.i./cwt)	**1.1**	**0.79**	**39**	<1

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Meadow vole (35 g) acute oral LD_{50} = 321 mg/kg-bw
[2] Based on dietary-based EEC and Rat NOAEC = 50 mg/kg-diet
[3] Based on lbs/cwt for seed treatments and Meadow vole (35 g) acute oral LD_{50} = 321 mg/kg-bw (adjusted)

Table 5-21. Acute and Chronic Seed Treatment RQs Derived Using T-REX for Methamidophos and Mammals

Use (Application Rate)	RQs for Small Mammals and SMHM (small mammals consuming treated seeds)*			Number of Seeds Consumed Resulting in an Exceedance (small mammal)[3]
	Acute Dose Based[1]	Acute based on Available Pesticide/sq. ft[1]	Chronic Dietary Based[2]	
Cotton (0.246 lbs a.i./cwt)	**17**	**1. 1**	**246**	<1
Peanuts (0.152 lb a.i./cwt)	**11**	**8.0**	**152**	<1

* LOC exceedances (acute risk to listed species (0.1); acute risk to non-listed species (0.5); and chronic risk to listed and non-listed species (1.0)) are bolded and shaded.
[1] Based on dose-based EEC and Rat (207.5 g) acute oral LD_{50} = 15.6 mg/kg-bw
[2] Based on dietary-based EEC and Rat NOAEC = 10 mg/kg-diet
[3] Based on lbs/cwt for seed treatments and Rat (207.5 g) acute oral LD_{50} = 15.6 mg/kg-bw (adjusted)

Table 5-22. LD_{50}/ft^2 Values Derived Using T-REX for Acephate and Mammals

Use (Application Rate)	Application Type	RQ (mammals at application site)*,[1]		
		Small (15 g)	Medium (35 g)	Large (1000 g)
Cotton (1 lb a.i./A)	Soil in-furrow, liquid	**8.8**	**4.6**	**0.37**
Golf Course Turf (4.95 lb a.i./A)	Broadcast, granular	**8.7**	**4.6**	**0.37**
Beans / peppers / brussels sprouts / cauliflower / celery / citrus / lettuce / mint / peanuts (1 lb a.i./A)	Broadcast, liquid	**1.8**	**0.93**	0.074

* LOC exceedances (acute risk to listed species (0.1)) are bolded and shaded.
[1] Based on dose-based EEC and Meadow vole (35 g) acute oral LD_{50} = 321 mg/kg-bw

Table 5-23. LD_{50}/ft^2 Values Derived Using T-REX for Methamidophos and Mammals

Use (Application Rate)	Application Type	RQ (mammals at application site)*,[1]		
		Small (15 g)	Medium (35 g)	Large (1000 g)
Cotton (0.77 lb a.i./A)	Soil in-furrow, liquid	**89**	**47**	**3.8**
Golf Course Turf (3.8 lb a.i./A)	Broadcast, granular	**88**	**46**	**3.8**

Beans / peppers / brussels sprouts / cauliflower / celery / citrus / lettuce / mint / peanuts (0.77 lb a.i./A)	Broadcast, liquid	**18**	**9.4**	**0.76**

* LOC exceedances (acute risk to listed species (0.1)) are bolded and shaded.
[1] Based on dose-based EEC and Rat (207.5 g) acute oral LD_{50} = 15.6 mg/kg-bw

5.1.2.c. Terrestrial Invertebrates

In order to assess the risks of acephate to terrestrial invertebrates, the honey bee is used as a surrogate for terrestrial invertebrates. EECs (µg a.i./g of bee) calculated by T-REX for small insects are divided by the calculated toxicity value for terrestrial invertebrates (Table 4-5 and Table 4-6). Larvae for both the BCB and the VELB are considered 'small insects' in this assessment, while the adults of these species are considered 'large insects'. There are also data available in the open literature on the acute toxicity of acephate and methamidophos to a variety of Lepidoptera species. Therefore, the most sensitive of these values are used to assess direct risk to the BCB. The honey bee toxicity data will be used to assess direct risk to the VELB. RQs for small insects and Lepidoptera species for acephate and its major degradate, methamidophos, are shown in Table 5-24 and Table 5-25.

Acute RQs exceed the listed species LOC (0.05) for terrestrial invertebrates for both acephate and methamidophos for all scenarios and both species. Based on these results, acephate does have the potential to directly affect the BCB and VELB. Additionally, there is a potential for indirect effects to those listed species that rely on terrestrial invertebrates as prey items during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, SMHM, SJKF, and CTS (all DPS)).

Table 5-24. Acute RQs for Terrestrial Invertebrate Exposure to Acephate

Use (Application Rate)	Small Insect RQ*[,1]	Lepidoptera RQ*[,2]
Fallow land (0.1245 lb a.i./A)	**1.8**	**0.83**
Cauliflower/celery/mint/peppers (1 lb a.i./A)	**26**	**12**
Citrus (4 lb a.i./A)	**129**	**59**
Ornamental shrub & vines (32 lb a.i./A)	**2049**	**947**

*LOC exceedances (RQ ≥ 0.05) are bolded and shaded.
[1] Based on EEC and Honey bee acute contact LD_{50} = 9.4 µg/g bw (Direct effects to VELB)
[2] Based on EEC and Soybean looper larvae acute contact LD_{50} = 20.34 µg/g bw (Direct effects to BCB)

Table 5-25. Acute RQs for Terrestrial Invertebrate Exposure to Methamidophos

Use (Application Rate)	Small Insect RQ*[,1]	Lepidoptera RQ*[,2]
Fallow land (0.096 lb a.i./A)	**1.2**	**1.7**
Cauliflower/celery/mint/peppers (0.77 lb a.i./A)	**17**	**24**
Citrus (3.0 lb a.i./A)	**74**	**106**
Ornamental shrub & vines (25 lb a.i./A)	**1135**	**1630**

*LOC exceedances (RQ ≥ 0.05) are bolded and shaded.
[1] Based on EEC and Honey bee acute contact LD_{50} = 10.7 µg/g bw (Direct effects to VELB)
[2] Based on EEC and Western spruce budworm larvae acute contact LD_{50} = 7.45 µg/g bw (Direct effects to BCB)

5.1.2.d. 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 BCB and the VELB have an obligate relationship with specific dicot plant species, the seedling emergence and vegetative vigor NOAEC for dicots are used to calculate RQs for indirect effects to these species via potential effects to dicots. No definitive EC_{25} data are available for terrestrial plants for either acephate or methamidophos. RQs for terrestrial plants exposed to acephate based on NOAEC data are shown in Table 5-26. Toxicity data for acephate's effects on monocots and dicots are identical, so these data are shown in one table. No Tier II toxicity data is available for methamidophos so no RQ values were calculated for the degradate.

RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario for semi-aquatic areas. Based on these results, acephate is not likely to indirectly affect the BCB and VELB because their habitats do not include semi-aquatic areas. Acephate's short half-life makes it unlikely that a significant amount would reach semi-aquatic areas.

While indirect effects to endangered species with non-obligate relationships with terrestrial plants are generally assessed using EC_{25} data, this data is not available for acephate so the RQs derived from the reported NOAEC values are considered here. This results in a more conservative assessment of risk. Based on these RQ values, there may be a potential for indirect effects to those listed species that rely on semi-aquatic plants during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, SMHM, and CTS).

The NOAEC values used in the RQ calculations for terrestrial plants are based on the highest application rates tested; no LOAEC values are available. Therefore, the RQ values presented here are a conservative estimate. No effects were seen on any plants, aquatic or terrestrial, in the available toxicity studies. Acephate's neurotoxic mode of action does not apply to plant physiology so effects on plants would not be expected, though data are still needed to confirm this. Additionally, acephate has been used as an agricultural insecticide on a wide variety of crops for decades, indicating its absence of negative effect on these crops. However, terrestrial plant incidents with acephate have been reported, and residues have been document after initial application, so risk should not be summarily discounted (Section 4.5).

Table 5-26. RQs for Terrestrial Plants Inhabiting Dry and Semi-Aquatic Areas Exposed to Acephate via Runoff and Drift

Use	Application rate (lbs a.i./A)	Application method	Drift Value (%)	Spray drift RQ*,[1]	Dry area RQ*,[1]	Semi-aquatic area RQ*,[1]
Fallow land	0.1245	Aerial	5	<0.1	<0.1	<0.1
Cauliflower/celery/mint/peppers	1	Aerial	5	<0.1	<0.1	0.14
Citrus	4	Airblast	5	<0.1	0.1	0.56
Ornamental shrub & vines	32	Ground	1	<0.1	0.48	**4.12**

*LOC exceedances (RQ ≥ 1) are bolded and shaded.

[1] Based on EEC and monocot and dicot seedling emergence and vegetative vigor NOAEC = 3.96 lb a.i./A.

5.1.3. Primary Constituent Elements of Designated Critical Habitat

For acephate use, 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 effects 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 a preliminary 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 based on analysis of risk quotients and a comparison to the Level of Concern (LOC). The final No Effect/May Affect determination is made after the spatial analysis is completed at the end of the risk description, Section 5.2.9. In Section 5.2.9, a discussion of any potential overlap between areas where potential usage may result in LAA effects and areas where species are expected to occur (including any designated critical habitat) is presented. If there is no overlap of the species habitat and occurrence sections with the Potential Area of LAA Effects a No Effect determination is made.

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 preliminary "no effect" determination is made, based on acephate'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 acephate. Based on this risk estimation process described above, all species in this assessment, the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF, have a preliminary "may affect" determination. A summary of the risk estimation results are provided in Table 5-27 for direct and indirect effects to the listed species assessed here and in Table 5-28 for the PCEs of their designated critical habitat.

Table 5-27. Risk Estimation Summary for Acephate – Direct and Indirect Effects

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
Freshwater Fish and Aquatic-phase Amphibians	Non-listed Species (Yes)	FW fish acute and chronic RQs for the degradate (only) exceed the LOCs for listed species for only the highest use; chronic RQs (based on estimated NOAEC values) also exceed for non-listed species for only the highest use.	Indirect Effects: SFGS, CCR, CTS (all DPS) (prey items)
	Listed Species (Yes)		Direct Effects: CTS (all DPS)
Freshwater Invertebrates	Non-listed Species (Yes)	RQs exceed the LOCs for listed and non-listed species for many uses.	Indirect Effects: SFGS, CCR, CTS (all DPS), CFWS (prey items)
	Listed Species (Yes)		Direct Effects: CFWS

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
Estuarine/Marine Fish	Non-listed Species (No) Listed Species (Yes)	No acute RQs exceed the LOC for non-listed species. Acute RQs for the degradate exceed the LOC for listed species. Insufficient data to determine chronic RQs.	<u>Indirect Effects</u>: CCR (prey items)
Estuarine/Marine Invertebrates	Non-listed Species (Yes) Listed Species (Yes)	Acute RQs for the degradate and the parent exceed the LOC for listed and non-listed species at the highest use rates. Chronic RQs exceed the LOC for non-listed species for the degradate only.	<u>Indirect Effects</u>: CCR (prey items)
Vascular Aquatic Plants	Non-listed Species (No)	Insufficient data to determine RQs, but weight of evidence suggests that the risk is unlikely.	<u>Indirect Effects</u>: SFGS, SMHM (habitat), CCR, CTS (all DPS), CFWS (food/habitat)
Non-Vascular Aquatic Plants	Non-listed Species (No)		
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes)	All RQs exceed the LOCs for listed and non-listed species at all but the lowest use rates (fallow land).	<u>Indirect Effects</u>: SFGS, CCR, SJKF (prey items), SMHM (rearing sites)
	Listed Species (Yes)		<u>Direct Effects</u>: SFGS, CCR, CTS (all DPS)
Mammals	Non-listed Species (Yes)	All RQs exceed the LOCs for listed and non-listed species at all but the lowest use rate (fallow land).	<u>Indirect Effects</u>: CCR, SJKF (prey items), SFGS,CTS (all DPS) (prey/habitat), SMHM (rearing sites)
	Listed Species (Yes)		<u>Direct Effects</u>: SMHM, SJKF
Terrestrial Invertebrates	Listed Species (Yes)	RQs exceed the listed species LOC at all use rates.	<u>Indirect Effects</u>: SFGS, CCR, SMHM, SJKF, CTS (all DPS) (prey items)
			<u>Direct Effects</u>: BCB, VELB
Terrestrial Plants - Monocots	Non-listed Species (No)	RQs exceed the LOC for listed species with obligate relationships at the highest use rate for semi-aquatic plants only. However, plants that BCB and VELB are obligate with do not inhabit that environment. Insufficient data to determine RQs for non-listed species or listed species without obligate relationships.	<u>Indirect Effects</u>: SFGS, CTS (all DPS) (habitat), CCR, SMHM, SJKF, CFWS (food/habitat), BCB, VELB (obligate, food/habitat)
Terrestrial Plants - Dicots	Non-listed Species (No)		
	Listed Species (Yes)		

Table 5-28. Risk Estimation Summary for Acephate – Effects to Designated Critical Habitat (PCEs)

Taxa	LOC Exceedances (Yes/No)	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 (Yes) Listed Species (Yes)	FW fish acute and chronic RQs for the degradate (only) exceed the LOCs for listed species for only the highest use; chronic RQs (based on estimated NOAEC values) also exceed for non-listed species for only the highest use.	CTS-CC, CTS-SB
Freshwater Invertebrates	Non-listed Species (Yes)	RQs exceed the LOCs for listed and non-listed species for many uses.	CTS-CC, CTS-SB
Estuarine/Marine Fish	Non-listed Species (No) Listed Species (Yes)	No acute RQs exceed the LOC for non-listed species. Acute RQs for the degradate exceed the LOC for listed species. Insufficient data to determine chronic RQs.	None
Estuarine/Marine Invertebrates	Non-listed Species (Yes) Listed Species (Yes)	Acute RQs for the degradate and the parent exceed the LOC for listed and non-listed species at the highest use rates. Chronic RQs exceed the LOC for non-listed species for the degradate only.	None
Vascular Aquatic Plants	Non-listed Species (No)	Insufficient data to determine RQs, but weight of evidence suggests that the risk is unlikely.	None
Non-Vascular Aquatic Plants	Non-listed Species (No)		None
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes) Listed Species (Yes)	All RQs exceed the LOCs for listed and non-listed species at all but the lowest use rates (fallow land).	CTS-CC, CTS-SB
Mammals	Non-listed Species (Yes)	All RQs exceed the LOCs for listed and non-listed species at all but the lowest use rates (fallow land).	CTS-CC, CTS-SB
Terrestrial Invertebrates	Listed Species (Yes)	RQs exceed the LOCs for listed species at all use rates.	CTS-CC, CTS-SB, BCB, VELB
Terrestrial Plants - Monocots	Non-listed Species[1] (No)	RQs exceed the LOC for listed species with obligate relationships at the highest use rate for semi-aquatic plants only. However, plants that BCB and VELB are obligate with do not inhabit that environment. Insufficient data to determine RQs for non-listed	CTS-CC, CTS-SB, BCB, VELB
Terrestrial Plants - Dicots	Non-listed Species (No)		CTS-CC, CTS-SB, BCB, VELB
	Listed Species (Yes)		BCB, VELB

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
		species or listed species without obligate relationships.	

[1] Only non-listed LOCs were evaluated because none of the assessed species have an obligate relationship with terrestrial monocots.

Following a preliminary "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.
- <u>Likelihood of the Effect Occurring</u>: Discountable effects are those that are extremely unlikely to occur.
- <u>Adverse Nature of Effect</u>: 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 5.2.8. 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. These discussions do not consider the spatial analysis. 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 acephate. Finally, in Section 5.2.9, a discussion of any potential overlap between areas of concern and the species (including any designated critical habitat) is presented. If there is no overlap of the species habitat and occurrence sections with the Potential Area of LAA Effects a No Effect determination is made.

5.2.1. Bay Checkerspot Butterfly

5.2.1.a. Direct Effects

Acute and chronic RQ values representing all uses of acephate exceed the listed species LOC for direct effects to the BCB, resulting in a preliminary "may affect" determination. EECs, calculated using T-REX for small insects, would have to be over 15 times lower than the EEC for the lowest use rate of acephate and over 30 times lower based on the toxicity of the degradate, methamidophos, to alleviate concerns of direct effects to listed Lepidoptera species.

Multiple bee kill incidents have been reported for acephate in Washington State with 40-60 colonies killed off per incident, suggesting a risk to non-target terrestrial insects. For more details associated with these incidents, see Appendix K. Open literature studies on bee colonies also demonstrate negative impacts on reproduction and brood survival (see Section 4.3.3.b). Studies on Lepidoptera species focus on target insects for acephate and therefore only provide acute toxicity and efficacy data. While the BCB is not a target pest species, it is in the same order (Lepidoptera) as some target pest species and therefore may be similarly affected by exposure to acephate.

The probability of an individual effect for a BCB is high: between 1 in 2.4 (40%) and 1 in 1.0 (100%) for the full range of acephate application rates. Assuming complete transformation to methamidophos, the probability of individual effect increases to 1 in 1.0 (100%) (Table 4-9). These probabilities are calculated based on the acute RQs and the probit slope calculated in the most sensitive Lepidoptera acute contact toxicity studies.

The collection of Lepidoptera studies with usable, definitive acute contact toxicity endpoints for both acephate and methamidophos was sufficiently robust to use these endpoints to quantitatively assess toxicity to the BCB. Acute contact LD_{50}s for acephate ranged from 20.34 µg/g bw for soybean looper larvae (*P. includes*) to 76.1 µg/g bw for Douglas-fir tussock moth larvae (*H. pseudotsugata*) (MRID 48650402, ECOTOX 73702, Ottens *et al*., 1984; ECOTOX 53649, Robertson & Lyon, 1973). Acute contact LD_{50}s for methamidophos ranged from 7.45 µg/g bw for Western spruce budworm larvae (*C. occidnetalis*) to 85.7 µg/g bw for tobacco budworm larvae (*H. virescens*) (MRID 48650403, ECOTOX 153300, Mohamad & Oloffs, 1987; ECOTOX 152802, Rose & Sparks, 1984).

One major uncertainty in the indirect risk picture for the BCB is due to the systemic nature of acephate. Acephate is taken up by plant roots and incorporated into plant tissues. While the plant itself may not be affected, acephate may be present in pollen and nectar of flowering plants exposed to acephate. Therefore, feeding on nectar of plants exposed to acephate through agricultural use or spray drift could result in exposure to the BCB. Measurements of acephate in nectar would be needed in order to quantify this potential exposure pathway.

Based on the weight of evidence presented here, there is a potential for direct effects to the BCB as a result of acephate uses.

5.2.1.b. Indirect Effects

The BCB relies on terrestrial dicot plants exclusively for both food and habitat and have an obligate relationship with dicots. Eggs are laid on a native plantain, which the larvae feed upon; if this food is not sufficient for development the larvae may move onto owl's clover. The adult butterflies live on nectar, feeding on a variety of plants. The BCB inhabits grasslands on serpentine soils, such as the Montara soil series; populations now remain only in San Mateo and Santa Clara counties.

RQs exceed the LOC for terrestrial plants only for the highest use scenario for semi-aquatic areas. No adverse effects were seen on terrestrial plants at the highest concentration tested in the study submitted to the Agency, *i.e.*, no LOAEC was established, so the RQs are conservative estimates. Based on these results, acephate is not likely to indirectly affect the BCB because its habitat does not include semi-aquatic areas. RQs are based on seedling emergence and vegetative vigor studies with acephate using monocots and dicots. Only Tier I data is available for methamidophos, so RQs are not calculated for the degradate. No effects were seen in the Tier I study using methamidophos on monocots or dicots. The neurotoxic mode of action of both acephate and methamidophos, like other organophosphate insecticides, is not applicable to plant physiology.

Many major and minor terrestrial plant incidents with acephate have been reported. However, all incidents where details are available involved the direct application of acephate products to ornamental plants. There are 453 minor plant incidents for which little information is available. Therefore, although plant damage may occur from direct application, effects to non-target plants are not expected to result in indirect effects to the BCB. For more details associated with these incidents, see Appendix K.

Based on the weight of evidence presented here, acephate is not likely to indirectly affect the BCB.

5.2.1.c. Modification of Designated Critical Habitat

Based on the assessment of direct and indirect effects to the BCB above, the modification of designated critical habitat for the BCB may occur.

5.2.2. Valley Elderberry Longhorn Beetle

5.2.2.a. Direct Effects

Acute and chronic RQ values representing all uses of acephate exceed the listed species LOC for direct effects to the VELB, resulting in a preliminary “may affect” determination. EECs, calculated using T-REX for small insects, would have to be over 30 times lower than the EEC for the lowest use rate of acephate to alleviate concerns of direct effects to the VELB.

Multiple bee kill incidents have been reported for acephate in Washington State with 40-60 colonies killed off per incident, suggesting a risk to non-target terrestrial insects. For more details associated with these incidents, see Appendix K. Open literature studies on bee colonies also demonstrate negative impacts on reproduction and brood survival (see Section 4.3.3.b). Studies on Coleoptera species focus on target insects for acephate and therefore provide mainly efficacy data as well as some acute toxicity data. While the VELB is not a target pest species, it is in the same order (Coleoptera) as some target pest species.

Three acute Coleoptera acephate studies were identified using adult boll weevils, adult coffee bean weevils, and mealybug destroyers. The first two studies tested acute contact toxicity using a direct topical application and found LD_{50}s of >5700 µg/g bw and >300 µg/g bw, respectively. The mealybug destroyer study used a foliar residue design and found a 48 hr LD_{50} of 988 mg/l (MRID 48650403, ECOTOX 153300, Mohamad & Oloffs, 1987). One acute Coleoptera methamidophos study was identified using the adult boll weevil. This study tested acute contact toxicity using a direct topical application and found an LD_{50} of 128.6 µg/g bw.

Because the collection of Coleoptera studies with usable, definitive acute toxicity endpoints is small and there is no EPA guideline to serve as a standard, these endpoints are not used to quantitatively assess toxicity of acephate and methamidophos to the VELB. The studies described above demonstrate much lower toxicity of acephate and methamidophos to some Coleoptera species than the toxicity to honey bees, the surrogate species for terrestrial insects. Thus, determinations of direct risk here may be conservative and overestimate the true risk to the VELB. However, the studies on Coleoptera species were all performed on adults, which would likely demonstrate lower toxicity of acephate than studies on Coleoptera larvae.

The probability of an individual effect for a VELB based on surrogate species data is high: 1 in 1.0 (100%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the acute RQs and the probit slope calculated in the most sensitive honey bee acute contact toxicity studies. Using acute RQs derived from the LD_{50} of 128.6 µg/g bw for the adult boll weevil exposed to methamidophos and the associated probit slope of 2.97 as a comparison to the surrogate species data, the probability of an individual effect is 1 in 654 (0.15%) for the lowest application rate but remains 1 in 1.0 (100%) for moderate and high application rates including citrus, golf courses, sod farms, fire ants, roses, ornamentals, and ornamental shrub & vines.

Like for the BCB, the systemic nature of acephate presents an uncertainty in the indirect risk assessment to the VELB. While the elderberry itself may not be affected by acephate exposure, acephate may be present in the tissues, leaves, and berries of any plants exposed via spray drift. Therefore, feeding on the plant could result in exposure to the VELB. Measurements of acephate in elderberry trees or other similar species would be needed in order to quantify this potential exposure pathway.

Based on the weight of evidence presented here, there is a potential for direct effects to the VELB as a result of acephate uses.

5.2.2.b. Indirect Effects

The VELB is associated with riparian elderberry trees during its entire life cycle and relies on these trees for both food and habitat. The VELB has an obligate relationship with the elderberry trees. Females lay their eggs on the bark and larvae hatch and burrow into the stems. The larval stage may last 2 years, after which the larvae enter the pupal stage and transform into adults.

RQs exceed the LOC for terrestrial plants only for the highest use scenario for semi-aquatic areas. No adverse effects were seen on terrestrial plants at the highest concentration tested in the study submitted to the Agency, *i.e.*, no LOAEC was established, so the RQs are conservative estimates. Based on these results, acephate is not likely to indirectly affect the VELB because its habitat does not include wetland areas. RQs are based on seedling emergence and vegetative vigor studies with acephate using monocots and dicots. Only Tier I data is available for methamidophos, so RQs are not calculated for the degradate. No effects were seen in the Tier I study using methamidophos on monocots or dicots. The neurotoxic mode of action of both acephate and methamidophos, like other organophosphate insecticides, is not applicable to plant physiology.

Many major and minor terrestrial plant incidents with acephate have been reported. However, all incidents where details are available involved the direct application of acephate products to ornamental plants. There are 453 minor plant incidents for which little information is available. Therefore, although plant damage may occur from direct application, effects to non-target plants such as the elderberry tree are not expected to result in indirect effects to the VELB. For more details associated with these incidents, see Appendix K.

Based on the weight of evidence presented here, acephate is not likely to indirectly affect the VELB.

5.2.2.c. Modification of Designated Critical Habitat

Based on the assessment of direct and indirect effects to the VELB above, the modification of designated critical habitat for the VELB may occur.

5.2.3. California Tiger Salamander (All 3 DPS)

5.2.3.a. Direct Effects

Aquatic-phase

Direct effects to the aquatic-phase CTS are estimated based on acute and chronic toxicity data from aquatic-phase amphibians and freshwater fish. The aquatic-phase includes life stages of the CTS that are obligatory aquatic organisms, including eggs and larvae. It also includes submerged terrestrial-phase juveniles and adults, which spend a portion of their time in water bodies that may receive runoff and spray drift containing acephate and methamidophos.

Acute or chronic RQ values representing the aquatic-phase CTS exceed the listed species LOC for direct effects to the aquatic-phase CTS only for the single highest use rate of acephate when assuming complete transformation to the degradate, methamidophos. Because this exceedance is only for one out of 30 uses modeled and because existing data for aquatic-phase amphibians suggest that they are less sensitive to acephate than are freshwater fish (Table 4-1), this risk is considered discountable and a preliminary "may effect" but "not likely to adversely affect" determination is made.

Although there are reported fish kill incidents for acephate, these incidents report acephate applied in combination with other pesticides. Therefore, it is not possible to determine which pesticide primarily caused the incident. There are 11 minor "fish and wildlife" incidents reported for acephate, but it is not known whether these were aquatic or terrestrial incidents. For more details associated with these incidents, see Appendix K.

Several studies have found no significant adverse effects on fish from acephate applications (Boscor, 1975, MRID 14637; Geen, 1981; Rabeni, 1979, MRID 14547; Schoettger, 1976, MRID 14861). One study found that >70% ChE inhibition is needed to achieve poisoning by acephate or methamidophos to rainbow trout and also noted persistent ChE depression in the brain following exposure (Zinkl, 1987). The study predicted but did not observe sublethal neurological effects as a result of this prolonged ChE depression.

Acute toxicity studies on aquatic-phase amphibians found acephate to be practically non-toxic to green frog larvae/tadpoles and the Northwestern salamander (MRIDs 00093943, 05019255, Lyons, 1976; ECOTOX 11134, Geen, 1984). A behavior bioassay on the green frog larvae found no effects at concentrations up to 500 ppm and another study on the same species (MRID 44042901, Hall, 1980) observed no signs of toxicity or bio-accumulation at concentrations up to 5 ppm. Exposure of Northwestern salamander egg masses to acephate concentrations of 798 ppm did not result in any effects on the time of hatching.

The probability of an individual effect for an aquatic-phase CTS based on aquatic-phase amphibian data and acute RQs is between 1 in 1.6E+273 and 1 in 3.7E+70 for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the acute RQs and the default probit slope of 4.5. Using the data-derived slope of 9.2 and RQs from the LD_{50} of 25 mg/L for rainbow trout exposed to methamidophos, the most sensitive endpoint, the probability of an individual effect is between 1 in 4.5E+281 and 1 in 1 in 2.0E+44.

Based on the weight of evidence presented here, acephate is not likely to directly affect the aquatic-phase CTS as a result of acephate uses except for the highest use rate on commercial lawn areas when assuming complete transformation to methamidophos and using freshwater fish toxicity data as a surrogate for aquatic-phase amphibians. For this use, acephate may effect but is unlikely to adversely affect the aquatic-phase CTS. Acephate toxicity data for aquatic-phase amphibians suggest that they are less sensitive to acephate than are freshwater fish and this pattern is expected to hold for the degradate.

Terrestrial-phase

Potential for direct effects to the terrestrial-phase CTS are assessed based on direct acute and chronic toxicity effects to birds as a surrogate due to a lack of toxicity data for terrestrial-phase amphibians. Acute and chronic RQ values representing all uses of acephate exceed the listed species LOC for direct effects to the terrestrial-phase CTS, resulting in a preliminary "may affect" determination. EECs, calculated using T-REX for small birds, would have to be over 40 times lower than the EEC for the lowest use rate of acephate and over 60 times lower based on the toxicity of the degradate, methamidophos, to alleviate concerns of direct effects to the terrestrial-phase CTS.

A refinement of the acute and chronic risks posed to the terrestrial-phase CTS was performed using the T-HERPS model. Avian RQ values used as screening surrogates for terrestrial-phase amphibians likely overestimate risks to amphibians. Overestimation is due to the higher energy requirements of birds over amphibians of the same body weight, which results in a higher daily food intake rate value and a resultant higher dose-based exposure for birds than would occur for an amphibian of the same body weight (see Section 3.3.1.b for more detail). The T-HERPS model refines the EEC and RQ values based on dietary intake rate of an amphibian, rather than a dietary intake rate of an avian. Acute and chronic RQs show a slight decrease when modeled in T-HERPS, but remain above the listed species LOC for all use scenarios. Model results from T-HERPs are from the most sensitive RQs, medium amphibians (20 g) consuming herbivorous mammals.

Major incidents involving acephate use and bird kills have been reported. An incident in South Carolina in 1998 involved 24 dead boat-tailed grackles. The birds were collected and methamidophos residues found within them were attributed to acephate use on fire ants. A similar incident in Georgia in 2005 involved 50 boat-tailed grackles found dead. Acephate had been used in the area to control fire ants and acephate residues were found within some of the birds. There are 11 minor "fish and wildlife" incidents reported for acephate, but it is not known whether these were aquatic or terrestrial incidents. For more details associated with these incidents, see Appendix K. No incidents have been reported involving terrestrial-phase amphibians.

Studies of sublethal effects of acephate exposure to avian species focus largely on cholinesterase (ChE) inhibition and behaviors surrounding this mode of action. Findings of these laboratory and field studies include significant ChE inhibition at environmentally relevant concentrations in a variety of bird species and observations of signs of sublethal toxic effects, including effects to reproduction. No open literature studies on the effects of acephate or methamidophos on terrestrial-phase amphibians have been identified.

The probability of an individual effect for a terrestrial-phase CTS based on avian toxicity data is between 1 in 42 (2.4%) and 1 in 1.0 (100%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the most sensitive acute RQs and the associated probit slope of 5.4. Using a slope of 4.6 and acute RQs derived from the most sensitive avian methamidophos study, the probability of an individual effect increases to 1 in 1.0 (100%) for all uses.

Based on the weight of evidence presented here, there is a potential for direct effects to the terrestrial-phase CTS as a result of acephate uses.

5.2.3.b. Indirect Effects

i. Potential Loss of Prey

CTS larvae are only able to eat small crustaceans, algae, and mosquito larvae. When they are large enough, they begin to consume aquatic insects, invertebrates and tadpoles of Pacific treefrogs, California red-legged frogs, western toads, and spadefoot toads. The terrestrial-phase CTS feeds on terrestrial invertebrates, insects, frogs, worms, and small mammals. Indirect effects to the CTS via loss of prey species are evaluated using toxicity data and other information gathered on freshwater invertebrates, freshwater fish, terrestrial invertebrates, and small mammals.

Freshwater Invertebrates

Acute RQs exceed the acute risk non-listed species LOC (0.5) for direct effects to freshwater invertebrates for 4 of the 30 uses assessed based on the peak EECs calculated using PRZM-EXAMS and toxicity values for acephate. Assuming complete transformation to the degradate, methamidophos, acute RQs exceed the non-listed species LOC (0.5) for 20 of the 30 uses. Chronic RQs exceed the LOC (1.0) for freshwater invertebrates for 1 of 30 uses assessed for acephate and 21 of 30 uses assessed based on the toxicity of methamidophos (using 21-day EECs).

Multiple studies in the open literature demonstrate lethal and sublethal toxicity of acephate to a variety of freshwater invertebrates (see Appendix G for a complete list). In one study, backswimmer (Notonectidae) ChE exposed to methamidophos *in vitro* remained inhibited in a phosphorylated state for at least 4 hours (ECOTOX 37219, Hussain *et al*., 1985). A previous study demonstrated the rapid conversion of acephate to methamidophos in the backswimmer (ECOTOX 11371, Hussain *et al*., 1984). The authors suggested that aquatic insects and fish that are exposed to acephate or methamidophos may not recover by spontaneous reactivation of acetylcholinesterase (AChE) and may therefore be stressed for some time because of physiological effects caused by inhibition of AChE.

The probability of an individual effect for a freshwater invertebrate is between 1 in 3.2E+10 and 1 in 2.2 (50%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the most sensitive acute RQs and the associated probit slope of 1.6. Using the data-derived slope of 4.9 and acute RQs from the most sensitive freshwater invertebrate methamidophos study, the probability of an individual effect increases to between 1 in 9.7E+39 and 1 in 1.0 (100%).

Based on the LOC exceedances and individual effect probabilities, indirect effects are anticipated to the CTS based on risk to freshwater invertebrate prey under the exposure scenarios evaluated in this assessment.

Freshwater Fish

There is no evidence in the literature that the aquatic-phase CTS consume fish. However, indirect effects to CTS through direct effects to fish (prey items) were considered in this assessment as CTS eats other aquatic vertebrates such as frogs, and fish serve as surrogates for frogs (aquatic-phase amphibians).

As detailed in the CTS direct effects section above (5.2.3.a), no acute RQ values representing any uses of acephate exceed the LOCs for effects to non-listed freshwater fish and the chronic RQ exceeds the LOC for only the highest use when assuming complete transformation to methamidophos. The probability of an individual effect was low such that effects to animals that depend on fish are considered discountable. Incident reports and open literature studies on the effects of acephate on freshwater fish also do not raise any concerns about potential risks. Therefore, no indirect effects are anticipated to the CTS based on this prey component (aquatic-phase amphibians – frogs).

Terrestrial Invertebrates

As detailed in the BCB and VELB direct effects sections above (5.2.1.a and 5.2.2.a), toxicity of acephate and methamidophos to terrestrial invertebrates is high. Acute RQs exceed the listed species LOC for all use scenarios and the probability of an individual effect is close to 100% (1 in 1.0) for all scenarios. There is no LOC defined for non-listed terrestrial invertebrates. However, the EECs, calculated using T-REX for small insects, would have to be over 15 times lower than the EEC for the lowest use rate of acephate and over 30 times lower based on the toxicity of the degradate, methamidophos, to alleviate concerns of direct effects to listed species, indicating high toxicity.

Incident reports and open literature studies on the effects of acephate to honey bees also demonstrate negative impacts on survival, reproduction, and behavior in field and laboratory situations. Multiple bee kill incidents have been reported for acephate in Washington State with 40-60 colonies killed off per incident, suggesting a risk to non-target terrestrial insects. For more details associated with these incidents, see Appendix K. Open literature studies on bee colonies also demonstrate negative impacts on reproduction and brood survival (see Section 4.3.3.b). One study demonstrated moderate toxicity of acephate to earthworms (ECOTOX 40531, Roberts and Dorough, 1983). Therefore, indirect effects are anticipated to the CTS based on risk to terrestrial invertebrate prey if acephate is used in close proximity to CTS habitat.

Small Mammals

Acute and chronic RQs calculated in T-REX exceed the non-listed species LOC for direct effects to small mammals for all but the lowest use scenario for acephate. Assuming complete transformation to the degradate, methamidophos, acute and chronic RQs exceed the non-listed species LOC for all use scenarios. EECs, calculated using T-REX for small mammals consuming short grass, would have to be two times lower than the EEC for the lowest use rate of acephate, assuming complete transformation to methamidophos, to alleviate concerns of direct effects to non-listed small mammals.

No incidents are reported involving acephate exposure and mammals. There are 11 minor “fish and wildlife” incidents reported for acephate, but it is not known whether these were aquatic or terrestrial incidents. Open literature studies on squirrels and mice exposed to acephate demonstrate ChE inhibition in the brain and skeletal muscle (ECOTOX 87471, Farag, 2000; ECOTOX 87472, Farag, 2000; MRID 40329701, ECOTOX 39518, Zinkl, 1980). Reproductive toxicity to mice is evident following exposure to either males or females. Exposure to males resulted in a decreased number of implantations and live fetuses, and an increased number of early resorptions as well as decreased sperm motility and count (ECOTOX 87471, Farag, 2000). Exposure to females resulted in decreased body weight during gestation, and decreased absolute and relative brain weight. Placental weight was also decreased and liver weight was increased. Maternal exposure to acephate during organogenesis significantly affected the number of implantations, number of live fetuses, number of early resorptions, mean fetal weight, and the incidence of external and skeletal malformations (ECOTOX 87472, Farag, 2000). All of these effects were seen at doses of 28 mg/kg/day and some at 14 mg/kg/day. The acephate EECs for small mammals consuming short grass, calculated in T-REX, varied between 28.49 mg/kg/day for the lowest use scenario and 32,663 mg/kg/day for the highest use scenario. Therefore, the reproductive effects seen in these studies are relevant. A study by Stehn (ECOTOX 35459, 1976) reported increased ingestion of arthropods by insectivorous mammals following acephate application. This signified a direct pathway for substantial exposure to acephate due to consumption of dead and dying insects, thereby potentially increasing exposure for small mammals.

The probability of an individual effect for a small mammal is between 1 in 9.1E+08 and 1 in 1.0 (100%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the most sensitive acute RQs and the associated slope of 5.18. Using a slope of 13 and acute RQs derived from the most sensitive small mammal methamidophos study, the probability of an individual effect increases to between 1 in 26 (3.8%) and 1 in 1.0 (100%).

Based on the LOC exceedances, individual effect probabilities, and open literature data, indirect effects are anticipated to the CTS based on risk to small mammal prey items.

ii. Potential Modification of Habitat

The CTS inhabits low elevation vernal pools and seasonal ponds and associated grassland, oak savannah, and coastal scrub plant communities. Juvenile and adult CTS spend the dry summer and fall months in the burrows of California ground squirrels (*Spermophilus beecheyi*) and Botta’s pocket gopher (*Thomomys bottae*). The CTS cannot dig their own burrows, and as a result their presence is associated with active burrows of these small mammals. Indirect effects to the CTS through potential modification of habitat are evaluated based on impacts of acephate on aquatic plants, terrestrial plants, and small mammals.

Aquatic Plants

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

As discussed in Section 5.1.1.e, the weight of evidence suggests that the risk to aquatic plants from exposure to acephate and its degradate, methamidophos, is unlikely. Further, the neurotoxic mode of action of both acephate and methamidophos, like other organophosphate insecticides, is not applicable to plant physiology. Therefore, no indirect effects are anticipated to the CTS based on this habitat component.

Terrestrial 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.

As discussed previously in Section 5.2.1.b, the weight of evidence suggests that effects to plants directly treated with acephate may occur. However, the level of effect is not anticipated to result in indirect effects to the CTS. The potential for off-site movement of acephate is reduced somewhat by its short environmental half-life. Therefore, the weight of evidence suggests that indirect effects are not anticipated to the CTS based on effects to terrestrial plants within its habitat.

Small Mammals

Juvenile and adult CTS rely on the burrows of small mammals for habitat in the dry summer and fall months.

As detailed in the CTS prey impacts discussion above, toxicity of acephate and methamidophos to small mammals is high. Acute and chronic RQs exceed the non-listed LOCs for direct effects to small mammals for all but the lowest use scenario (fallow land) for acephate and for all use scenarios for methamidophos. The probability of an individual effect is close to 100% for all moderate and high use scenarios including beans, cauliflower, celery, peppers, lettuce, citrus, golf courses, ornamental shrub & vines, and others. Open literature studies on the effects of acephate to small mammals also demonstrate negative impacts on nervous system function and reproduction. Based on the LOC exceedances, individual effect probabilities, and open literature data, indirect effects are anticipated to the CTS based on risk to small mammal-created habitat under exposure scenarios evaluated.

5.2.3.c. Modification of Designated Critical Habitat

Based on the assessment of indirect effects to the CTS via effects on small mammals in Section 5.2.3.b, the modification of designated critical habitat for the CTS-CC and CTS-SB may occur. There is no designated critical habitat for the CTS-SC.

5.2.4. California Clapper Rail

5.2.4.a. Direct Effects

Potential for direct effects to the CCR are assessed based on direct acute and chronic toxicity effects to birds. Acute and chronic RQ values representing all uses of acephate exceed the LOCs for direct effects to the CCR, resulting in a preliminary "may affect" determination. EECs, calculated using T-REX for small birds, would have to be over 40 times lower than the EEC for the lowest use rate of acephate and over 60 times lower assuming complete transformation to the degradate, methamidophos, to alleviate concerns of direct effects to the CCR.

Major incidents involving acephate use and bird kills have been reported. An incident in South Carolina in 1998 involved 24 dead boat-tailed grackles. The birds were collected and methamidophos residues found within them were attributed to acephate use on fire ants. A similar incident in Georgia in 2005 involved 50 boat-tailed grackles found dead. Acephate had been used in the area to control fire ants and acephate residues were found within some of the birds. There are 11 minor "fish and wildlife" incidents reported for acephate, but it is not known whether these were aquatic or terrestrial incidents. For more details associated with these incidents, see Appendix K.

Studies of sublethal effects of acephate exposure to avian species focus largely on cholinesterase (ChE) inhibition and behaviors surrounding this mode of action. Findings of these laboratory and field studies include significant ChE inhibition in a variety of bird species and observations of signs of sublethal toxic effects, including effects to reproduction. No open literature studies on the effects of acephate or methamidophos on terrestrial-phase amphibians have been identified.

The probability of an individual effect for a CCR based on avian toxicity data is between 1 in 42 and 1 in 1.0 (100%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the most sensitive acute RQs and the associated probit slope of 5.4. Using a slope of 4.6 and acute RQs derived from the most sensitive avian methamidophos study, the probability of an individual effect increases to 1 in 1.0 (100%) for all uses.

Based on the weight of evidence presented here, there is a potential for direct effects to the CCR as a result of acephate uses.

5.2.4.b. Indirect Effects

i. Potential Loss of Prey

The CCR are generalist and opportunistic feeders that forage at the upper end of marshes, along the ecotone between mudflat and higher vegetated zones, and in tidal sloughs. Mussels, clams, arthropods, snails, worms and small fish are its preferred foods, which it retrieves by probing and scavenging the surface while walking. The bird will only forage on mudflats or very shallow water where there is taller plant material nearby to provide protection at high tide. Although CCRs typically consume invertebrates, they have also been known to occasionally consume small birds and mammals, including the salt marsh harvest mouse. The CCR diet may contain up to 15% plant material.

Indirect effects to the CCR via loss of prey species and plant foods are evaluated using toxicity data and other information gathered on freshwater fish, freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrates, aquatic plants, birds, small mammals, terrestrial invertebrates, and terrestrial plants.

Freshwater Fish

As detailed in the CTS direct effects section above (5.2.3.a), no acute RQ values representing any uses of acephate exceed the LOCs for effects to non-listed freshwater fish and the chronic RQ exceeds the LOC for only the highest use when assuming complete transformation to methamidophos. The probability of an individual effect did not exceed 1 in 2.5E+40. Incident reports and open literature studies on the effects of acephate on freshwater fish also do not raise any concerns about potential risks. Therefore, no indirect effects are anticipated to the CCR based on this prey component.

Freshwater Invertebrates

As detailed in the CTS indirect effects section above (5.2.3.b), acute and chronic RQs exceed the non-listed species LOCs for approximately 10% of uses when not accounting for the effects of the degradate, methamidophos, and approximately 70% of the uses when assuming complete transformation to the degradate. Multiple studies in the open literature demonstrate lethal and sublethal toxicity of acephate to a variety of freshwater invertebrates (see Appendix G for a complete list). Therefore, indirect effects are anticipated to the CCR based on this prey component.

Estuarine/Marine Fish

No acute RQ values representing any uses of acephate exceed the non-listed species LOC (0.5) for estuarine/marine fish. The acute RQs exceed the listed species LOC (0.05) for 6 of the 30 use scenarios. There are no chronic RQs due to a lack of chronic toxicity data for estuarine/marine fish. Peak EECs, calculated using PRZM-EXAMS, would have to be nearly four times higher than the highest aquatic peak EEC to trigger concerns of impacts on non-listed estuarine/marine fish based on the most sensitive relevant endpoint - the toxicity of the degradate, methamidophos, to estuarine/marine fish.

If the same acute-to-chronic ratio used for freshwater fish, 144 (Section 4.2.1.b), is applied to estuarine/marine fish, the estimated chronic toxicity value would be 0.59 mg/L for acephate and 0.039 mg/L for methamidophos. These values would result in exceedance of the chronic LOC for seven uses for methamidophos (fire ants, golf courses, sod farms, roses, ornamentals, ornamental shrub & vines, and commercial lawn areas) and none for acephate. This approach involves a great deal of uncertainty due to the extrapolation from one chemical to a different chemical and from freshwater fish to estuarine/marine fish. Therefore, these values are not used to quantitatively estimate risk in this assessment but suggest a potential for risk of chronic toxicity to estuarine/marine fish from acephate application.

Although there are reported fish kill incidents for acephate, these incidents report acephate applied in combination with other pesticides. Therefore, it is not possible to determine which pesticide primarily caused the incident. There are 11 minor "fish and wildlife" incidents reported for acephate, but it is not known whether these were aquatic or terrestrial incidents. For more details associated with these incidents, see Appendix K. There are no open literature studies on the effects of acephate on estuarine/marine fish.

The probability of an individual effect for an estuarine/marine fish is low, between 1 in 6.6E+158 and 1 in 2.8E+18 for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the acute RQs and the default probit slope of 4.5. Using the same default slope and RQs derived from methamidophos toxicity data, the probability of an individual effect is between 1 in 9.2E+113 and 1 in 1 in 2.6E+4.

Based on the weight of evidence presented here, indirect effects are not anticipated to the CCR based on this prey component.

Estuarine/Marine Invertebrates

Acute and chronic RQ values exceed the non-listed species LOC for estuarine/marine invertebrates only for the two highest use scenarios (ornamental shrub & vines and commercial lawn areas), assuming complete transformation to methamidophos. For acephate alone, only the acute non-listed species LOC is exceeded and only for the single highest use scenario (commercial lawn areas). Peak EECs would need to be 70% or less of the highest use peak EEC to alleviate concerns of impacts to estuarine/marine invertebrates. The estuarine/marine invertebrate RQs are based on data from a study on pink shrimp (*Penaeus durorarum*). Stomach content analysis of the CCR has found over 60% bivalves – mussels and clams – but no shrimp. Note that using the most sensitive LC_{50} value for a bivalve, Eastern oyster larvae (*Crassostrea virginica*), exposed to acephate in place of the pink shrimp data does not change the outcome of the RQ analysis.

There are no incident reports or open literature studies available on the effects of acephate on estuarine/marine invertebrates; however, incidents on invertebrates are unlikely to be noticed and reported to the Agency.

The probability of an individual effect for an estuarine/marine invertebrate is between 1 in 6.3E+95 and 1 in 390 (0.41%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the acute RQs and the default probit slope of 4.5. Using the same default slope and RQs derived from methamidophos toxicity data, the probability of an individual effect is between 1 in 7.9E+83 and 1 in 4.0 (25%).

Based on the weight of evidence, indirect effects to the CCR based on this prey component are possible. Because LOC exceedances are seen only for the two highest modeled application rates, which each assume 26 applications per year in this assessment, modification of labels to specify number of applications per year and application intervals for labels missing this information could sufficiently affect RQs to eliminate any concern of risk to estuarine/marine invertebrates.

Aquatic Plants

As detailed above (see Section 5.1.1.e), there is little data with which to assess toxicity of acephate to aquatic plants. However, the available non-vascular aquatic plant endpoint shows that toxicity is low.

All available plant toxicity data, aquatic and terrestrial, show that while effects on plants are possible the phytotoxicity of acephate is low and effects are unlikely to rise to a level at which indirect effects to listed species are expected. Therefore, no indirect effects are anticipated to the CCR based on this food component.

Birds

As detailed in the CCR direct effects section above, toxicity of acephate to avian species is high. Acute and chronic RQs for all uses of acephate exceed the LOCs for all use scenarios and the probability of an individual effect is close to 100% (1 in 1.00) for all uses except for the lowest use scenario without accounting for the degradate toxicity. Two major incidents involving acephate use and boat-tailed grackle kills have been reported. Findings of open literature studies demonstrate significant ChE inhibition in a variety of bird species and observations of signs of sublethal toxic effects, including effects to reproduction.

Based on the LOC exceedances, individual effect probabilities, reported incidents, and open literature data, indirect effects are anticipated to the CCR based on risk to small avian prey.

Small Mammals

As detailed in the CTS indirect effects section above (5.2.3.b), toxicity of acephate and methamidophos to small mammals is high. Acute and chronic RQs exceed the listed and non-listed LOCs for direct effects to small mammals for all but the lowest use scenario for acephate and for all use scenarios for methamidophos. The probability of an individual effect is close to 100% for all moderate and high use scenarios. Open literature studies on the effects of acephate to small mammals also demonstrate negative impacts on nervous system function and reproduction. Based on the LOC exceedances, individual effect probabilities, and open literature data, indirect effects are anticipated to the CCR based on risk to small mammal prey.

Terrestrial Invertebrates

As detailed in the BCB and VELB direct effects sections above (5.2.1.a and 5.2.2.a), toxicity of acephate and methamidophos to terrestrial invertebrates is high. Acute RQs exceed the listed species LOC for all use scenarios and the probability of an individual effect is close to 100% (1 in 1.0) for all scenarios. There is no LOC defined for non-listed terrestrial invertebrates. However, the EECs, calculated using T-REX for small insects, would have to be over 15 times lower than the EEC for the lowest use rate of acephate and over 30 times lower assuming complete transformation to the degradate, methamidophos, to alleviate concerns of direct effects to listed species, indicating high toxicity.

Incident reports and open literature studies on the effects of acephate to honey bees also demonstrate negative impacts on survival, reproduction, and behavior in field and laboratory situations. Multiple bee kill incidents have been reported for acephate in Washington State with 40-60 colonies killed off per incident, suggesting a risk to non-target terrestrial insects. For more details associated with these incidents, see Appendix K. Open literature studies on bee colonies also demonstrate negative impacts on reproduction and brood survival (see Section 4.3.3.b). One study demonstrated moderate toxicity of acephate to earthworms (ECOTOX 40531, Roberts and Dorough, 1983). Therefore, indirect effects are anticipated to the CCR based on risk to terrestrial invertebrate prey.

Terrestrial Plants

As detailed in the CTS indirect effects section above (5.2.3.b), RQs exceed the LOC for terrestrial plants only for the highest use scenario for semi-aquatic areas. Acephate's short half-life makes it unlikely that a significant amount would reach semi-aquatic areas. Further, the neurotoxic mode of action of both acephate and methamidophos, like other organophosphate insecticides, is not applicable to plant physiology. Many major and minor terrestrial plant incidents with acephate have been reported. All incidents where details are available involved the direct application of acephate products to ornamental plants. There are 453 minor plant incidents for which little information is available. For more details associated with these incidents, see Appendix K.

The weight of evidence presented above suggests that terrestrial plants that are directly sprayed with acephate products may be affected. However, given the range of the CCR and the relatively limited area of potentially affected terrestrial plants, plant damage is not expected to adversely affect the CCR from reduction in food or habitat in the context of an effects determination. Therefore, no indirect effects are anticipated to the CTS based on this food component.

ii. Potential Modification of Habitat

The CCR inhabits cordgrass marshes around San Francisco Bay. CCR juveniles can disperse a sufficient distance to be found in both residential and agricultural areas east of SF Bay and along the open coast.

Aquatic Plants

As previously discussed the weight of evidence suggests that the risk to aquatic plants from exposure to acephate and its degradate, methamidophos, is unlikely. Therefore, no indirect effects are anticipated to the CCR based on this habitat component.

Terrestrial Plants

The evidence presented above suggests that effects to plants directly treated with acephate may occur. However, the level of effect is not anticipated to result in indirect effects to the CCR. Therefore, the weight of evidence suggests that indirect effects are not anticipated to the CCR based on effects to terrestrial plants within its habitat.

5.2.5. California Freshwater Shrimp

5.2.5.a. Direct Effects

Acute RQs exceed the listed species LOC (0.05) for direct effects to freshwater invertebrates for 9 of the 30 uses assessed based on the peak EECs calculated using PRZM-EXAMS and toxicity values for acephate. Assuming complete transformation to the degradate, methamidophos, acute RQs exceed the listed species LOC for 27 of the 30 uses. Chronic RQs exceed the LOC (1.0) for freshwater invertebrates for 1 of 30 uses assessed for acephate and 21 of 30 uses assessed based on the toxicity of methamidophos (using 21-day EECs).

Multiple studies in the open literature demonstrate lethal and sublethal toxicity of acephate to a variety of freshwater invertebrates including mayfly, stonefly, damselfly, water-boatman, backswimmer, and waterflea (see Appendix G for details). Multiple studies in the open literature demonstrate lethal and sublethal toxicity of acephate to a variety of freshwater invertebrates (see Appendix G for a complete list). In one study, backswimmer (Notonectidae) ChE exposed to methamidophos *in vitro* remained inhibited in a phosphorylated state for at least 4 hours (ECOTOX 37219, Hussain *et al*., 1985). A previous study demonstrated the rapid conversion of acephate to methamidophos in the backswimmer (ECOTOX 11371, Hussain *et al*., 1984). The authors suggested that aquatic insects and fish that are exposed to acephate or methamidophos may not recover by spontaneous reactivation of acetylcholinesterase (AChE) and may therefore be stressed for some time because of physiological effects caused by inhibition of AChE.

The probability of an individual effect for a freshwater invertebrate is between 1 in 3.2E+10 and 1 in 2.2 (50%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the most sensitive acute RQs and the associated probit slope of 1.6. Using the data-derived slope of 4.9 and acute RQs from the most sensitive freshwater invertebrate methamidophos study, the probability of an individual effect increases to between 1 in 9.7E+39 and 1 in 1.0 (100%).

Based on the LOC exceedances and individual effect probabilities, there is a potential for direct effects to the CFWS as a result of acephate uses.

5.2.5.b. Indirect Effects

The CFWS relies on aquatic and terrestrial plants for both food and habitat. The CFWS feeds on decomposing vegetation and other detritus, consuming minute diverse particles conveyed by currents to downstream pools, which includes zooplankton. The CFWS is found only in low elevation perennial streams or intermittent streams with perennial pools in the northern San Francisco Bay Area. Freshwater shrimp require low gradient streams with diverse habitat structure including undercut banks, exposed roots, woody debris and overhanging vegetation. Indirect effects to the CFWS via loss of food and habitat are evaluated using toxicity data and other information gathered on freshwater invertebrates, aquatic plants, and terrestrial plants.

Freshwater Invertebrates

As detailed in the CTS indirect effects section (5.2.3.b), acute and chronic RQs exceed the non-listed species LOCs for approximately 10% of uses when not accounting for the effects of the degradate, methamidophos, and approximately 70% of the uses when assuming complete transformation to the degradate. Multiple studies in the open literature demonstrate lethal and sublethal toxicity of acephate to a variety of freshwater invertebrates (see Appendix G for a complete list). Therefore, indirect effects are anticipated to the CFWS based on this prey component under the exposure scenarios evaluated.

Aquatic Plants

As detailed above (Section 5.1.1.e), there is little data with which to assess toxicity of acephate to aquatic plants. However, the available non-vascular aquatic plant endpoint shows that toxicity is low.

All available plant toxicity data, aquatic and terrestrial, shows that while effects on plants are possible the phytotoxicity of acephate is low and effects are unlikely to rise to a level at which indirect effects to listed species are expected. Therefore, no indirect effects are anticipated to the CFWS based on this food and habitat component.

Terrestrial Plants

As previously discussed, RQs exceed the LOC for terrestrial plants only for the highest use scenario for semi-aquatic areas. Acephate’s short half-life makes it unlikely that a significant amount would reach semi-aquatic areas. Further, the neurotoxic mode of action of both acephate and methamidophos, like other organophosphate insecticides, is not applicable to plant physiology. Many major and minor terrestrial plant incidents with acephate have been reported. However, all incidents where details are available involved the direct application of acephate products to ornamental plants. There are 453 minor plant incidents for which little information is available. For more details associated with these incidents, see Appendix K.

The weight of evidence presented above suggests that effects to plants directly treated with acephate may occur. However, the level of effect is not anticipated to result in indirect effects to the CFWS. The potential for off-site movement of acephate is reduced somewhat by its short environmental half-life. Therefore, the weight of evidence suggests that indirect effects are not anticipated to the CFWS based on effects to terrestrial plants within its habitat or used as a food source.

5.2.6. Salt Marsh Harvest Mouse

5.2.6.a. Direct Effects

Acute and chronic RQs calculated in T-REX exceed the listed species LOC (0.1) for direct effects to the SMHM for all but the lowest use scenario (fallow land) for acephate. Assuming complete transformation to the degradate, methamidophos, acute and chronic RQs exceed the listed species LOC for all use scenarios. EECs, calculated using T-REX for small mammals consuming short grass, would have to be ten times lower than the EEC for the lowest use rate of acephate, assuming complete transformation to methamidophos, to alleviate concerns of direct effects to listed small mammals.

No incidents are reported involving acephate exposure and mammals. There are 11 minor "fish and wildlife" incidents reported for acephate, but it is not known whether these were aquatic or terrestrial incidents. Open literature studies on squirrels and mice exposed to acephate demonstrate ChE inhibition in the brain and skeletal muscle (ECOTOX 87471, Farag, 2000; ECOTOX 87472, Farag, 2000; MRID 40329701, ECOTOX 39518, Zinkl, 1980). Reproductive toxicity to mice is evident following exposure to either males or females. Exposure to males resulted in a decreased number of implantations and live fetuses, and an increased number of early resorptions as well as decreased sperm motility and count (ECOTOX 87471, Farag, 2000). Exposure to females resulted in decreased body weight during gestation, and decreased absolute and relative brain weight. Placental weight was also decreased and liver weight was increased. Maternal exposure to acephate during organogenesis significantly affected the number of implantations, number of live fetuses, number of early resorptions, mean fetal weight, and the incidence of external and skeletal malformations (ECOTOX 87472, Farag, 2000). All of these effects were seen at doses of 28 mg/kg/day and some at 14 mg/kg/day. The acephate EECs for small mammals consuming short grass, calculated in T-REX, varied between 28.49 mg/kg/day for the lowest use scenario and 32,663 mg/kg/day for the highest use scenario. Therefore, the reproductive effects seen in these studies are relevant. A study by Stehn (ECOTOX 35459, 1976) reported increased ingestion of arthropods by insectivorous mammals following acephate application. This signified a direct pathway for substantial exposure to acephate due to consumption of dead and dying insects, thereby potentially increasing exposure for small mammals.

The probability of an individual effect for a small mammal is between 1 in 9.1E+08 and 1 in 1.0 (100%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the most sensitive acute RQs and associated probit slope of 5.18. Using a slope of 13 and acute RQs derived from the most sensitive small mammal methamidophos study, the probability of an individual effect increases to between 1 in 26 (3.8%) and 1 in 1.0 (100%).

Based on the LOC exceedances, individual effect probabilities, and open literature data, there is a potential for direct effects to the SMHM as a result of acephate uses.

5.2.6.b. Indirect Effects

i. Potential Loss of Prey

The diet of the SMHM consists of seeds, grasses, forbs and insects. Indirect effects to the SMHM via loss of food and prey species are evaluated using toxicity data and other information gathered on terrestrial invertebrates and terrestrial plants.

Terrestrial Invertebrates

As detailed in the BCB and VELB direct effects sections above (5.2.1.a and 5.2.2.a), toxicity of acephate and methamidophos to terrestrial invertebrates is high. Acute RQs exceed the listed species LOC for all use scenarios and the probability of an individual effect is close to 100% (1 in 1.0) for all scenarios. There is no LOC defined for non-listed terrestrial invertebrates. However, the EECs, calculated using T-REX for small insects, would have to be over 15 times lower than the EEC for the lowest use rate of acephate and over 30 times lower assuming complete transformation to the degradate, methamidophos, to alleviate concerns of direct effects to listed species, indicating high toxicity.

Incident reports and open literature studies on the effects of acephate to honey bees also demonstrate negative impacts on survival, reproduction, and behavior in field and laboratory situations. Multiple bee kill incidents have been reported for acephate in Washington State with 40-60 colonies killed off per incident, suggesting a risk to non-target terrestrial insects. For more details associated with these incidents, see Appendix K. Open literature studies on bee colonies also demonstrate negative impacts on reproduction and brood survival (see Section 4.3.3.b). One study demonstrated moderate toxicity of acephate to earthworms (ECOTOX 40531, Roberts and Dorough, 1983). Therefore, indirect effects are anticipated to the SMHM based on risk to terrestrial invertebrate prey.

Terrestrial Plants

As detailed in the CTS indirect effects section above (5.2.3.b), RQs exceed the LOC for terrestrial plants only for the highest use scenario for semi-aquatic areas. Acephate's short half-life makes it unlikely that a significant amount would reach semi-aquatic areas. Many major and minor terrestrial plant incidents with acephate have been reported. However, all incidents where details are available involved the direct application of acephate products to ornamental plants. There are 453 minor plant incidents for which little information is available. For more details associated with these incidents, see Appendix K.

The weight of evidence presented above suggests that effects to plants directly treated with acephate may occur. However, the level of effect is not anticipated to result in indirect effects to the SMHM. The neurotoxic mode of action of acephate does not apply to plant physiology. Therefore, the weight of evidence suggests that indirect effects are not anticipated to the SMHM based on effects to terrestrial plants used as food sources.

ii. Potential Modification of Habitat

The SMHM is a small, mostly nocturnal rodent that lives in tidal and diked salt marshes, only around the SF Bay and its tributaries. The SMHM is a cover-dependent species. That is, they only live under thick vegetation. They are dependent on thick cover of native halophytes of the salt marsh environment, which is typified by salt marsh herbs, grasses and reeds. SMHM nests are minimal and are often built over old birds' nests. The SMHM may also use Suisun shrew nests, after the young shrews have dispersed.

Aquatic Plants

As detailed above (Section 5.1.1.e), there is little data with which to assess toxicity of acephate to aquatic plants. However, the available non-vascular aquatic plant endpoint shows that toxicity is low.

All available plant toxicity data, aquatic and terrestrial, shows that while effects on plants are possible the phytotoxicity of acephate is low and effects are unlikely to rise to a level at which indirect effects to listed species are expected. Therefore, no indirect effects are anticipated to the SMHM based on this habitat component.

Terrestrial Plants

As previously discussed, the weight of evidence suggests that effects to plants directly treated with acephate may occur. However, the level of effect is not anticipated to result in indirect effects to the SMHM. The potential for off-site movement of acephate is reduced somewhat by its short environmental half-life. Therefore, the weight of evidence suggests that indirect effects are not anticipated to the SMHM based on effects to terrestrial plants within its habitat.

Small Mammals

The SMHM can use shrew nests for rearing sites. As described in the SMHM direct effects discussion above, toxicity of acephate and methamidophos to small mammals is high. Acute and chronic RQs exceed the non-listed species LOC (0.5) for direct effects to small mammals for all but the lowest use scenario (fallow land) for acephate and for all use scenarios assuming complete transformation to methamidophos. The probability of an individual effect is close to 100% (1 in 1) for all moderate and high use scenarios. Open literature studies on the effects of acephate to small mammals also demonstrate negative impacts on nervous system function and reproduction. Based on the LOC exceedances, individual effect probabilities, and open literature data, indirect effects are anticipated to the SMHM based on risk to small mammal-created habitat.

Birds

The SMHM often creates rearing sites over old birds' nests. As detailed in the CCR direct effects section (5.2.4.a), toxicity of acephate to avian species is high. Acute and chronic RQs for all uses of acephate exceed the LOCs for all use scenarios and the probability of an individual effect is close to 100% (1 in 1) for all uses except for the lowest use scenario without accounting for the degradate toxicity. Two major incidents involving acephate use and boat-tailed grackle kills have been reported. Findings of open literature studies demonstrate significant ChE inhibition in a variety of bird species and observations of signs of sublethal toxic effects, including effects to reproduction.

Based on the LOC exceedances, individual effect probabilities, reported incidents, and open literature data, indirect effects are anticipated to the SMHM based on risk to bird-created habitat.

5.2.7. San Francisco Garter Snake

5.2.7.a. Direct Effects

Potential for direct effects to the SFGS are assessed based on direct acute and chronic toxicity effects to birds as a surrogate due to a lack of toxicity data for reptiles. Acute and chronic RQ values representing all uses of acephate exceed the LOCs for direct effects to the SFGS, resulting in a preliminary "may affect" determination. EECs, calculated using T-REX for small birds, would have to be over 40 times lower than the EEC for the lowest use rate of acephate and over 60 times lower assuming complete transformation to the degradate, methamidophos, to alleviate concerns of direct effects to the SFGS.

A refinement of the acute and chronic risks posed to the SFGS was performed using the T-HERPS model. Avian RQ values used as screening surrogates for reptiles likely overestimate risks to reptiles. Overestimation is due to the higher energy requirements of birds over reptiles of the same body weight, which results in a higher daily food intake rate value and a resultant higher dose-based exposure for birds than would occur for a reptile of the same body weight (see Section 3.3.1.b for more detail). The T-HERPS model refines the EEC and RQ values based on dietary intake rate of a reptile, rather than a dietary intake rate of an avian. Acute and chronic RQs show a slight decrease when modeled in T-HERPS, but remain above the listed species LOC for all use scenarios except for the lowest use scenario when not accounting for the degradate (fallow land). Model results from T-HERPs are from the most sensitive RQs, medium reptiles (20 g) consuming herbivorous mammals.

Major incidents involving acephate use and bird kills have been reported. An incident in South Carolina in 1998 involved 24 dead boat-tailed grackles. The birds were collected and methamidophos residues found within them were attributed to acephate use on fire ants. A similar incident in Georgia in 2005 involved 50 boat-tailed grackles found dead. Acephate had been used in the area to control fire ants and acephate residues were found within some of the birds. There are 11 minor "fish and wildlife" incidents reported for acephate, but it is not known whether these were aquatic or terrestrial incidents. For more details associated with these incidents, see Appendix K. No incidents have been reported involving reptiles.

Studies of sublethal effects of acephate exposure to avian species focus largely on cholinesterase (ChE) inhibition and behaviors surrounding this mode of action. Findings of these laboratory and field studies include significant ChE inhibition in a variety of bird species and observations of signs of sublethal toxic effects, including effects to reproduction. No open literature studies on the effects of acephate or methamidophos on reptiles have been identified.

The probability of an individual effect for a SFGS based on avian toxicity data is between 1 in 42 (2.4%) and 1 in 1.0 (100%) for the full range of acephate uses (Table 4-9). These probabilities are calculated based on the most sensitive acute RQs and the associated probit slope of 5.4. Using a slope of 4.6 and acute RQs derived from the most sensitive avian methamidophos study, the probability of an individual effect increases to 1 in 1.0 (100%) for all uses.

Based on the weight of evidence presented here, there is a potential for direct effects to the SFGS as a result of acephate uses.

5.2.7.b. Indirect Effects

i. Potential Loss of Prey

Adult SFGS feed primarily on California red-legged frogs and juvenile bullfrogs. Newborn and juvenile snakes prey upon Pacific tree frogs. Small mammals, reptiles, amphibians, terrestrial and aquatic invertebrates, and some fish species may also be consumed by the SFGS if they can be captured in shallow water. Indirect effects to the SFGS via loss of prey species are evaluated using toxicity data and other information gathered on freshwater fish, freshwater invertebrates, birds, small mammals, and terrestrial invertebrates.

Freshwater Fish and Aquatic-phase Amphibians

As detailed in the CTS direct effects section above (5.2.3.a), no acute RQ values representing any uses of acephate exceed the LOCs for effects to non-listed freshwater fish and the chronic RQ exceeds the LOC for only the highest use when assuming complete transformation to methamidophos. The probability of an individual effect was low. Incident reports and open literature studies on the effects of acephate on freshwater fish also do not raise any concerns about potential risks. Therefore, no indirect effects are anticipated to the SFGS based on this prey component.

Freshwater Invertebrates

As detailed in the CTS indirect effects section above (5.2.3.b), acute and chronic RQs exceed the non-listed species LOCs for approximately 10% of uses when not accounting for the effects of the degradate, methamidophos, and approximately 70% of the uses when assuming complete transformation to the degradate. Multiple studies in the open literature demonstrate lethal and sublethal toxicity of acephate to a variety of freshwater invertebrates (see Appendix G for a complete list). Therefore, indirect effects are anticipated to the SFGS based on this prey component.

Birds, Terrestrial-phase Amphibians, and Reptiles

As detailed in the SFGS direct effects section above (5.2.7.a), toxicity of acephate to avian species is high. SFGS are not known to prey on birds, but avian species are used as a surrogate here for terrestrial-phase amphibians and reptiles. Acute and chronic RQs for all uses of acephate exceed the LOCs for all use scenarios and the probability of an individual effect is close to 100% (1 in 1) for all uses except for the lowest use scenario (fallow land) without accounting for the degradate toxicity. Acute and chronic RQs show a slight decrease when refined using T-HERPS for terrestrial-phase amphibians and reptiles, but remain above the non-listed LOCs for all but the lowest use scenario (fallow land) without accounting for the degradate toxicity. Two major incidents involving acephate use and boat-tailed grackle kills have been reported. Findings of open literature studies demonstrate significant ChE inhibition in a variety of bird species and observations of signs of sublethal toxic effects, including effects to reproduction.

Based on the LOC exceedances, individual effect probabilities, reported incidents, and open literature data, indirect effects are anticipated to the SFGS based on risk to terrestrial-phase amphibian and reptile prey species.

Small Mammals

As detailed in the CTS indirect effects section above (5.2.3.b), toxicity of acephate and methamidophos to small mammals is high. Acute and chronic RQs exceed the listed and non-listed LOCs for direct effects to small mammals for all but the lowest use scenario for acephate and for all use scenarios for methamidophos. Additionally, the T-HERPS refinement for direct effects to the SFGS (described in 5.2.7.a above) is based on herbivorous mammal prey. Acute and chronic RQs for the SFGS based on small mammal prey are above the listed species LOC for all use scenarios except for the lowest use scenario when not accounting for the degradate (fallow land).

The probability of an individual effect to a small mammal is close to 100% for all moderate and high use scenarios. Open literature studies on the effects of acephate to small mammals also demonstrate negative impacts on nervous system function and reproduction. Based on the LOC exceedances, individual effect probabilities, and open literature data, indirect effects are anticipated to the SFGS based on risk to small mammal prey.

Terrestrial Invertebrates

As detailed in the BCB and VELB direct effects sections above (5.2.1.a and 5.2.2.a), toxicity of acephate and methamidophos to terrestrial invertebrates is high. Acute RQs exceed the listed species LOC for all use scenarios and the probability of an individual effect is close to 100% (1 in 1.0) for all scenarios. There is no LOC defined for non-listed terrestrial invertebrates. However, the EECs, calculated using T-REX for small insects, would have to be over 15 times lower than the EEC for the lowest use rate of acephate and over 30 times lower assuming complete transformation to the degradate, methamidophos, to alleviate concerns of direct effects to listed species, indicating high toxicity.

Incident reports and open literature studies on the effects of acephate to honey bees also demonstrate negative impacts on survival, reproduction, and behavior in field and laboratory situations. Multiple bee kill incidents have been reported for acephate in Washington State with 40-60 colonies killed off per incident, suggesting a risk to non-target terrestrial insects. For more details associated with these incidents, see Appendix K. Open literature studies on bee colonies also demonstrate negative impacts on reproduction and brood survival (see Section 4.3.3.b). One study demonstrated moderate toxicity of acephate to earthworms (ECOTOX 40531, Roberts and Dorough, 1983). Therefore, indirect effects are anticipated to the SFGS based on risk to terrestrial invertebrate prey.

ii. Potential Modification of Habitat

The SFGS inhabits densely vegetated ponds near open hillsides where it can sun, feed, and find cover in rodent burrows as well as forage extensively in aquatic habitats. Freshwater habitats include natural and manmade (e.g. stock) ponds, slow moving streams, vernal pools and other ephemeral or permanent water bodies which typically support inundation during winter rains. Upland habitats are within 200 ft of the mean high water mark of such aquatic habitats.

Aquatic Plants

The weight of evidence presented above suggests that the risk to aquatic plants from exposure to acephate and its degradate, methamidophos, is discountable. Therefore, no indirect effects are anticipated to the SFGS based on this habitat component.

Terrestrial Plants

The weight of evidence suggests that effects to plants directly treated with acephate may occur. However, the level of effect is not anticipated to result in indirect effects to the SFGS. The potential for off-site movement of acephate is reduced somewhat by its short environmental half-life. Therefore, the weight of evidence suggests that indirect effects are not anticipated to the SFGS based on effects to terrestrial plants within its habitat.

Small Mammals

SFGS rely on the burrows of small mammals for shelter and aestivation when ponds become dry. SFGSs may also forage for amphibians in the rodent burrows during the summer.

As described in the SFGS prey impacts discussion above, toxicity of acephate and methamidophos to small mammals is high. Acute and chronic RQs exceed the non-listed LOCs for direct effects to small mammals for all but the lowest use scenario (fallow land) for acephate and for all use scenarios for methamidophos. The probability of an individual effect is close to 100% for all moderate and high use scenarios. Open literature studies on the effects of acephate to small mammals also demonstrate negative impacts on nervous system function and reproduction. Based on the LOC exceedances, individual effect probabilities, and open literature data, indirect effects are anticipated to the SFGS based on risk to small mammal-created habitat.

5.2.8. San Joaquin Kit Fox

5.2.8.a. Direct Effects

Acute and chronic RQs calculated in T-REX exceed the listed species LOC for direct effects to the SJKF for all but the lowest use scenario (fallow land) for acephate. When assuming complete transformation to the degradate, methamidophos, acute and chronic RQs exceed the LOCs for all use scenarios. EECs, calculated using T-REX for large mammals consuming short grass, would have to be five times lower than the EEC for the lowest use rate of acephate, assuming complete transformation to methamidophos, to alleviate concerns of direct effects to listed large mammals.

No incidents are reported involving acephate exposure and mammals. There are 11 minor "fish and wildlife" incidents reported for acephate, but it is not known whether these were aquatic or terrestrial incidents. Open literature studies on squirrels and mice exposed to acephate demonstrate ChE inhibition in the brain and skeletal muscle (ECOTOX 87471, Farag, 2000; ECOTOX 87472, Farag, 2000; MRID 40329701, ECOTOX 39518, Zinkl, 1980). Reproductive toxicity to mice is evident following exposure to either males or females. Exposure to males resulted in a decreased number of implantations and live fetuses, and an increased number of early resorptions as well as decreased sperm motility and count (ECOTOX 87471, Farag, 2000). Exposure to females resulted in decreased body weight during gestation, and decreased absolute and relative brain weight. Placental weight was also decreased and liver weight was increased. Maternal exposure to acephate during organogenesis significantly affected the number of implantations, number of live fetuses, number of early resorptions, mean fetal weight, and the incidence of external and skeletal malformations (ECOTOX 87472, Farag, 2000). All of these effects were seen at doses of 28 mg/kg/day and some at 14 mg/kg/day. The acephate EECs for small mammals consuming short grass, calculated in T-REX, varied between 28.49 mg/kg/day for the lowest use scenario and 32,663 mg/kg/day for the highest use scenario. Therefore, the reproductive effects seen in these studies are relevant. A study by Stehn (ECOTOX 35459, 1976) reported increased ingestion of arthropods by insectivorous mammals following acephate application. This signified a direct pathway for substantial exposure to acephate due to consumption of dead and dying insects, thereby potentially increasing exposure for small mammals.

The probability of an individual effect for a large mammal is between 1 in 6.5E+14 and 1 in 1.0 (100%) for the full range of acephate application rates (Table 4-9). These probabilities are calculated based on the most sensitive mammalian acute RQs and associated probit slope of 5.18. Using a slope of 13 and acute RQs derived from the most sensitive mammalian methamidophos study, the probability of an individual effect increases to between 1 in 1.1E+06 and 1 in 1.0 (100%).

Based on the LOC exceedances, individual effect probabilities, and open literature data, there is a potential for direct effects to the SJKF as a result of acephate uses.

5.2.8.b. Indirect Effects

i. Potential Loss of Prey

The SJKF feeds on rodents and other small animals, including blacktailed hares, desert cottontails, mice, kangaroo rats, squirrels, birds, and lizards as well as insects and grass. Indirect effects to the SJKF via loss of food and prey species are evaluated using toxicity data and other information gathered on birds, mammals, terrestrial invertebrates, and terrestrial plants.

Birds and Reptiles

As detailed in the SFGS direct effects section (5.2.7.a), toxicity of acephate to avian and reptile species is high. SJKF are known to prey on birds and lizards. Acute and chronic avian RQs for all uses of acephate exceed the LOCs for all use scenarios and the probability of an individual effect is close to 100% (1 in 1.00) for all uses except for the lowest use scenario (fallow land) without accounting for the degradate toxicity. Acute and chronic RQs show a slight decrease when refined using T-HERPS for reptiles consuming small mammals, but remain above the LOCs for all use scenarios. Two major incidents involving acephate use and boat-tailed grackle kills have been reported. Findings of open literature studies demonstrate significant ChE inhibition in a variety of bird species and observations of signs of sublethal toxic effects, including effects to reproduction.

Based on the LOC exceedances, individual effect probabilities, reported incidents, and open literature data, indirect effects are anticipated to the SJKF based on risk to avian and reptile prey species.

Small Mammals

As detailed in the SMHM direct effects section (5.2.6.a), toxicity of acephate and methamidophos to small mammals is high. Acute and chronic RQs exceed the listed and non-listed LOCs for direct effects to small mammals for all but the lowest use scenario for acephate and for all use scenarios for methamidophos. The probability of an individual effect is close to 100% for all moderate and high use scenarios. Open literature studies on the effects of acephate to small mammals also demonstrate negative impacts on nervous system function and reproduction. Based on the LOC exceedances, individual effect probabilities, and open literature data, indirect effects are anticipated to the SJKF based on risk to small mammal prey.

Terrestrial Invertebrates

As detailed in the BCB and VELB direct effects sections above (5.2.1.a and 5.2.2.a), toxicity of acephate and methamidophos to terrestrial invertebrates is high. Acute RQs exceed the listed species LOC for all use scenarios and the probability of an individual effect is close to 100% (1 in 1.0) for all scenarios. There is no LOC defined for non-listed terrestrial invertebrates. However, the EECs, calculated using T-REX for small insects, would have to be over 15 times lower than the EEC for the lowest use rate of acephate and over 30 times lower based on the toxicity of the degradate, methamidophos, to alleviate concerns of direct effects to listed species, indicating high toxicity.

Incident reports and open literature studies on the effects of acephate to honey bees also demonstrate negative impacts on survival, reproduction, and behavior in field and laboratory situations. Multiple bee kill incidents have been reported for acephate in Washington State with 40-60 colonies killed off per incident, suggesting a risk to non-target terrestrial insects. For more details associated with these incidents, see Appendix K. Open literature studies on bee colonies also demonstrate negative impacts on reproduction and brood survival (see Section 4.3.3.b). One study demonstrated moderate toxicity of acephate to earthworms (ECOTOX 40531, Roberts and Dorough, 1983). Therefore, indirect effects are anticipated to the SJKF based on risk to terrestrial invertebrate prey.

Terrestrial Plants

As detailed in the CTS indirect effects section (5.2.3.b), RQs exceed the LOC for terrestrial plants only for the highest use scenario for semi-aquatic areas. Acephate's short half-life makes it unlikely that a significant amount would reach semi-aquatic areas. Many major and minor terrestrial plant incidents with acephate have been reported. However, all incidents where details are available involved the direct application of acephate products to ornamental plants. There are 453 minor plant incidents for which little information is available. For more details associated with these incidents, see Appendix K.

The weight of evidence presented above suggests that effects to plants directly treated with acephate may occur. However, the level of effect is not anticipated to result in indirect effects to the SJKF. The neurotoxic mode of action of acephate does not apply to plant physiology. Therefore, the weight of evidence suggests that indirect effects are not anticipated to the SJKF based on effects to terrestrial plants within its habitat.

ii. Potential Modification of Habitat

The SJKF inhabits grasslands in the San Joaquin Valley and eastern Bay Area Counties, foraging in California prairie and Sonoran grasslands in the vicinity of freshwater marshes and alkali sinks, where there is a dense ground cover of tall grasses and San Joaquin saltbush. Seasonal flooding in such habitats is normal.

Terrestrial plants serve several important habitat-related functions for the listed assessed species. However, the weight of evidence presented above suggests that indirect effects to the SJKF from exposure of terrestrial plants to acephate are possible, but not likely. Therefore, no indirect effects are anticipated to the SJKF based on impacts on habitat.

5.2.9. Spatial Extent of Potential Effects

Since LOCs are exceeded, analysis of the spatial extent of potential LAA effects is needed to determine where effects may occur in relation to the treated site. If the potential area of usage and subsequent Potential Area of LAA Effects overlaps with BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, or SJKF habitat or areas of occurrence or critical habitat of the BCB, VELB, CTS-CC, or CTS-SB, a likely to adversely affect determination is made. If the Potential Area of LAA Effects and the habitat and areas of occurrence or critical habitat do not overlap, a no effect determination is made.

To determine this area, the footprint of acephate's use pattern is identified, using corresponding land cover data, see Section 2.7. This area is defined by all land cover types that represent the labeled outdoor uses of acephate including agriculture, orchards/vineyards, pasture, and non-agriculture. Actual usage is expected to occur in a smaller area as the chemical is only expected to be used on a portion of the identified area. The spatial extent of the effects determination also includes areas beyond the initial area of concern that may be impacted by runoff and/or spray drift (Use Footprint + distance downstream or downwind from use sites where organisms relevant to the assessed species may be affected). The determination of the buffer distance and downstream dilution for spatial extent of the effects determination is described below.

5.2.9.a. Spray Drift

In order to determine terrestrial and aquatic habitats of concern due to acephate exposures through spray drift, it is necessary to estimate the distance that spray applications can drift from the treated area and still be present at concentrations that exceed levels of concern. Ground applications of acephate granular formulations are not expected to result in any spray drift. For the flowable uses, a quantitative analysis of spray drift distances was completed using AgDRIFT (v. 2.01) using default inputs for ground applications (*i.e.*, high boom, ASAE droplet size distribution = very fine to fine, 90th percentile of the data distribution) and aerial applications (*i.e.*, ASAE very fine to fine). As mentioned in Section 2.3, label amendments following the IRED included language about the reduction of spray drift. However, this language was general in nature and does not specify or impact the parameters considered here (*e.g.*, droplet size, release height, or wind speed).

For this assessment, a Tier I spray drift analysis was completed to determine whether a buffer zone could be defined at <1000 ft. Based on the current widespread use patterns of acephate (see Figure 2-10) a buffer distance >1000 ft is not expected to be achievable. The distance of potential impact away from the use sites is determined by the distance required to fall below the LOC for the taxonomic group that has the largest RQ to LOC ratio, which is for invertebrates in both terrestrial and aquatic systems. Spray drift buffer distances were calculated for the highest application rates for aerial, ground, and airblast applications for terrestrial and aquatic habitats. Results of this analysis are in Table 5-29.

Based on endpoints derived for freshwater aquatic and terrestrial invertebrates, adverse effects to invertebrates are expected to occur at distances >1000 ft from the use site for aerial or ground applications of acephate. For airblast applications, adverse effects are expected at >1000 ft for terrestrial systems and up to 65.6 ft for ponds. All species in this assessment, the BCB, VELB, CTS, CCR, CFWS, SMHM, SFGS, and SJKK, are directly and/or indirectly affected by impacts to aquatic and/or terrestrial invertebrates. The dissipation distance is expected to increase based on a decrease in droplet size as fine drops will result in more drift. In some cases, topography (such as an intervening ridge) or weather conditions (such as prevailing winds) could affect the estimates presented in Table 5-29.

Table 5-29. Spray Drift Dissipation Distances for Acephate

Application Type	Use (Application Rate)	Terrestrial Buffer (ft)	Aquatic Buffer[1] (ft)
Aerial	Christmas tree (1.725 lb a.i./A)	>1000	>1000
Ground	Ornamental shrub and vines (32 lb a.i./A)	>1000	>1000
Airblast	Citrus (4 lb a.i./A)	>1000	65.6

[1] Calculations based on a standard EPA pond.

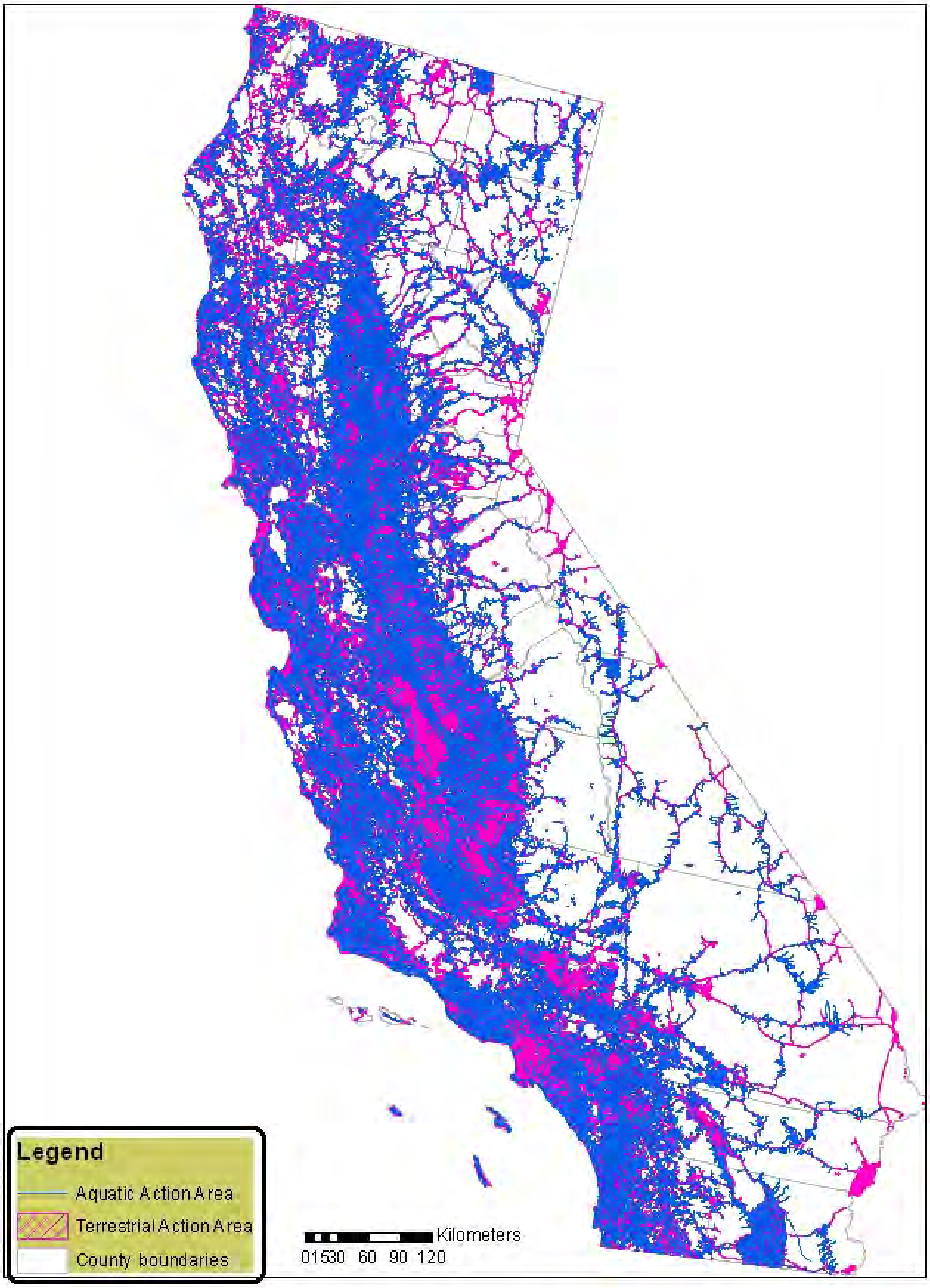
5.2.9.b. Downstream Dilution Analysis

The downstream extent of exposure in streams and rivers where the EEC could potentially be above levels that would exceed the most sensitive LOC is calculated using the downstream dilution model. Because the use patterns for acephate include all potential land use types, a downstream dilution analysis is not necessary for acephate as no part of the state can be excluded using a downstream dilution analysis.

5.2.9.c. Overlap of Potential Areas of LAA Effect and Habitat and Occurrence of BCB, VELB, CTS, CCR, CFWS, SMHM, SFGS, and SJKF

The spray drift and downstream dilution analyses help to identify areas of potential effect to the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF from registered uses of acephate. The Potential Area of LAA Effects on survival, growth, and reproduction for the assessed species from acephate spray drift extend from the site of application to greater than 1000 feet from the site of application (see Figure 5-1). The variety of use patterns and widespread geographical use of acephate in the action area results in a large Potential Area of LAA Effects covering nearly the entire western half of California, including the entire San Francisco Bay region. When spray drift distances are added to the footprint of the Initial Area of Concern (which represents potential acephate use sites) and compared to the assessed species' habitat, acephate's LAA effect area is defined. The overlap between the Potential Area of LAA Effect (Figure 5-1) and BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF habitat, as depicted in Figure 2-2 through Figure 2-9, including designated critical habitat, indicates that acephate use in California has the potential to affect the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF.

Figure 5-1. Acephate Potential Area of Likely to Adversely Affect.



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

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

5.3. Effects Determinations

5.3.1. Bay Checkerspot Butterfly

Acephate is expected to directly impact the BCB based on toxicity to Lepidoptera species and other terrestrial invertebrates. Indirect effects from impacts on food and habitat are not anticipated due to low toxicity to terrestrial plants. There is overlap between the areas of LAA effect for acephate and BCB range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination and a **habitat modification determination** for the BCB, based on the potential for direct effects and effects to the PCEs of critical habitat.

5.3.2. Valley Elderberry Longhorn Beetle

Acephate is expected to directly impact the VELB based on toxicity to terrestrial invertebrates. Indirect effects from impacts on food and habitat are not anticipated due to low toxicity to terrestrial plants. There is overlap between the areas of LAA effect for acephate and VELB range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination and a **habitat modification determination** for the VELB, based on the potential for direct effects and effects to the PCEs of critical habitat.

5.3.3. California Tiger Salamander (All 3 DPS)

Acephate is expected to directly impact the CTS based on toxicity to terrestrial-phase amphibians, using avian surrogate species data. Indirect effects from impacts on prey are also anticipated based on toxicity to mammals, terrestrial invertebrates, and freshwater invertebrates. Indirect effects from impacts on habitat are anticipated due to effects on mammal burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. There is overlap between the areas of LAA effect for acephate and CTS range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the CTS (all DPS) and a **habitat modification determination** for the designated critical habitat of the CTS-CC, and CTS-SB based on the potential for direct and indirect effects and effects to the PCEs of critical habitat. The CTS-SC does not have a designated critical habitat.

5.3.4. California Clapper Rail

Acephate is expected to directly impact the CCR based on toxicity to avian species. Indirect effects from impacts on prey are also anticipated based on toxicity to birds, mammals, terrestrial invertebrates, and freshwater invertebrates. Indirect effects from impacts on habitat are not anticipated due to low toxicity to aquatic and terrestrial plants. There is overlap between the areas of LAA effect for acephate and CCR range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the CCR. The CCR does not have a designated critical habitat.

5.3.5. California Freshwater Shrimp

Acephate is expected to directly impact the CFWS based on toxicity to freshwater invertebrates. Indirect effects from impacts on prey are also anticipated based on toxicity to freshwater invertebrates. Indirect effects from impacts on habitat are not anticipated due to low toxicity to aquatic and terrestrial plants. There is overlap between the areas of LAA effect for acephate and CFWS range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the CFWS. The CFWS does not have a designated critical habitat.

5.3.6. Salt Marsh Harvest Mouse

Acephate is expected to directly impact the SMHM based on toxicity to small mammals. Indirect effects from impacts on prey are also anticipated based on toxicity to terrestrial invertebrates. Indirect effects from impacts on habitat are anticipated due to effects on small mammal and bird nest availability. SMHM use these nests as rearing sites. There is overlap between the areas of LAA effect for acephate and SMHM range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the SMHM. The SMHM does not have a designated critical habitat.

5.3.7. San Francisco Garter Snake

Acephate is expected to directly impact the SFGS based on toxicity to reptiles, using avian surrogate species data. Indirect effects from impacts on prey are also anticipated based on toxicity to terrestrial-phase amphibians, reptiles, mammals, terrestrial invertebrates, and freshwater invertebrates. Indirect effects from impacts on habitat are anticipated due to effects on mammal burrow availability. SFGS rely on the burrows of small mammals for shelter and aestivation. There is overlap between the areas of LAA effect for acephate and SFGS range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the SFGS. The SFGS does not have a designated critical habitat.

5.3.8. San Joaquin Kit Fox

Acephate is expected to directly impact the SJKF based on toxicity to large mammals. Indirect effects from impacts on prey are also anticipated based on toxicity to birds, mammals, and terrestrial invertebrates. Indirect effects from impacts on habitat are not anticipated due to low toxicity to terrestrial plants. There is overlap between the areas of LAA effect for acephate and SJKF range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the SJKF. The SJKF does not have a designated critical habitat.

5.3.9. Addressing the Risk Hypotheses

In order to conclude this risk assessment, it is necessary to address the risk hypotheses defined in Section 2.9.1. Based on the conclusions of this assessment, two of the hypotheses can be rejected, meaning that three of the stated hypotheses represent concerns in terms of direct and indirect effects of acephate on the BCB, VELB, CTS, CCR, CFWS, SMHM, SFGS, and SJKF and their designated critical habitat.

The labeled uses of acephate may:

- directly affect BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and/or modify their designated critical habitat by reducing or changing the composition of food supply;
- indirectly affect CTS (all DPS) and CFWS 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);
- indirectly affect CTS (all DPS) and/or modify their designated critical habitat by reducing or changing terrestrial habitat in their current range (via reduction in small burrowing mammals leading to reduction in underground refugia/cover).

The labeled uses of acephate are not expected to:

- indirectly affect CTS (all DPS), CCR, CFWS, SMHM, and SFGS 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 BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and/or modify their designated critical habitat by reducing or changing the composition of the terrestrial plant community in the species' current range;

6. Uncertainties

Uncertainties that apply to most assessments completed for the San Francisco Bay Species Litigation are discussed in Attachment I. This section describes additional uncertainties specific to this assessment.

6.1. Exposure Assessment Uncertainties

6.1.1. Terrestrial Exposure Assessment

6.1.1.a. T-REX

Organisms consume a variety of dietary items and may exist in a variety of sizes at different life stages. For foliar applications of liquid formulations, T-REX estimates exposure for the following dietary items: short grass, tall grass, broadleaf plants/small insects, fruits/pods/seeds/large insects, and seeds for granivores. Birds (used as a surrogate for amphibians and reptiles), including the CCR, and mammals, including the SJKF and SMHM, consume all of these items. The size classes of birds represented in T-REX are the small (20 g), medium (100 g), and large (1000 g). The size classes for mammals are small (15 g), medium (35 g), and large (1000 g). EECs are calculated for the most sensitive dietary item and size class for birds (surrogate for amphibians and reptiles) and mammals. Table 6-1 shows the percentages of the EECs and RQs of the various dietary classes for each size class as compared to the most sensitive dietary class (short grass) and size class (small mammal or bird). This information could be used to further characterize potential risk that is specific to the diet of birds and mammals. For example, if a mammal only consumes broadleaf plants and small insects and the RQ was 100 for small mammals consuming short grass, the RQ for small mammals that only consumed broadleaf plants and small insects would be 56 (100 x 0.56).

Table 6-1. Percentage of EEC or RQ for the Specified Dietary Items and Size Classes as Compared to the EEC or RQ for The Most Sensitive Dietary Items (Short Grass) and Size Class (Small Bird or Small Mammal)

Dietary Items	Percentage of EECs or RQs for the Specified Dietary Items and Size Class as compared to the EEC or RQ for Small Birds[1] or Small Mammals Consuming Short Grass					
Birds: Dose Based EECs and RQs						
Size Class	Small, 20 g		Mid, 100 g		Large, 1000 g	
	EEC	RQ	EEC	RQ	EEC	RQ
Short Grass	100%	100%	57%	45%	26%	14%
Tall Grass	46%	46%	26%	21%	12%	7%
Broadleaf plants/small Insects	56%	56%	32%	25%	14%	8%
Fruits/pods/seeds/large insects	6%	6%	4%	3%	2%	1%
Granivores	1%	1%	1%	1%	0.4%	0.2%
Mammals: Dose-Based EECs and RQs						
Size Class	Small, 15 g		Mid, 35 g		Large, 1000 g	
	EEC	RQ	EEC	RQ	EEC	RQ
Short Grass	100%	100%	69%	85%	16%	46%
Tall Grass	46%	46%	32%	39%	7%	21%
Broadleaf plants/small Insects	56%	56%	39%	48%	9%	26%
Fruits/pods/seeds/large insects	6%	6%	4%	5%	1%	3%
Granivores	1%	1%	1%	1%	0.2%	0.6%

Dietary Items	Percentage of EECs or RQs for the Specified Dietary Items and Size Class as compared to the EEC or RQ for Small Birds[1] or Small Mammals Consuming Short Grass
Mammals and Birds: Dietary-based EECs and RQs for all Size Classes[2]	
Short Grass	100%
Tall Grass	46%
Broadleaf plants/sm Insects	56%
Fruits/pods/seeds/lg insects	6%

[1] The percents of the maximum RQ shown here for birds are based on the Agency's default avian scaling factor of 1.15.
[2] Percentages for dose-based chronic EECs and RQs for mammals are equivalent to the acute dose-based EECs and RQs.

In the risk assessment, RQs were only calculated for the most sensitive dietary class relevant to the organisms assessed. For most organisms, not enough data is available to conclude that birds or mammals may not exclusively feed on a dietary class for at least some time period. However, most birds and mammals consume a variety of dietary items and thus the RQ will overestimate risk to those organisms. For example, the CCR is estimated to consume only 15% plant material (USFWS, 2003). Additionally, some organisms will not feed on all of the dietary classes. For example, many amphibians would only consume insects and not any plant material.

6.1.1.b. T-HERPS

For foliar applications of liquid formulations, T-HERPS estimates exposure for the following dietary items: broadleaf plants/small insects, fruits/pods/seeds/large insects, small herbivore mammals, small insectivore mammals, and small amphibians. Snakes and amphibians may consume all of these items. The default size classes of amphibians represented in T-HERPS are small (2 g), medium (20 g), and large (200 g). The default vertebrate prey size that the medium and large amphibians can consume is 13 g and 133 g, respectively (small amphibians are not expected to eat vertebrate prey). The default size classes for snakes are small (2 g), medium (20 g), and large (800 g). The default vertebrate prey size that medium and large snakes can consume is 25 g and 1,286 g, respectively (small snakes are not expected to eat vertebrate prey). EECs are calculated for the most sensitive dietary item and size class for amphibians and snakes. Table 6-2 shows the percentages of the EECs and RQs of the various dietary classes for each size class as compared to the most sensitive dietary class (herbivorous mammal) and size class [medium (20 g) amphibian or snake]. This information could be used to further characterize potential risk that is specific to the diet of amphibians and snakes.

Table 6-2. Percentage of EEC or RQ for the Specified Dietary Class as Compared to the EEC or RQ for The Most Sensitive Dietary Class (Small Herbivore Mammals) and Size Class (Medium Amphibian or Snake)

Dietary Items	Percentage of EECs or RQs for the Specified Dietary Items and Size Class as compared to the EEC or RQ for Medium Amphibians or Snakes Consuming Small Herbivore Mammals		
Amphibians: Acute Dose Based EECs and RQs			
Size Class	Small, 2 g	Mid, 20 g	Large, 200 g
Broadleaf plants/sm Insects	5%	3%	2%
Fruits/pods/seeds/lg insects	0.5%	0.3%	0.2%

Small herbivore mammals	N/A	100%	37%	
Small insectivore mammals	N/A	6%	2%	
Small amphibians	N/A	2%	1%	
Snakes: Acute Dose-Based EECs and RQs				
Size Class	Small, 2 g	Mid, 20 g	Mid, 200 g[1]	Large, 800 g
Broadleaf plants/sm Insects	3%	2%	1%	1%
Fruits/pods/seeds/lg insects	0.4%	0.2%	0.1%	0.1%
Small herbivore mammals	N/A	100%	40%	23%
Small insectivore mammals	N/A	6%	3%	1%
Small amphibians	N/A	2%	2%	1%
Amphibians and Snakes: Acute and Chronic Dietary-based EECs and RQs for all Size Classes				
	Amphibians		Snakes	
Broadleaf plants/sm Insects	56%		73%	
Fruits/pods/seeds/lg insects	6%		8%	
Small herbivore mammals	100%		100%	
Small insectivore mammals	6%		6%	
Small amphibians	2%		2%	

[1] To provide more information, a 200 g snake (eating a 291 g prey item) was also modeled (in addition to the default body sizes).

In the risk assessment, RQs were only calculated for the most sensitive dietary class relevant to the organisms assessed. For most organisms, not enough data are available to conclude that amphibians or snakes may not exclusively feed on a dietary class for at least some time period. However, most amphibians and snakes consume a variety of dietary items and thus the RQ will overestimate risk to those organisms. Additionally, some organisms will not feed on all of the dietary classes. For example, many amphibians would only consume insects and not any plant material.

6.1.2. Exposure in Estuarine/Marine Environments

PRZM-EXAMS modeled EECs are intended to represent exposure of aquatic organisms in relatively small ponds and low-order streams. Therefore it is likely that EECs generated from the PRZM-EXAMS model will over-estimate potential concentrations in larger receiving water bodies such as estuaries, embayments, and coastal marine areas because chemicals in runoff water (or spray drift, etc.) should be diluted by a much larger volume of water than would be found in the ‘typical’ EXAMS pond. However, as chemical constituents in water draining from freshwater streams encounter brackish or other near-marine-associated conditions, there is potential for important chemical transformations to occur. Many chemical compounds can undergo changes in mobility, toxicity, or persistence when changes in pH, Eh (redox potential), salinity, dissolved oxygen (DO) content, or temperature are encountered. For example, desorption and re-mobilization of some chemicals from sediments can occur with changes in salinity (Jordan *et al.*, 2008; Means, 1995; Swarzenski *et al.*, 2003), changes in pH (*e.g.*, Wood and Baptista 1993; Parikh et al. 2004; Fernandez et al. 2005), Eh changes (Velde and Church, 1999; Wood and Baptista, 1993), and other factors. Thus, although chemicals in discharging rivers may be diluted by large volumes of water within receiving estuaries and embayments, the hydrochemistry of the marine-influenced water may negate some of the attenuating impact of the greater water volume; for example, the effect of dilution may be confounded by changes in chemical mobility (and/or bioavailability) in brackish water. In addition, freshwater contributions from discharging streams and rivers do not instantaneously mix with more saline water bodies. In these settings, water will commonly remain highly stratified, with fresh water lying atop denser, heavier saline water – meaning that exposure to concentrations found in discharging stream water may propagate some distance beyond the outflow point of the stream (especially near the water surface). Therefore, it is not assumed that discharging water will be rapidly diluted by the entire water volume within an estuary, embayment, or other coastal aquatic environment. PRZM-EXAMS model results should be considered consistent with concentrations that might be found near the head of an estuary unless there is specific information – such as monitoring data – to indicate otherwise. Conditions nearer to the mouth of a bay or estuary, however, may be closer to a marine-type system, and thus more subject to the notable buffering, mixing, and diluting capacities of an open marine environment. Conversely, tidal effects (pressure waves) can propagate much further upstream than the actual estuarine water, so discharging river water may become temporarily partially impounded near the mouth (discharge point) of a channel, and resistant to mixing until tidal forces are reversed.

For acephate, there is some additional uncertainty due to the lack of aerobic aquatic metabolism data. This uncertainty has been accounted for by using twice the aerobic soil metabolism half-life as a surrogate for the aerobic aquatic metabolism data. Aerobic soil metabolism and aerobic aquatic metabolism tend half similar magnitudes. Using twice the aerobic soil metabolism as a surrogate for the aerobic aquatic metabolism will be generate values longer (more conservative) than the true value most of the time.

The Agency does not currently have sufficient information regarding the hydrology and hydrochemistry of estuarine aquatic habitats to develop alternate scenarios for assessed listed species that inhabit these types of ecosystems. The Agency acknowledges that there are unique brackish and estuarine habitats that may not be accurately captured by PRZM-EXAMS modeling results, and may, therefore, under- or over-estimate exposure, depending on the aforementioned variables.

6.1.3. Spray Drift Modeling

It is unlikely that the same organism would be exposed to the maximum amount of spray drift from every application made. In order for an organism to receive the maximum concentration of acephate from multiple applications, each application of acephate would have to occur under identical atmospheric conditions (*e.g.*, same wind speed and same wind direction) and the animal or plant being exposed would have to be located in the same location, which receives the maximum amount of spray drift, after each application. Additionally, other factors, including variations in topography, cover, and meteorological conditions over the transport distance are not accounted for by the AgDRIFT model (*i.e.*, it models spray drift from ground applications in a flat area with little to no ground cover and a steady, constant wind speed and direction). Therefore, in most cases, the drift estimates from AgDRIFT may overestimate exposure, especially as the distance increases from the site of application, since the model does not account for potential obstructions (*e.g.*, large hills, berms, buildings, trees, *etc*.).

6.1.4. Degradate Exposure

The assumption of 100% conversion of acephate to the major degradate methamidophos likely results in an overestimate of risk to all taxa. While acephate is expected to degrade completely and rapidly into methamidophos, this process would not occur instantaneously but rather over time, dependant on environmental conditions, as acephate breaks down and methamidophos forms. During this process, methamidophos would also break down into further degradation products.

An analysis accounting for the formation and decline of the parent and degradate over time would provide more accurate aquatic and terrestrial EECs. However, the current aquatic and terrestrial exposure models (PRZM-EXAMS and T-REX) do not allow for analysis of the formation and decline of a degradate.

6.1.5. Use Patterns

When the number of applications and/or application interval were not specified on the product label, 26 applications per year and a 3 day minimum period for reapplication were assumed. These assumptions apply to approximately 2/3 of the acephate uses in California, listed in Table 3-1. These are conservative maximum assumptions that result in high EECs and RQs for the highest application rates. While these high numbers of applications and short application intervals are unlikely to represent typical usage, they are possible scenarios under the labeled use and therefore analyzed as such here. Label specifications of fewer allowed applications per year and/or greater minimum reapplication periods would decrease, but not obviate, the estimates of risk in this assessment.

Acephate is registered for use outdoors around residential buildings, homes, and apartments. The spatial and temporal variability inherent in this use pattern relative to agricultural uses makes it far more difficult to calculate resulting EECs. In the aquatic exposure assessment, a commercial area lawn scenario is used as a conservative representation of both residential and commercial lawn uses. As a conservative approach, risk resulting from residential uses is likely overestimated by the commercial lawn use scenario.

6.2. Effects Assessment Uncertainties

6.2.1. Data Gaps and Uncertainties

Toxicity data gaps for acephate and methamidophos comprise chronic freshwater and estuarine/marine fish studies and aquatic plant studies.

Acute to chronic ratios (ACRs) are used to estimate chronic toxicity of both acephate and methamidophos to freshwater fish. This method makes use of a robust data set of acute and chronic freshwater fish toxicity data for other organophosphate insecticides. The largest ratio from this data set is used for the ACR in order to provide a conservative estimate. However, there is uncertainty associated with this method, as there is considerable variation in the organophosphate ACRs, which range from 5.4 for terbufos to 144.0 for dichlorvos (see 4.2.1.b for more details). Acephate and methamidophos are also less acutely toxic to freshwater fish than the organophosphates used to calculate the ACR, with LC_{50}s of 852 ppm and 25 ppm, respectively. The acute toxicity values of the other organophosphates range from 0.0076 ppm for terbufos to 7.4 ppm for dimethoate. By using the largest ratio, the chronic risk is more likely to be overestimated than under estimated, however if either acephate or methamidophos have true ACRs that are greater than 144.0, the chronic risk to freshwater fish will be under estimated. This method cannot be used to estimate chronic toxicity to estuarine/marine fish because of the lack of a sufficient data set. Therefore, chronic toxicity to estuarine/marine fish remains a data gap and an uncertainty in the risk assessment. These chronic fish toxicity uncertainties affect direct assessment of risk to the CTS and indirect assessment of risk to the SFGS and CCR.

Only one aquatic plant data point exists for acephate. There is a non-definitive EC_{50} value for a non-vascular diatom, but no associated NOAEC value for this study. There is no toxicity data for vascular aquatic plants for acephate or for either vascular or non-vascular aquatic plants for methamidophos. This lack of data prevents a quantitative risk analysis of acephate's effects on aquatic plant food and/or habitats for the SFGS, CCR, SMHM, CTS, and CFWS.

6.2.2. Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on acephate are not available for reptiles or terrestrial-phase amphibians; therefore, birds are used as surrogate species for reptiles, terrestrial-phase amphibians, the SFGS, and the CTS. Reptiles and amphibians are poikilotherms (body temperature varies with environmental temperature) while birds are homeotherms (temperature is regulated, constant, and largely independent of environmental temperatures). Therefore, reptiles and amphibians tend to have much lower metabolic rates and lower caloric intake requirements than birds or mammals. As a consequence, birds are likely to consume more food than amphibians or reptiles. Consequently, use of avian food intake allometric equation as a surrogate for reptile and terrestrial-amphibians is likely to result in an over-estimation of exposure. Therefore, endpoints based on bird ecotoxicity data are assumed to be protective of potential direct effects to reptiles and terrestrial-phase amphibians including the SFGS and CTS, and extrapolation of the risk conclusions from the most sensitive tested species to the SFGS and CTS are likely to overestimate the potential risks to those species. The T-HERPS model attempts to account for this difference and refines the risk estimation for reptiles and terrestrial-phase amphibians.

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 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 characterization purposes.

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

6.2.4. Acute LOC Assumptions

The risk characterization section of this assessment includes an evaluation of the potential for individual effects. The individual effects probability associated with the acute RQ is based on the assumption that the dose-response curve fits a probit model. It uses the mean estimate of the slope and the LC_{50} to estimate the probability of individual effects. When raw data associated with the LC_{50} is not available, a default value of 4.5 is used for the probit slope.

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 acephate to BCB, VELB, CTS, CCR, CFWS, SMHM, SFGS, and SJKF and their designated critical habitat.

Based on the best available information, the Agency makes a Likely to Adversely Affect determination for the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF. Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, VELB, CTS-CC, and CTS-SB from the use of the chemical. Given the LAA determination for BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and potential modification of designated critical habitat for BCB, VELB, CTS-CC, and CTS-SB, a description of the baseline status and cumulative effects is provided in Attachment III.

A summary of the risk conclusions and effects determinations for the BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, and SJKF and their critical habitat, given the uncertainties discussed in Section 6 and Attachment I, is presented in Table 7-1 and Table 7-2. Use specific effects determinations are provided in Table 7-3 and Table 7-4

Table 7-1. Effects Determination Summary for Effects of Acephate on the BCB, VELB, CTS, CCR, CFWS, SMHM, SFGS, and SJKF

Species	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Terrestrial*** All acute and chronic RQs are above the listed species LOC (0.05) for Lepidoptera species. Probability of individual effect is between 40% (1 in 2.4) and 100% (1 in 1.0). Direct effects to the BCB are likely under exposure scenarios evaluated in this assessment.

Species	Effects Determination	Basis for Determination
		Potential for Indirect Effects
		Terrestrial food items, habitat The BCB relies on terrestrial plants exclusively for both food and habitat and has an obligate relationship with dicots. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use rate scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). The BCB habitat does not include wetland areas. While terrestrial plant incidents with acephate have been reported, all incidents where details are available involved the direct application of acephate products to ornamental plants and most involved multi-a.i. formulations that have since been voluntarily cancelled by the registrants. Acephate's neurotoxic mode of action does not apply to plant physiology. Additionally, acephate has been used as an agricultural insecticide on a wide variety of crops for decades, indicating its absence of negative effect on these crops. Therefore, effects to non-target plants are not expected to result in indirect effects to the BCB.
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial All acute and chronic RQs are above the listed species LOC (0.05) for terrestrial invertebrate species. Probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. Direct effects to the VELB are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Terrestrial food items, habitat The VELB relies on elderberry trees exclusively for both food and habitat in an obligate relationship. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use rate scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). The VELB habitat does not include wetland areas. While terrestrial plant incidents with acephate have been reported, all incidents where details are available involved the direct application of acephate products to ornamental plants and most involved multi-a.i. formulations that have since been voluntarily cancelled by the registrants. Acephate's neurotoxic mode of action does not apply to plant physiology. Additionally, acephate has been used as an agricultural insecticide on a wide variety of crops for decades, indicating its absence of negative effect on these crops. Therefore, effects to non-target plants are not expected to result in indirect effects to the VELB.
California Tiger Salamander (All 3 DPS) (*Ambystoma*	May Affect, Likely to Adversely	**Potential for Direct Effects**
		Aquatic-phase (Eggs, Larvae, and Adults) Acute and chronic RQs exceed the listed species LOCs (0.05 and 1.0, respectively) for freshwater fish (as a surrogate species to the aquatic-phase

Species	Effects Determination	Basis for Determination
californiense)	Affect (LAA)	amphibian) only for the single highest use rate of acephate (commercial lawn areas) when assuming complete transformation to the degradate, methamidophos. No RQs exceed the listed species acute LOC (0.05) for aquatic-phase amphibian toxicity data. Probability of individual effect does not exceed 1 in 2.0E+44. Direct effects to the aquatic-phase CTS are not likely. ***Terrestrial-phase (Juveniles and Adults)*** All acute and chronic RQs are above the listed species LOCs (0.1 and 1.0, respectively) for birds (as a surrogate species to the terrestrial-phase amphibian) and remain above these LOCs after refinement using T-HERPS. Probability of individual effect is between 2.4% (1 in 42) and 100% (1 in 1.0). Direct effects to the terrestrial-phase CTS are likely under exposure scenarios evaluated in this assessment. **Potential for Indirect Effects** ***Aquatic prey items, aquatic habitat, cover, and primary productivity*** For freshwater fish and frogs the chronic RQ exceeds the LOC (1.0) for only the highest use rate (commercial lawn areas). Acute and chronic RQs for freshwater invertebrate prey are above the non-listed species LOC (0.5) for a majority of acephate uses and probability of individual effect can be as high as 100% (1 in 1.0). RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is likely to indirectly affect the aquatic-phase CTS via effects on freshwater invertebrate prey under exposure scenarios evaluated in this assessment. ***Terrestrial prey items, habitat*** Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) when not accounting for the degradate, methamidophos, and for all use scenarios when assuming complete transformation to methamidophos. Probability of individual effect to a small mammal can be as high as 100% (1 in 1.0). All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the terrestrial-phase CTS via terrestrial invertebrate and small mammal prey as well as habitat in small mammal burrows.
California Clapper Rail (*Rallus longirostris*	May Affect, Likely to Adversely	**Potential for Direct Effects** ***Terrestrial*** All acute and chronic RQs are above the listed species LOCs (0.1 and 1.0, respectively) for birds. Probability of individual effect is between 2.4% (1

Species	Effects Determination	Basis for Determination
obsoletus)	Affect (LAA)	in 42) and 100% (1 in 1.0). Direct effects to the CCR are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity For both freshwater and estuarine/marine fish, no acute or chronic RQs exceed the non-listed species LOCs (0.5 and 1.0, respectively) with the exception of the chronic RQ for freshwater fish for the highest use scenario (commercial lawn areas). Acute and chronic RQs for freshwater invertebrate prey are above non-listed species LOC (0.5) for a majority of acephate uses and probability of individual effect can be as high as 100% (1 in 1.0). Acute and chronic RQ values exceed the non-listed species LOC (0.5 and 1.0, respectively) for estuarine/marine invertebrates only for the highest use rate scenarios. Probability of individual effect varies from 1 in 6.3E+95 to 1 in 4.0 (25%). RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is likely to indirectly affect the CCR via freshwater and estuarine/marine invertebrate prey under exposure scenarios evaluated in this assessment.
		Terrestrial prey items, riparian habitat All acute and chronic RQs are above the non-listed species LOCs (0.5 and 1.0, respectively) for birds except for the lowest use rate (fallow land) when not accounting for toxicity of the degradate, methamidophos. All LOCs for birds are exceeded when assuming complete transformation to methamidophos. The probability of individual effect associated with these RQs to a bird is close to 100% (1 in 1.0) for nearly all uses. Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) for acephate and probability of individual effect can be as high as 100% (1 in 1.0). All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the CCR via bird, mammal, and invertebrate prey under exposure scenarios evaluated in this assessment.
California Freshwater Shrimp (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic Acute RQs for aquatic invertebrates exceed the listed species LOC for 27 of the 30 uses assessed when assuming complete transformation to the degradate, methamidophos (11 of 30 when not accounting for methamidophos). Chronic RQs exceed the LOC for 21 of the 30 uses assessed when the degradate is taken into account (1 of 30 when it is not). Probability of an individual effect associated with the RQs is between 1in

Species	Effects Determination	Basis for Determination
		9.7E+39 and 1 in 1.0 (100%). Direct effects to the CFWS are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity Acute and chronic RQs for freshwater invertebrate prey are above non-listed species LOC (0.5) for a majority of acephate uses and probability of individual effect can be as high as 100% (1 in 1.0). RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is likely to indirectly affect the CFWS via freshwater invertebrate prey under exposure scenarios evaluated in this assessment.
		Terrestrial prey items, riparian habitat RQs exceed the LOC (1.0) for terrestrial plants only for the highest use rate scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Acephate is not likely to indirectly affect the CFWS via terrestrial plant food and habitat.
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial Acute and chronic RQs for small mammals exceed the listed LOCs (0.1 and 1.0, respectively) for all but the lowest use rate scenario (fallow land) when not accounting for the degradate, methamidophos and for all use scenarios when assuming complete transformation to methamidophos. Probability of individual effect to a small mammal associated with the RQs is between 1 in 9.1E+08 and 1 in 1.0 (100%). Direct effects to the SMHM are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Aquatic habitat, cover, and primary productivity RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is not likely to indirectly affect the SMHM via aquatic plant habitat.
		Terrestrial prey items, habitat All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. All acute and chronic RQs are above the non-listed species LOCs (0.5 and 1.0, respectively) for birds and the probability of individual effect is close to 100% (1 in 1.0) for nearly all uses. Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0,

Species	Effects Determination	Basis for Determination
		respectively) for all but the lowest use scenario (fallow land) when not accounting for the degradate, methamidophos, and for all use scenarios when assuming complete transformation to methamidophos. Probability of individual effect to a small mammal can be as high as 100% (1 in 1.0). RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the SMHM via terrestrial invertebrate prey and rearing sites built on bird and small mammal nests.
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial All acute and chronic RQs are above the listed species LOCs (0.1 and 1.0, respectively) for birds (as a surrogate species to the reptile) and remain above the LOCs after refinement using T-HERPS. Probability of individual effect associated with the RQs is between 2.4% (1 in 42) and 100% (1 in 1.0). Direct effects to the SFGS are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity For freshwater fish the chronic RQ exceeds the LOC (1.0) for only the highest use rate (commercial lawn areas). The acute RQ does not exceed the non-listed LOC (0.5) for any uses. Acute and chronic RQs for freshwater invertebrate prey are above non-listed species LOC (0.5) for a majority of acephate uses and probability of individual effect can be as high as 100% (1 in 1.0). RQs cannot be calculated for aquatic plants due to a lack of toxicity data, but risk is believed to be discountable based on the data available. Based on the EC_{50} value of >50 mg/L for an aquatic non-vascular plant, the NOAEC would have to be over 20 times lower for an LOC exceedance at the highest use rate of acephate (commercial lawn areas). These results show that acephate is likely to indirectly affect the SFGS via freshwater invertebrate prey under exposure scenarios evaluated in this assessment.
		Terrestrial prey items, riparian habitat All acute and chronic RQs are above the non-listed species LOCs (0.5 and 1.0, respectively) for birds, terrestrial-phase amphibians, and reptiles except for the lowest use rate (fallow land) when not accounting for toxicity of the degradate, methamidophos. All LOCs for birds are exceeded when assuming complete transformation to methamidophos. The probability of individual effect to a bird is close to 100% for nearly all uses. Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) when not accounting for the degradate, methamidophos, and all LOCs are exceeded when assuming complete transformation to methamidophos. The probability of individual effect to a small mammal can be as high as 100% (1 in 1.0). All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. RQs exceed the LOC (1.0) for

Species	Effects Determination	Basis for Determination
		terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the SFGS via bird, mammal, and invertebrate prey as well as the mammal burrow component of habitat.
San Joaquin Kit Fox (*Vulpes macrotis mutica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial Acute and chronic RQs for large mammals exceed the listed species LOCs (0.1 and 1.0, respectively) for all but the lowest use rate scenario when not accounting for toxicity of the degradate, methamidophos, and for all use scenarios when assuming complete transformation to methamidophos. Probability of individual effect associated with the acute RQs is between 1 in 6.5E+14 and 1 in 1.0 (100%). Direct effects to the SJKF are likely under exposure scenarios evaluated in this assessment.
		Potential for Indirect Effects
		Terrestrial prey items, riparian habitat All acute and chronic RQs are above the non-listed species LOCs (0.5 and 1.0, respectively) for birds except for the lowest use rate (fallow land) when not accounting for toxicity of the degradate, methamidophos. All LOCs for birds are exceeded when assuming complete transformation to methamidophos. The probability of individual effect to a bird is close to 100% for nearly all uses. Acute and chronic RQs for small mammals exceed the non-listed LOCs (0.5 and 1.0, respectively) for all but the lowest use scenario (fallow land) when not accounting for the degradate, methamidophos, and all LOCs are exceeded when assuming complete transformation to methamidophos. The probability of individual effect to a small mammal can be as high as 100% (1 in 1.0). All acute RQs are above the listed species LOC (0.05) for terrestrial invertebrate species; probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. RQs exceed the LOC (1.0) for terrestrial plants only for the highest use scenario assessed (ornamental shrub & vines) for semi-aquatic areas. No adverse effects were seen on terrestrial plants in the study submitted to the Agency (*i.e.*, no LOAEC was established). Acephate's neurotoxic mode of action does not apply to plant physiology. Based on these results, acephate is likely to indirectly affect the SJKF via bird, mammal, and invertebrate prey under exposure scenarios evaluated in this assessment.

Table 7-2. Effects Determination Summary for the Critical Habitat Impact Analysis

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly	Habitat Modification	All acute and chronic RQs are above the listed species LOC (0.05) for Lepidoptera species. Probability of individual effect is between 40% (1 in 2.4) and 100% (1 in 1.0). Direct effects to the BCB are likely under exposure scenarios evaluated in this assessment.
Valley Elderberry Longhorn Beetle	Habitat Modification	All acute and chronic RQs are above the listed species LOC (0.05) for terrestrial invertebrate species. Probability of individual effect is close to 100% (1 in 1.0) for all use scenarios. Direct effects to the VELB are likely under exposure scenarios evaluated in this assessment.
California Tiger Salamander Central California Distinct Population Segment	Habitat Modification	Acute and chronic RQs for small mammals exceed the non-listed LOCs for all but the lowest use rate scenario (fallow land) for acephate and probability of individual effect can be as high as 100%. Small mammals are essential in creating the underground habitat that juvenile and adult California tiger salamanders depend upon for food, shelter, and protection from the elements and predation.
California Tiger Salamander Santa Barbara County Distinct Population Segment	Habitat Modification	Acute and chronic RQs for small mammals exceed the non-listed LOCs for all but the lowest use rate scenario for acephate (fallow land) and probability of individual effect can be as high as 100%. Small mammals are essential in creating the underground habitat that juvenile and adult California tiger salamanders depend upon for food, shelter, and protection from the elements and predation.

Table 7-3. Use Specific Summary of the Potential for Adverse Effects to Aquatic Taxa

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment:									
	Estuarine/Marine Vertebrates[1]		CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Estuarine/Marine Invertebrates[4]		Vascular Plants[5]	Non-vascular Plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic		
Cotton seed treatment	No	--	No	No	No	No	No	No	No	No
Fallow land	No	--	No	No	No	No	No	No	No	No
Tomatoes	No	--	No	No	No	No	No	No	No	No
Beans	No	--	No	No	**Yes***	No	No	No	No	No
Peanuts	No	--	No	No	**Yes***	No	No	No	No	No
Mint	No	--	No	No	**Yes***	No	No	No	No	No
Cotton	No	--	No	No	**Yes***	No	No	No	No	No
Peppers	No	--	No	No	**Yes***	No	No	No	No	No
Grapes 2	No	--	No	No	**Yes***	No	No	No	No	No
Celery	No	--	No	No	**Yes***	**Yes**	No	No	No	No
Grapes 1	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Almonds, non-bearing	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Drainage systems	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Rights-of-way	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Bermuda grass	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Apples, non-bearing	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Citrus 2	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Cauliflower	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Alfalfa	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Christmas trees	No	--	No	No	**Yes**	**Yes**	No	No	No	No
Paved areas	No	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Lettuce	No	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Fire ants	No	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Citrus 1	No	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Golf courses	**Yes***	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Sod farms	**Yes***	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Roses	**Yes***	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Ornamentals	**Yes***	--	No	No	**Yes**	**Yes**	**Yes***	No	No	No
Ornamental shrub & vines	**Yes***	--	No	No	**Yes**	**Yes**	**Yes**	**Yes**	No	No
Commercial lawns	**Yes***	--	**Yes***	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No

[1] A yes in this column indicates a potential for indirect effects to CCR.
[2] A yes in this column indicates a potential for indirect effects to SFGS and CCR. A yes also indicates a potential for direct and indirect effects for the CTS-CC, CTS-SC, and CTS-SB.

[3] A yes in this column indicates a potential for direct effects to the CFWS and indirect effects to the CFWS, SFGS, CCR, CTS-CC, CTS-SB, and CTS-SC.
[4] A yes in this column indicates a potential for indirect effects to CCR.
[5] A yes in this column indicates a potential for indirect effects to SFGS, CCR, SMHM, CTS-CC, CTS-SC, CTS-SB, and CFWS.
* RQ exceeds the LOC for listed species (potential for direct effects) but not for non-listed species (no potential for indirect effects). LOCs are 0.05 for acute risk to listed aquatic species, 0.5 for acute risk to non-listed aquatic species, 1.0 for chronic risk to all aquatic species, and 1.0 for risk to aquatic plants.
NOTE: This table counts a potential for effect based on the toxicity of the major degradate, methamidophos, assuming 100% conversion. Methamidophos is more toxic than the parent, acephate.

Table 7-4. Use Specific Summary of the Potential for Adverse Effects to Terrestrial Taxa

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment:												
	SMHM and Small Mammals[1]		**SJKF and Large Mammals[2]**		**CCR and Small Birds[3]**		**CTS-CC, CTS-SC, CTS-SB and Amphibians[4]**		**SFGS and Reptiles[5]**		**BCB, VELB, and Invertebrates (Acute)[6]**	**Dicots[7]**	**Monocots[7]**
	Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**			
All Uses	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No

[1] A yes in this column indicates a potential for direct effects to SMHM and indirect effects to SFGS, CCR, SMHM, SJKF, CTS-CC, CTS-SC, CTS, and CTS-SB.
[2] A yes in this column indicates a potential for direct and indirect effects to SJKF. The only exception to the potential for effects to large mammals is for acute effects for the fallow land use for an indirect effects assessment (not applicable in this assessment because there are no indirect effects based on large mammals).
[3] A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, SMHM, SJKF, CTS-CC, CTS-SC, and CTS-SB.
[4] A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS-CC, CTS-SC, CTS-SB, SFGS, and CCR.
[5] A yes in this column indicates the potential for direct and indirect effects to SFGS and other reptiles.
[6] A yes in this column indicates a potential for direct effect to BCB and VELB and indirect effects to SFGS, CCR, SMHM, SJKF, CTS-CC, CTS-SC, and CTS-SB.
[7] A yes in this column indicates a potential for indirect effects to BCB, VELB, SFGS, CCR, SMHM, CTS-CC, CTS-SC, CTS-SB, and CFWS. For the BCB and VELB this is based on the listed species LOC because of the obligate relationship with terrestrial monocots and dicots. For other species, the LOC exceedances are evaluated based on the LOC for non-listed species.
*LOCs are 0.05 for acute risk to listed terrestrial invertebrates, 0.1 for acute risk to other listed terrestrial species, 0.5 for acute risk to non-listed terrestrial species, 1.0 for chronic risk to all terrestrial species, and 1.0 for risk to terrestrial plants.
NOTE: This table counts a potential for effect based on the toxicity of the major degradate, methamidophos, assuming 100% conversion. Methamidophos is more toxic than the parent, acephate.

Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated.

When evaluating the significance of this risk assessment's direct/indirect and adverse habitat modification effects determinations, it is important to note that pesticide exposures and predicted risks to the listed 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 BCB, VELB, CTS (all DPS), CCR, CFWS, SMHM, SFGS, 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

A bibliography of ECOTOX references, identified by the letter E followed by a number, is located in Appendix H.

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