Risks of Aluminum and Magnesium Phosphides Uses to the Federally Threatened Alameda Whipsnake (*Masticophis lateralis euryxanthus)* and California Tiger Salamander (*Ambystoma californiense*), Central California Distinct Population Segment

And Federally Endangered California Tiger Salamander (*Ambystoma californiense*) Sonoma County Distinct Population Segment and Santa Barbara County Distinct Population Segment, San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*), and San Joaquin Kit Fox (*Vulpes macrotis mutica)*

Pesticide Effects Determinations
PC Codes: 066501, 066504
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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
AW	Alameda Whipsnake
BCF	Bioconcentration Factor
BEAD	Biological and Economic Analysis Division
bw	Body Weight
CAM	Chemical Application Method
CARB	California Air Resources Board
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
Kd	Solid-water Distribution Coefficient
KF	Freundlich Solid-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 Joaquine 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 on the Alameda whipsnake (*Masticophis lateralis euryxanthus* AW), California tiger salamander (*Ambystoma californiense*, Central California, Sonoma County, and Santa Barbara County Distinct Population Segments CTS), San Francisco garter snake (*Thamnophis sirtalis tetrataenia* SFGS), and San Joaquin kit fox (*Vulpes macrotis mutica* SJKF) arising from FIFRA regulatory actions regarding use of aluminum and magnesium phosphides (or referred to collectively in this document as phosphides) on all outdoor use sites. It should be noted that this assessment only includes outdoor use sites as all other uses of these pesticides are indoors and expected to have incomplete exposure pathways to the outside environment. In addition, this assessment evaluates whether these outdoor uses can be expected to result in modification of designated critical habitat for the AW and the CTS. 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 aluminum and magnesium phosphides were alleged to be of concern to the AW, CTS, SFGS, and SJKF (*Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS)).

The AW was listed as threatened in 1997 by the USFWS. The species occurs in the Inner Coast Ranges in Contra Costa, Alameda, San Joaquin, and Santa Clara Counties in California. 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. Owing to the highly dispersed nature of the pesticides considered in this assessment, each population segment for CTS is considered to be equally affected. 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. CTS 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 estivation. 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

Aluminum and magnesium phosphides are fumigants for which the only outdoor use is as a control for burrowing small mammals, which are considered as part of the Federal action evaluated in this assessment. The formulations for these outdoor uses include tablet and pellet products. All other uses for aluminum and magnesium phosphides are considered indoor uses and are not expected to affect any outdoor environment. The outdoor use receives specific

consideration in this assessment. The indoor uses are expected to present no complete exposure pathway to outdoor ecological receptors and as such are automatically determined to have "no effect" on species assessed in the document or any associated Critical Habitat. As a result they will not be further considered in this assessment.

1.2.2. Environmental Fate Properties of Aluminum and Magnesium Phosphides

In keeping with the fumigant intent of the products, aluminum and magnesium phosphides react quickly upon contact with moisture or acids to give off the very toxic gas phosphine (PH_3). Phosphine is a heavier than air gas and is rapidly degraded. Subterranean releases of phosphine adsorb rapidly to soil by two processes: an irreversible chemisorption and a reversible physiosorption. These sorption processes suggest low potential for mobility within the soil column. Degradation of soil associated phosphine is rapid with half-lives in dry and moist soils of five and eleven days.

In summary aluminum and magnesium phosphides released to sealed subterranean burrows of animals, can be expected to react rapidly to produce phosphine which in turn will degrade rapidly in the burrow air and adsorb strongly to soil where it will again degrade rapidly.

1.2.3. Evaluation of Degradates and Stressors of Concern

The only degradate of concern for aluminum and magnesium phosphide is phosphine gas. Essentially the two active ingredients are delivery agents for the biologically active degradate. Other degradates are aluminum and magnesium hydrates and phosphate which are considered common in the environment and given the small amounts used in a given burrow (12g) the amounts of phosphates and metal ions are inconsequential.

1.3. Assessment Procedures

This assessment does not include quantitative estimates of either exposure or effects. Instead, the intended use of the pesticides in targeted and sealed small mammal burrows is assumed to result in complete mortality of all animal inhabitants of these treated burrows. Consequently there is no quantitative evaluation of risk. And risk for lethal effects is assumed to be 100 percent.

1.3.1. Exposure Assessment

The exposure assessment in this document does not involve quantification of exposure levels. The nature of the confined space uses in the outdoor environment allow for a conservative and protective assumption that use of the pesticide as labeled will achieve asmospheric concentrations of the toxic and pesticidal degradates adequate to achieve the intended 100 percent mortality of the target pests. The outdoor spaces to which the pesticide is applied are subterranean and involve the sealing of the spaces immediately upon application to prevent escape of toxic material to the surface and to exclude organisms from exposing the treated areas underground. Aluminum and magnesium phosphides react soil moisture and produce the toxic gas phosphine, which is heavier than air, reacts quickly with water, and binds to soil particles. As such, phosphine within the burrows is expected to remain within burrows when the pesticide products are used as directed.

1.3.1.a. Aquatic Exposures

Aquatic exposure estimates to aluminum and magnesium phosphides were not evaluated as the pesticide materials are placed underground in sealed mammal burrow chambers and the material is expected to react fully to produce phosphine gas, which in turn rapidly degrades in the chamber air with any remaining phosphine adsorbing strongly to and degrading rapidly with chamber soils. Therefore, **there is no complete exposure pathway expected for aquatic environments.**

1.3.1.b. Terrestrial Exposures

No exposure modeling was conducted for any of the listed species and any non-listed species upon which the listed species depend. Instead, the pesticides are expected to react fully when placed in the sealed mammal burrow chambers, producing lethal concentrations of phosphine gas. Therefore all exposures within the burrow are considered to be lethal to all animal inhabitants of the burrows. The label requirement for sealing the burrows upon treatment combined with the rapid, largely irreversible, and high degradable association of the gas with soil precludes any concern for migration of the phosphine to surface air. **In summary terrestrial organism exposure is only expected to be complete for organisms present in the animal burrows at the time of treatment.**

1.3.2. Toxicity Assessment

The assessment endpoints for listed species evaluation usually 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. Phosphine gas produced from the introduction of aluminum and magnesium phosphides to the targeted and sealed small mammal burrows is assumed to be lethal, regardless of acute lethal toxicity testing endpoints empirically determined, to all organisms residing within the burrows. This is consistent with the intended use of the product.

Because of the expected incomplete exposure pathways for phosphine to organisms above the soil surface, exposures to sublethal concentrations of phosphine are not expected. Also, because all organisms are assumed dead within the exposure area, there is no need to explore sublethal effects including but not limited to reproduction and growth effects. Therefore no evaluation for specific empirical effects endpoints related to survival, reproduction or growth assessment endpoints was conducted. Federally-designated critical habitat has been established for the AW and the CTS. Primary constituent elements (PCEs) were used to evaluate whether aluminum and magnesium phosphides have the potential to modify designated critical habitat.

1.3.3. Measures of Risk

Because the exposure pathway was assumed complete within the targeted and sealed small mammal burrows and the intended reaction product from the pesticide products (phosphine gas) was assumed to reach acutely lethal concentrations in all targeted and sealed burrows, no quantitative expression of risk was conducted. Therefore, in all targeted and sealed small mammal burrow environments, the potential for lethality to all animals (vertebrate and invertebrate) within these burrows is assumed to be 100 percent.

1.4. Summary of Conclusions

Based on the best available information, the Agency makes a No Effect determination for all indoor uses and for all species evaluated in this assessment and any associated Critical Habitat.

Based on the best available information, the Agency makes a May Affect, and Likely to Adversely Affect determination for all evaluated species from aluminum and magnesium phosphide's outoor uses. Additionally, the Agency has determined that there is the potential for modification of designated critical habitat for the AW and the CTS by virtue of sealing and rendering toxic treated small mammal burrows, and the elimination of small mammals that construct such burrows. 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 Tables 1-3 and 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 AW, CTS, SFGS, and SJKF and potential modification of designated critical habitat for AW, CTS a description of the baseline status and cumulative effects for these species is provided in Attachment III.

Table 1-1. Effects Determination Summary for Effects of Aluminum and Magnesium Phosphides on AW, CTS, SFGS, and SJKF

Species	Effects Determination	Basis for Determination
		Potential for Direct Effects

Species	Effects Determination	Basis for Determination
Alameda Whipsnake (*Masticophis lateralis euryxanthus*)	May Affect, Likely to Adversely Affect (LAA)	Any snake residing in a small mammal burrow targeted for treatment will be killed by the exposure to phosphine.
		Potential for Indirect Effects
		Terrestrial prey items, burrow shelter destruction Animal prey items present in the treated small mammal burrows will be killed by exposure to phosphine. Poisoning of small mammals and sealing burrows will likely deprive the listed organism of sheltering sites.
California tiger salamander (*Ambystoma californiense*) all distinct population segments	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic-phase (Eggs, Larvae, and Adults): No effect via this pathway. No exposure is expected to occur.
		Terrestrial-phase (Juveniles and Adults): Any salamander residing in a small mammal burrow targeted for treatment will be killed by the exposure to phosphine.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover and/or primary productivity No effect via this pathway. No exposure is expected to occur.
		Terrestrial prey items, burrow shelter destruction Animal prey items present in the treated small mammal burrows will be killed by exposure to phosphine. Poisoning of small mammals and sealing burrows will likely deprive the listed organism of sheltering sites.
San Francisco garter snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Any snake residing in a small mammal burrow targeted for treatment will be killed by the exposure to phosphine.
		Potential for Indirect Effects
		Terrestrial prey items, burrow shelter destruction Animal prey items present in the treated small mammal burrows will be killed by exposure to phosphine. Poisoning of small mammals and sealing burrows will likely deprive the listed organism of sheltering sites.
San Joaquin kit fox *(Vulpes macrotis mutica*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Any fox residing in a small mammal burrow targeted for treatment will be killed by the exposure to phosphine.
		Potential for Indirect Effects

Species	Effects Determination	Basis for Determination
		Terrestrial prey items, burrow shelter destruction Animal prey items present in the treated small mammal burrows will be killed by exposure to phosphine. Poisoning of small mammals and sealing burrows will likely deprive the listed organism of sheltering sites.

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

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Alameda Whipsnake (*Masticophis lateralis euryxanthus*)	**Habitat modification**	Application of pesticide to rodent burrows will affect the PCE associated with the availability of small mammal burrows. The pesticide will render treated burrows acutely toxic to all inhabitants. The sealing of the burrows upon treatment will remove burrow availability. Destruction of the target small mammals will reduce the population available to construct new burrows.
California tiger salamander (*Ambystoma californiense*) all distinct population segments	**Habitat modification**	Application of pesticide to rodent burrows will affect the PCE associated with the availability of small mammal burrows. The pesticide will render treated burrows acutely toxic to all inhabitants. The sealing of the burrows upon treatment will remove burrow availability. Destruction of the target small mammals will reduce the population available to construct new burrows.

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 Terrestrial Environment:						
	Fish		Amphibians		Invertebrates		Aquatic Plants
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute
Outdoor small mammal burrows	no	no	no	no	no	no	no

A finding of "no" in this table is predicated on the expectation of no complete exposure pathway to aquatic environments.

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:												
	Small Mammals		Large Mammals		Birds		Amphibians		Reptiles		Invertebrates (Acute)	Dicots	Monocots
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Outdoor small mammal burrows	yes	NA	yes	NA	no	NA	yes	NA	yes	NA	yes	yes (with high uncertainty)	yes (with high uncertainty)

NA- Not applicable: the complete lethality of exposed organisms to the pesticides' generated phosphine gas precludes pertinent assessment of chronic effects.
A finding of "no" in this table is predicated on the expectation of no complete exposure pathway to plants
High uncertainty for findings regarding plants is based on above ground effects data for phosphine exposure to root zone exposures in the case of aluminum and magnesium phosphide uses.

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, 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 listed species 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 assessment is to evaluate potential direct and indirect effects on the Alameda whipsnake (*Masticophis lateralis euryxanthus* AW) California tiger salamander (*Ambystoma californiense*, Central California, Sonoma County, and Santa Barbara County Distinct Population Segments CTS), San Francisco garter snake (*Thamnophis sirtalis tetrataenia* SFGS), and San Joaquin kit fox (*Vulpes macrotis mutica* SJKF) arising from FIFRA regulatory actions regarding use of aluminum and magnesium phosphides on all outdoor use sites. Because indoor uses are expected to have an incomplete exposure pathway to the outside environment, we have determined they will have "no effect" on the species at issue in this assessment. The remainder of this assessment will therefore, focus exclusively on the outdoor uses of aluminum and magnesium phosphides. This ecological risk assessment has been prepared consistent with a stipulated injunction settling the case *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS).

The AW was listed as threatened in 1997 by the USFWS. The species occurs in the Inner Coast Ranges in Contra Costa, Alameda, San Joaquin, and Santa Clara Counties in California.

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. The main difference in the assessment will be in the spatial analysis. 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. CTS 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 estivation.

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 aluminum and magnesium phosphides is based on an action area. The action area is the area directly or indirectly affected by the federal action, as indicated by the risk quotients that exceed 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 aluminum and magnesium phosphides 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 species previously listed in this section 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 aluminum and magnesium phosphides 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.

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 aluminum and magnesium phosphides in accordance with the approved product labels for California is "the action" relevant to this ecological risk assessment.

Uses of aluminum and magnesium phosphide include a variety of indoor-only fumigation uses to eliminate insect pests in stored materials. These uses include the treatment of warehouses, sealed commodity storage structures, farm storage structures, bagged storage, mills, rail cars, trucks vans, and the holds of ships. The materials may be used for fumigation of the following stored materials:

almonds
animal feed
barley
coffee beans
peanuts
corn
wheat
pecans
millet
flower seed
dates
popcorn
soybeans
grass seed
safflower seed
rice
sunflower seeds
rye
triticale
Brazil nuts
cocoa beans
oats
seed and pod vegetables
vegetable seeds
cashews
walnuts
processed candy and sugar
cereal flours and bakery mixes
cereal foods
processed cereals,
cheese and its by-products
chocolate and its products
processed coffee corn grits
cured/dried meat/fish products
dates and figs,
dried eggs and their solids
dried milk and its products
dried fruits
processed nuts
processed oats
soybean flour
processed tea
yeast
cloth and fiber (*from cotton and wool*)
clothing
straw and hay
feathers
hair
leather
tobacco
wood
paper
dried plants and flowers
seeds (*other than grass, ornamental and vegetable*)

sorghum
sesame seed

Because these uses involve structures and containment of the fumigation gases within the structures the Agency believes these indoor uses present no significant releases of phosphine and therefore no complete exposure pathways to ecological receptors. In addition there are no incidents or environmental monitoring data to suggest that this assumption is invalid. As a result, the Agency has determined these uses will have "no effect" on the previously identified listed species and will not be assessed further in this risk assessment and effects determination.

However, there is a single outdoor use for aluminum and magnesium phosphides. This outdoor use involves the application of tablets or pellets of the pesticides to small rodent burrows and subsequent sealing of the burrow entrances to prevent emission of the pesticide degradate, and killing agent, phosphine gas. The burrowing pest control use involves underground burrow systems located in agricultural areas, orchards, non-crop areas (pasture/rangeland), golf courses, athletic fields, airports, cemeteries, rights-of-way, earthen dams, parks and recreation areas and other non-residential institutional or industrial sites.

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

2.2.1. Evaluation of Degradates and Other Stressors of Concern

Upon exposure to soil and air moisture, aluminum and magnesium phosphides produce phosphine gas. This is the pesticidal agent associated with application of these pesticides and is the material expected to exert toxic effects on all taxa residing within the treated small mammal burrows.

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).

The phosphides assessed in this document do not have registered products that contain multiple active ingredients

2.3. Previous Assessments

The Agency completed a Reregistration Eligibility Document in 1998 (Sylvester et al. 1998) for the two phosphides assessed herein. The document concluded "no ecological or fate data have been required in the past …. and none are needed at this time." The document identifies no concern for non-target organisms and states:

> "Al phosphide and Mg phosphide are expected to degrade rapidly in the environment to aluminum hydroxide and magnesium hydroxide and phosphine, the toxicant of these pesticides. It appears that phosphine will degrade in days and is at low risk for contaminating ground or surface waters….Phosphine trapped beneath the soil surface will bind to soil, inhibiting movement, and be oxidized to phosphates."

In 1981, The United States Department of the Interior's Fish and Wildlife Service completed a biological opinion on the use of magnesium phosphide for rodent and mole pest control (FWS/OES EPA-81-6). The Biological Opinion stated: "Analysis of the chemical action of magnesium phosphide, the areas of intended use, the life history and ecological data of listed and proposed species indicate that any species using or inhabiting burrow systems could be impacted by the use of this pesticide." The document continues with the finding of jeopardy for the following species; black footed ferret (*Mustela nigripes*), eastern indigo snake (*Drymarchon corais couperi*), San Joaquin kit fox, Utah prairie dog (*Cynomys parvidens*), blunt-nosed leopard lizard (*Gamelia silus*) , and the desert tortoise (*Gopherus agassizii*).

2.4. Environmental Fate Properties and Transport Mechanisms

The following discussion summarizes the properties and fate assessment as described in the 1998 RED (Sylvester et al. 1998) and forms the basis for conclusions regarding the fate of aluminum and magnesium phosphides post application and the resulting phosphine gas produced.

Aluminum phosphide (AlP) and magnesium phosphide (Mg_3P_2) appear to be non-persistent under most environmental conditions and are **non-mobile in soil** because of their instability at atmospheric moisture contents. AlP and Mg_3P_2 react with water or moisture in air to generate the highly toxic gas phosphine (PH_3) which is the active ingredient of these pesticides (Cotton and Wilkerson 1988, Fluck 1973, greenwood and Earnshaw 1984, WHO 1988). Other products of hydrolysis are aluminum and magnesium hydroxides. The reactions can be written as follows:

(1) $AlP + 3H_2O$ -----> $Al(OH)_3 + PH_3$ or

(2) $Mg_3P_2 + 6H_2O)$ -----> $3Mg(OH)_2 + 2PH_3$.

The aluminum and magnesium hydroxide residues can further react to produce mineral phases that are known to occur naturally in the environment (5). Inorganic phosphate and other phosphorus oxyacids are expected to be other products formed from the oxidation of PH_3 in soils (WHO 1988,Holton and Robinson 1972, EFED 1998).

Under normal environmental conditions phosphine exists as a gas. The solubility of phosphine in water at normal atmospheric pressure is approximately 340 ppm (WHO 1988) and the Ostwald solubility constant (the ratio of the concentration in solution to the concentration in the gas phase at equilibrium) is 0.201 (Fluck 1973). Because of its high vapor pressure (40 mm Hg at -129.4 ^{o}C) and Henry's Law Constant (0.1 atm m^3/mol), phosphine at the soil surface is expected to rapidly dissipate into the atmosphere (WHO 1988).

Phosphine in the atmosphere is rapidly degraded (WHO 1988). The half-life in air was 5 hours with the mechanism of degradation being photoreaction with hydroxy radicals. The dark half-life was 28 hours. The expected reaction products of phosphine in air are oxyacids of phosphorus and inorganic phosphate which are nonvolatile.

Several published laboratory studies suggest that phosphine below the soil surface is quickly adsorbed and degraded. Gaseous phosphine added to soil headspace at 1000 mg/kg dry soil in closed containers degrades 50% after approximately 5 days with air dried soil and 11 days in water saturated soil (Hilton and Robinson 1972). Smaller quantities of phosphine may be removed by soil through a faster mechanism because phosphine added at a lower concentration (0.35 μg / kg) was undetectable in 50 minutes (Eiseman et al. 1997). Diffusion through the soil environment is expected to be slow as phosphine is sorbed in seconds when pushed through several types of soil in a nitrogen carrier (Berck and Gunther 1970). The interaction of phosphine with soil appears to be mixed chemisorption (irreversible) and physisorption (reversible) with the extent of each dependent on soil type.

It should be noted that the labels for burrow uses of aluminum and magnesium phosphide requires insertion of the pellets far enough below the soil surface to prevent smothering of the pellets by the seal closing off the burrow. This suggests that release of phosphine gas will not occur at the soil surface where it might dissipate to the atmosphere. The combination of heavier than air density (vapor density 1.17, WHO 1988), insertion well below the soil surface, and the reactivity and bining of phosphine to soil all suggest that exposures to phosphine gas are isolated within the burrow chamber.

2.4.1. Mechanism of Action

While the exact mechanism of toxicity of the active degradate, phosphine, is not completely understood, it is a strong reducing agent. A variety of enzyme systems, and the biological redox system, especially the components of the mitochondrial electron transport chain, are probably the sites of its action. Phosphine is lethally toxic to invertebrates and vertebrates with the target pests including a variety of insect pests of stored commodities and materials and mammalian pests in subterranean burrows.

2.4.2. Use Characterization

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for aluminum and magnesium phosphides 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.

The majority of labeled uses of aluminum and magnesium phosphides uses are indoors uses as a fumigant for a variety of agricultural and non agricultural materials. As a consequence of their indoor application, these uses are not expected to have any implications for listed species and are not included further in this assessment. However, there is one outdoor use for both of these phosphides. Table 2-1 presents the uses and corresponding application rates and methods of application considered in this assessment.

Table 2-1. Aluminum and Magnesium Phosphide Uses Assessed for California

Use (App. Method)	Form.	Maximum Single App. Rate	Maximum App. Rate per Year (lbs a.i./acre)	Maximum Number of App. per Year	Minimum Retreatment Interval (days)
Burrowing pest control	tablets/pellets	10-20 tablets or pellets per burrow (12g/burrow)	Not specified	Not specified	1-3 days if burrows reopen

Abbreviations: App. = applications; Form. = formulation

The United States Geological Survey's (USGS) national pesticide usage data (based on information from 1999 to 2004, (http://water.usgs.gov/nawqa/pnsp/usage/maps/compound_listing.php?year=02) does not present data for aluminum or magnesium phoshide.

California PUR provides data for the years 2000 to 2008 for "production uses" of pesticides in the state. "Production use" data is the daily reporting of pesticide use on a given section of land (public land survey system (PLSS) one-mile square). Aluminum phosphide "production uses" data totals 225,445 lbs. Of this amount, only 34,909 lbs are map-able across the reported 1796 PLSS sections. However a significant amount of aluminum phosphide is reported as "non-production uses" with 738,500 lbs tabulated from CA Pesticide Use Reporting which eclipses production uses by a factor of 3. Non-production uses are monthly tabulations that are not associated with non-agricultural entities (this later set of data is more suggestive of indoor commodity fumigation uses.

Magnesium phosphide production uses from 2000-2008 PUR data totals 6905 lbs, where only 2533 lbs could be mapped. A total of 15,340 lbs was recorded for non-production uses, which is more than double the production uses. The top five non-production counties are Yolo, Colusa, San Joaquin, Stanislaus and Butte; two of these counties are concurrent with species habitat.

2.5. Assessed Species

Table 2-2 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 2-1 for maps of the current range and designated critical habitat, if applicable, of the assessed listed species.

The AW was listed as threatened in 1997 by the USFWS. The species occurs in the Inner Coast Ranges in Contra Costa, Alameda, San Joaquin, and Santa Clara Counties in California. 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. Owing to the highly dispersed nature of the pesticide uses considered in this assessment, each population segment for CTS is considered to be equally affected. 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. CTS 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 estivation. 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.

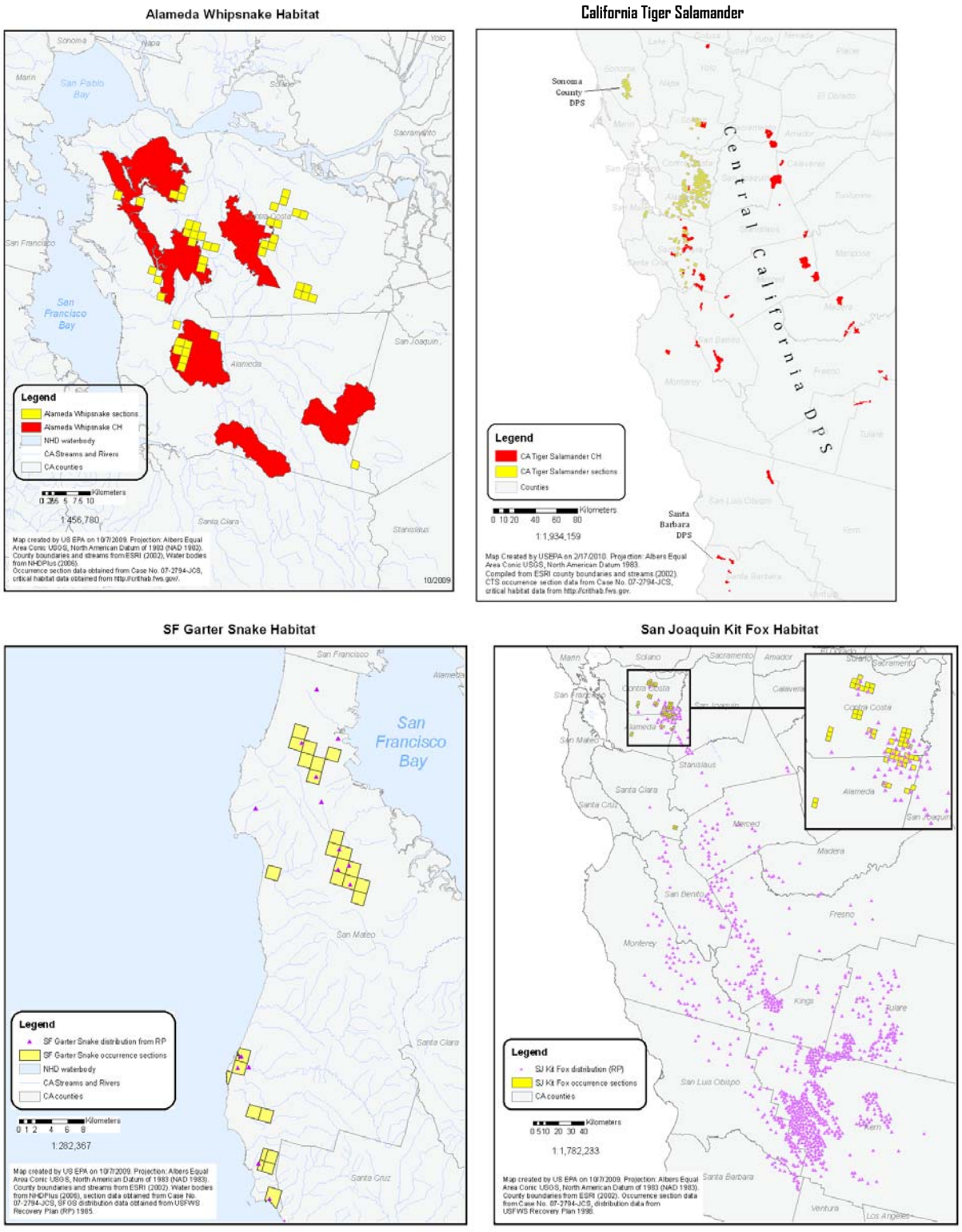

Figure 2-1. Maps of Species Current Range and Applicable Designated Critical Habitat

Table 2-2. 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
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	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.

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
			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)			
Alameda Whipsnake (AW) (*Masticophis lateralis euryxanthus*)	3 – 5 ft	Contra Costa and Alameda Counties in California (additional occurrences in San Joaquin and Santa Clara Counties)	Primarily, scrub and chaparral communities. Also found in grassland, oak savanna, oak-bay woodland, and riparian areas. Lands containing rock outcrops, talus, and small mammal burrows.	Yes	Emerge from hibernation and begin mating from late March through mid-June. Females lay eggs in May through July. Eggs hatch from August through November. Hibernate during the winter months.	Lizards, small mammals, nesting birds, other snakes including rattlesnakes
California Tiger Salamander (CTS) (*Ambystoma californiense*)	Adult 14.2-80.5 g^3	CTS-SC are primarily found on the Santa Rosa Plain in Sonoma County. 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	Freshwater pools or ponds (natural or man-made, vernal pools, ranch stock ponds, other fishless ponds); Grassland or oak savannah communities, in low foothill regions; Small mammal burrows	Yes	Emerge from burrows and breed: fall and winter rains 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 Phase: algae, snails, zooplankton, small crustaceans, and aquatic larvae and invertebrates, smaller tadpoles of Pacific tree frogs, CRLF, toads; Terrestrial Phase: terrestrial invertebrates, insects, frogs, small mammals, and worms

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
		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.				

[1] For more detailed information on the distribution, habitat requirements, and life history information of the assessed listed species, see Attachment III.
[2] Oviparous = eggs hatch within the female's body and young are born live.
[3] See Page 369 of Trenham *et al.* (2000).

2.6. Designated Critical Habitat

Critical habitat has been designated for the CTS and the AW. Risk to critical habitat is evaluated separately from risk of 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 2-3 describes the PCEs for the critical habitats designated for the aforementioned species.

Table 2-3. Designated Critical Habitat PCEs for the CTS and AW[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]	FR Vol. 69 No. 226 CTS, 68584, 2004
	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	
Alameda whipsnake	Scrub/shrub communities with a mosaic of open and closed canopy	71 FR 58175 58231, 2006
	Woodland or annual grassland plant communities contiguous to lands containing PCE 1	
	Lands containing rock outcrops, talus, and small mammal burrows within or adjacent to PCE 1 and or PCE 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.

More detail on the designated critical habitat applicable to this assessment can be found in Attachment III. 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 aluminum and magnesium phosphides that may alter the PCEs of the designated critical habitat for the CTS and AW 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 aluminum and magnesium phosphides are expected to directly impact living organisms within the action area, critical habitat analysis of these chemicals 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 area 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 aluminum and magnesium phosphides are likely to encompass considerable portions of the United States based on the diffuse nature of the target pests and varied sites of use. 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 assessed species 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 the assessed species 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 aluminum and magnesium phosphides. An analysis of labeled uses and review of available product labels was completed. 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 aluminum and magnesium phosphides the following uses are considered as part of the federal action evaluated in this assessment:

1. Indoor uses for fumigation of variety of food and non-food commodities and materials in enclosed areas including commercial storage facilities, farm storage structures, truck, rail and other transport vehicles, ships, and food processing facilities.

2. Outdoor uses of the pesticides for burrowing mammalian pest (except chipmunks) control on agricultural areas, golf courses, athletic fields, airports, cemeteries, rights-of-way, earthen dams, parks, and recreation areas and other non-residential institutional or industrial sites.

Label Registration Number	Outdoors Use Sites for California	Target Pest	Specific Prohibitions
Aluminum Phosphide			
19713-571, 19713-569, 43743-1, 43743-2, 70506-13, 70506-14, 70506-15, 72959-1, 72959-2, 72959-4, 72959-5, 81951-1, 81951-2	burrowing pest control, underground burrow systems located ONLY on agricultural areas, orchards, non-crop areas (pasture/rangeland), golf courses, athletic fields, airports, cemetaries, rights-of-way, earthen dams, parks and recreation areas and other non-residential institutional or industrial sites	burrowing mammals except chipmunks	Burrows are sealed with paper, turf or soil. Cannot apply to burrows within 100 feet of buildings occupied or may be occupied by humans or domestic animals.
Magnesium Phosphide			
70506-16, 70506-17	burrowing pest control, underground burrow systems located ONLY on agricultural areas, orchards, non-crop areas (pasture/rangeland), golf courses, athletic fields, airports, cemetaries, rights-of-way, earthen dams, parks and recreation areas and other non-residential institutional or industrial sites	burrowing mammals except chipmunks	Burrows are sealed with paper, turf, or soil. Cannot apply to burrows within 100 feet of buildings occupied or may be occupied by humans or domestic animals.

Following a determination of the assessed uses, an evaluation of the potential "footprint" of aluminum and magnesium phosphide 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. For the phosphides assessed herein, these land cover types encompass the

majority of the state of California and further refinement of the initial footprint will not provide meaningful additional spatial resolution.

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. There are no drift or run-off pathways identified for the outdoor uses of aluminum and magnesium phosphides nor is there an available quantitative risk analysis for LOC comparison purposes. Therefore the application sites are assumed to comprise the Potential Area of LAA.

2.8. Assessment Endpoints and Measures of Ecological Effect

While this assessment uses assessment endpoints and measures of ecological effect in a manner similar to other assessments, the assessment does not assess risk in a quantitative manner.

2.8.1. Assessment Endpoints

Table 2-4 identifies the taxa used to assess the potential for direct and indirect effects from the uses of the phosphides for each listed species assessed here.

Table 2-4. Taxa Used in the Analyses of Direct and Indirect Effects for the Assessed Listed Species.

Listed Species	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Estuarine/ Marine Fish	Estuarine/ Marine Inverts.	Aquatic Plants
San Francisco garter snake	Indirect (prey/ habitat)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Joaquin kit fox	Direct Indirect (prey)	n/a	Indirect (prey)	n/a	n/a	n/a	n/a	n/a
Alameda whipsnake	Indirect (prey/ habitat)	n/a	Indirect (prey)	n/a	n/a	n/a	n/a	n/a
California tiger salamander	Indirect (prey/ habitat)	n/a	Indirect (prey)	n/a	n/a	n/a	n/a	n/a

Abbreviations: n/a = Not applicable as no listed species resource requirement for the taxa or complete exposure pathway to these taxa are evident

In all cases the effects endpoint assessed for each taxa is lethality. Aluminum and magnesium phosphide are assumed to generate phosphine gas within the treated animal burrows at levels that are 100 percent lethal. This assumption precludes the assignation of a quantitative effects threshold measure to these lethal effects. Sublethal and chronic effects related to growth and reproduction are not considered as no organisms within the affected area (burrows) are expected to survive.

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 the phosphides 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).

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.

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 the phosphides to the environment and subsequent release of phosphine gas. The following risk hypotheses are presumed in this assessment.

The labeled use of aluminum and magnesium phosphides within the action area may:

- directly affect AW, CTS, SFGS, and SJKF by causing mortality;
- indirectly affect AW, CTS, SFGS, SJKF and/or modify their designated critical habitat by reducing or changing the composition of food supply;
- indirectly affect AW, CTS, SFGS, SJKF 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 aluminum and magnesium phosphide release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for AW, CTS, SFGS, SJKF and the conceptual models for the terrestrial PCE components of critical habitat are shown in Error! Reference source not found.. 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. The conceptual models only deal with terrestrial exposures as there is no expected complete exposure pathway to surface waters owing to the high reactivity of the phosphides and

resultant phosphine gas and the sealed animal burrow requirement on the labels which contains the gas within the burrows. Similarly there is only one complete exposure pathway for terrestrial organisms, inhalation of produced phosphine within the animal burrows, which is limited to underground environs because of the high reactivity and immobility of phosphine in soil and the sealed nature of the treated burrows which prevents gas escape.

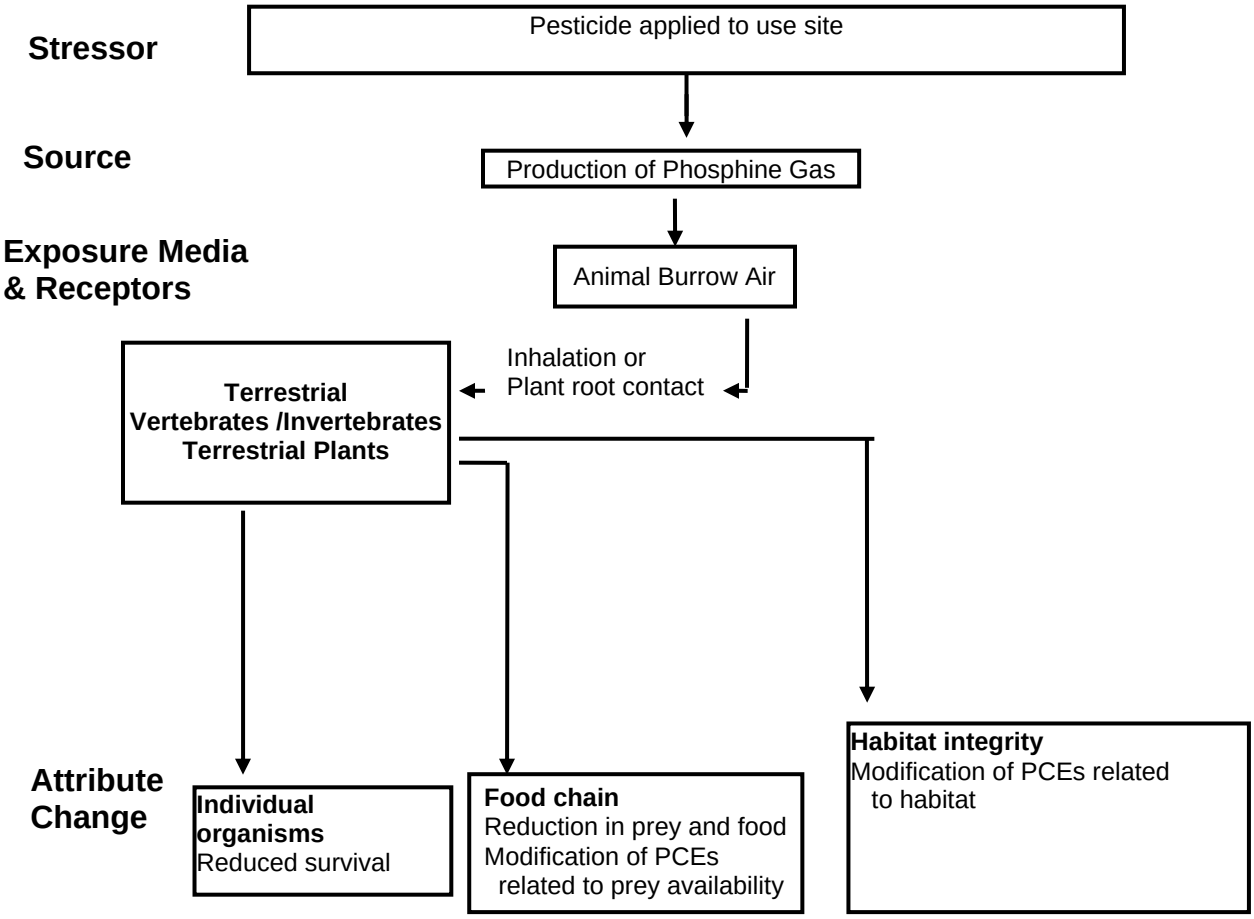

Figure 2-2. Conceptual model depicting stressors, exposure pathways, and potential effects to terrestrial organisms from the use of Aluminum and Magnesium Phosphides in Outdoor Scenarios.

2.10. Analysis Plan

This assessment does not include quantitative estimates of either exposure or effects. Instead, the intended use of the pesticides in targeted and sealed small mammal burrows is assumed to result in complete mortality of all animal inhabitants of these treated burrows and plant roots entering these treated burrows are exposed to phosphoine at plant-damaging levels. The complete exposure pathway is inhalation of the product-degradate phosphine gas. Exposure pathways for above ground terrestrial animals, and all aquatic organisms are considered

incomplete and not subject to analysis. Consequently there is no quantitative evaluation of risk, and risk for lethal effects is assumed to be 100 percent within the treated burrow.

2.10.1. Measures of Exposure

No quantitative measures of exposure are included in this risk assessment. Exposures within treated animal burrows to the biologically active degradate phosphine gas are assumed to reach concentrations sufficient to induce 100 percent mortality within the treated animal burrows.

2.10.2. Measures of Effect

No quantitative measures of effect are presented in this assessment. All concentrations of the biologically active degradate phosphine gas are assumed to be sufficient to produce 100 percent mortality in exposed organisms. As the exposure assumptions preclude complete exposure pathways for above ground portions of terrestrial plants, above ground terrestrial animals and all aquatic organisms, the assumption of lethality at all phosphine concentrations is valid for those vertebrate and invertebrate organisms and the rooted portions of terrestrial plants inhabiting treated animal burrows.

2.10.2.a. Integration of Exposure and Effects

In this risk assessment, no numerical integration of exposure and effects is made. The assessment assumes that effects occur within the confines of treated animal burrows and produce complete morality in vertebrates and invertebrates residing therein as well as terrestrial plants rooted in the burrows.

2.10.3. Data Gaps

Data gaps in this assessment include the absence of any guideline studies on environmental fate and effects. Fate information needs have been made through reliance on the previous RED document's fate characterization which drew from published sources. Effects data limitations are obviated in a conservative manner by assuming that exposure to phosphide-derived phosphine gas is completely lethal for all animal organisms within treated burrows.

3. Exposure Assessment

Aluminum and magnesium phosphides for outdoor use areas are formulated as a pellet or a tablet, which is applied directly to burrow chambers well below the soil surface. It is important to note that the labels require the immediate sealing of the animal burrows with soil and/or vegetative matter upon treatment to prevent any off-gassing of phosphine to the above ground environment and maintain a high concentration of the gas within the burrow. To be protective of human's and domesticated animals occupying nearby structures, the labels prohibit application within 100 feet of such occupied buildings. This is intended to prevent phosphine gas entry to the structure, should treated burrows communicate with the internal structure space.

3.1. Label Application Rates and Intervals

The formulated product labels legally limit aluminum and magnesium phosphide potential use to only those sites that are specified on the labels. Currently registered outdoor uses of aluminum and magnesium phosphide within California include those summarized in Table 3-1.

Table 3-1. Aluminum and Magnesium Phosphide Outdoor Uses

Label Registration Number	Outdoors Use Sites for California	Target Pest	Application Rate	Number	Interval	Timing	Method	Specific Prohibitions
Aluminum Phosphide								
19713-571, 19713-569, 43743-1, 43743-2, 70506-13, 70506-14, 70506-15, 72959-1, 72959-2, 72959-4, 72959-5, 81951-1, 81951-2	burrowing pest control, underground burrow systems located on agricultural areas, orchards, non-crop areas (pasture/rangeland), golf courses, athletic fields, airports, cemeteries, rights-of-way, earthen dams, parks and recreation areas and other non-residential institutional or industrial sites	burrowing mammals except chipmunks	2 to 4 tablets or 10 to 20 pellets (12g/burrow)	not specified	not specified	not specified	pellets or tablets applied directly into burrows	Burrows are sealed with paper, turf or soil. Cannot apply to burrows within 100 feet of buildings occupied or may be occupied by humans or domestic animals.
Magnesium Phosphide								
70506-16, 70506-17	burrowing pest control, underground burrow systems located on agricultural areas, orchards, non-crop areas (pasture/rangeland), golf courses, athletic fields, airports, cemeteries, rights-of-way, earthen dams, parks and recreation areas and other non-residential institutional or industrial sites	burrowing mammals except chipmunks	2 to 4 tablets or 10 to 20 pellets (12g/burrow)	not specified	not specified	not specified	pellets or tablets applied directly into burrows	Burrows are sealed with paper, turf, or soil. Cannot apply to burrows within 100 feet of buildings occupied or may be occupied by humans or domestic animals.

3.2. Aquatic Exposure Assessment

No aquatic exposure pathway is considered complete. Therefore surface water levels of aluminum and magnesium phosphides or phosphine gas from outdoor uses are expected to be zero.

3.2.1. Existing Monitoring Data

No monitoring data for aluminum or magnesium phosphide or phosphine gas are available in air, groundwater, or surface water in California.

3.3. Terrestrial Animal Exposure Assessment

3.3.1. Exposure to Residues in Terrestrial Food Items

No terrestrial quantitative exposure assessment was conducted. Aluminum and magnesium phosphide additions to animal burrows yields phosphine gas. The concentrations are assumed to be at a level lethal to 100 percent of the animal inhabitants of the burrows. The properties of phosphine gas suggest rapid degradation and some binding to soil solids that preclude migration of the gas to above ground areas. The label-required sealing of burrows prevents gas migration through burrow entrances. The heavier than air nature of phosphine gas (density 1.17, WHO 1988) would suggest that gas released with sealed underground chambers will remain below the surface.

3.4. Terrestrial Plant Exposure Assessment

Because phosphides are expected to react in their entirety to phosphine gas, which, in turn, is expected to be contained well below ground under the labeled conditions of use and is rapidly expected to degrade to mineral constituents of the soil, no exposure to biologically significant levels of toxic moieties is expected for terrestrial plants above ground. However exposure of plant roots to phosphine gas within animal burrows cannot be precluded but is not quantifiable.

4. Effects Assessment

Exposure to phosphine gas, the toxic degradate of aluminum and magnesium phosphide is expected to be at levels producing 100 percent lethality in organisms exposed to a contained atmosphere in animal burrows. Consequently no evaluation of toxicity was conducted and the assumption is expected to be protective under the labeled conditions of use.

4.1. Toxicity of Aluminum and Magnesium Phosphides to Aquatic Organisms

The lack of complete exposure pathways to aquatic systems precludes risk to aquatic organisms.

4.2. Toxicity of Aluminum and Magnesium Phosphides to Terrestrial Organisms

All concentrations of phosphine in sealed animal burrows are assumed to be 100 percent lethal to burrow-inhabiting terrestrial animals. There are no expected complete exposure pathways above ground as the label requires a sealing of animal burrows, the material will react and/or bind with soil material, and the heavier than air properties of phosphine would suggest that releases of phosphine underground burrows will remain below the soil surface. For terrestrial plants there are no data for the direct evaluation of root exposure to phosphine gas. However, WHO (1988) reports that phosphine produced a harmful effect on growing lettuce between 3 and 8 mg/m^3. Additionally WHO reports no adverse effects on the germination of watercress seeds in soil that had been treated for 3 days with air containing either 20 or 1400 mg phosphine/m^3. Given that up to 20 g of parent aluminum or magnesium phosphide are released to a closed burrow, it is concluded that phosphine gas production could reach damaging levels when plant roots are exposed.

4.3. Toxicity of Chemical Mixtures

No chemical mixture data are available. Aluminum and magnesium phosphide are not formulated with any other active ingredients.

4.4. 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 aluminum and magnesium phosphides was completed on November 16, 2010. The results of this review for terrestrial, plant, and aquatic incidents are discussed below in Sections 4.4.1 through 4.4.3.

No incidents were reported for magnesium phosphide. Reported vertebrate incidents for aluminum phosphide were not likely associated with labeled uses of the pesticide; the reports of phosphine measurements in wildlife mortality incidents suggest that phosphine exposure is associated with terrestrial non-target vertebrate mortalities, should exposure occur via the oral route.

The one plant incident associated with aluminum phosphide, owing to the nature of required incident reporting for minor incidents, contains too little information to reach a definitive conclusion regarding plant effects.

4.4.1. Terrestrial Incidents

No incidents have been reported for magnesium phosphide.

The EIIS incident database reports five wildlife mortality incidents for aluminum phosphide. Incident I009650-001 involved Canada geese and the conclusions of the incident report indicate

the mortalities are likely the result of intentional baiting, which is currently a misuse of aluminum phosphide.

Incident I004724-001 is a report of a dead goose apparently killed by phosphine gas (detected by Drager tube analysis). The report suggests zinc phosphide (a bait formulation) or aluminum phosphide may have caused the poisoning. The report indicates that the probable route of administration was via bait, which is more likely for zinc phosphide rather than aluminum phosphide.

Incident 1013685-001 is a report of red pandas being killed at the Washington DC National Zoological Park following administration of aluminum phosphide pellets to rat burrows within the exhibit enclosure. The report does not discuss the potential for material spillage or burrows being left unsealed. It does mention that the applicators had not used the material before. In its evaluation of the incident, the National Research Council (NRC 2004) reported that treated burrows were left unsealed and there was a potential for above ground exposure via pellet material left on the ground's surface which would constitute a misuse of the material.

Incident I003110-001 involves a report of turkey mortality. The report indicates that phosphine was detected in the crop of a dead bird which contained grass and a grain-based mash with a sharp odor. This incident likely represents a bait ingestion incident more likely associated with ingestion of zinc phosphide bait or an off-label use of aluminum phosphide in bait.

Incident 1017673-001 involves a grey squirrel mortality attributed to ingestion of treated bait. This incident does not represent a labeled use of aluminum phosphide.

The AIMS includes an additional incident (number 2228) involving wild turkeys (4 individuals dead). The incident attributes the mortality to either zinc or aluminum phosphide. The report included information that phosphine was measured in the gut suggesting oral ingestion. This is more likely associated with consumption of bait treated with zinc phosphide rather than phosphine released from aluminum phosphide pellets within animal burrows.

4.4.2. Plant Incidents

No incidents have been reported for magnesium phosphide. There is one aggregate minor incident report for plants involving the use of aluminum phosphide as Weevil-Cide. The nature of the effect and the circumstances associated with the incident are not known.

4.4.3. Aquatic Incidents

No incidents have been reported for aluminum or magnesium phosphide.

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

No probit slope response relationships have been investigated. Terrestrial animal exposure is expected to result in 100 percent mortality in exposed animals in treated burrows.

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 AW, CTS, SFGS, SJFK or for modification to their designated critical habitat from the use of aluminum and magnesium phosphide in CA. This risk characterization does not employ quantification techniques, such as risk quotient calculations, as employed in other assessments. In place of such an approach, the assessment conservatively concludes that lethality of terrestrial animals is complete for any organisms inhabiting treated burrows (section 5.1.

5.1. Risk Estimation

The conclusions of this risk assessment are not quantitatively determined through the comparison of risk quotients and Agency established levels of concern. This assessment presents evidence and rationale for asserting that the only complete exposure pathway for non-target biota is through inhalation or gas contact with phosphine within the confines of treated burrows. Exposure of terrestrial animals and, more uncertainly, the roots of terrestrial plants, occurring within treated animal burrows, is qualitatively judged to be sufficient to produce 100 percent lethality in all animal taxa residing in the burrows and in plants rooted in the burrows. Because exposure to aquatic organisms and above ground terrestrial exposure to terrestrial organisms is not expected to occur for either indoor or outdoor uses of the pesticides, intoxication with the phosphides or produced phosphine gas for ecological receptors above the soil surface or in aquatic environments is not expected.

5.1.1. Primary Constituent Elements of Designated Critical Habitat

For aluminum and magnesium phosphide uses, 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 a non-quantitative analysis of exposure and hazard the final No Effect/May Affect determination is made after the spatial analysis is completed at the end of the risk description, Section 5.2.3. In Section 5.2.3, 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.

A summary of the risk concerns based on non-quantitative assessment are provided in Table 5-1 for direct and indirect effects to the listed species assessed here and in Table 5-2 for the PCEs of their designated critical habitat.

Table 5-1. Risk Estimation Summary for Aluminum and Magnesium Phosphides - Direct and Indirect Effects

Taxa	Risk Concerns	Description of Results of Risk Estimation	Assessed Species Potentially Affected
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species yes	Acute lethal effects at 100 percent for all organisms in treated burrows.	Indirect Effects: AW, CTS, SFGS
	Listed Species yes		Direct Effects: CTS, AW, SFGS, SJKF
Mammals	Non-listed Species yes		Indirect Effects: AW, SFGS, SJKF
	Listed Species yes		Direct Effects: SJKF
Terrestrial Invertebrates	Listed Species yes		Direct/Indirect Effects: CTS, AW, SFGS

Table 5-2. Risk Estimation Summary for Aluminum and Magnesium Phosphides – Effects to Designated Critical Habitat. (PCEs)

Taxa	Risk Concerns	Description of Results of Risk Estimation	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species yes	Reductions in prey base and or burrow availability	AW, CTS
	Listed Species yes	Toxic levels of pesticide in potential rodent burrows	
Mammals	Non-listed Species yes	Reductions in prey base, reductions in burrows for sheltering	AW, CTS
	Listed Species yes	Toxic levels of pesticide in potential rodent burrows	
Terrestrial Invertebrates	Listed Species yes	Reductions in prey base	AW, CTS

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:

- Significance of Effect: Insignificant effects are those that cannot be meaningfully measured, detected, or evaluated in the context of a level of effect where "take" occurs for even a single individual. "Take" in this context means to harass or harm, defined as the following:
    - Harm includes significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.
    - Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.
- Likelihood of the Effect Occurring: Discountable effects are those that are extremely unlikely to occur.
- Adverse Nature of Effect: Effects that are wholly beneficial without any adverse effects are not considered adverse.

A description of the risk and effects determination for each of the established assessment endpoints for the assessed species and their designated critical habitat is provided in Sections 5.2.1 and 5.2.2. 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 aluminum and magnesium phosphide. Finally, in Section 5.2.3, 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. Effects Determinations

Application of aluminum and magnesium phosphide to animal burrows can be expected to result in acute mortality to those organisms exposed in treated burrows. The direct toxic effects to those organisms present in treated burrows are expected to reach 100 percent lethality for the AW, CTS, SFGS, and SJKF.

Indirect effects on the AW, CTS, SFGS, and SJKF would include reductions in prey base, through eradication of vertebrate and invertebrate prey items within treated burrows. The eradication of small mammals in treatment areas will reduce the availability of animal burrows for AW, CTS, SFGS, and SJKF sheltering.

5.2.2. Modification of Designated Critical Habitat

Treatment of potential burrowing sites, lethal effects on prey base, and reduction in small animal burrowing opportunities lead to a finding of modification of critical habitat for the AW and CTS.

5.2.3. Spatial Extent of Potential Effects

The diffuse use site characteristics suggest that adverse effects to the species and modification of critical habitat may occur throughout the geographical extent of species and critical habitat. Figure 5.1 below presents the association of California PUR use data for the years 2000 through 2008 and the associated locations of the species assessed in this document.

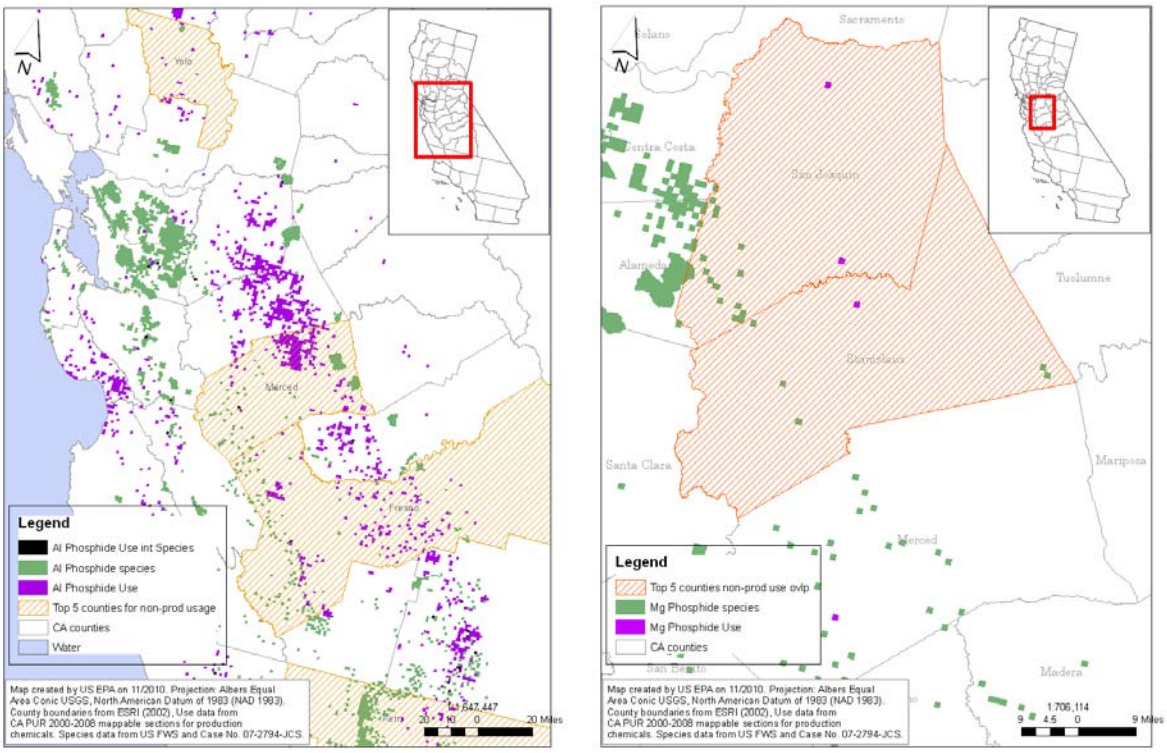

Figure 5-1. Map Showing the Overlap of Assessed Species with California PUR 2000 to 2008 Use Data.

5.2.3.a. Spray Drift

No drift events are expected to occur from application of pelleted or tableted phosphides to burrows. The production of phosphine gas within the burrows is expected to be contained underground.

5.2.3.b. Downstream Dilution Analysis

No downstream effects are expected because complete exposure pathways to aquatic systems are not expected.

5.3. Effects Determinations

For all species assessed aluminum and magnesium phosphide use as a vertebrate control agent applied to small mammal burrows presents an acute lethal risk to any individual present within the treated burrows. Both pesticides react to produce phosphine gas, which is expected to reach concentrations in the air of sealed burrows capable of producing 100 percent mortality of all animals within the burrow system. This represents a lethal effect directly to all assessed species, to animal prey, and the small mammals constructing these burrows. Lethal effects to animal prey and to those animals constructing burrows represent indirect effects to all species assessed as well as representing habitat modification for the AW and CTS. The widespread nature of the potential application sites for aluminum and magnesium phosphide suggests that there is considerable overlap potential between the use of these pesticides and the areas inhabited by the listed species assessed and the critical habitats designated for the AW and the CTS.

Therefore, the Agency makes a may affect, and likely to adversely affect determination for the AW, CTS, SFGS, and SJKF and a habitat modification determination for the designated critical habitat for the AW and CTS based on the potential for direct and indirect effects and effects to the PCEs of critical habitat.

5.3.1. Addressing the Risk Hypotheses

In order to conclude this risk assessment, it is necessary to address the risk hypotheses defined earlier in this document. Based on the conclusions of this assessment, none of the hypotheses can be rejected, meaning that the stated hypotheses represent concerns in terms of direct and indirect effects of aluminum and magnesium phosphide on the AW, CTS, SFGS, and SJKF and designated critical habitat for AW and CTS.

The labeled outdoor use of aluminum and magnesium phosphide may:

- directly affect AW, CTS, SFGS, and SJKF by causing mortality;
- indirectly affect AW, CTS, SFGS, SJKF and/or modify their designated critical habitat by reducing or changing the composition of food supply; and
- indirectly affect AW, CTS, SFGS, SJKF 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).

6. Uncertainties

The predominant uncertainties associated with this assessment are the lack of air concentration estimates for phosphine gas in treated small mammal burrows and the lack definitive toxicity estimates in terrestrial organisms. It is possible that the assumption that inhalation exposures within the burrows are lower than that expected to achieve complete mortality of all animal inhabitants and that the assessment may overestimate acute lethal risk within burrow complexes. If that is the case, survivors may be at risk for reproduction and growth risks but quantifying such risk is not possible given the paucity of effects and environmental fate data.

6.1.1. Sublethal Effects

While there may be potential for sublethal risks associated with phosphine gas exposure, the assumption in this assessment is that exposures always rise to the point of complete lethality within the confines of the treated animal burrows. This is a conservative approach expected to be protective of the species assessed and the prey resources upon which they may rely.

6.1.2. Plant Effects

Plant effects data for phosphine gas discussed herein measure plant response to atmospheric exposure of above ground portions of plants to the gas. The effect of root exposure is not empirically demonstrated. Extrapolation of available information indicating plant damage from atmospheric exposure to exposure of plant roots within treated burrows is an uncertainty. Given this uncertainty, the extrapolation may or may not be conservative.

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 aluminum and magnesium phosphides to the AW, CTS, SFGS, and SJKF and the designated critical habitat for AW and CTS

Based on the best available information, the Agency makes a May Affect, and Likely to Adversely Affect determination for all evaluated species from the outdoor use of aluminum and magnesium phosphides. Additionally, the Agency has determined that there is the potential for modification of designated critical habitat for the AW and the CTS by virtue of sealing and rendering toxic, treated small mammal burrows and the elimination of small mammals that construct such burrows. 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 Tables 7-3 and 7-4. 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 AW, CTS, SFGS, and SJKF and potential modification of designated critical habitat for AW, CTS a description of the baseline status and cumulative effects for these species is provided in Attachment II.

Table 7-1. Effects Determination Summary for Effects of Aluminum and Magnesium Phosphides on AW, CTS, SFGS, and SJKF

Species	Effects Determination	Basis for Determination
Alameda whipsnake (*Masticophis lateralis euryxanthus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Any snake residing in a small mammal burrow targeted for treatment will be killed by the exposure to phosphine.
		Potential for Indirect Effects

Species	Effects Determination	Basis for Determination
		Terrestrial prey items, burrow shelter destruction Animal prey items present in the treated small burrows will be killed by exposure to phosphine. Poisoning of small mammals and sealing burrows will likely deprive the listed organism of sheltering sites.
California tiger salamander (*Ambystoma californiense*) all distinct population segments	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic-phase (Eggs, Larvae, and Adults): No effect via this pathway. No exposure is expected to occur.
		Terrestrial-phase (Juveniles and Adults): Any salamander residing in a small mammal burrow targeted for treatment will be killed by the exposure to phosphine.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover and/or primary productivity No effect via this pathway. No exposure is expected to occur.
		Terrestrial prey items, burrow shelter destruction Animal prey items present in the treated small burrows will be killed by exposure to phosphine. Poisoning of small mammals and sealing burrows will likely deprive the listed organism of sheltering sites.
San Francisco garter snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Any snake residing in a small mammal burrow targeted for treatment will be killed by the exposure to phosphine.
		Potential for Indirect Effects
		Terrestrial prey items, burrow shelter destruction Animal prey items present in the treated small burrows will be killed by exposure to phosphine. Poisoning of small mammals and sealing burrows will likely deprive the listed organism of sheltering sites.
San Joaquin kit fox *(Vulpes macrotis mutica*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Any fox residing in a small mammal burrow targeted for treatment will be killed by the exposure to phosphine.
		Potential for Indirect Effects
		Terrestrial prey items, burrow shelter destruction Animal prey items present in the treated small burrows will be killed by exposure to phosphine. Poisoning of small mammals and sealing burrows will likely deprive the listed organism of sheltering sites.

Table 7-2. Effects Determination Summary for the Critical Habitat Impact Analysis

Designated Critical Habitat for:	Effects Determination	Basis for Determination

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Alameda whipsnake (*Masticophis lateralis euryxanthus*)	**Habitat modification**	Application of pesticide to rodent burrows will affect the PCE associated with the availability of small mammal burrows. The pesticide will render treated burrows acutely toxic to all inhabitants. The sealing of the burrows upon treatment will remove burrow availability. Destruction of the target small mammals will reduce the population available to construct new burrows.
California tiger salamander (*Ambystoma californiense*) all distinct population segments	**Habitat modification**	Application of pesticide to rodent burrows will affect the PCE associated with the availability of small mammal burrows. The pesticide will render treated burrows acutely toxic to all inhabitants. The sealing of the burrows upon treatment will remove burrow availability. Destruction of the target small mammals will reduce the population available to construct new burrows.

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 Terrestrial Environment:						
	Fish		Amphibians		Invertebrates		Aquatic Plants
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute
Outdoor small mammal burrows	no	no	no	no	no	no	no

A finding of "no in this table is predicated on the expectation of no complete exposure pathway to aquatic environments.

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:												
	Small Mammals		Large Mammals		Birds		Amphibians		Reptiles		Invertebrates (Acute)	Dicots	Monocots
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Outdoor small mammal burrows	yes	NA	yes	NA	no	NA	yes	NA	yes	NA	yes	yes (with high uncertainty)	yes (with high uncertainty)

NA- Not applicable: the complete lethality of exposed organisms to the pesticides' generated phosphine gas precludes pertinent assessment of chronic effects.
A finding of "no in this table is predicated on the expectation of no complete exposure pathway to above ground environments
High uncertainty for findings regarding plants is based on above ground effects data for phosphine exposure to root zone exposures in the case of aluminum and magnesium phosphide uses.

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 AW, CTS, 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.

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