Risks of Methomyl Use to Federally Threatened Bay Checkerspot Butterfly (*Euphydryas editha bayensis*), Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*), California Tiger Salamander (*Ambystoma californiense*), Central California Distinct Population Segment, and Delta Smelt (*Hypomesus transpacificus*),

And the Federally Endangered California Clapper Rail (*Rallus longirostris obsoletus*), California Freshwater Shrimp (*Syncaris pacificus*), 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 Tidewater Goby (*Eucyclogobius newberryi)*

Pesticide Effects Determinations
PC Code: 090301
CAS Number: 16752-77-5

Environmental Fate and Effects Division
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Primary Authors:
Tiffany Coleman, Environmental Engineer
Tanja Crk, Biologist
Environmental Risk Branch III
Environmental Fate and Effects Division (7507P)

Secondary Review:
James Hetrick, Ph.D., Senior Scientist
Melissa Panger, Ph.D., Senior Scientist
Rosanna Louie-Juzwiak, Risk Assessment Process Leader
Environmental Risk Branch III
Environmental Fate and Effects Division (7507P)

Branch Chief, Environmental Risk Assessment Branch III:
Dana Spatz
Environmental Fate and Effects Division (7507P)

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List of Commonly Used Abbreviations and Nomenclature

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

EEC	Estimated Environmental Concentration
EFED	Environmental Fate and Effects Division
e.g.	Latin *exempli gratia* ("for example")
EIM	Environmental Information Management System
EPI	Estimation Programs Interface
ESU	Evolutionarily significant unit
et al.	Latin *et alii* ("and others")
etc.	Latin *et cetera* ("and the rest" or "and so forth")
EXAMS	Exposure Analysis Modeling System
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
FQPA	Food Quality Protection Act
ft	Feet
GENEEC	Generic Estimated Exposure Concentration model
HPLC	High Pressure Liquid Chromatography
IC_{05}	5% Inhibition Concentration
IC_{50}	50% (or median) Inhibition Concentration
i.e.	Latin for *id est* ("that is")
IECV1.1	Individual Effect Chance Model Version 1.1
KABAM	$\underline{K}_{OW}$ (based) <u>A</u>quatic <u>B</u>io<u>A</u>ccumulation <u>M</u>odel
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 Bay Checkerspot Butterfly (BCB, *Euphydryas editha bayensis*), Valley Elderberry Longhorn Beetle (VELB, *Desmocerus californicus dimorphus*), California Tiger Salamander Central California DPS (CTS-CC DPS, *Ambystoma californiense*), Delta Smelt (DS, *Hypomesus transpacificus*), California Clapper Rail (CCR, *Rallus longirostris obsoletus*), California Tiger Salamander: Sonoma County DPS (CTS-SC DPS, *A. californiense*), California Tiger Salamander: Santa Barbara County DPS (CTS-SB DPS, *A. californiense*), California Freshwater Shrimp (CFWS, *Syncaris pacifica*), San Francisco Garter Snake (SFGS, *Thamnophis sirtalis tetrataenia*), and Tidewater Goby (TG, *Eucyclogobius newberryi*) arising from FIFRA regulatory actions regarding use of methomyl, a carbamate insecticide, on agricultural and non-agricultural sites. In addition, this assessment evaluates whether these actions can be expected to result in modification of designated critical habitat for the Bay Checkerspot Butterfly (BCB, *E. editha bayensis*), Valley Elderberry Longhorn Beetle (VELB, *D. californicus dimorphus*), California Tiger Salamander Central California DPS (CTS-CC DPS, *A. californiense*), Delta Smelt (DS, *H. transpacificus*), California Tiger Salamander: Santa Barbara County DPS (CTS-SB DPS, *A. californiense*), and Tidewater Goby (TG, *E. newberryi*). 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 methomyl was alleged to be of concern to the BCB, VELB, CTS, DS, CCR, CFS, SFGS, and TG (*Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS).

- **Bay Checkerspot Butterfly (BCB):** The BCB was listed as threatened in 1987 by the USFWS. The species primarily inhabits native grasslands on serpentine outcrops around the San Francisco Bay Area in California.
- **Valley Elderberry Longhorn Beetle (VELB):** The VELB was listed as threatened in 1980 by the USFWS. The species is found in areas with elderberry shrubs throughout California's Central Valley and associated foothills on the east and the watershed of the Central Valley on the west.
- **California Tiger Salamander (CTS):** There are currently three CTS Distinct Population Segments (DPSs): the Sonoma County(SC) DPS, the Santa Barbara (SB) DPS, and the Central California (CC) DPS. Each DPS is considered separately in the risk assessment as they occupy different geographic areas. The main difference in the assessment will be in the spatial analysis. The CTS-SB 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.

- **Delta Smelt (DS):** The DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007a). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater.
- **CA Clapper Rail (CCR):** The CCR was listed by the USFWS as an endangered species in 1970. The species is found only in California in coastal wetlands along the San Francisco estuary and Suisun Bay.
- **California Freshwater Shrimp (CFS):** The CFS was listed as endangered in 1988 by the USFWS. The CFS inhabits freshwater streams in Central California in the lower Russian River drainage and westward to the Pacific Ocean and coastal streams draining into Tomales Bay and southward into the San Pablo Bay.
- **San Francisco Garter Snake (SFGS):** 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.
- **Tidewater Goby (TG):** The TG was listed as endangered in 1994 by the USFWS. The range of the TG is limited to coastal brackish water habitats along the coast of California.

1.2. Scope of Assessment

1.2.1. Uses Assessed

Methomyl is an insecticide currently registered for use on a wide variety of sites including field, vegetable, and orchard crops; turf (sod farms only); livestock quarters; commercial premises; and refuse containers. Estimates of methomyl usage indicate that it is used extensively on sweet corn, lettuce, cotton, and alfalfa (these uses represent 50% of methomyl-use in the United States and are registered uses in California). All uses are agricultural, industrial, or commercial; there are no residential uses for methomyl. It is recognized that methomyl is used in many parts of the U.S.; however, the scope of this assessment limits consideration of the areas of use that may be applicable to the protection of the SFBay and its designated critical habitat within the state of California. For a complete list of uses, please see Section 2.

Methomyl is formulated mainly as soluble concentrates, but also includes granular, pelleted/tableted, and bait/solid formulations. Baited granular formulations are not assessed as they are expected to primarily occur around buildings in urban areas, removed from areas where the San Francisco (SF) Bay species being assessed are likely to occur. Application methods for the agricultural uses of methomyl include aircraft (fixed-wing and helicopter), high and low volume ground sprayer, ultra low volume sprayer, and granule application. Although most potential uses are assessed, risks from ground boom and aerial applications are the focus of this assessment because they are expected to result in the highest off-target concentrations of methomyl. Runoff associated with large rainfall events is expected to be responsible for the greatest off-target movement of methomyl.

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

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

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. Methomyl has registered products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **APPENDIX A**. A list of accepted literature on mixtures is available in **APPENDIX F**. If effects data are available for a formulated product containing more than one active ingredient, they may be used qualitatively or quantitatively in accordance with the Agency’s Overview Document and the Services' Evaluation Memorandum (U.S., EPA 2004; USFWS/NMFS 2004).

1.2.2. Environmental Fate Properties of Methomyl

As noted in the 1998 Reregistration Eligibility Decision (RED), methomyl is moderately persistent and mobile in soil. Methomyl is less persistent in aqueous environments. It is stable to hydrolysis at lower pHs (neutral to acidic), but it degrades slowly in alkaline conditions ($t_{1/2}$ = 30 days). Methomyl degradation appears to be dependent on microbially-mediated (aerobic soil metabolism - $t_{1/2}$ = 4.3 - 45 d; anaerobic soil metabolism - $t_{1/2}$ = 14 days; aerobic aquatic metabolism - $t_{1/2}$ = 3.5-4.5 d) and abiotic processes (photodegradation in water - $t_{1/2}$ = 1 d). Under anaerobic conditions, methomyl degradation is likely to be faster than under aerobic conditions (Smelt *et al.*, 1983), particularly in the presence of reduced iron (Bromilow *et al.*, 1986). In laboratory studies, methomyl does not readily adsorb to soil and has the potential to be mobile (mean K_{oc} = 46 mL/g_{oc}). **Table 1-1** summarizes the fate and physical-chemical properties of methomyl based on information from the registrants.

Field dissipation studies (MRIDs 41623901, 41623902, 42288001, 43217903) show varying dissipation rates of the chemical in soils (DT_{50} from 4 to 54 days). Dissipation rates were related primarily to differences in soil moisture content, which may affect the microbial activity, and rainfall/irrigation, which could influence leaching. Methomyl was detected in soil as deep as 15 – 90 cm.

Table 1-1.Summary of Environmental Chemistry, Fate and Transport Properties of Methomyl.

<table>
<tr><th>PARAMETER</th><th colspan="2">VALUE</th><th>REFERENCE/ COMMENTS</th></tr>
<tr><td colspan="4">Selected Physical/Chemical Parameters</td></tr>
<tr><td>PC code</td><td colspan="2">090301</td><td></td></tr>
<tr><td>CAS No.</td><td colspan="2">16752-77-5</td><td></td></tr>
<tr><td>Chemical name</td><td colspan="2">(S-methyl N-((methylcarbamoyl)oxy) thioacetimidate</td><td></td></tr>
<tr><td>Chemical formula</td><td colspan="2">$C_5H_{10}N_2O_2S$</td><td></td></tr>
<tr><td>Molecular weight</td><td colspan="2">162.2 g/mol</td><td>Product Chemistry</td></tr>
<tr><td>Water solubility (20 °C)</td><td colspan="2">5.5×10^4 mg/L</td><td>MRID 41402101</td></tr>
<tr><td>Vapor pressure</td><td colspan="2">5.4×10^{-6} torr</td><td>MRID 41209701</td></tr>
<tr><td>Henry's law constant (atm-m^3/mol)</td><td colspan="2">2.1×10^{-11} atm-m^3/mol</td><td>(calculated)</td></tr>
<tr><td>K_{OW}</td><td colspan="2">1.31</td><td>MRID 00157991</td></tr>
<tr><td colspan="4">Persistence</td></tr>
<tr><td rowspan="2">Hydrolysis</td><td colspan="2">pH 5: stable
pH 7: stable
pH 9: 30 d</td><td>MRID 00131249</td></tr>
<tr><td colspan="2">pH 2.09-7.11: >413 d
pH 7.40: 337 d
pH 7.67: 206 d
pH 7.92: 123 d
pH 8.42: 40.8 d
pH 8.88: 14.6 d
pH 8.89: 16.1 d
pH 9.45: 4.77 d
pH 9.92: 1.66 d</td><td>Strathmann and Stone, 2002 (values calculated from rate constants)</td></tr>
<tr><td rowspan="2">Photolysis in water</td><td colspan="2">$t_{1/2}$ = 1 d</td><td>MRID 0161885
Clear water, near surface</td></tr>
<tr><td colspan="2">50 d (natural water)
Stable (pH 7 buffer w/ no excess nitrate)
42 days (pH 7 buffer w/ 100 M excess nitrate)
8.5 days (pH 7 buffer w/ 1000 M excess nitrate)</td><td>MRID 43823305</td></tr>
<tr><td>Photolysis in soil</td><td colspan="2">$t_{1/2}$ = 33 d</td><td>MRID 00163745</td></tr>
<tr><td rowspan="3">Aerobic soil metabolism</td><td>Flanagan silt loam</td><td>44 days</td><td>MRID 00008568</td></tr>
<tr><td>Madera, CA loam</td><td>12 days</td><td>MRID 43217901</td></tr>
<tr><td>USA (mattapex), Loam
France (nambsheim), SandyLoam
Germany (speyer 2.2), Sandy Loam</td><td>7.9 days
6.4 days
4.3 days</td><td>MRID 45473401</td></tr>
<tr><td>Anaerobic soil metabolism</td><td colspan="2">Madera, CA loam: 14 d</td><td>MRID 432179-02</td></tr>
<tr><td>Aerobic aquatic metabolism</td><td colspan="2">Auchingilsie clay loam: 4.0 d
Hinchingbrooke silty clam loam: 4.6 d</td><td>MRID 433254-01</td></tr>
</table>

PARAMETER	VALUE				REFERENCE/ COMMENTS
Anaerobic aquatic metabolism	No data				
	Mobility				
Batch equilibrium	**Soil Texture**	**K_f[1]**	**1/N**	**K_{oc}**	MRID 00161884
	Sandy loam	0.72	0.86	65	
	Silt loam	1.0	0.86	45	
	Silt	1.4	0.86	36	
	Sandy loam	0.23	0.90	39	
	Field Dissipation				
Terrestrial field dissipation	54 d (CA sandy loam cropped to cabbage); leached to deepest sample depth (60-90 cm) 4-6 d (MS loam cropped to cabbage); leached to 15-30 cm sample depth				MRID 41623901/ 41623902 MRID 42288001/ 43217903
	Bioaccumulation				
Accumulation in fish, BCF	No data				Bioaccumulation is not expected based on low K_{ow}

1. Units of $(mg/kg)/(mg/L)^{1/N}$, where 1/N is the Freundlich exponent.

Potential transport mechanisms for methomyl include surface water runoff, spray drift, and leaching. Secondary drift (atmospheric transport) of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems is not expected given methomyl's relatively high solubility in water (5.5×10^4 mg/L), low vapor pressure (5.4×10^{-6} torr) and Henry's law constant (2.1×10^{-11} atm-m^3/mol).

1.2.3. Evaluation of Degradates and Stressors of Concern

Major degradates include methomyl oxime (S-methyl-N-hydroxythioacetimidate), acetonitrile, acetamide ,and CO_2. There are data demonstrating the formation of methomyl sulfoxide during disinfection (chlorination) in water treatment (MRID 46210701), although this compound was not found in any environmental fate studies. According to ECOSAR (See **APPENDIX D** for ECOSAR output), the calculated endpoints indicate that the fish and invertebrates are less sensitive to the oxime than to the parent compound (Fish (LC50) = 76.219 ppm for oxime, Fish (EC50) = 0.320 ppm for parent; invertebrates (LC50) = 8.436 ppm for oxime, invertebrates (EC50) = 0.005 ppm for parent). ECOSAR calculated an EC50 for green algae of 8.557 ppm for the oxime. One open literature study on micro-algae showed an EC50 range from 108-184 ppm. The aquatic plant data suggest that the oxime may possibly be more toxic to aquatic plants, but this is based on a single open literature study (Record #: 118717, Pereira *et al.*2009)that was deemed qualitative, and not for quantitative use (*i.e.,* not suitable for RQ calculations See Section 5.1.1e). Based on the available data, the oxime appears to be less toxic to aquatic organisms than the parent compound. Previously, methomyl was deemed to not have any degradates with toxicological concerns (DP 374952), which also includes the oxime and degradate methomyl sulfoxide. Therefore, this assessment is based on the parent, methomyl, alone.

1.3. Assessment Procedures

A description of routine procedures for evaluating risk to the SF Bay species are provided in Attachment I.

1.3.1. Exposure Assessment

1.3.1.a. Aquatic Exposures

Tier-II aquatic exposure models are used to estimate high-end exposures of methomyl in aquatic habitats resulting from runoff and spray drift from different uses. The models used to predict aquatic EECs are the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). The AgDRIFT model is also used to estimate deposition of methomyl on aquatic habitats from spray drift. The peak model-estimated environmental concentrations resulting from different methomyl uses range from 2.5 µg/L (sorghum) to 61.9 µg/L (cole crops, particularly cabbage). These estimates are supplemented with analysis of available California surface water monitoring data from U. S. Geological Survey's National Water Quality Assessment (NAWQA) program and the California Department of Pesticide Regulation (CDPR). There were 19 detections of methomyl reported by NAWQA for California surface waters out of 394 samples. The maximum concentration reported was 0.67 µg/L and all detects were concentrated to four sites. The maximum concentration of methomyl reported by the CDPR surface water database (5.4 µg/L) is roughly 11.6 times *lower* than the highest peak model-estimated environmental concentration.

1.3.1.b. Terrestrial Exposures

To estimate methomyl exposures to terrestrial species resulting from uses involving methomyl applications, the T-REX model is used for foliar and granular uses (*i.e.*, on sweet corn). The AgDRIFT model is also used to estimate deposition of methomyl on terrestrial habitats from spray drift. The T-HERPS model is used to allow for further characterization of dietary exposures of terrestrial-phase amphibians relative to birds.

1.3.2. Toxicity Assessment

The assessment endpoints include direct toxic effects on survival, reproduction, and growth of individuals, as well as indirect effects, such as reduction of the food source and/or modification of habitat. The Agency evaluated registrant-submitted studies and data from the open literature (where available) to characterize methomyl toxicity. The most sensitive toxicity value available from acceptable or supplemental studies for each taxon relevant for estimating potential risks to the assessed species and/or their designated critical habitat was used.

Methomyl is highly toxic to freshwater and moderately toxic to estuarine/marine fish. It is very highly toxic to freshwater and marine/estuarine invertebrates on an acute exposure basis. The compound has growth effects on a chronic basis as well for estuarine/marine fish at a LOAEC of 0.490 mg a.i./L; the chronic freshwater fish endpoint (NOAEC: 0.012 mg a.i./L) is based on an acute to chronic ratio (ACR). In addition, methomyl has reproductive effects on a chronic basis for freshwater invertebrates at a LOAEC of 0.001 mg a.i./L; the chronic estuarine/marine invertebrate endpoint (NOAEC: 0.0024 mg a.i./L) is based on an acute to chronic ratio (ACR). Methomyl is highly toxic and slightly toxic on an acute oral and subacute dietary exposure basis, respectively, to birds. It is highly toxic to mammals on an acute oral exposure basis. Methomyl has reproductive effects on birds and mammals, affecting number of eggs and offspring produced as well as pup body weight in subsequent generations at 150 (bird) and 75 (rat) mg a.i./kg-diet concentrations, respectively. Methomyl is classified as highly toxic to honey bees on an acute contact exposure basis. Registrant submitted data on aquatic and terrestrial plants are not available. However, an open literature study on algae was reviewed and used qualitatively in risk characterization. A review of efficacy studies on terrestrial plants is available in this document as well.

1.3.3. Measures of Risk

Acute and chronic risk quotients (RQs) are compared to the Agency's Levels of Concern (LOCs) to identify instances where methomyl use has the potential to adversely affect the assessed species or adversely modify their designated critical habitat. When RQs for a particular type of effect are below LOCs, the pesticide is considered to have "no effect" on the species and its designated critical habitat. Where RQs exceed LOCs, a potential to cause adverse effects or habitat modification is identified, leading to a conclusion of "may affect". If methomyl use "may affect" the assessed species, and/or may cause effects to designated critical habitat, the best available additional information is considered to refine the potential for exposure and effects, and distinguish actions that are Not Likely to Adversely Affect (NLAA) from those that are Likely to Adversely Affect (LAA).

1.4. Summary of Conclusions

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 methomyl to SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and the designated critical habitat of BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG.

Based on the best available information, the Agency makes a May Affect, Likely to Adversely Affect determination for the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG. The species critical habitat and/or occurrence sections overlap with the use footprint**.** Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG from the use of the chemical. Given the LAA determination for SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and potential modification of designated critical habitat for BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG, a description of the baseline status and cumulative effects is provided in Attachment III.

A summary of the risk conclusions and effects determinations for the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and the critical habitat, given the uncertainties discussed in Section 6 and

Attachment I, is presented in **Table 1-2** and **Table 1-3**. Use specific effects determinations are provided in **Table 1-4** and **Table 1-5**.

Table 1-2. Effects Determination Summary for Effects of Methomyl on the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG

Species	Effects Determination	Basis for Determination
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: dose and dietary-based RQs >0.1 for most assessed uses for small and medium-sized reptiles (based on toxicity data for birds) consuming arthropodsand herbivorous mammals • Chronic: dietary-based RQs >1 for most assessed uses for small and medium-sized reptiles (based on toxicity data for birds) consuming arthropods and herbivorous mammals • Granular (RQs 3.83-14.35) and scatter bait (RQ 5.55) uses exceed LOCs (based on bird toxicity data) • Bird (surrogates for reptiles) incident data indicate numerous deaths of various species by baiting and unknown use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird toxicity data) ranges from 1 in 294,000 to 1 in 1 (at the default slope of 4.5) **Potential for Indirect Effects** • SFGS prey base is affected based on LOC exceedences; SFGS feeds on invertebrates (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; terrestrial invert RQs: 42.30-157.12), fish (freshwater fish RQs: acute: 0.13-0.19; chronic: 1.99-2.67), small mammals (15g mammal RQs: acute: 1.02-7.25; chronic: 1.80-58.01), reptiles and amphibians (bird RQs: acute: 0.12-27.97; chronic: 1.44-3.34; 20g reptile: acute: 0.15 -23.29; chronic: 1.10-2.56) • Granular (RQs 1.58-5.92) and scatter bait (RQ 4.91) uses exceed LOCs for mammals (prey of SFGS) • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: honey bee, lab rat, bird, freshwater invertebrate/fish) ranges from 1 in $5.37x\ 10^7$ to 1 in 1
California Clapper Rail (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: dose and dietary-based RQs >0.1 for most assessed uses for small and medium-sized birds consuming arthropods and herbivorous mammals • Chronic: dietary-based RQs >1 for most assessed uses for small and medium-sized birds consuming arthropods and herbivorous mammals • Granular (RQs 3.83-14.35) and scatter bait (RQ 5.55) uses exceed LOCs (based on bird toxicity data) • Bird incident data indicate numerous deaths of various species by baiting and unknown use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird toxicity data) ranges from 1 in 294,000 to 1 in 1 (at the default slope of 4.5) **Potential for Indirect Effects** • CCR prey base is affected; CCR feeds on aquatic invertebrates, worms, spiders (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; terrestrial invert RQs: 42.30-157.12; estuarine/marine invert: acute: 0.13-3.26; chronic: 1.33-17.75), dead fish (freshwater fish RQs: acute: 0.13-0.19; chronic: 1.99-2.67), small mammals (15g mammal RQs: acute: 1.02-7.25; chronic: 1.80-58.01), small birds and amphibians/frogs (bird RQs: acute: 0.12-27.97; chronic: 1.44-3.34)

Species	Effects Determination	Basis for Determination
		• Granular (RQs 1.58-5.92) and scatter bait (RQ 4.91) uses exceed LOCs for mammals (prey of CCR) • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: honey bee, lab rat, bird, freshwater invertebrate/fish, estuarine/marine invertebrate/fish) ranges from 1 in 8.8 x 10^{24} to 1 in 1
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Terrestrial invertebrate/ arthropod RQs > 0.05 (the interim terrestrial invertebrate LOC) for all uses. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on honey bee toxicity data) is 1 in 1 **Potential for Indirect Effects** • Habitat modification (without terrestrial plant data risk is assumed); furthermore, incident data on melons indicates damage to terrestrial plants after ground application possibly due to a methomyl formulation • The species critical habitat and/or occurrence sections overlap with the use footprint
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Terrestrial invertebrate/ arthropod RQs > 0.05 (the interim terrestrial invertebrate LOC) for all uses. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on honey bee toxicity data) is 1 in 1 **Potential for Indirect Effects** • Habitat modification (without terrestrial plant data risk is assumed); furthermore, incident data on melons indicates damage to terrestrial plants after ground application possibly due to a methomyl formulation • The species critical habitat and/or occurrence sections overlap with the use footprint
California Tiger Salamander (*Ambystoma californiense*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: dose and dietary-based RQs >0.1 for most assessed uses for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Chronic: dietary-based RQs >1 for most assessed uses for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Granular (RQs 3.83-14.35) and scatter bait (RQ 5.55) uses exceed LOCs (based on bird toxicity data) • Bird (which are surrogates for terrestrial-phase amphibians) incident data indicate numerous deaths of various species by baiting and unknown use patterns • Acute: RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait, with respect to freshwater fish (which are a surrogate for aquatic-phase amphibians)

Species	Effects Determination	Basis for Determination
		• Chronic: RQs >1 for cabbage and scatter bait, , with respect to freshwater fish (which are a surrogate for aquatic-phase amphibians) • One large fish kill attributed to methomyl was reported • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird and freshwater fish toxicity data) ranges from 1 in 5.37 x 10^7 to 1 in 1
		Potential for Indirect Effects
		• CTS prey base is affected; CTS feeds on algae, aquatic invertebrates/ zooplankton, freshwater snails, terrestrial invertebrates, worms (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; terrestrial invert RQs: 42.30-157.12; estuarine/marine invert: acute: 0.13-3.26; chronic: 1.33-17.75), fish (freshwater fish RQs: acute: 0.13-0.19; chronic: 1.99-2.67), small mammals (15g mammal RQs: acute: 1.02-7.25; chronic: 1.80-58.01), amphibians/ frogs (bird RQs: acute: 0.12-27.97; chronic: 1.44-3.34; 20g amphibian: acute: 0.12-16.44; chronic: 1.45-3.36) • Granular (RQs 1.58-5.92) and scatter bait (RQ 4.91) uses exceed LOCs for mammals (prey of CTS) • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: honey bee, lab rat, bird, freshwater invertebrate/fish) ranges from 1 in 5.37 x 10^7 to 1 in 1
Delta Smelt (*Hypomesus transpacificus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		• Acute: RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait, with respect to freshwater fish; a single RQ value is at the listed species LOC of 0.05 for the use on cabbage, with respect to estuarine/marine fish • Chronic: RQs >1 for cabbage and scatter bait, with respect to freshwater fish; all chronic RQs are less than 1 for estuarine/marine fish • One large fish kill was a reported incident • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on estuarine/marine and freshwater fish toxicity data) ranges from 1 in 8.8 x 10^{24} to 1 in 877
		Potential for Indirect Effects
		• DS prey base is affected; adult DS feeds on planktonic copepods, cladocerans, amphipods and insect larvae and juvenile DS feed on zooplankton (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; estuarine/marine invert: acute: 0.13-3.26; chronic: 1.33-17.75); the DS larvae feed on phytoplankton • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates:estuarine/marine and freshwater invertebrates) ranges from 1 in 29,900 to 1 in 1
California Freshwater Shrimp (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		• With regard to estuarine/marine invertebrate data, Acute: RQs > 0.05 for all assessed uses Chronic: RQs >1 for all except one assessed use (*i.e.*, sorghum) • With regard to freshwater invertebrate data, Acute: RQs > 0.05 for all assessed uses Chronic: RQs >1 for all assessed uses • The species critical habitat and/or occurrence sections overlap with the use footprint

Species	Effects Determination	Basis for Determination
		• Probability of individual effect (based on freshwater invertebrate toxicity data) ranges from 1 in 6.69 to 1 in 1
		Potential for Indirect Effects
		• CFS prey base is affected; CFS feeds on zooplankton (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86), detritus, algae, aquatic macrophyte fragments, aufwuchs • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: freshwater invertebrates) ranges from 1 in 6.69 to 1 in 1
Tidewater Goby (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		• Acute: RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait, with respect to freshwater fish; a single RQ value is at the listed species LOC of 0.05 for the use on cabbage, with respect to estuarine/marine fish • Chronic: RQs >1 for cabbage and scatter bait, with respect to freshwater fish; all chronic RQs are less than 1 for estuarine/marine fish • One large fish kill was a reported incident • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on estuarine/marine and freshwater fish toxicity data) ranges from 1 in 8.8×10^{24} to 1 in 877
		Potential for Indirect Effects
		• TG prey base is affected; adult TG feeds on small benthic invertebrates, crustaceans, snails, mysids, aquatic insect larvae, juvenile TG feeds on unicellular zooplankton (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; estuarine/marine invert: acute: 0.13-3.26; chronic: 1.33-17.75) or phytoplankton • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates:estuarine/marine and freshwater invertebrates) ranges from 1 in 29,900 to 1 in 1

Table 1-3. Effects Determination Summary for the Critical Habitat Impact Analysis

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	Habitat Modification	• Risk to terrestrial plants and thus BCB habitat (esp. dwarf plantain, purple owl's clover, exserted paintbrush) was assumed. (RQs were not calculated given no available terrestrial plant data.) • Incident data on melons indicates damage to terrestrial plants after ground application possibly due to a methomyl formulation • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)	Habitat Modification	• Risk to terrestrial plants and thus VELB habitat (esp. elderberry trees) was assumed. (RQs were not calculated given no available terrestrial plant data.) • Incident data on melons indicates damage to terrestrial plants after ground application possibly due to a methomyl formulation • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint
California Tiger Salamander (*Ambystoma californiense*) [Central CA, Santa Barbara County]	Habitat Modification	• Terrestrial arthropod RQs > 0.05 (the interim terrestrial invertebrate LOC) for all uses. • Risk to terrestrial plants and thus CTS habitat was assumed. (RQs were not calculated given no available terrestrial plant data.) • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Mammal acute dose-based RQs >0.5 for all assessed uses; chronic: dose- and/or dietary-based RQs>0.1 for all assessed uses. • Bird (surrogate for terrestrial-phase amphibians) acute dose and dietary-based RQs >0.1 (listed sp.) for most assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals; chronic dietary-based RQs >1 for most assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals • Fish (surrogate for aquatic-phase amphibians) acute RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait; chronic RQs >1 for cabbage and scatter bait • Freshwater invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all assessed uses
Delta Smelt (*Hypomesus transpacificus*)	Habitat Modification	• Risk to terrestrial plants and thus DS habitat was assumed. (RQs were not calculated given no available terrestrial plant data.) • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Freshwater invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all assessed uses • Estuarine/marine invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all except one assessed use (*i.e.*, sorghum)
Tidewater Goby (*Eucyclogobius newberryi*)	Habitat Modification	• Risk to terrestrial plants and thus TG habitat was assumed. (RQs were not calculated given no available terrestrial plant data.) • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Freshwater invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all assessed uses • Estuarine/marine invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all except one assessed use (*i.e.*, sorghum)

Table 1-4. Use Specific Summary of The Potential for Adverse Effects to Aquatic Taxa

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment:									
	DS, TG and Estuarine/Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Estuarine/Marine Invertebrates[4]		Vascular Plants[5]	Non-vascular Plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic		
Bulbs /Onions	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Cereal grains /Corn	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Cereal grains /Corn	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Cereal grains (sp. Sorghum)	No	No	No	No	Yes	Yes	Yes	No	No	No
Cole crops /Cabbage	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Grasses /Turf	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Herbs /Anise/Mint	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Leguminous forage (alfalfa)	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Non-cole leafy crops /Celery	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Scatter bait	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Avocado	No	No	No	No	Yes	Yes	Yes	Yes	No	No

1 A yes in this column indicates a potential for direct effects to DS and TG and indirect effects to CCR, TG, and DS as a result of an effect to estuarine/marine fish.
2 A yes in this column indicates a potential for direct effects to DS, TG and indirect effects to SFGS, CCR, TG, and DS. A yes also indicates a potential for direct and indirect effects for the CTS-CC, CTS-SC, and CTS-SB as a result of an effect to freshwater fish.
3 A yes in this column indicates a potential for direct effects to the CFWS and indirect effects to the CFWS, SFGS, CCR, CTS-CC, CTS-SB, CTS-SC, TG, and DS as a result of an effect to freshwater invertebrates.
4 A yes in this column indicates a potential for indirect effects to CCR, TG, and DS as a result of an effect to estuarine/marine invertebrates.
5 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS.

Table 1-5. 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[1]		**CCR and Small Birds[2]**		**CTS-CC, CTS-SC, CTS-SB and Amphibians[3]**		**SFGS and Reptiles[4]**		**BCB, VELB, and Invertebrates (Acute)[5]**	**Dicots[6]**	**Monocots[6]**
	Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**			
Bulbs /Onions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cereal grains /Corn	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cereal grains /Corn	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cereal grains (sp. Sorghum)	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
Cole crops /Cabbage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grasses /Turf	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Herbs /Anise/Mint	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Leguminous forage (alfalfa)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non-cole leafy crops /Celery	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Avocado	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Granular	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A	N/A	Yes	Yes
Scatter bait	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A	N/A	Yes	Yes

1 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS, and CTS-SB as a result of an effect to small mammals.

2 A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, CTS-CC, CTS-SC,and CTS-SB as a result of an effect to small birds.

3 A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS-CC, CTS-SC, CTS-SB, SFGS, CCR as a result of an effect to terrestrial-phase amphibians (for which birds serve as surrogate).

4 A yes in this column indicates the potential for direct and indirect effects to SFGS and other reptiles as a result of an effect to reptiles (for which birds serve as a surrogate).
5 A yes in this column indicates a potential for direct effect to BCB and VELB and indirect effects to SFGS, CCR, CTS-CC, CTS-SC, and CTS-SB as a result of an effect to terrestrial invertebrates.
6 A yes in this column indicates a potential for indirect effects to BCB, VELB, SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS. For the BCB and VELB this is based on the listed species LOC because of the obligate relationship with terrestrial monocots and dicots. For other species, the LOC exceedances are evaluated based on the LOC for non-listed species.
N/A – information not available

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

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

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

2. Problem Formulation

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

2.1. Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the BCB, VELB, CTS, DS, CCR, CFS, SFGS, and TG arising from FIFRA regulatory actions regarding use of methomyl on a variety of agricultural and on agricultural uses. This ecological risk assessment has been prepared consistent with a stipulated injunction in the case *Center for Biological Diversity (CBD) vs. EPA et al.* (Case No. 07-2794-JCS) entered in Federal District Court for the Northern District of California on May 17, 2010.

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

- **Bay Checkerspot Butterfly (BCB):** The PCEs for BCBs are areas on serpentinite-derived soils that support the primary larval host plant (*i.e.*, dwarf plantain) and at least one of the species' secondary host plants. Additional BCB PCE's include the presence of adult nectar sources, aquatic features that provide moisture during the spring drought, and areas that provide adequate shelter during the summer diapause.
- **Valley Elderberry Longhorn Beetle (VELB):** The PCEs for the VELBs include areas that contain its host plant (*i.e.,* elderberry trees).
- **California Tiger Salamander (CTS):** The PCEs for CTSs are standing bodies of freshwater sufficient for the species to complete the aquatic portion of its life cycle that are adjacent to barrier-free uplands that contain small mammal burrows. An additional PCE is upland areas between sites (as described above) that allow for dispersal of the species.
- **Delta Smelt (DS):** The PCEs for DSs are shallow fresh or brackish backwater sloughs for egg hatching and larval viability, suitable water with adequate river flow for larval and juvenile transport, suitable rearing habitat, and unrestricted access to suitable spawning habitat.
- **Tidewater Goby (TG):** The PCEs for TGs are persistent, shallow aquatic habitats with salinity from 0.5 parts per thousand (ppt) to 12 ppt, that contain substrates suitable for the construction of burrows and submerged aquatic plants that provide protection. An

additional PCE is the presence of sandbars that at least partially closes a lagoon or estuary during the late spring, summer, and fall.

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 methomyl is based on an action area. The action area is the area directly or indirectly affected by the federal action, as indicated by the exceedance of the Agency's Levels of Concern (LOCs). It is acknowledged that the action area for a national-level FIFRA regulatory decision associated with a use of methomyl may potentially involve numerous areas throughout the United States and its Territories. However, for the purposes of this assessment, attention will be focused on relevant sections of the action area including those geographic areas associated with locations of the BCB, VELB, CTS-CC DPS, DS, CTS-SB DPS, and TG 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 methomyl in accordance with current labels:

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

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

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

2.2. Scope

Methomyl is a carbamate insecticide currently registered for use on a wide variety of sites including field, vegetable, and orchard crops; turf (sod farms only); livestock quarters; commercial premises; and refuse containers. Estimates of methomyl usage indicate that it is used extensively on sweet corn, lettuce, cotton, and alfalfa (these uses represent 50% of methomyl-use in the United States and are registered uses in California. All uses are agricultural, industrial, or commercial; there are no residential uses for methomyl. It is recognized that methomyl is used in many parts of the U.S., however, the scope of this assessment limits consideration of the areas of use that may be applicable to the protection of the BCB, VELB, CTS, DS, CCR, CFS, SFGS, TG and its designated critical habitat within the state of California.

Methomyl is formulated mainly as soluble concentrates, but also includes granular, pelleted/tableted, and bait/solid formulations. Application methods for the agricultural uses of methomyl include aircraft (fixed-wing and helicopter), high and low volume ground sprayer, ultra low volume sprayer, and granule application. Although all potential uses are assessed, risks from ground boom and aerial applications are focused on in this assessment because they are expected to result in the highest off-target concentrations of methomyl. Runoff associated with large rainfall events is expected to be responsible for the greatest off-target movement of methomyl.

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

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

2.2.1. Evaluation of Degradates and Other Stressors of Concern

Major degradates include methomyl oxime (S-methyl-N-hydroxythioacetimidate) detected at a maximum of 44% in the alkaline hydrolysis study; acetonitrile detected at a maximum of 66%, 40% and 27% in the aqueous photolysis, soil photolysis and aerobic aquatic metabolism studies, respectively; acetamide detected at 14% in the aerobic aquatic metabolism study; and CO_2 detected at 22.5-75% in the aerobic soil, anaerobic soil, and aquatic metabolism studies. Methomyl oxime was detected at high concentrations in the alkaline hydrolysis study, but was only a minor degradate in the aerobic soil metabolism, anaerobic soil metabolism, photolysis and aerobic aquatic metabolism studies. There are data demonstrating the formation of methomyl sulfoxide during disinfection (chlorination) in water treatment (MRID 46210701), although this compound was not found in any environmental fate studies.

According to ECOSAR (See **APPENDIX D** for ECOSAR output), the calculated endpoints indicate that the fish and invertebrates are less sensitive to the oxime than than to the parent compound (Fish (LC50) = 76.219 ppm for oxime, Fish (EC50) = 0.320 ppm for parent; invertebrates (LC50) = 8.436 ppm for oxime, invertebrates (EC50) = 0.005 ppm for parent). ECOSAR calculated an EC50 for green algae of 8.557 ppm for the oxime. One open literature study on micro-algae showed an EC50 range from 108-184 ppm. The aquatic plant data suggest that the oxime may possibly be more toxic to aquatic plants, but this is based on a single open literature study (Record #: 118717, Pereira *et al.*2009)that was deemed qualitative, and not for quantitative use (*i.e.,* not suitable for RQ calculations See Section 5.1.1e). Based on the available data, the oxime appears to be less toxic to aquatic organisms than the parent compound. Previously, methomyl was deemed to not have any degradates with toxicological concerns (DP 374952 - Panger, 2010), which also includes the oxime and degradate methomyl sulfoxide. Therefore, this assessment is based on the parent, methomyl, alone.

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 (U.S., EPA 2004; USFWS/NMFS 2004).

Methomyl has registered products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **APPENDIX A**. The results of this analysis show that the formulated product (Stimukil fly bait, EPA Reg. No. 53871-3) is more toxic to the laboratory rat than is the technical grade active ingredient. As a result, scatter bait uses under this formulation label are modeled with the formulation toxicity data. With regard to scatter bait and remaining assessed uses, the RQs based on the technical grade active ingredient toxicity data exceed Agency LOCs; refinement to the endpoint based on the formulated product is not expected to alter risk conclusions.

2.3. Previous Assessments

Several ecological risk assessments for methomyl have been completed since it was first registered in 1968. The most encompassing assessment was for the Reregistration Eligibility Decision (RED) process and was completed in 1998 (USEPA 1998*b*). The current risk assessment builds upon the 1998 risk assessment, which determined that acute and chronic risk quotients (RQ) exceeded risk levels of concern (LOC) for endangered/threatened birds (and, thus, reptiles and terrestrial-phase amphibians), mammals, and aquatic vertebrates (and, thus, aquatic-phase amphibians) and invertebrates.

Following the RED, the following mitigation and Integrated Pest Management (IPM) plans were added to the labels for all methomyl formulated products:

1) The registrant will revise end use product labels to reduce the maximum seasonal use rates as noted below;

Crop	Old Season Rate (lb ai)	New Season Rate (lb ai)	Percent Decrease
Broccoli	7.2	6.3	12.5
Cabbage	9.0	7.2	20
Cauliflower	9.0	7.2	20
Celery	9.0	7.2	20
Chinese cabbage	8.1	7.2	11.1
Corn, sweet	7.2	6.3	12.5
Lettuce, head	9.0	7.2	20
Tomato	7.2	6.3	12.5

2) The registrant will reduce the single maximum per acre application rate of methomyl by 50% from 1.8 pounds to 0.9 pounds on peaches and commercial sod farms. No methomyl crop use will exceed a single application rate of 0.9 pounds of methomyl per acre.
3) The following statement supporting the use of an Integrated Pest Management (IPM) plan must be added to the labels. "This product should be used as part of an Integrated Pest Management (IPM) program which can include biological, cultural, and genetic practices aimed at preventing economic pest damage. Application of this product should be based on IPM principles and practices including field scouting or other detection methods, correct target pest identification, population monitoring and treating when target pest populations reach locally determined action thresholds. Consult your state cooperative extension service, professional consultant or other qualified authorities to determine appropriate action threshold levels for treating specific pest/crop systems in your area."
4) Based on the environmental risk assessment for methomyl, the following advisories are required to be on the label for methomyl: a labeling statement for potential ground water contamination, a labeling statement to minimize the potential for surface water contamination and labeling statements are required on manufacturing use products and end use products based on the toxicity to nontarget organisms. A bee hazard statement is also required.
5) The following spray drift label requirement for products with aerial applications is required to be on the label for methomyl: "Do not apply by ground equipment within 25 feet, or by air within 100 feet of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds. Increase the buffer zone to 450 feet from the above aquatic areas when ultra low volume application is made."

The Agency consulted with the USFWS in 1989 regarding methomyl impacts on some endangered species (USFWS 1989). As a result, the USFWS issued a formal Biological Opinion that identified reasonable and prudent measures and alternatives to mitigate effects of methomyl use on endangered species.

Subsequent to the RED, the registrant submitted several studies including, but not limited to, two predatory mite studies (MRID 451255-01, 451255-02); two aphid studies (MRID 451333-01, 451333-02); two earthworm studies (MRID 454592-01, 449693-01); an acute oral and contact honey bee study (MRID 450930-01), a supplemental aqueous photolysis study (MRID 43823305), an acceptable storage stability study (MRID 43708807), and a supplemental aerobic soil metabolism study (MRID 45473401). These studies have been reviewed and are incorporated into the current risk assessment. The current assessment also builds on the previous RED by incorporating open literature (from the ECOTOX search engine) and assessing indirect effects, including those effects caused by the potential loss of food items (*e.g.*, terrestrial and aquatic invertebrates).

On April 1, 2003, the Agency initiated formal consultation with the National Marine Fisheries Service relative to an effects determination regarding methomyl's potential effects to 26 Environmentally Significant Units (ESUs) of Pacific salmon and steelhead. That assessment determined that use of methomyl would have no effect (NE) on two ESU's based on lack of use in proximity to waters supporting these two ESUs and that methomyl was Likely to Adversely Affect (LAA) 24 ESUs both directly and indirectly based on effects to the aquatic invertebrate prey base. In response to the Agency's effects determination and consultation, NMFS issued a Biological Opinion (BO) in 2009 (NMFS, 2009; http://www.epa.gov/espp/litstatus/effects/index.htm#methomyl). In the BO NMFS concluded that the use of methomyl is likely to jeopardize the continued existence of 18 salmonid ESUs and destroy or adversely modify designated critical habitat for 16 ESUs (USEPA, 2010).

On July 20, 2007, the Agency submitted a risk assessment and effects determination to the USFWS for the California red-legged frog (*Rana aurora draytonii*) (CRLF) (and its designated critical habitat) relative to the use of methomyl in California (http://www.epa.gov/espp/litstatus/effects/redleg-frog/index.html#methomyl). A LAA effects determination was made based on the potential for direct effects to both aquatic- and terrestrial-phase CRLF and the potential for indirect effects to prey taxa (for both aquatic- and terrestrial-phase CRLF). Additionally, a 'habitat modification' effects determination was made for CRLF designated critical habitat based on the potential for effects to prey items for both aquatic- and terrestrial-phase CRLF.

In 2007, DuPont submitted a voluntary cancelation on strawberries. The use was cancelled in the fall of 2010. Likewise, in preparation for the N-Methyl Carbamate (NMC) Cumulative, the individual chemical dietary risk assessment identified grapes as a risk driver and Dupont responded by submitting a voluntary cancellation for the use on grapes. A final cancellation order for grapes was published December 8, 2010.

On July 16, 2010, the Agency submitted a Registration Review Problem Formulation for Environmental Fate, Ecological Risk, Endangered Species, and Drinking Water Exposure Assessments for Methomyl. Subsequent to the problem formulation, the registrant submitted a passerine acute oral toxicity study waiver (MRID 48736202). The waiver was reviewed by EFED on May 16, 2012 (USEPA 2012, DP Barcode 400766); EFED continues to believe that an avian acute oral toxicity study with passerines is a critical data gap. Furthermore, terrestrial and aquatic plant data were recommended by EFED during the registration review process. A refined DWA is currently being developed for methomyl.

2.4. Environmental Fate Properties

As noted in the 1998 RED, methomyl is moderately persistent and mobile in soil. Methomyl is less persistent in aqueous environments. It is stable to hydrolysis at lower pHs (neutral to acidic), but it degrades slowly in alkaline conditions ($t_{1/2}$ = 30 days). Methomyl degradation appears to be dependent on microbially-mediated (aerobic soil metabolism - $t_{1/2}$ = 4.3 - 44 d; anaerobic soil metabolism - $t_{1/2}$ = 14 days; aerobic aquatic metabolism - $t_{1/2}$ = 4-4.6 d) and abiotic processes (photodegradation in water - $t_{1/2}$ = 50 d). Under anaerobic conditions methomyl degradation is likely to be faster than under aerobic conditions (Smelt *et al.*, 1983), particularly in the presence of reduced iron (Bromilow *et al.*, 1986). In laboratory studies, methomyl does not readily adsorb to soil and has the potential to be mobile (mean K_{oc} = 46 ± 13

L/kg_{OC}). **Tables 2-2 and 2-3** summarizes the fate and physical-chemical properties of methomyl based on information from the registrants.

Major degradates include methomyl oxime (S-methyl-N-hydroxythioacetimidate) detected at a maximum of 44% in the alkaline hydrolysis study; acetonitrile detected at a maximum of 66%, 40% and 27% in the aqueous photolysis, soil photolysis and aerobic aquatic metabolism studies, respectively; acetamide detected at 14% in the aerobic aquatic metabolism study; and CO_2 detected at 22.5-75% in the aerobic soil, anaerobic soil, and aquatic metabolism studies. The only non-volatile degradate in the laboratory studies was methomyl oxime (S-methyl-N-hydroxythioacetimidate). It was present at high concentrations in the alkaline hydrolysis study, but was only a minor degradate in the aerobic soil metabolism, anaerobic soil metabolism, photolysis and aerobic aquatic metabolism studies.

Several studies showed that dissipation of methomyl is rapid on foliage (Willis and McDowell, 1987). Of the ten studies for methomyl identified in this review of foliar dissipation, three measured total residues on the leaves rather than dislodgeable residues. One of these three studies had significant rainfall during the study. The two remaining studies, one on mint and the other on Bermuda grass, had half-lives of 0.5 and 2.5 days, respectively. Because these studies only had rainfall after the pesticide is mostly dissipated and volatilization is likely to be very small for methomyl (see next section), the dominant route of foliar dissipation is likely aerobic metabolism on the leaf surface.

Mobility. Methomyl is mobile in soils as demonstrated by soil thin-layer chromatography (TLC; R_f values 0.64-0.79; MRID 00044306). A batch equilibrium study shows that methomyl has a low affinity to bind to soil (see **Table 2-1** further indicating that the chemical will be mobile (MRID 00161884). Methomyl binding (which is low) is significantly correlated with soil organic carbon content, with a mean K_{OC} of 46 ± 13 L/kg_{OC}.

Table 2-1 Summary of Soil Batch Equilibrium Parameters for Methomyl. [A]

Soil	Fraction of Organic Carbon	Mean K_d	K_{OC}	K_F	1/n	K_{FOC}
Cecil sandy loam	0.012	0.79	65	0.73	0.85	61
Flanagan silt Loam	0.025	1.1	45	1.0	0.87	41
Keyport silt loam	0.043	1.6	36	1.4	0.86	32
Woodstown sandy loam	0.006	0.24	39	0.23	0.88	37

[A] K_d is the soil-water partition coefficient. K_{OC} is the organic carbon-normalized partition coefficient based on mean K_d's. K_F is the Freundlich coefficient. 1/n is the Freundlich exponent. K_{FOC} is similar to K_{OC} except based on Freundlich coefficients

Methomyl is a highly soluble chemical in water (5.5×10^4 mg/L; MRID 41402101). Its vapor pressure (5.4×10^{-6} torr) and Henry's Law Constant (2.1×10^{-11} atm-m^3/mol) indicate that it has a low potential to volatilize (MRID 41209701).

Bioaccumulation. The low octanol/water partition coefficient (K_{ow}) of 1.31 ± 0.02 (mean ± std. error; MRID 157991) suggests that the chemical will have a low tendency to accumulate in aquatic biota.

Field Dissipation. Two guideline terrestrial field dissipation studies are available for methomyl (MRID 41623901/41623902, 42288001/43217903). Dissipation half-lives from the surface soil of cropped cabbage fields ranged from 4-6 days in Mississippi to 54 days in California. Two factors may explain the differences in dissipation between the two sites. Soil moisture content, which may affect the level of biological activity, varied between the two sites (moisture contents ranged from 2.5% to 17% in the California soils and averaged 16% over the first 15 days in the Mississippi soils). The Mississippi site received more rainfall, which may have led to more leaching out of the surface. In both studies most of the methomyl residues were found in the upper 30 cm of soil.

Prospective Groundwater Study. A small-scale prospective ground-water monitoring study was conducted for methomyl (MRID 43568301). Lannate L, a formulated product of methomyl, was applied in August 1992 to a site cropped in sweet corn in Cook County, Georgia. Monitoring continued until October 1994 when the study was terminated. The study was conducted by DuPont in a highly vulnerable, high use area of Georgia. Methomyl was applied to the crop at 0.45 lbs a.i./A 25 times over 63 days for a total of 11.25 lbs a.i./A. Although this rate represents 1.5x the maximum label rate per crop of sweet corn, the study was conducted to support a potential increase in the maximum label rate. Groundwater was monitored monthly for a period of 27 months. Methomyl was not detected in groundwater when detections occurred in 12-foot depth suction lysimeters at concentrations up to 0.943 µg/L. Out of the 156 samples taken from six down-gradient wells in this study, only six samples from five wells contained methomyl residues. Concentrations ranged from 0.110 to 0.428 µg/L, using a detection limit of 0.1 µg/L, at 62 and 117 days after the initial treatment (DAIT). Sampling continued for 789 (DAIT), but no detections were seen after 117 DAIT.

Table 2-2 and Table 2-3 lists the physical-chemical properties of methomyl. Please see Section 3 for further discussion on the environmental fate and transport properties of methomyl.

Table 2-2. Physical-chemical Properties of Methomyl

Property	Parent Compound	
	Value and units	MRID or Source
Molecular Weight	162.2 g/mol	Product chemistry (calculated)
Chemical Formula	$C_5H_{10}N_2O_2S$	Product chemistry
Vapor Pressure	5.4×10^{-6} torr	MRID 41209701
Henry's Law Constant	2.1×10^{-11} atm-m^3/mole	Estimated from water solubility and vapor pressure
Water Solubility	5.5×10^4 mg/L @ 20°C	MRID 41402101
Octanol – water partition coefficient (K_{OW})	1.31	MRID 00157991

Table 2-3. Summary of methomyl Environmental Fate Properties

Study	Value and unit	Major Degradate *Minor Degradates*	MRID # or Citation	Study Classification, Comment
Abiotic Hydrolysis	Half-life[1] = pH 5: stable pH 7: stable pH 9: 36 d; pH 2.09-7.11: >413 d pH 8.88: 14.6 d pH 7.40: 337 d pH 8.89: 16.1 d pH 7.67: 206 d pH 9.45: 4.77 d pH 7.92: 123 d pH 9.92: 1.66 d pH 8.42: 40.8 d	MHTA: S-methyl-N-hydroxythioacetimidate (40-44% in pH 9 solution only)	MRID 00131249; Strathmann and Stone, 2002 (values calculated from rate constants)	Acceptable
Direct Aqueous Photolysis	Half-life[1] = 50 d (natural water) Stable (pH 7 buffer w/ no excess nitrate) 42 days (pH 7 buffer w/ 100 M excess nitrate) 8.5 days (pH 7 buffer w/ 1000 M excess nitrate)	Transformation products were not determined.	MRID 43823305	Supplemental – no transformation products were addressed, no volatiles were collected, and a material balance could not be determined . Dissipation was observed (40-90% decrease in 15 days)
Soil Photolysis	Half-life[1] = 33 day	Acetonitrile (40% at 30 days)	MRID 00163745	Acceptable
Aerobic Soil Metabolism	Half-life[1] = Flanagan silt loam: 44 days, Madera, CA loam: 12 days; USA (mattapex), Loam: 7.9 days France (nambshem), Sandy Loam: 6.4 days Germany (speyer 2.2), Sandy Loam: 4.3 days	CO_2 (75.3% at 3 months) *MHTA (2.3%);* CO_2 (51% at 30 days) Unextracted Residues (32.2% at 30 days) *Methomyl oxime (0.8%),* CO_2 (59.2% at 30 days) Unextracted Residues (25.2% at 30 days) *Methomyl oxime (2.2%),* CO_2 (51% at 30 days) Unextracted Residues (31% at 30 days) *Methomyl oxime (1.4%)*	MRID 00008568, 43217901; MRID 454 73401	Acceptable; Supplemental
Anaerobic Soil Metabolism	Half-life[1] = 14 days (static), loam 7 days (flowing), loam	CO_2 (52.9%) *MHTA (0.9%)*	MRID 43217902	Acceptable
Aerobic Aquatic	Half-life[1] =	Acetonitrile (23.65-	MRID 43325401	Supplemental

Study	Value and unit	Major Degradate *Minor Degradates*	MRID # or Citation	Study Classification, Comment
Metabolism	Auchingilsie clay loam: 3.5 days Hinchingbrooke silty clam loam: 4.8 days	27.02% in traps, 15.8-16.9% in water and sediment) Acetamide (14.1% in water and sediment) CO_2 (32.14-46.21% in trap)		
Anaerobic Aquatic Metabolism	No data	No data	No data	No data
Freundlich solid-water distribution coefficient (K_F)	K_F, 1/n 0.72 L/kg, 0.86, Sandy Loam 1.0 L/kg, 0.86, Silt Loam 1.4 L/kg, 0.86, Silt 0.23 L/kg, 0.90, Sandy Loam	No data on transformation products	MRID 00161884	Acceptable
Organic-carbon normalized distribution coefficient (K_{OC})	K_{OC} = 46 ± 13 L/kg_{OC} (n=4)	No data on transformation products	MRID 00161884	Acceptable
Terrestrial Field Dissipation	Dissipation Half-life[1,2] = 54 d (CA sandy loam cropped to cabbage); leached to deepest sample depth (60-90 cm) 4-6 d (MS loam cropped to cabbage); leached to 15-30 cm sample depth		MRIDs 41623901, 41623902 42288001, 43217903	
Aquatic Field Dissipation	No data	No data	No data	No data
Bioconcentration Factor (BCF)- Species Name	No data	No data	No data	Bioaccumulation is not expected based on low K_{ow}
Foliar degradation half-life	0.5 d (mint); 2.5 d (Bermuda grass)		Kiigemagi and Deinzer, 1979; Sheets *et al.*, 1982	

Abbreviations: wt=weight
[1]Half-lives were calculated using the single-first order equation and nonlinear regression, unless otherwise specified.
[2]The value may reflect both dissipation and degradation processes.

2.4.1. Environmental Transport Mechanisms

Potential transport mechanisms for methomyl include surface water runoff, spray drift, and leaching. Secondary drift (atmospheric transport) of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems is not expected given methomyl's relatively high solubility in water (5.5×10^4 mg/L), low vapor pressure (5.4×10^{-6} torr) and Henry's law constant (2.1×10^{-11} atm-m^3/mol). Air monitoring data reported by CDPR show that methomyl was not detected in 84 samples taken in 1987 and 20 samples taken in 1989 in Fresno County. In the Association of American Pesticide Control Officials (AAPCO) 1999 Pesticide Enforcement Survey (http://aapco.ceris.purdue.edu/doc/surveys/drift99.html), state agencies reported that the number of drift complaints associated with methomyl is low as compared with 2,4-D, atrazine, dicamba, paraquat and glyphosate, which were the most common. However the survey does not provide information on the magnitude of exposure, nor does it differentiate between drift and volatility, and indicates that the most common confirmation technique is visual examination of drift and residue confirmation.

Air monitoring data collected from the 1960s through the 1980s, and summarized by Majewski and Capel (1995), do not indicate the presence of methomyl in the atmosphere, due in large part to the lack of testing for methomyl. The authors' review a single study which tested for methomyl in ambient air at three residential sites near an agricultural area in Salinas, California which were sampled during a high pesticide use month. Methomyl was not detected at any of the air monitoring sites (the level of detection was 35 nanograms per cubic meter).

In general, deposition of drifting or volatilized pesticides is expected to be greatest close to the site of application. Computer models of spray drift (AgDRIFT) are used to determine potential exposures to aquatic and terrestrial organisms via spray drift. The distance of potential impact away from the use sites (action area) is determined by the distance required to fall below the LOC for the taxonomic group that has the largest RQ to LOC ratio.

2.4.2. Mechanism of Action

Based on its chemical structure, methomyl belongs to the oxime carbamate class of insecticides. A number of other insecticides included in this chemical class, such as aldicarb, butocarboxin, and oxamyl are very similar in structure to methomyl.

Carbamate insecticides act by inhibiting acetylcholinesterase and reducing the degradation of the neurotransmitter acetylcholine. As a result, intersynaptic concentrations of acetylcholine increase as the neurotransmitter accumulates leading to increased firing of the postsynaptic neurons. This may ultimately lead to convulsions, paralysis, and death of the organism exposed to the chemical.

2.4.3. Use Characterization

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for methomyl 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.

Methomyl is currently registered for use on a wide variety of sites including field, vegetable, and orchard crops; turf (sod farms only); livestock quarters; commercial premises; and refuse containers (see **Table 2-4**). There are no residential uses for methomyl. Seven end-use products containing methomyl are currently registered for use in the United States (see **Table 2-5**). Three of the end-use products are for agricultural use and are labeled 'restricted use' (Methomyl 5G

Granules, Lannate SP), indicating that only certified pesticide applicators are legally allowed to apply the product. The other four end-use products are for scatter bait or bait station uses and are not labeled 'restricted use'.

Table 2-4. Summary of Current Methomyl Uses.

Summary of Current Methomyl Uses.	
Use Category	**Uses**
Agricultural	Alfalfa, anise/fennel, asparagus, barley, beans (succulent and dry), beets, Bermuda grass (pasture), blueberries, broccoli, broccoli raab, Brussels sprouts, cabbage, carrot, cauliflower, celery, chicory, Chinese broccoli, Chinese cabbage, collards (fresh market), corn (sweet, field, popcorn, and seed), cotton, cucumber, eggplant, endive/escarole, garlic, horseradish, leafy green vegetables, lentils, lettuce (head and leaf), lupine, melons, mint, nonbearing nursery stock (field grown), oats, onions (dry and green), peanuts, peas, peppers, potato, pumpkin, radishes, rye, sorghum, soybeans, spinach, sugar beet, summer squash, sweet potato, tobacco, tomatillo, tomato, sod, wheat
Orchard	Apple, avocado, grapefruit, lemon, nectarines, oranges, peaches, pears (northeastern U.S. only), pecans (southeastern U.S. only), pomegranates, tangelo, tangerine
Non-Agricultural	Bakeries, beverage plants, broiler houses, canneries, commercial dumpsters that are enclosed, commercial use sites (unspecified), commissaries, dairies, dumpsters, fast food establishments, feedlots, food processing establishments, hog houses, kennels, livestock barns, meat processing establishments, poultry houses, poultry processing establishments, restaurants, supermarkets, stables, warehouses

Table 2-5. Currently Registered Methomyl End-Use Products.				
FORMULATION	**EPA REG. NO. (date latest label)**	**% ACTIVE**	**METHODS OF APPLICATION**	**USE RESTRICTIONS**
LANNATE SP There are 14 SLNs; 7 are for CA: CA770308 CA770431 CA770495 CA780136 CA860059 CA900034 CA910011	352-342 (12/8/2010)	90% by weight	Ground Aerial Chemigation	- Overhead sprinkler chemigation is allowed for alfalfa, barley, oats, green and dry bulb onion, potatoes, rye, sugar beets, and wheat. Refer to supplemental, or Special Local Need (SLN) label or crop specific sections of this label for direction for chemigation. Do not apply this product through any other type of irrigation systems, except those allowed by instructions provided in supplemental, SLN or this product label. - Do not apply by ground equipment within 25 ft, or by air within 100 feet of lakes, reservoirs, rivers, estuaries, commercial fish ponds, and natural, permanent streams, marshes, or ponds (increase buffer to 450 ft with ultra low volume application). - Use only in commercial and farm plantings (not for home plantings or after opening for U-Pick operations). - Use of hand held application equipment is prohibited. - Pilot must not assist in mixing and loading operations.
METHOMYL 90SP There are no SLNs	83100-28 (4/5/2011)	see 352-342		

Table 2-5. Currently Registered Methomyl End-Use Products.				
FORMULATION	**EPA REG. NO. (date latest label)**	**% ACTIVE**	**METHODS OF APPLICATION**	**USE RESTRICTIONS**
LANNATE LV There are 4 SLNs; none are for CA	352-384 (12/8/2010)	2.4 lb ai/gallon	Ground Aerial Chemigation	- Overhead sprinkler chemigation is allowed for alfalfa, barley, succulent and dried beans, oats, green and dry bulb onion, succulent peas, potatoes, rye, sweet corn (not in CA), sugar beets, and wheat. Drip chemigation is allowed for onions. Refer to supplemental, or Special Local Need (SLN) label or crop specific sections of this label for direction for chemigation. Do not apply this product through any other type of irrigation systems, except those allowed by instructions provided in supplemental, SLN or this product label. - Do not apply by ground equipment within 25 ft, or by air within 100 feet of lakes, reservoirs, rivers, estuaries, commercial fish ponds, and natural, permanent streams, marshes, or ponds (increase buffer to 450 ft with ultra low volume application). - Use only in commercial and farm plantings (not for home plantings or after opening for U-Pick operations). - Use of hand held application equipment is prohibited. - Pilot must not assist in mixing and loading operations.
METHOMYL 29LV There are no SLNs	83100-27 (11/23/2011)	see 352-384		
GOLDEN MALRIN RF-128 FLY KILLER	2724-274 (10/20/2010)	1.0%	Scatter bait Bait station	- Not to be used inside or around homes, or any other place where children or pets are likely to be present. - Place scatterbait in areas inaccessible to livestock. Keep children and pets out of treated areas. Do not place scatterbait around commercial dumpsters that are not enclosed. - Bait stations should be at least 4' above ground and in areas not accessible to children, pets, and livestock. - Brush paste on outside of structures so that it is inaccessible to children, pets, and livestock.
LURECTRON SCATTERBAIT	7319-6 (11/15/2011)	1.0%	Scatter bait Bait station Brush on paste	
STIMUKIL FLY BAIT	53871-3 (8/17/2004)	1.0%	Scatter bait Bait station Brush on paste	
METHOMYL 5G GRANULES	57242-2 (8/21/2011)	5%	Ground, banded application in corn whorl	- Do not apply within 25 ft of lakes, reservoirs, rivers, estuaries, commercial fishponds, and natural, permanent streams, marshes or natural, permanent ponds. - Not for use in home plantings or U-Pick operations.

There are a total of 30 products containing methomyl. This includes three technical products (352-366, 70552-2, and 81598-9) and one manufacturing use product (352-361). These four products are used only to formulate methomyl end use products and are not reviewed further. Of the 30 products, 18 are SLNs; however, there are only seven SLN registrations for use in California. The other 11 SLNs are not reviewed further.

Table 2-5 provides a complete listing of the remaining eight section 3 end-use products and the seven SLNs. The table includes the formulation, EPA registration number, date of stamped label, % active ingredient, methods of application, and any relevant use restrictions.

Two of the end-use products are labelled as 'restricted use' chemicals (Lannate® LV and Lannate® SP), indicating that only licensed pesticide applicators are legally allowed to apply the product. None of the scatter bait/bait station end-use products are labelled as 'restricted use' chemicals. Methomyl is registered for use on a wide variety of sites including field, vegetable, and orchard crops; turf (sod farms only); livestock quarters; commercial premises; and refuse containers. Low volume aerial applications (a minimum of 1 gallon of tank mixture/acre) are allowed in CA for a variety of non-orchard agricultural uses (see **APPENDIX B**). For the purposes of this assessment 'agricultural uses' refer to all field and vegetable crops and sod farms. Orchard uses are analyzed separately from other agricultural uses because of their different use patterns.

For agricultural and orchard uses, the maximum *single* application rate allowed on the labels is 0.9 lb active ingredient (a.i.)/acre, which is the most common single maximum application rate for all agricultural uses (see **APPENDIX B** for a complete list of registered uses and application rates).

Maximum *seasonal* labeled application rates (indicated on the label as maximum application rates per *crop*) for agricultural uses range from 0.9 lb a.i./acre/crop [*i.e*., Bermuda grass (pasture), avocado, lentils, beans (interplanted with trees), sorghum, and soybeans (interplanted with trees)] to 7.2 lbs a.i./acre/crop [*i.e*., cabbage, lettuce (head), cauliflower, broccoli raab, celery, and Chinese cabbage].

All orchard and most agricultural uses involve foliar application. The only granular agricultural/orchard use is for corn (which also has a foliar use). Since the maximum seasonal application rate for methomyl use on corn is the same for the foliar and granular formulations, and no spray drift is expected for granular use, modeling only foliar applications for corn in the aquatic assessment is expected to be conservative. The granular use on corn and all foliar uses were also assessed in the terrestrial assessment.

All non-agricultural and non-orchard, outdoor uses for methomyl in CA are limited to bait stations and scatter bait around agricultural (*e.g*., animal premises) and commercial structures and commercial dumpsters. The bait station use involves placing the pesticide within the bait station and hanging the bait station at least four feet off the ground (as stipulated on the labels); as a result, no spray drift or runoff is expected from this use. The scatter bait can be mixed with water to form a paste which can be brushed onto walls, window sills, and support beams. Since the scatter bait uses are also granular applications, no spray drift exposure is expected but there is potential for off-site exposure via runoff. Therefore, the scatter bait is modeled in the aquatic assessment. Scatter bait is also assessed as a granular application in the terrestrial assessment.

Table 2-6 presents the uses and corresponding application rates and methods of application considered in this assessment.

Table 2-6. Methomyl Uses Assessed for California

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
Alfalfa	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	3.6 lb ai/A	10	1 crop with multiple cuttings	3.6 lb a.i./A
	Lannate SP Methomyl 90SP						
Anise (Fennel)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb a/A	10	2	9 lb a.i./A
	Lannate SP Methomyl 90SP						
Apple (ground only)	Lannate LV Methomyl 29LV	0.9 lb ai/A	7	4.5 lb ai/A	5	1	4.5 lb a.i./A
	Lannate SP Methomyl 90SP						
Asparagus	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	8	1	4.5 lb a.i./A
	Lannate SP Methomyl 90SP						
Avocado	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	0.9 lb ai/A	2	1	0.9 lb a.i./A
	Lannate SP Methomyl 90SP						
Barley	Lannate LV Methomyl 29LV	0.45 lb ai/A	5	1.8 lb ai/A	4	1	1.8 lb a.i/.A
	Lannate SP Methomyl 90SP						
Beans, Succulent (kidney, lima, mung, Navy, pinto, snap, wax, broad, fava, asparagus beans, blackeyed peas, cowpeas)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	10	1	4.5 lb a.i/.A
	Lannate SP Methomyl 90SP						
Sweet Lupine, White Sweet Lupine, White Lupine, Grain Lupine	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	10	1	4.5 lb a.i./A
	Lannate SP Methomyl 90SP						
Beans, Dry (same as succulent beans)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	10	1	4.5 lb a.i/.A

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
	Lannate SP Methomyl 90SP						
Beans[SLN] (interplanted with nonbearing almonds, plums, prunes, peaches, and walnuts) (CA-770431)	Lannate SP	0.45 lb ai/A	5	0.9 lb ai/A	2	1	0.9 lb a.i/.A
Beets (table)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	3.6 lb ai/A	8	2	7.2 lb a.i/.A
	Lannate SP Methomyl 90SP						
Bermudagrass (pasture)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	0.9 lb ai/A	4	1	0.9 lb a.i/.A
	Lannate SP Methomyl 90SP						
Blueberries (ground only)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	3.6 lb ai/A	4	1	3.6 lb a.i./A
	Lannate SP Methomyl 90SP						
Broccoli	Lannate LV Methomyl 29LV	0.9 lb ai/A	2	6.3 lb ai/A	10	Imperial Valley: 1 Coastal Valleys: 3 San Joaquin Valley: 2	6.3 lb a.i./A 18.9 lb a.i./A 12.6 lb a.i./A
	Lannate SP Methomyl 90SP						
Broccoli, Chinese[SLN] (CA-860059)	Lannate SP	0.9 lb ai/A	5	4.5 lb ai/A	5	2	9 lb a.i./A
Broccoli Raab[SLN] (CA-900034)	Lannate SP	0.9 lb ai/A	5	7.2 lb ai/A	10	Imperial Valley: 1 Coastal Valleys: 3 San Joaquin Valley: 2	7.2 lb a.i./A 21.6 lb a.i./A 14.4 lb a.i./A
Brussels Sprouts	Lannate LV Methomyl 29LV	0.9 lb ai/A	2	5.4 lb ai/A	10	1	5.4 lb ai/A
	Lannate SP Methomyl 90SP						
Cabbage	Lannate LV Methomyl 29LV	0.9 lb ai/A	2	7.2 lb ai/A	15	3	21.6 lb a.i./A
	Lannate SP Methomyl 90SP						

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
Carrot	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	6.3 lb ai/A	10	1	6.3 lb a.i./A
	Lannate SP Methomyl 90SP						
Cauliflower	Lannate LV Methomyl 29LV	0.9 lb ai/A	2	7.2 lb ai/A	10	Coastal Region: 2 San Joaquin Valley: 1	14.4 lb a.i./A 7.2 lb a.i./A
	Lannate SP Methomyl 90SP						
Celery	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	7.2 lb ai/A	10	2.5	18 lb a.i./A
	Lannate SP Methomyl 90SP						
Chicory	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	1.8 lb ai/A	2	San Joaquin Valley: 2 Desert: 1	3.6 lb a.i./A 1.8 lb a.i./A
	Lannate SP Methomyl 90SP						
Chinese Cabbage	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	7.2 lb ai/A	10	3	21.6 lb a.i./A
	Lannate SP Methomyl 90SP						
Collards (fresh market only)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	5.4 lb ai/A	8	3	16.2 lb a.i./A
	Lannate SP Methomyl 90SP						
Corn (field and popcorn)	Lannate LV Methomyl 29LV	0.45 lb ai/A	5	2.5 lb ai/A	10	1	2.5 lb a.i./A
	Lannate SP Methomyl 90SP						
Corn (seed)	Lannate SP Methomyl 90SP	0.45 lb ai/A	5	2.5 lb ai/A	10	1	2.5 lb a.i./A
Corn (sweet)	Lannate LV Methomyl 29LV	0.45 lb ai/A	1	6.3 lb ai/A	28	3	18.9 lb a.i./A
	Lannate SP Methomyl 90SP						
Corn (sweet)	Methomyl 5G Granules	0.15 lb ai/A	NR	6.3 lb ai/A	10	3	18.9 lb a.i./A
Cotton[2]	Lannate LV Methomyl	0.675 lb ai/A	3	1.8 lb ai/A	8	1	1.8 lb a.i./A

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
	29LV						
	Lannate SP Methomyl 90SP						
Cucumber	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	5.4 lb ai/A	12	1	5.4 lb a.i./A
	Lannate SP Methomyl 90SP						
Eggplant	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	10	1	4.5 lb a.i./A
	Lannate SP Methomyl 90SP						
Endive, Escarole	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	8	2 (less in desert)	9 lb a.i./A
	Lannate SP Methomyl 90SP						
Garlic	Lannate LV Methomyl 29LV	0.45 lb ai/A	5	2.7 lb ai/A	6	1	2.7 lb a.i./A
	Lannate SP Methomyl 90SP						
Grapefruit[3]	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	2.7 lb ai/A	4	1	2.7 lb a.i./A
	Lannate SP Methomyl 90SP						
Horseradish (ground Only)	Lannate LV Methomyl 29LV	0.45 lb ai/A	5	1.8 lb ai/A	4	1	1.8 lb a.i./A
	Lannate SP Methomyl 90SP						
Leafy Green Vegetables (beet tops, dandelions, kale, mustard greens, parsley, Swiss chard, turnip greens)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	3.6 lb ai/A	8	4	14.4 lb a.i./A
	Lannate SP Methomyl 90SP						
Lemon[3]	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	2.7 lb ai/A	4	1	2.7 lb a.i./A
	Lannate SP Methomyl 90SP						
Lentils	Lannate LV Methomyl	0.9 lb ai/A	5	0.9 lb ai/A	2	1	0.9 lb a.i./A

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
	29LV						
	Lannate SP Methomyl 90SP						
Lettuce (head varieties)	Lannate LV Methomyl 29LV	0.9 lb ai/A	2	7.2 lb ai/A	15	Central Coast: 2 Central Valley: 2 Other Regions: 1	14.4 lb a.i./A 14.4 lb a.i./A 7.2 lb a.i./A
	Lannate SP Methomyl 90SP						
Lettuce (leaf varieties)	Lannate LV Methomyl 29LV	0.9 lb ai/A	2	3.6 lb ai/A	8	Desert: 1 Other Regions: 2	3.6 lb a.i./A 7.2 lb a.i./A
	Lannate SP Methomyl 90SP						
Melons (cantaloupe, casaba, Santa Claus, Crenshaw, honeydew, honey balls, Persian, golden pershaw, mango melon, pinapple melon, snake, watermelon)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	5.4 lb ai/A	12	1	5.4 lb a.i./A
	Lannate SP Methomyl 90SP						
Mint (peppermint, spearmint)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	1.8 lb ai/A	4	Peppermint: 1* Spearmint: 2*	1.8 lb a.i./A 3.6 lb a.i./A
	Lannate SP Methomyl 90SP						
Nectarine$_4$	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	2.7 lb ai/A	3	1	2.7 lb a.i./A
	Lannate SP Methomyl 90SP						
Nonbearing Fruit, Grape, and Nut Nursery Stock (field grown)[SLN] (CA-770308)	Lannate SP	0.9 lb ai/A	5	4.5 lb ai/A	5	1	4.5 lb a.i./A
Oats	Lannate LV Methomyl 29LV	0.45 lb ai/A	5	1.8 lb ai/A	4	1	1.8 lb a.i./A
	Lannate SP Methomyl 90SP						
Onions (green)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	5.4 lb ai/A	8	3	16.2 lb a.i./A
	Lannate SP						

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
	Methomyl 90SP						
Onions (dry bulb)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	3.6 lb ai/A	8	1	3.6 lb a.i./A
	Lannate SP Methomyl 90SP						
Oranges[3]	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	2.7 lb ai/A	4	1	2.7 lb a.i./A
	Lannate SP Methomyl 90SP						
Peaches	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	5.4 lb ai/A	6	1	5.4 lb a.i./A
	Lannate SP Methomyl 90SP						
Peas, succulent (pigeon peas, chick, garbanzo, dwarf peas, garden peas, green peas, English peas, Field peas, edible pod peas)	Lannate LV Methomyl 29LV	0.9 lb ai/A	3	2.7 lb ai/A	6	1	2.7 lb a.i./A
	Lannate SP Methomyl 90SP						
Peppers (bell, hot, pimentos, sweet)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	10	1	4.5 lb a.i./A
	Lannate SP Methomyl 90SP						
Pomegranates	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	1.8 lb ai/A	2	1	1.8 lb a.i./A
	Lannate SP Methomyl 90SP						
Potato	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	10	1	4.5 lb a.i./A
	Lannate SP Methomyl 90SP						
Pumpkins[SLN] (CA-910011) (San Joaquin, Stanislaus, Merced, Sacramento, and Riverside Counties)	Lannate SP	0.9 lb ai/A	5	2.7 lb ai/A	3	1	2.7 lb a.i./A
Radishes[SLN]	Lannate SP	0.9 lb ai/A	5	1.8 lb ai/A	2	5	9 lb a.i./A

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
(CA-770495)							
Rye	Lannate LV Methomyl 29LV	0.45 lb ai/A	5	1.8 lb ai/A	4	1	1.8 lb a.i./A
	Lannate SP Methomyl 90SP						
Sorghum (except sweet sorghum)	Lannate LV Methomyl 29LV	0.45 lb ai/A	5	0.9 lb ai/A	2	1	0.9 lb a.i./A
	Lannate SP Methomyl 90SP						
Soybeans	Lannate LV Methomyl 29LV	0.45 lb ai/A	5	1.35 lb ai/A	3	1	1.35 lb a.i./A
	Lannate SP Methomyl 90SP						
Soybeans [SLN] (interplanted with nonbearing almonds, plums, prunes, peaches, and walnuts) (CA-770431)	Lannate SP	0.45 lb ai/A	5	0.9 lb ai/A	2	1	0.9 lb a.i./A
Spinach	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	3.6 lb ai/A	8	3	10.8 lb a.i./A
	Lannate SP Methomyl 90SP						
Sugar Beet	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	4.5 lb ai/A	10	1	4.5 lb a.i./A
	Lannate SP Methomyl 90SP						
Summer Squash (crookneck, straightneck, scallop, vegetable marrow, spaghetti, hyotan, cucuzza, hechima, Chinese okra, bitter melon, balsam pear, balsam apple, Chinese cucumber)	Lannate LV Methomyl 29LV	0.9 lb ai/A	5	5.4 lb ai/A	12	1	5.4 lb a.i./A
	Lannate SP Methomyl 90SP						
Sweet Potatoes [SNL]	Lannate SP	0.9 lb ai/A	5	2.7 lb ai/A	3	1	2.7 lb a.i./A

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
(Aerial only) (CA-780136)							
Tangelo, Tangerine[3]	Lannate LV Methomyl 29LV Lannate SP Methomyl 90SP	0.9 lb ai/A	5	2.7 lb ai/A	4	1	2.7 lb a.i./A
Tomato	Lannate LV Methomyl 29LV Lannate SP Methomyl 90SP	0.9 lb ai/A	5	6.3 lb ai/A	16	1	6.3 lb a.i./A
Tomatillo	Lannate LV Methomyl 29LV Lannate SP Methomyl 90SP	0.9 lb ai/A	5	4.5 lb ai/A	5	1	4.5 lb a.i./A
Turf (sod farms only)	Lannate LV Methomyl 29LV Lannate SP Methomyl 90SP	0.9 lb ai/A	5	3.6 lb ai/A	4	2	7.2 lb a.i./A
Wheat	Lannate LV Methomyl 29LV Lannate SP Methomyl 90SP	0.45 lb ai/A	5	1.8 lb ai/A	4	1	1.8 lb a.i./A
Feedlots, livestock housing, kennels, food processing plants, fenced dumpsters (outside)	Golden Malrin Lucreton Scatterbait Stimukil Fly Bait	Scatterbait 0.22 lb ai/A (4 oz prod/500 ft^2)	1	NR	NR	N/A	
Feedlots, livestock housing, kennels, food processing plants, fenced dumpsters (outside)	Golden Malrin Lucreton Scatterbait Stimukil Fly Bait	Bait Station 0.22 lb ai/A (1 oz prod/bait station with 4 bait stations/500 ft^2)	1	NR	NR	N/A	
Livestock housing	Lucreton Scatterbait	Brush on paste	1	NR	NR	N/A	

Use (App. Method)	Form.	Maximum Single App. Rate (lbs a.i./acre)	Minimum Retreatment Interval (days)	Maximum App. Rate per Crop (lbs a.i./acre)	Maximum Number of App. per Crop	Maximum Number of Crops per Year	Maximum App. Rate per Year (lbs a.i./acre)
(outside)	Stimukil Fly Bait	Mix w/ water (4 oz product + 4 oz water) and brush on structures					
Walkways in caged poultry layer houses (inside)	Golden Malrin	Scatterbait 0.22 lb ai/A (4 oz prod/500 ft^2)	1	NR	NR	N/A	
	Lurcreton Scatterbait						
	Stimukil Fly Bait						
Walkways in caged poultry layer houses (inside)	Golden Malrin	Bait Station 0.22 lb ai/A (1 oz prod/bait station with 4 bait stations/500 ft^2)	1	NR	NR	N/A	
	Lurcreton Scatterbait						
	Stimukil Fly Bait						

Abbreviations: App. = applications; Form. = formulation; N/A = not applicable; NR = not reported on label
[1] 5 days was used unless otherwise stated on the label.
[2] Different rates depending on geographic region; the listed rates are for CA
[3] Limited to use in CA, AZ, and HI
[SLN] = CA Special Local Needs 24(c)
[4] Limited to use in CA, and AZ
* For perennial crops, we used the number of cuttings per year

Of all of the registered uses of methomyl (excluding non-CA Special Local Needs [SLN] registrations), the following uses are excluded from our assessment because they are not registered for use in or applicable to CA:

- peanuts (not grown in CA)
- pears (methomyl is registered for use on pears in the Northeastern U.S. only)
- pecans (methomyl is registered for use on pecans in the Southeastern U.S. only)
- tobacco (not grown in CA).

Several methomyl crops can be grown more than one time per year in CA (i.e., they have multiple crop cycles). Most methomyl product labels specify application rates on a per crop cycle basis (not on a per year basis). Information from BEAD indicates that many crops can be grown more than one time/year in California (U.S. EPA 2007). Since standard PRZM scenarios only consist of one crop per year, applications to only one crop per year were modeled. For uses where methomyl is applied for multiple cropping cycles within a year, EECs presented in this assessment may underpredict exposures. For all other labeled uses, it was assumed that a maximum seasonal application specified on the label was equivalent to a maximum annual application. [1] . For the labeled application rates and information from EPA's Office of Pesticide Programs' Benefits and Economic Analysis Division (BEAD) on the number of times each crop for which methomyl is registered for use can be grown in CA see **APPENDIX B**.

According to the the Agency's Biological and Economic Analysis Division (BEAD), California's average pounds per 1,000 acres of farmland range from a maximum of 27.3 lbs of methomyl down to < 1 lb (**Figure 2-1**).

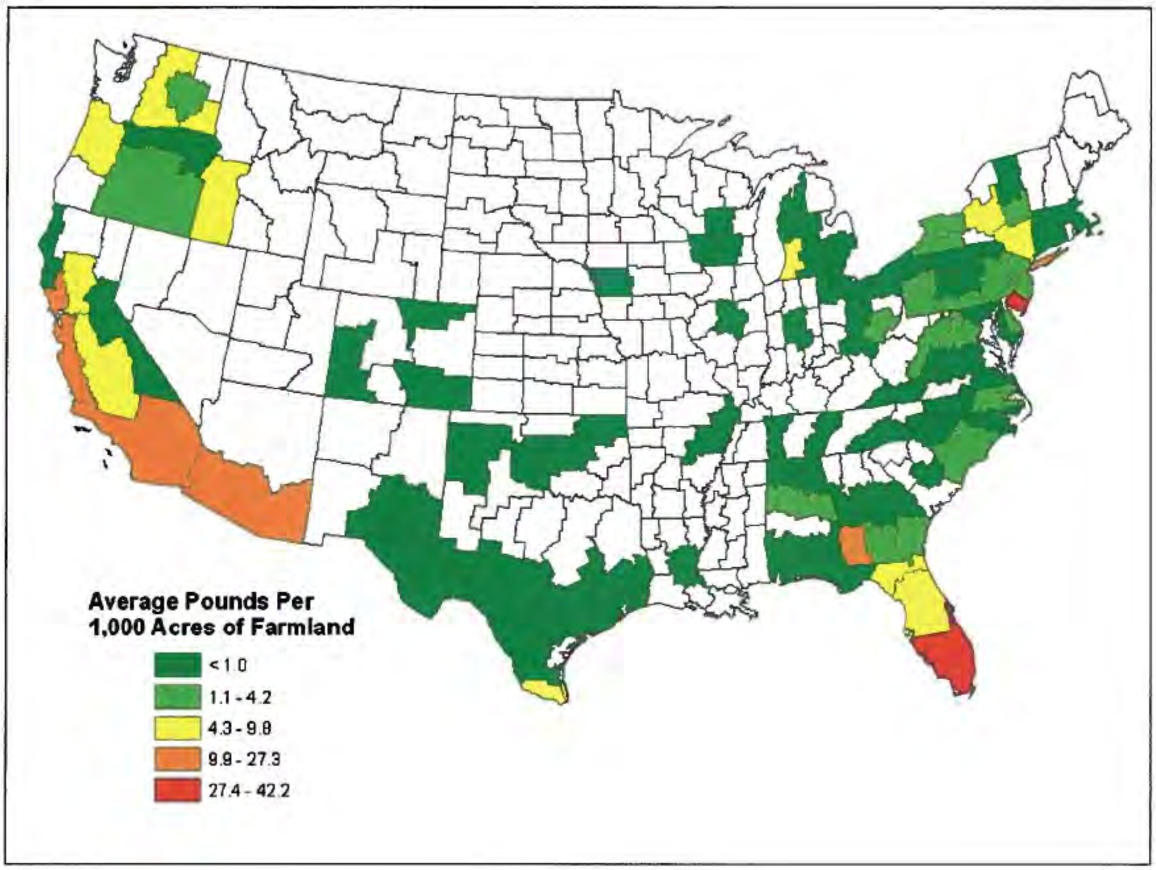

Figure 2-1. Methomyl Usage by Cop Reporting District (2006-2010)[2]

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[1] *USEPA. 2007. Maximum Number of Crop Cycles Per Year in California for Methomyl Use Sites. Memo from Monisha Kaul (BEAD) to Melissa Panger (EFED). Dated 27 February 2007.*

2 This is a map of agricultural pesticide usage at the Crop Reporting District (CRD) level. CRDs are boundaries created by USDA NASS which are aggregates of counties (USDA, 2010). Pesticide usage is displayed as average pounds (for the years 2006-2010) per 1,000 acres offarmland in a CRD to nonnalize for the variation in farmland between CRDs. Farmland acreage was obtained from USDA (2007).

Usage is based on private market surveys of pesticide use in agriculture (Proprietary Data, 2006-2010). The" survey data are limited to the states that represent the top 80-90% of acreage for the individual crops, therefore, use may be occurring in regions outside the scope of the survey. CRDs showing no usage of pesticides may be due to either the lack of pesticide use in the region or non-participation in the agricultural surveys. In addition, across the years, there may be variations in the specific crops included in the eRD survey. This may result in a lower annual average for the CRD.

BEAD provided an analysis of both national- and county-level usage information (Kaul, 2012) using state-level usage data obtained from USDA-NASS[3], Doane (www.doane.com; the full dataset is not provided due to its proprietary nature) and the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[4]. CDPR PUR is considered a more comprehensive source of usage data than USDA-NASS or EPA proprietary databases, and thus the usage data reported for methomyl by county in this California-specific assessment were generated using CDPR PUR data. Eleven years (1999-2010) of usage data were included in this analysis. Data from CDPR PUR were obtained for every agricultural pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system.[5] BEAD summarized these data to the county level by site, pesticide, and unit treated. Calculating county-level usage involved summarizing across all applications made within a section and then across all sections within a county for each use site and for each pesticide. The county level usage data that were calculated include: average annual pounds applied, average annual area treated, and average and maximum application rate across all eleven years. The units of area treated are also provided where available.

It is important to note that the uses considered in this risk assessment represent all currently registered uses according to a review of all current labels. No other uses are relevant to this assessment. Any reported use, such as may be seen in the CDPR PUR database, represent either historic uses that have been canceled (see Section 2.3), mis-reported uses, or mis-use. Historical uses, mis-reported uses, and misuse are not considered part of the federal action and, therefore, are not considered in this assessment.

CDPR PUR data for all methomyl uses in CA can be found in **Table** 2-7. All uses that were misuses, unknown uses, or uses that have been cancelled were not included in the table below. The use sites stating animal premises, poultry, chicken, etc were left in the table because it is believed this may be due to the bait use which is a methomyl registered use. The maximum average annual pounds of methomyl applied between 1999 to 2010 belonged to lettuce with 49,370.05 lbs, then alfalfa (43,070.94 lbs), and corn (37,441.15).

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[3] United States Depart of Agriculture (USDA), National Agricultural Statistics Service (NASS) Chemical Use Reports provide summary pesticide usage statistics for select agricultural use sites by chemical, crop and state. See http://www.pestmanagement.info/nass/app_usage.cfm.

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

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

Table 2-7. Summary of California Department of Pesticide Registration (CDPR) Pesticide Use Reporting (PUR) Data from 1999 to 2010 for Currently Registered Methomyl Uses[1]

Site Name	Average Annual Pounds Applied	Average Application Rate (lbs a.i./unit area)	Maximum Application Rate (lbs a.i./unit area)	Reported Unit Area Per Site
ALFALFA	43,070.94	0.5	4.6	Acres
ALMOND	11.37	0.9	1.5	Acres
ANIMAL PREMISE	0.01	0.0	0.0	Thousand cubic feet
ANIMAL PREMISE	0.92	0.0	0.0	Square feet
ANIMAL PREMISE	0.01	0.0	0.0	Cubic feet
ANIMAL PREMISE	0.11	0.1	0.4	Not stated
ANIMAL PREMISE	1.11	0.0	0.2	Acres
ANIMAL PREMISE	15.88	0.1	1.6	Misc. unit
APPLE	127.07	0.7	0.9	Acres
ASPARAGUS	1,353.89	0.8	9.1	Acres
AVOCADO	25.13	0.8	0.9	Acres
BEAN, DRIED	4,780.43	0.6	4.5	Acres
BEAN, SUCCULENT	2,578.03	0.6	2.7	Acres
BEAN, UNSPECIFIED	884.36	0.6	6.8	Acres
BEET	167.82	0.6	0.9	Acres
BERMUDAGRASS	1,277.70	0.6	0.9	Acres
BLUEBERRY	411.18	0.7	1.4	Acres
BROCCOLI	0.00	0.0	0.0	Square feet
BROCCOLI	4,614.16	0.7	9.0	Acres
BRUSSELS SPROUT	155.87	0.9	1.0	Acres
CABBAGE	0.00	0.0	0.0	Square feet
CABBAGE	1,529.94	0.7	3.4	Acres
CABBAGE	0.04	0.6	0.6	Misc. unit
CANTALOUPE	6,417.69	0.6	9.0	Acres
CARROT	1,841.80	0.6	4.5	Acres
CARROT	1.80	0.6	0.6	Square feet
CARROT (FORAGE - FODDER)	0.15	0.9	0.9	Acres
CAULIFLOWER	1,169.24	0.7	4.5	Acres
CELERY	7,610.29	0.8	9.0	Acres
CELERY	1.96	0.9	0.9	Square feet
CHICKEN	0.20	0.0	0.0	Misc. unit
CHICORY	18.42	0.8	0.9	Acres
CHINESE CABBAGE (NAPPA)	315.17	0.8	17.3	Acres

Site Name	Average Annual Pounds	Average Application Rate (lbs a.i./unit area)	Maximum Application Rate (lbs a.i./unit area)	Reported Unit Area Per Site
CHINESE GREENS	3.94	1.0	1.8	Acres
CILANTRO	0.02	0.3	0.3	Acres
CITRUS	53.44	5.8	47.7	Acres
COLLARD	58.00	0.5	0.9	Acres
CORN (FORAGE - FODDER)	3,123.69	0.4	4.7	Acres
CORN, HUMAN CONSUMPTION	37,441.15	0.4	6.8	Acres
CORN, HUMAN CONSUMPTION	2.76	0.9	0.9	Not stated
CORN, HUMAN CONSUMPTION	3.41	0.3	0.5	Square feet
COTTON	1,899.94	0.6	4.5	Acres
COTTON (FORAGE - FODDER)	1.35	0.5	0.5	Acres
EGGPLANT	118.19	0.9	18.0	Acres
ENDIVE (ESCAROLE)	335.56	0.7	9.0	Acres
FORAGE HAY/SILAGE	16.11	0.4	0.5	Acres
GARLIC	765.99	0.4	1.7	Acres
GRAPEFRUIT	14.86	0.8	0.9	Acres
LETTUCE, HEAD	49,370.05	0.7	7.2	Acres
LETTUCE, HEAD	0.87	0.5	0.6	Square feet
LETTUCE, LEAF	0.50	0.5	0.5	Square feet
LETTUCE, LEAF	28,727.72	0.6	10.8	Acres
MELON	2,379.84	0.6	4.5	Acres
MINT	21.70	0.7	2.9	Acres
NECTARINE	5,625.51	0.8	9.1	Acres
OAT	14.37	0.9	6.8	Acres
OAT (FORAGE - FODDER)	69.31	0.4	1.2	Acres
ONION, DRY	13,035.65	0.7	12.2	Acres
ONION, GREEN	368.37	0.6	1.8	Acres
ORANGE	2,027.40	0.8	11.3	Acres
PEACH	845.90	0.9	9.6	Acres
PEAS	2,144.44	0.8	9.0	Acres
PEAS (FORAGE - FODDER)	0.23	0.9	0.9	Acres
POMEGRANATE	3,222.28	0.8	1.8	Acres
POTATO	3,905.84	0.7	9.2	Acres
POULTRY	0.02	0.0	0.0	Square feet
POULTRY	0.00	0.0	0.0	Thousand cubic feet
POULTRY	0.82	0.1	0.2	Acres
POULTRY	2.08	0.0	0.2	Misc. unit

Site Name	Average Annual Pounds	Average Application Rate (lbs a.i./unit area)	Maximum Application Rate (lbs a.i./unit area)	Reported Unit Area Per Site
POULTRY	0.03	0.0	0.0	
PUMPKIN	581.99	0.6	11.5	Acres
RADISH	21.36	0.8	2.0	Acres
RYE	2.37	0.4	0.5	Acres
RYEGRASS	5.44	0.5	0.5	Acres
SORGHUM (FORAGE - FODDER)	502.73	0.5	4.5	Acres
SORGHUM/MILO	126.03	0.4	0.7	Acres
SPINACH	2,725.94	0.7	7.7	Acres
SQUASH	0.19	0.5	0.5	Square feet
SQUASH	447.15	0.6	5.9	Acres
SQUASH, SUMMER	104.55	0.7	1.1	Acres
SQUASH, WINTER	1.58	0.9	1.4	Acres
SQUASH, ZUCCHINI	5.61	0.5	0.7	Acres
STRUCTURAL PEST CONTROL	20.72	Not Stated	Not Stated	Not stated
STRUCTURAL PEST CONTROL	1.64	0.7	0.7	Acres
SUGARBEET	16,205.26	0.6	5.4	Acres
SUGARBEET (FORAGE - FODDER)	114.98	0.5	0.9	Acres
SWEET POTATO	1,515.80	0.8	2.7	Acres
TANGELO	3.95	0.6	0.9	Acres
TANGERINE	126.17	0.7	0.9	Acres
TOMATILLO	18.16	0.6	2.7	Acres
TOMATO	9,810.11	0.7	9.4	Acres
TOMATO	0.01	0.0	0.0	Square feet
TOMATO, PROCESSING	12.86	0.5	0.5	Square feet
TOMATO, PROCESSING	21,532.56	0.6	8.1	Acres
TURF/SOD	0.56	0.5	0.5	Acres
TURKEY	0.07	0.0	0.0	Misc. unit
UNCULTIVATED AG	21.73	0.5	0.7	Acres
UNCULTIVATED AG	3.95	0.3	0.5	Square feet
UNCULTIVATED NON-AG	4.13	3.3	4.5	Acres
VEGETABLES, LEAFY	13.78	0.8	0.9	Acres
VERTEBRATE CONTROL	5.65	0.7	0.9	Acres
VERTEBRATE CONTROL	0.04	Not Stated	Not Stated	Not stated
WATERMELON	2,864.38	0.7	4.5	Acres
WHEAT	79.43	0.5	0.9	Acres
WHEAT (FORAGE - FODDER)	48.54	0.4	0.5	Acres

1- Based on data supplied by BEAD (February 23, 2012).

2.5. Assessed Species

Table 2-8 provides a summary of the current distribution, habitat requirements, and life history parameters for the listed species being assessed. More detailed life-history and distribution information can be found in **Attachment III**. See **Figure 2-2** through **Figure 2-9** for maps of the current range and designated critical habitat, if applicable, of the assessed listed species.

- **Bay Checkerspot Butterfly (BCB):** The BCB was listed as threatened in 1987 by the USFWS. The species primarily inhabits native grasslands on serpentine outcrops around the San Francisco Bay Area in California.
- **Valley Elderberry Longhorn Beetle (VELB):** The VELB was listed as threatened in 1980 by the USFWS. The species is found in areas with elderberry shrubs throughout California's Central Valley and associated foothills on the east and the watershed of the Central Valley on the west.
- **California Tiger Salamander (CTS):** There are currently three CTS Distinct Population Segments (DPSs): the Sonoma County(SC) DPS, the Santa Barbara (SB) DPS, and the Central California (CC) DPS. Each DPS is considered separately in the risk assessment as they occupy different geographic areas. The main difference in the assessment will be in the spatial analysis. The CTS-SB 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.
- **Delta Smelt (DS):** The DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007a). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater.
- **CA Clapper Rail (CCR):** The CCR was listed by the USFWS as an endangered species in 1970. The species is found only in California in coastal wetlands along the San Francisco estuary and Suisun Bay.
- **California Freshwater Shrimp (CFS):** The CFS was listed as endangered in 1988 by the USFWS. The CFS inhabits freshwater streams in Central California in the lower Russian River drainage and westward to the Pacific Ocean and coastal streams draining into Tomales Bay and southward into the San Pablo Bay.
- **San Francisco Garter Snake (SFGS):** 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.
- **Tidewater Goby (TG):** The TG was listed as endangered in 1994 by the USFWS. The range of the TG is limited to coastal brackish water habitats along the coast of California.

Table 2-8. Summary of Current Distribution, Habitat Requirements, and Life History Information for the Assessed Listed Species[1]

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)	Adult butterfly - 5 cm in length	Santa Clara and San Mateo Counties [Because the BCB distribution is considered a metapopulation, any site with appropriate habitat in the vicinity of its historic range (Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara counties) should be considered potentially occupied by the butterfly (USFWS 1998, p. II-177)].	1) Primary habitat – native grasslands on large serpentine outcrops; 2) Secondary habitat – 'islands' of smaller serpentine outcrops with native grassland; 3) Tertiary habitat – non-serpentine areas where larval food plants occur	Yes	Larvae hatch in March – May and grow to the 4th instar in about two weeks. The larvae enter into a period of dormancy (diapause) that lasts through the summer. The larvae resume activity with the start of the rainy season. Larvae pupate once they reach a weight of 300 - 500 milligrams. Adults emerge within 15 to 30 days depending on thermal conditions, feed on nectar, mate and lay eggs during a flight season that lasts 4 to 6 weeks from late February to early May	Obligate with dwarf plantain. Primary diet is dwarf plantain plants (may also feed on purple owl's-clover or exserted paintbrush if the dwarf plantains senesce before the larvae pupate). Adults feed on the nectar of a variety of plants found in association with serpentine grasslands
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	Males: 1.25–2.5 cm length Females: 1.9–2.5 cm length	Central Valley of California (from Shasta County to Fresno County in the San Joaquin Valley)	Completely dependent on its host plant, elderberry (*Sambucus species*), which is a common component of the remaining riparian	Yes	The larval stage may last 2 years living within the stems of an elderberry plant. Then larvae enter the pupal stage and transform into adults. Adults	Obligates with elderberry trees (*Sambucus* sp). Adults eat the elderberry foliage until about June when they mate. Upon hatching the

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
			forests and adjacent upland habitats of California's Central Valley		emerge and are active from March to June feeding and mating, when the elderberry produces flowers.	larvae tunnel into the tree where they will spend 1-2 years eating the interior wood which is their sole food source.
California Tiger Salamander (CTS) (*Ambystoma californiense*)	Adult 14.2-80.5 g[4]	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 the Central Coast Range (southern Santa Cruz, Monterey, northern San Luis Obispo, and portions of western San Benito, Fresno,	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, and worms

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
		and Kern Counties). CTS-SB are found in Santa Barbara County.				
Delta Smelt (DS) (*Hypomesus transpacificus*)	Up to 120 mm in length	Suisun Bay and the Sacramento-San Joaquin estuary (known as the Delta) near San Francisco Bay, CA	The species is adapted to living in fresh and brackish water. They typically occupy estuarine areas with salinities below 2 parts per thousand (although they have been found in areas up to 18ppt). They live along the freshwater edge of the mixing zone (saltwater-freshwater interface).	Yes	They spawn in fresh or slightly brackish water upstream of the mixing zone. Spawning season usually takes place from late March through mid-May, although it may occur from late winter (Dec.) to early summer (July-August). Eggs hatch in 9 – 14 days.	They primarily planktonic copepods, cladocerans, amphipods, and insect larvae. Larvae feed on phytoplankton; juveniles feed on zooplankton.
California Clapper Rail (CCR) (*Rallus longirostris obsoletus)*	250 - 350 g Juveniles ~50 g[3]	Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties	Tidal marsh habitat	No	<u>Breeding</u>: Feb. - August <u>Nesting:</u> mid-March-Aug. <u>Lay Eggs:</u> March - July <u>Incubation</u>: 23 to 29 days; Leave nest: 35 to 42 days after hatch; Juveniles fledge at ten weeks and can breed during the spring after they hatch	Opportunistic feeders: freshwater and estuarine invertebrates, seeds, worms, mussels, snails, clams, crabs, insects, and spiders; occasionally consume small birds and mammals, dead fish, up to 15% plant material
California Freshwater Shrimp	Up to 50 mm postorbital	Marin, Napa, and Sonoma Counties, CA	Freshwater, perennial streams; they	No	Breed once a year, typically in Sept. Eggs	Feed on detritus (algae, aquatic

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
(CFWS) (*Syncaris pacifica*)	length (from the eye orbit to tip of tail)		prefer quiet portions of tree-lined streams with underwater vegetation and exposed tree roots		adhere to the pleopods and are cared for for 8 – 9 months; embryos emerge during May or early June.	macrophyte fragments, zooplankton, and aufwuchs)
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
Tidewater Goby (TG) (*Eucyclogobius newberryi*)	50 mm in length	Along the coast in California (from 3 miles south of the CA/OR border to 44 miles north of the US/Mexico border –there are gaps in the geographic distribution where lagoons and/or estuaries are absent)	Coastal brackish water habitats, primarily coastal lagoons, estuaries, river mouths, and marshes. They are typically found in water less than 1 m deep with salinities of less than 12 parts per thousand.	Yes	They are typically an annual species. Spawning has been observed in every month of the year except Dec. Females may lay more than 1 clutch in a year. Eggs take from 9 to 11 days to hatch.	They are generalists that eat a wide variety of invertebrates [small benthic invertebrates, crustaceans, snails, mysids, and aquatic insect larvae). Juveniles probably feed on unicellular phytoplankton or zooplankton.

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

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

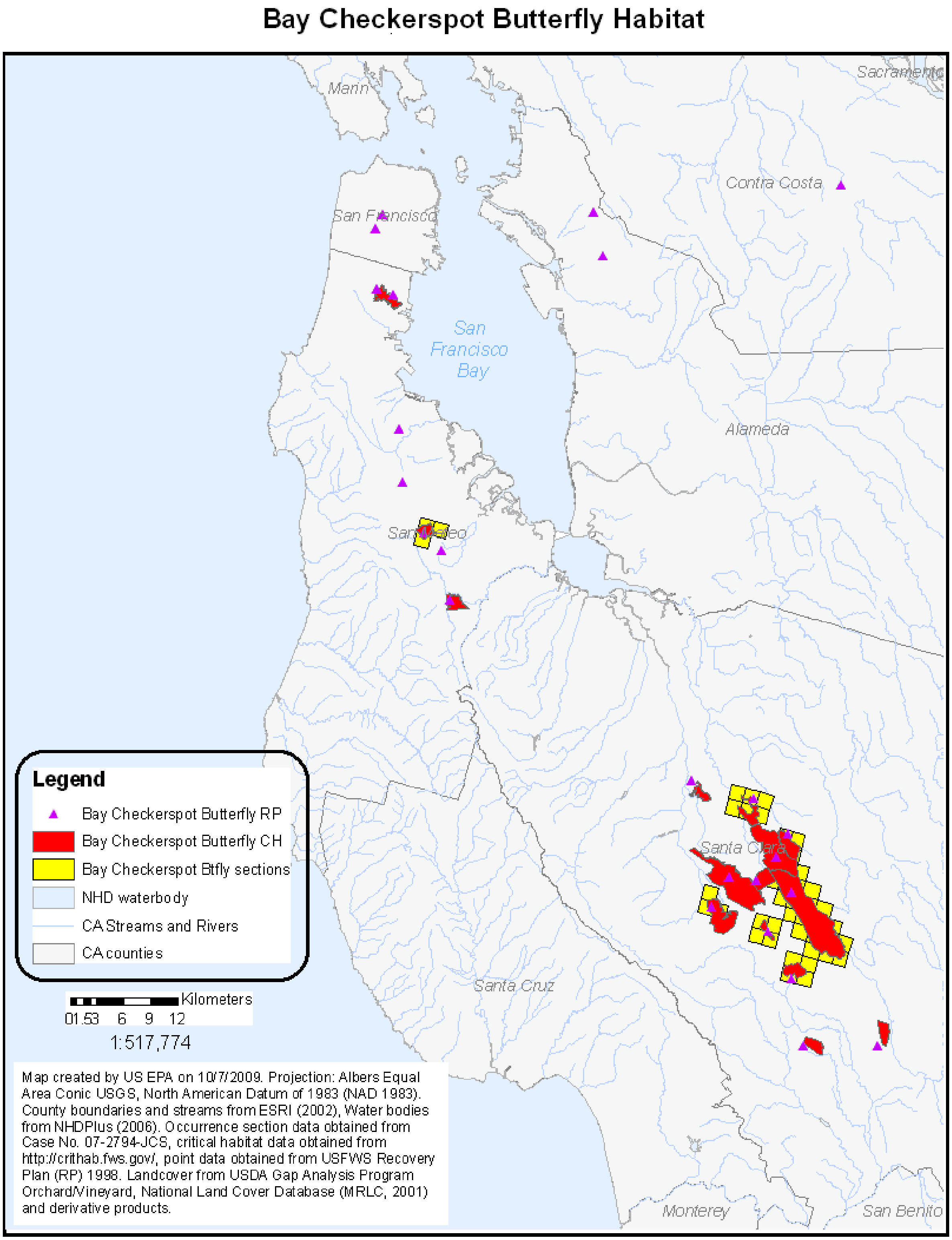

Figure 2-2. Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

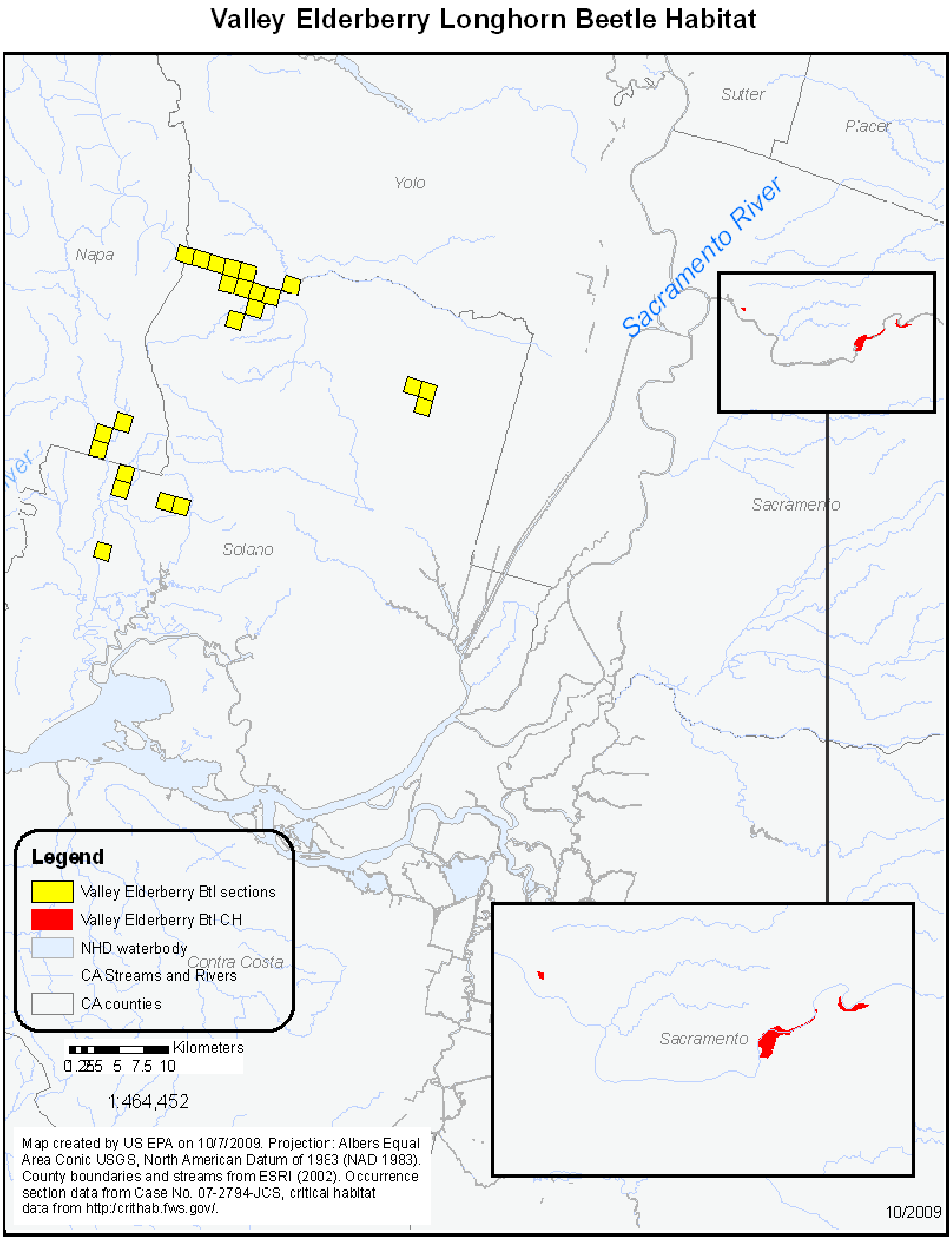

Figure 2-3. Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

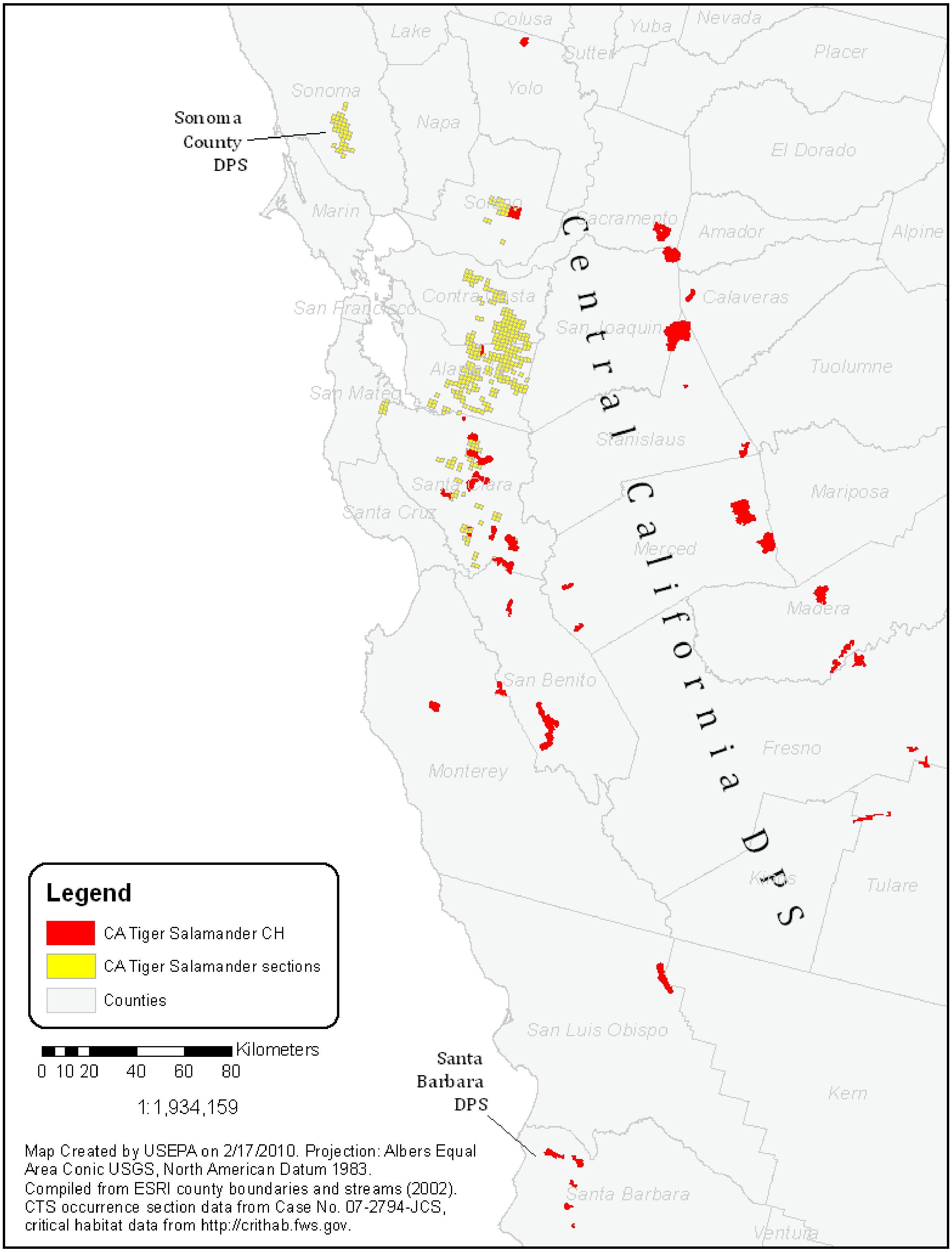

Figure 2-4. California Tiger Salamander (CTS) (*Ambystoma californiense*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

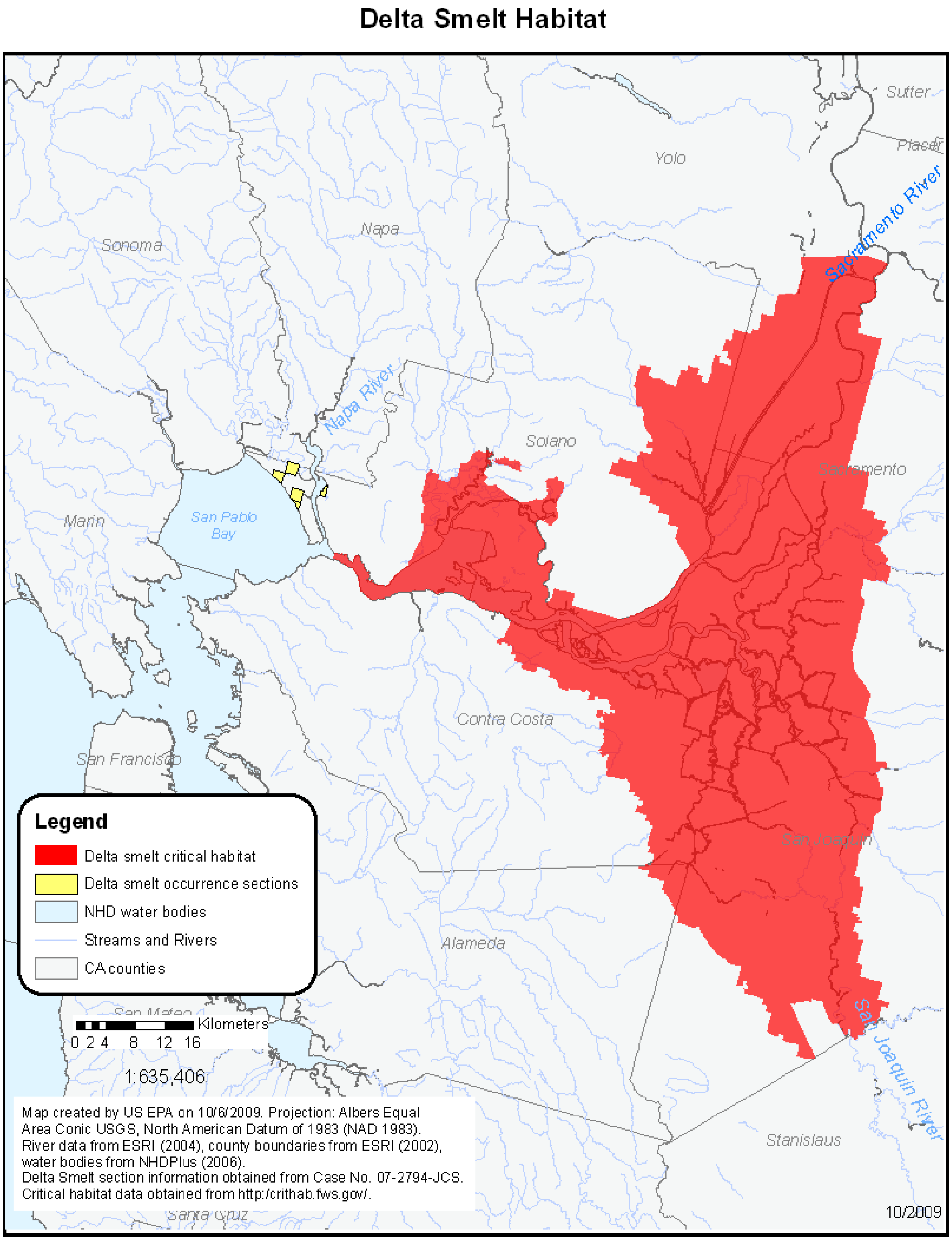

Figure 2-5. Delta Smelt (DS) (*Hypomesus transpacificus*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

California Clapper Rail Habitat

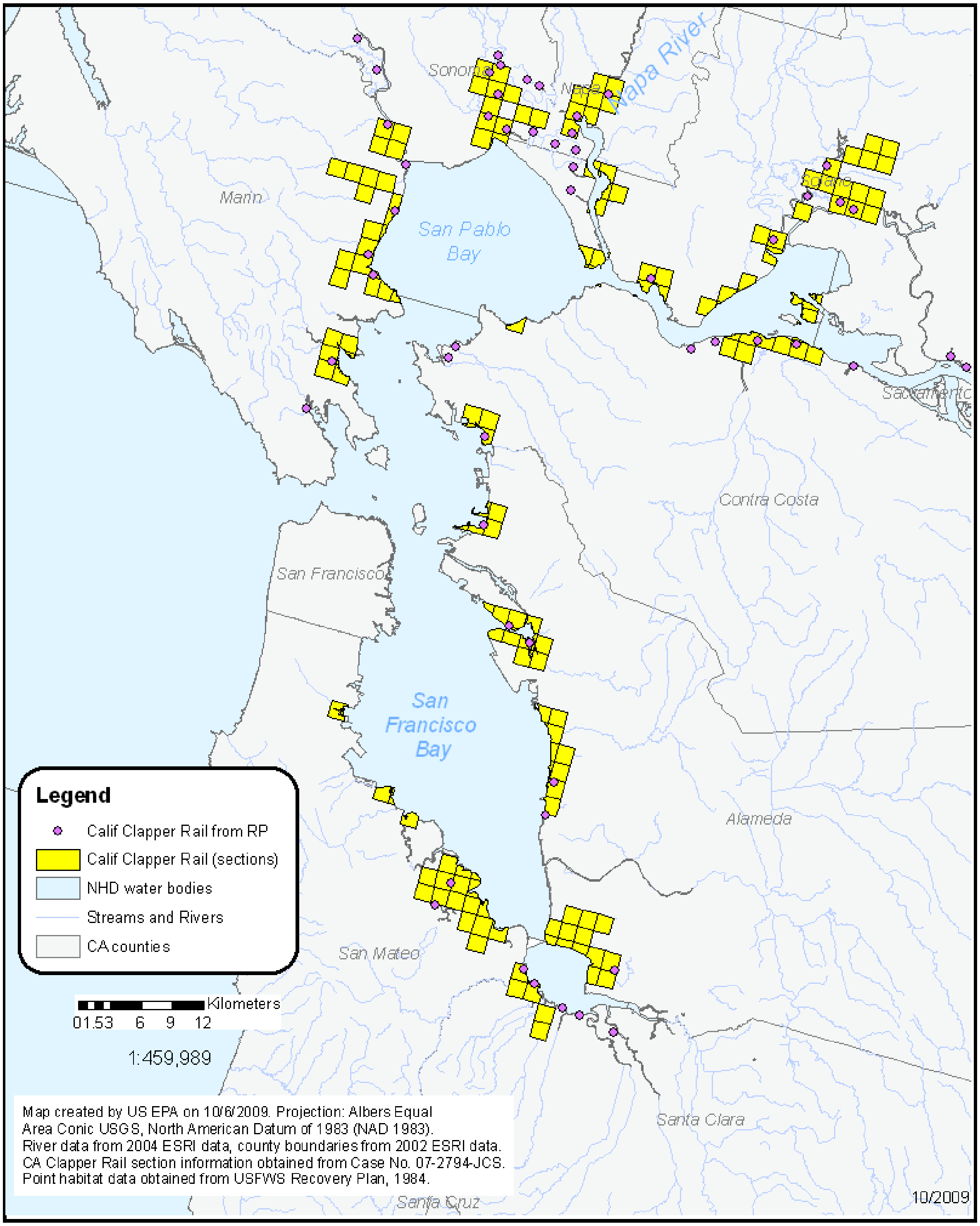

Figure 2-6. California Clapper Rail (CCR) (*Rallus longirostris obsoletus)* Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

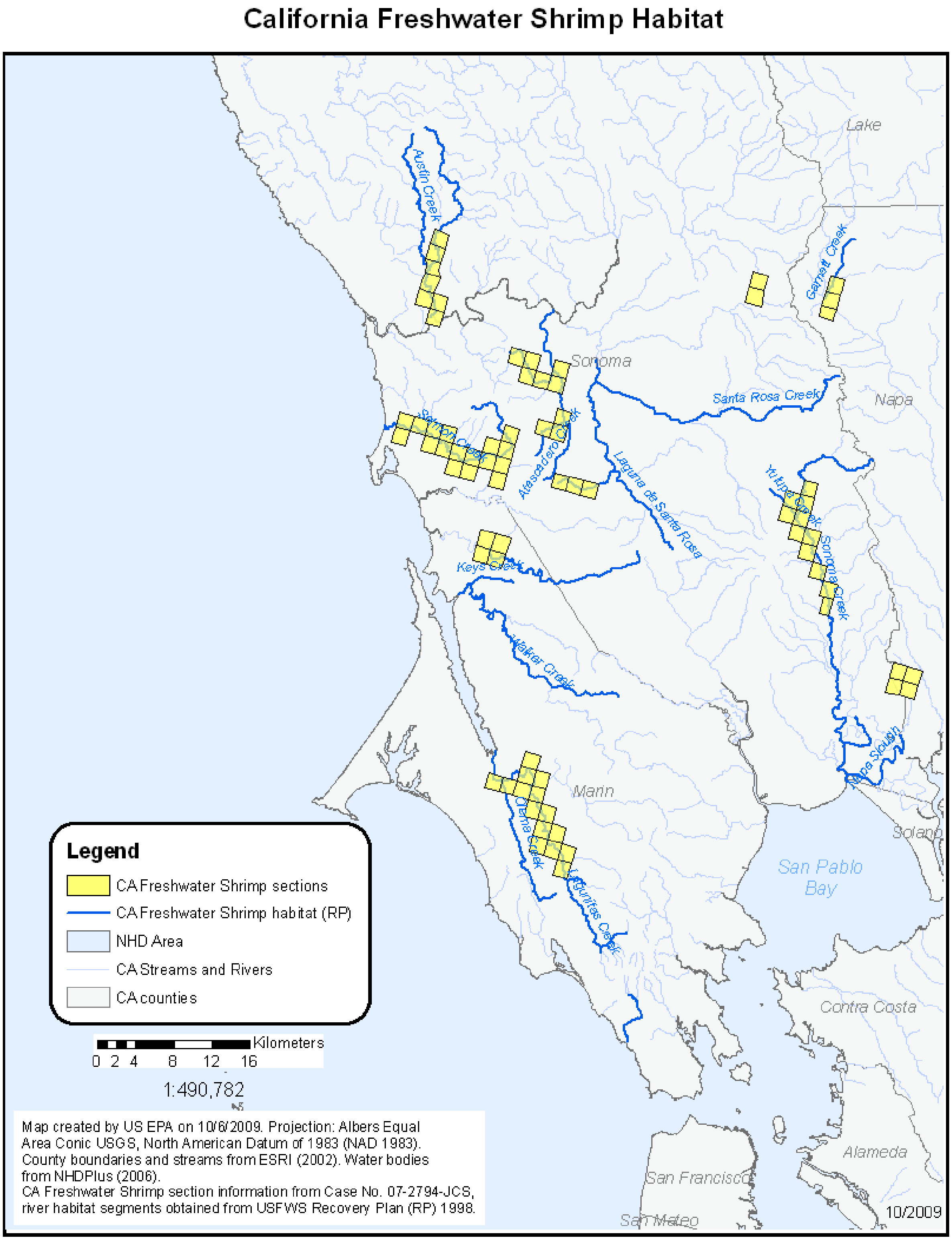

Figure 2-7. California Freshwater Shrimp (CFWS) (*Syncaris pacifica*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

SF Garter Snake Habitat

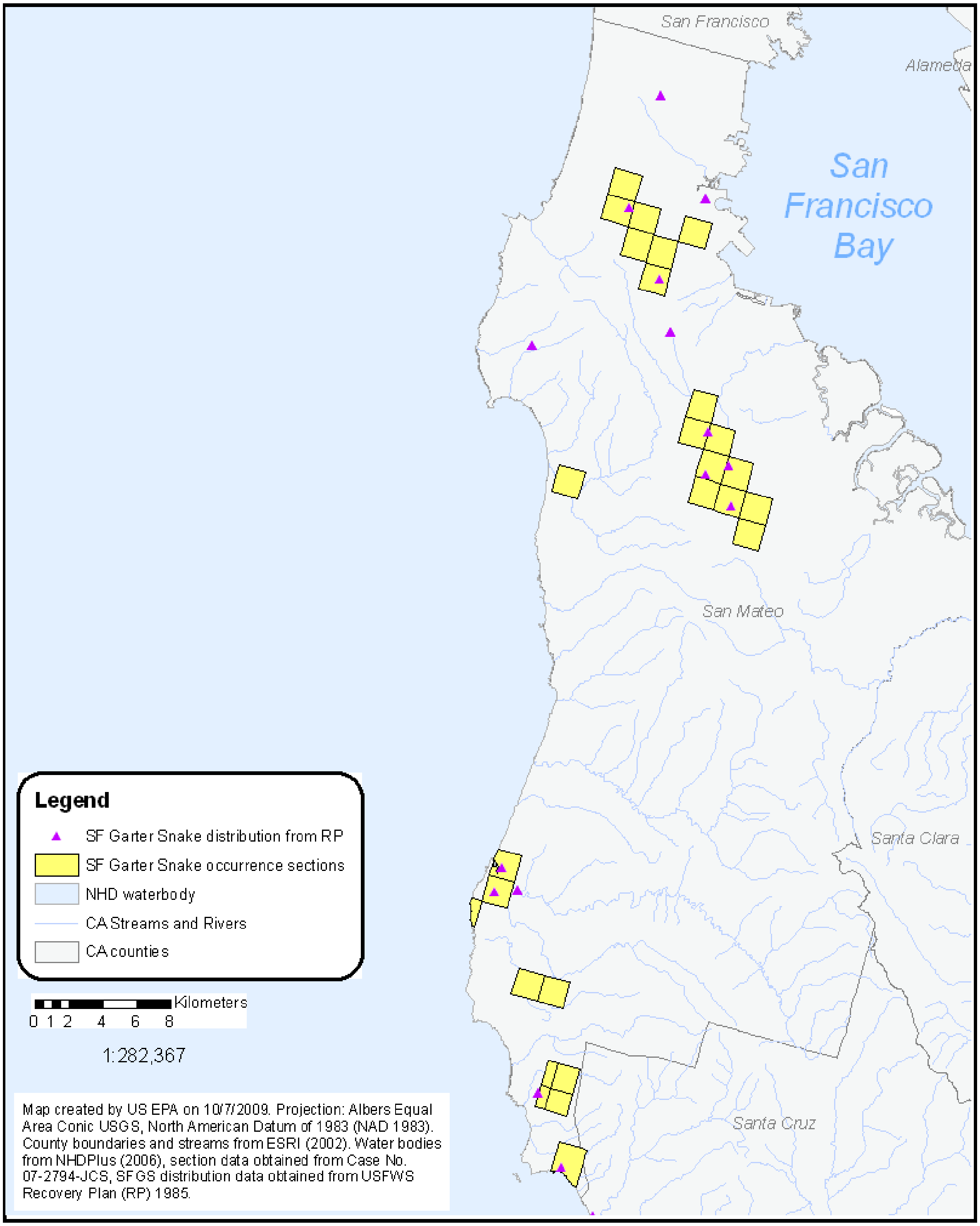

Figure 2-8. San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

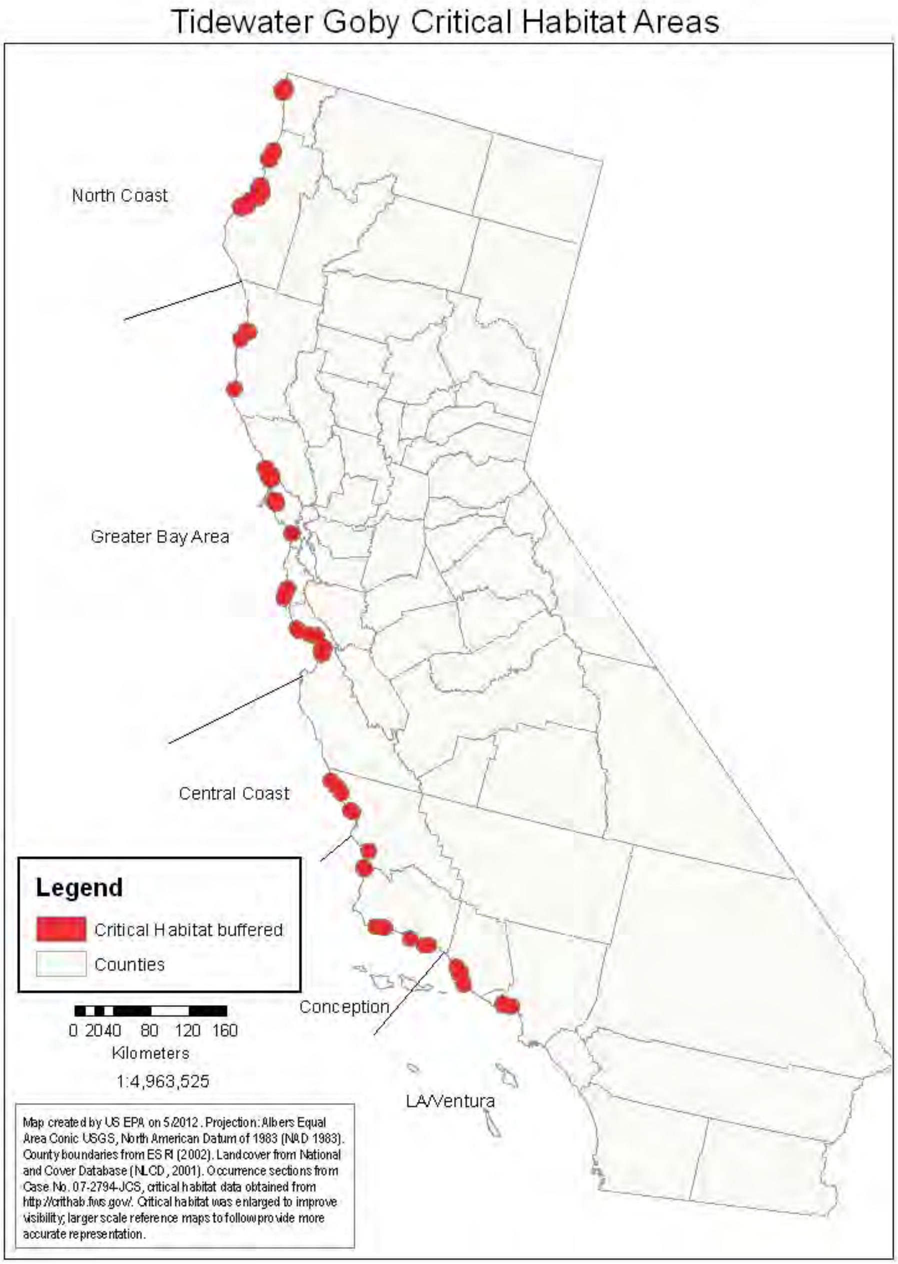

Figure 2-9. Tidewater Goby (TG) (*Eucyclogobius newberryi*) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS. The critical habitat and sections are exaggerated here by a buffer applied to the original habitat polygons. A series of larger scale maps are referenced in **Appendix L** which show the actual area of critical habitat and sections.

2.6. Designated Critical Habitat

Critical habitat has been designated for the BCB, VELB, CTS-CC DPS, DS, CTS-SB DPS, and TG. Risk to critical habitat is evaluated separately from risk to effects on the species. 'Critical habitat' is defined in the ESA as the geographic area occupied by the species at the time of the listing where the physical and biological features necessary for the conservation of the species exist, and there is a need for special management to protect the listed species. It may also include areas outside the occupied area at the time of listing if such areas are ‘essential to the conservation of the species. Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas that provide essential life cycle needs of the species or areas that contain certain primary constituent elements (PCEs) (as defined in 50 CFR 414.12(b)). **Table 2-9** describes the PCEs for the critical habitats designated for the BCB, VELB, CTS-CC DPS, DS, CTS-SB DPS, and TG.

Table 2-9. Designated Critical Habitat PCEs for the BCB, VELB, CTS-CC DPS, DS, CTS-SB DPS, and TG Species[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	
Valley Elderberry Longhorn Beetle	Areas that contain the host plant of this species [*i.e.*, elderberry trees (*Sambucus* sp.)] (a dicot)	43 FR 35636 35643, 1978
Bay Checkerspot Butterfly	The presence of annual or perennial grasslands with little to no overstory that provide north/south and east/west slopes with a tilt of more than 7 degrees for larval host plant survival during periods of atypical weather (*e.g.*, drought).	66 FR 21449 21489, 2001
	The presence of the primary larval host plant, dwarf plantain (*Plantago erecta*) (a dicot) and at least one of the secondary host plants, purple owl's-clover or exserted paintbrush, are required for reproduction, feeding, and larval development.	
	The presence of adult nectar sources for feeding.	
	Aquatic features such as wetlands, springs, seeps, streams, lakes, and ponds and their associated banks, that provide moisture during periods of spring drought; these features can be ephemeral, seasonal, or permanent.	
	Soils derived from serpentinite ultramafic rock (Montara, Climara, Henneke, Hentine, and Obispo soil series) or similar soils (Inks, Candlestick, Los Gatos, Fagan, and Barnabe soil series) that provide areas with fewer aggressive, nonnative plant species for larval host plant and adult nectar plant survival and reproduction.[2]	
	The presence of stable holes and cracks in the soil, and surface rock outcrops that provide shelter for the larval stage of the bay checkerspot butterfly during summer diapause.[2]	
Tidewater Goby	Persistent, shallow (in the range of about 0.1-2 m), still-to-slow-moving, aquatic habitat most commonly ranging in salinity from less	65 FR 69693 69717, 2000

Species	PCEs	Reference
	than 0.5 ppt to about 10-12 ppt, which provides adequate space for normal behavior and individual and population growth	
	Substrates (*e.g.*, sand, silt, mud) suitable for the construction of burrows for reproduction	
	Submerged and emergent aquatic vegetation, such as *Potamogeton pectinatus* and *Ruppia maritima*, that provides protection from predators	
	Presence of a sandbar(s) across the mouth of a lagoon or estuary during the late spring, summer, and fall that closes or partially closes the lagoon or estuary, thereby providing relatively stable water levels and salinity.	
Delta Smelt	Spawning Habitat—shallow, fresh or slightly brackish backwater sloughs and edgewaters to ensure egg hatching and larval viability. Spawning areas also must provide suitable water quality (*i.e.*, low "concentrations of pollutants) and substrates for egg attachment (*e.g.*, submerged tree roots and branches and emergent vegetation).	59 FR 65256 65279, 1994
	Larval and Juvenile Transport—Sacramento and San Joaquin Rivers and their tributary channels must be protected from physical disturbance and flow disruption. Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay. Suitable water quality must be provided so that maturation is not impaired by pollutant concentrations.	
	Rearing Habitat—Maintenance of the 2 ppt isohaline and suitable water quality (low concentrations of pollutants) within the Estuary is necessary to provide delta smelt larvae and juveniles a shallow protective, food-rich environment in which to mature to adulthood.	
	Adult Migration— Unrestricted access to suitable spawning habitat in a period that may extend from December to July. Adequate flow and suitable water quality may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their associated tributaries. These areas also should be protected from physical disturbance and flow disruption during migratory periods.	

[1] These PCEs are in addition to more general requirements for habitat areas that provide essential life cycle needs of the species such as, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing (or development) of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.
[2] PCEs that are abiotic, including, physical-chemical water quality parameters such as salinity, pH, and hardness are not evaluated.

More detail on the designated critical habitat applicable to this assessment can be found in Attachment II. Activities that may destroy or adversely modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the species. Evaluation of actions related to use of methomyl that may alter the PCEs of the designated critical habitat for BCB, VELB, CTS-CC DPS, DS, CTS-SB DPS, and TG 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 methomyl is expected to directly impact living organisms within the action area, critical habitat analysis for methomyl is limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes.

2.7. Action Area and LAA Effects Determination Area

2.7.1. Action Area

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

It is important to note that the state-wide action area does not imply that direct and/or indirect effects and/or critical habitat modification are expected to or are likely to occur over the full extent of the action area, but rather to identify all areas that may potentially be affected by the action. The Agency uses more rigorous analysis including consideration of available land cover data, toxicity data, and exposure information to determine areas where BCB, VELB, CTS, DS, CCR, CFS, SFGS, and TG and their 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 methomyl. An analysis of labeled uses and review of available product labels was completed. Labeled uses that are special local needs (SLN) uses not specified for use in California or restricted to specific states were excluded from this assessment. In addition, a distinction has been made between food use crops and those that are non-food/non-agricultural uses. For those uses relevant to the assessed species, the analysis indicates that, for methomyl, there is a multitude of agricultural, orchard, and non-agricultural uses that are considered as part of the federal action evaluated in this assessment. For a summary of uses, please see **Table 2-6**.

Following a determination of the assessed uses, an evaluation of the potential "footprint" of methomyl 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 methomyl, these land cover types include cultivated crops; developed high, low, medium intensity; developed open space; forest; open water; orchards; pasture/hay; and wetlands. Since there are a large number of uses covering a high number of land cover types, in this case, an initial area of concern map was not developed. Since the chemical may be used over a wide area, an initial area of concern map may under represent potential use.

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

The AgDRIFT model (Version 2.01) is used to define how far from the initial area of concern an effect to a given species may be expected via spray drift (*e.g.*, the drift distance). The spray drift analysis for methomyl uses the most sensitive endpoint for aquatic exposure, and terrestrial exposure. The terrestrial exposure spray drift analysis was further broken down into invertebrates versus non-invertebrates. The most sensitive endpoints for spray drift were: 5 µg a.i./L (acute, aquatic assessment), 0.7 µg a.i./L (chronic, aquatic assessment), 24.2 mg/kg-bw (acute non-invertebrate, terrestrial assessment), 75 mg/kg-bw (chronic non-invertebrate, terrestrial assessment), 0.16µg a.i./bee (acute invertebrate, terrestrial assessment). Further details on the spray drift analysis are provided in Section 5.2.11.a.

In addition to the buffered area from the spray drift analysis, the Potential Area of LAA Effects area also considers the downstream extent of methomyl that exceeds the LOC based on downstream dilution analysis (discussed in Section 5.2.11.b).

An evaluation of usage information was conducted to determine the area where use of methomyl may impact the assessed species. This analysis is used to characterize where predicted exposures are most likely to occur, but does not preclude use in other portions of the action area. A more detailed review of the county-level use information was also completed. These data suggest that methomyl has historically been used on a wide variety of agricultural and non-agricultural uses.

2.8. Assessment Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected."[6] Selection of the assessment endpoints is based on valued entities (*e.g.*, CTS, organisms important in the life cycle of the CTS, and the PCEs of its designated critical habitat), the ecosystems potentially at risk (*e.g*,. waterbodies, riparian vegetation, and upland and dispersal habitats), the migration pathways of methomyl (*e.g*., runoff, spray drift, *etc*.), and the routes by which ecological receptors are exposed to methomyl-related contamination (*e.g*., direct contact, *etc*.).

2.8.1. Assessment Endpoints

A complete discussion of all the toxicity data available for this risk assessment, including resulting measures of ecological effect selected for each taxonomic group of concern, is included in Section 4 of this document. **Table 2-10** identifies the taxa used to assess the potential for direct and indirect effects from the uses of methomyl for each listed species assessed here. The specific assessment endpoints used to assess the potential for direct and indirect effects to each listed species are provided in **Table 2-11**.

Table 2-10. Taxa Used in the Analyses of Direct and Indirect Effects for the Assessed Listed Species.

Listed Species	Birds	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Estuarine /Marine Fish	Estuarine /Marine Inverts.	Aquatic Plants
San Francisco garter snake**	Direct/ Indirect (prey) Acute/ Chronic: Bobwhite quail	Indirect (prey/ habitat) Acute/ Chronic: Lab rat	Indirect (habitat) No data available	Indirect (prey) Acute only: Honey bee	Indirect (prey) Acute: Channel catfish Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	n/a	n/a	Indirect (habitat) Open lit and other carbamate data available
California clapper rail**	Direct/ Indirect (prey) Acute/ Chronic: Bobwhite quail	Indirect (prey) Acute/ Chronic: Lab rat	Indirect (food/ habitat) No data available	Indirect (prey) Acute only: Honey bee	Indirect (prey) Acute: Channel catfish Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	Indirect (prey) Acute/ Chronic: Sheepshead minnow	Indirect (prey) Acute/ Chronic: Northern pink shrimp	Indirect (food/ habitat) Open lit and other carbamate data available
Bay checkerspot butterfly	n/a	n/a	Indirect (food/ habitat)* No data available	Direct Acute only: Honey bee	n/a	n/a	n/a	n/a	n/a

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

Listed Species	Birds	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Estuarine /Marine Fish	Estuarine /Marine Inverts.	Aquatic Plants
Valley elderberry longhorn beetle	n/a	n/a	Indirect(food/ habitat)* No data available	Direct Acute only: Honey bee	n/a	n/a	n/a	n/a	n/a
California tiger salamander	Direct/ Indirect Acute/ Chronic: Bobwhite quail	Indirect (prey/ habitat) Acute/ Chronic: Lab rat	Indirect (habitat) No data available	Indirect (prey) Acute only: Honey bee	Direct / Indirect (prey) Acute: Channel catfish Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	n/a	Indirect (prey) Acute/ Chronic: Northern pink shrimp	Indirect (food/ habitat) Open lit and other carbamate data available
Tidewater goby	n/a	n/a	Indirect (habitat) No data available	n/a	Direct*** Acute: Channel catfish Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	Direct*** Acute/ Chronic: Sheepshead minnow	Indirect (prey) Acute/ Chronic: Northern pink shrimp	Indirect (habitat) Open lit and other carbamate data available
Delta smelt	n/a	n/a	Indirect (habitat) No data available	n/a	Direct*** Acute: Channel catfish Chronic: Fathead minnow	Indirect (prey) Acute/ Chronic: Waterflea	Direct*** Acute/ Chronic: Sheepshead minnow	Indirect (prey) Acute/ Chronic: Northern pink shrimp	Indirect (food/ habitat) Open lit and other carbamate data available
California freshwater shrimp	n/a	n/a	Indirect (food/ habitat) No data available	n/a	n/a	Direct/ Indirect (prey) Acute/ Chronic: Waterflea	n/a	Direct Acute/ Chronic: Northern pink shrimp	Indirect (food/ habitat) Open lit and other carbamate data available

Abbreviations: n/a = Not applicable; Terr. = Terrestrial; Invert. = Invertebrate; FW = Freshwater
* obligate relationship
** Consumption of residues of methomyl in aquatic organisms may result in direct effects to the San Francisco Garter Snake and the Clapper Rail.
***The most sensitive fish species across freshwater and estuarine/marine environments is used to assess effects for these species because they may be found in freshwater or estuarine/marine environments. Note, however, that both sets of RQs were calculated, one for the freshwater and the other for the estuarine/marine environment.

Table 2-11. Taxa and Assessment Endpoints Used to Evaluate the Potential for Use of Methomyl to Result in Direct and Indirect Effects to the Assessed Listed Species or Modification of Critical Habitat.

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
1. Freshwater Fish and Aquatic-Phase Amphibians	Direct Effect – -Tidewater Goby* -Delta Smelt* -California Tiger Salamander	Survival, growth, and reproduction of individuals via direct effects	1a. Most sensitive fish acute 96-hr LC_{50} (0.32 mg a.i./L) for channel catfish (*Ictalurus punctatus*, MRID 40098001) 1b. Most sensitive fish chronic NOAEC (0.012 mg a.i./L) for channel catfish (*I. punctatus*, based on an ACR calculation) 1c. Most sensitive fish early-life stage NOAEC (0.057 mg/L, based on larval survival) for fathead minnow (*Pimephales promelas,* MRID 00131255). A fish life cycle test NOAEC (0.076 mg/L, based on growth) for fathead minnow (*P. promelas*, MRID 43072101).
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail -[CA Tiger Salamander?]	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS) via indirect effects on aquatic prey food supply (*i.e.,* fish and aquatic-phase amphibians)	
2. Freshwater Invertebrates	Direct Effect – -CA FW Shrimp	Survival, growth, and reproduction of individuals via direct effects	2a. Most sensitive freshwater invertebrate 48-hr EC_{50} (0.005 mg a.i./L) for waterflea (*Daphnia magna*, MRID 40098001). 2b. Most sensitive freshwater invertebrate chronic NOAEC (0.0007 mg a.i./L) for waterflea (*D. magna*, MRID 1312541)
	Indirect Effect (prey) -CA FW shrimp -SF Garter Snake -CA Clapper Rail - CA Tiger Salamander -Tidewater Goby -Delta Smelt	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS, TG, and DS) via indirect effects on aquatic prey food supply (*i.e.*, freshwater invertebrates)	
3. Estuarine/Marine Fish	Direct Effect – -Tidewater Goby* - Delta Smelt*	Survival, growth, and reproduction of individuals via direct effects	3a. Most sensitive estuarine/marine fish 96-hr LC_{50} (1.16 mg a.i./L) for sheepshead minnow (*Cyprinodon variegatus*, MRID 41441202) 3b. Most sensitive estuarine/marine fish chronic NOAEC (0.260 mg a.i./L) for sheepshead minnow (*C. variegatus*, MRID 45013202) 3c. Most sensitive estuarine/marine fish early-life stage NOAEC (0.26 mg a.i./L, for total length and wet weight) for sheepshead minnow (*C. variegatus*, MRID 45013202)
	Indirect Effect (prey) -CA Clapper Rail	Survival, growth, and reproduction of individuals via indirect effects on aquatic prey food supply (*i.e.,* estuarine/marine fish)	
4. Estuarine/Marine Invertebrates	Indirect Effect (prey) -CA Clapper Rail -Tidewater Goby -Delta Smelt	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (TG and DS) via indirect effects on	4a. Most sensitive estuarine/marine invertebrate 96-hr LC_{50} (0.019 mg a.i./L) for northern pink shrimp (*Penaeus duorarum*, MRID 00009134) 4b. Most sensitive estuarine/marine

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
		aquatic prey food supply (*i.e.*, estuarine/marine invertebrates)	invertebrate chronic NOAEC (0.0024 mg a.i./L) for northern pink shrimp (*P. duorarum*, based on an ACR calculation)
5. Aquatic Plants (freshwater/marine)	<u>Indirect Effect (food/habitat)</u> -SF Garter Snake (fw) -CA Clapper Rail (fw) -CA Tiger Salamander (fw) -Tidewater Goby (fw/em) -Delta Smelt (fw/em) -CA FW Shrimp (fw)	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS, TG, DS) via indirect effects on habitat, cover, food supply, and/or primary productivity (*i.e.*, aquatic plant community)	5a. Vascular plant acute EC_{50} data not available for methomyl; toxicity data available from other carbamates 5b. Non-vascular plant acute EC_{50} (108-184 mg a.i./L) for *Pseudokirchneriella subcapitata* (a microalgae) from the open literature (Record # 118717, Pereira *et al.* 2009), but endpoints are for qualitative use only. Toxicity data available from other carbamates.
6. Birds	<u>Direct Effect</u> -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals via direct effects	6a. Most sensitive bird[**] or terrestrial-phase amphibian acute LC_{50} (1,100 mg/kg-diet, MRID 00022923) or LD_{50} (24.2 mg/kg-bw, MRID 00161886) for bobwhite quail (*Colinus virginianus*) 6b. Most sensitive bird[**] or terrestrial-phase amphibian chronic NOAEC (150 mg/kg-diet) for bobwhite quail (*C. virginianus*, MRID 41898602)
	<u>Indirect Effect (prey/rearing sites)</u> -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS) via indirect effects on terrestrial prey (birds)	
7. Mammals	<u>Direct Effect</u> None.	Survival, growth, and reproduction of individuals via direct effects	7a. Most sensitive laboratory mammalian acute LC_{50} or LD_{50} (30 mg a.i./kg-bw) for the laboratory rat (*Rattus norvegicus*, MRID 42140101) 7b. Most sensitive laboratory mammalian chronic NOAEL (75 mg a.i./kg-diet or 3.75 mg a.i./kg/day) for the laboratory rat (*R. norvegicus*, MRIDs 43250701, 43769401)
	<u>Indirect Effect (prey/habitat from burrows/rearing sites)</u> -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS) via indirect effects on terrestrial prey (mammals) and/or burrows/rearing sites	
8. Terrestrial Invertebrates	<u>Direct Effect</u> -Bay Checkerspot Butterfly -Valley elderberry longhorn beetle	Survival, growth, and reproduction of individuals via direct effects	8a. Most sensitive terrestrial invertebrate acute contact LD_{50} (0.16 μg a.i./bee) for the honey bee (*Apis mellifera*, MRID 45093001); in the same study an acute oral LD_{50} was determined to be 0.28 μg a.i./bee 8b. Most sensitive terrestrial invertebrate chronic NOAEC not available
	<u>Indirect Effect (prey)</u> -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS) via indirect effects on terrestrial prey (terrestrial invertebrates)	
9. Terrestrial Plants	<u>Indirect Effect</u>	Survival, growth, and	9a. Distribution of EC_{25} for monocots

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
	(food/habitat) (non-obligate relationship) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander -Tidewater Goby -Delta Smelt -CA Freshwater Shrimp	reproduction of individuals or modification of critical habitat/habitat (CTS-SB DPS, TG, DS, BCB, VELB) via indirect effects on food and habitat (*i.e.,* riparian and upland vegetation)	not available 9b. Distribution of EC_{25} (EC_{05} or NOAEC for the BCB and the VELB) for dicots not available
	Indirect Effect (food/habitat) (obligate relationship) -Bay Checkerspot Butterfly -Valley Elderberry Longhorn Beetle		

Abbreviations: SF=San Francisco
*The most sensitive fish species across freshwater and estuarine/marine environments is used to assess effects for these species because they may be found in freshwater or estuarine/marine environments.
** Birds are used as a surrogate for terrestrial-phase amphibians and reptiles.

Methomyl has registered products containing multiple active ingredients. The only methomyl products that contain multiple active ingredients involve the scatter bait/bait station uses (*i.e.*, STIMUKIL® FLY BAIT, LURECTRON® SCATTERBAIT, GOLDEN MALRIN® RF-128 FLY KILLER). As noted in **APPENDIX A**, of the formulated products, two products (EPA Reg. No. 2724-274 and 53871-3) have an LD_{50} value and associated confidence intervals. When these product LD_{50}s and associated confidence intervals are adjusted for the percent methomyl (1.1 and 1%, respectively) the adjusted LD_{50} value of 34.2 mg a.i./kg-bw (CI range of 27.8 to 42 mg a.i./kg, MRID 41950001 for the Golden Marlin formulation with EPA Reg. No. 2724-274) is not statistically distinct from the female rat 14-day LD_{50} of methomyl (30 mg a.i./kg-bw; CI range of 23 - 40 mg a.i./kg, MRID 42140101); however, the LD_{50} value of 14 mg a.i./kg-bw (CI range of 11.7-16.8 mg a.i./kg, MRID 44933202 for the Stimukil fly bait with EPA Reg. No. 53871-3) suggests that the formulation is more toxic than the active ingredient alone. Thus, it is reasonable to conclude that an assumption of dose-addition would be appropriate. As a result, the scatter bait use is assessed for the terrestrial environment using the Stimukil fly bait formulation label and formulation-based rat laboratory data.

The remaining methomyl formulations only contain a single active ingredient (*i.e.*, methomyl). Available toxicity data for aquatic freshwater animals did not show any significant differences between formulated commercial products and the technical active ingredient. For species in which comparative data are available, the confidence intervals of the toxicity endpoints for freshwater fish and invertebrates exposed to the TGAI and formulated methomyl overlap, indicating that the toxicity of methomyl TGAI and formulated methomyl are very similar, if not the same, for freshwater animals (see **APPENDIX J**). Toxicity data for birds are only available for the TGAI. For terrestrial invertebrates (as of the CRLF 2007 assessment) there were not enough comparative data to determine the relative toxicity between the TGAI and formulated methomyl. Since methomyl is the only active ingredient in the formulated products tested, and the primary route of exposure for terrestrial invertebrates is expected to be deposition via spray drift, toxicity data from both the TGAI and formulated methomyl products (from products similar to those currently registered) are appropriate for assessing potential acute risks to terrestrial invertebrates. As a result, the risk analyses were conducted using the most sensitive endpoint determined from toxicity studies using either formulated commercial products, corrected for active ingredient, or technical active ingredient.

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

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

2.9. Conceptual Model

2.9.1. Risk Hypotheses

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

The labeled use of methomyl within the action area may:

- directly affect SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and/or modify their designated critical habitat by reducing or changing the composition of food supply;

- indirectly affect SFGS, CCR, CTS, DS, CFS, and TG and/or modify their designated critical habitat by reducing or changing the composition of the aquatic plant community in the species' current range, thus affecting primary productivity and/or cover;
- indirectly affect SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and/or modify their designated critical habitat by reducing or changing the composition of the terrestrial plant community in the species' current range;
- indirectly affect SFGS, CCR, CTS, DS, CFS, and TG and/or modify their designated critical habitat by reducing or changing aquatic habitat in their current range (via modification of water quality parameters, habitat morphology, and/or sedimentation);
- indirectly affect CTS 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 methomyl release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for BCB, VELB, CTS, DS, CCR, CFS, SFGS, and TG species and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in **Figure 2-10** and **Figure 2-11** . Although the conceptual models for direct/indirect effects and modification of designated critical habitat PCEs are shown on the same diagrams, the potential for direct/indirect effects and modification of PCEs will be evaluated separately in this assessment. Exposure routes shown in dashed lines are not quantitatively considered because the contribution of those potential exposure routes to potential risks to BCB, VELB, CTS, DS, CCR, CFS, SFGS, and TG and modification to designated critical habitat is expected to be negligible.

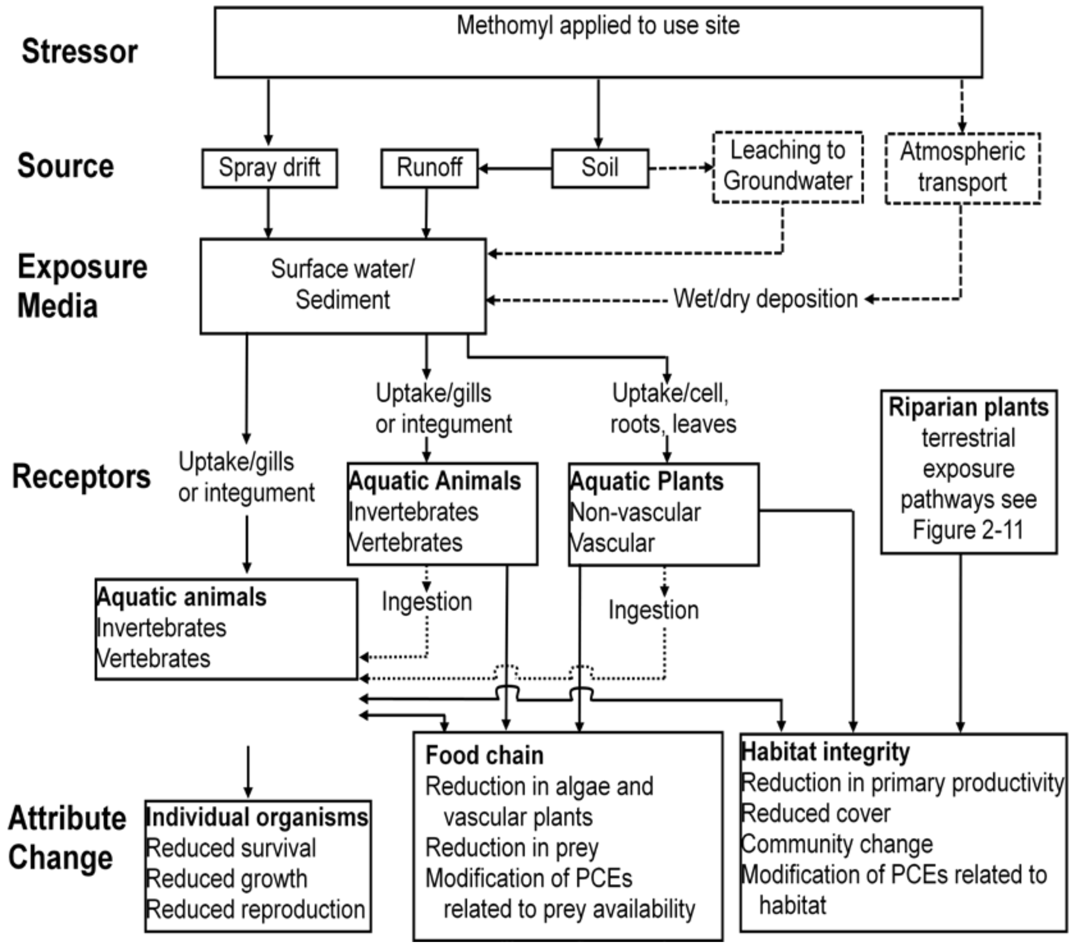

Figure 2-10. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Aquatic Organisms from the Use of Methomyl.
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

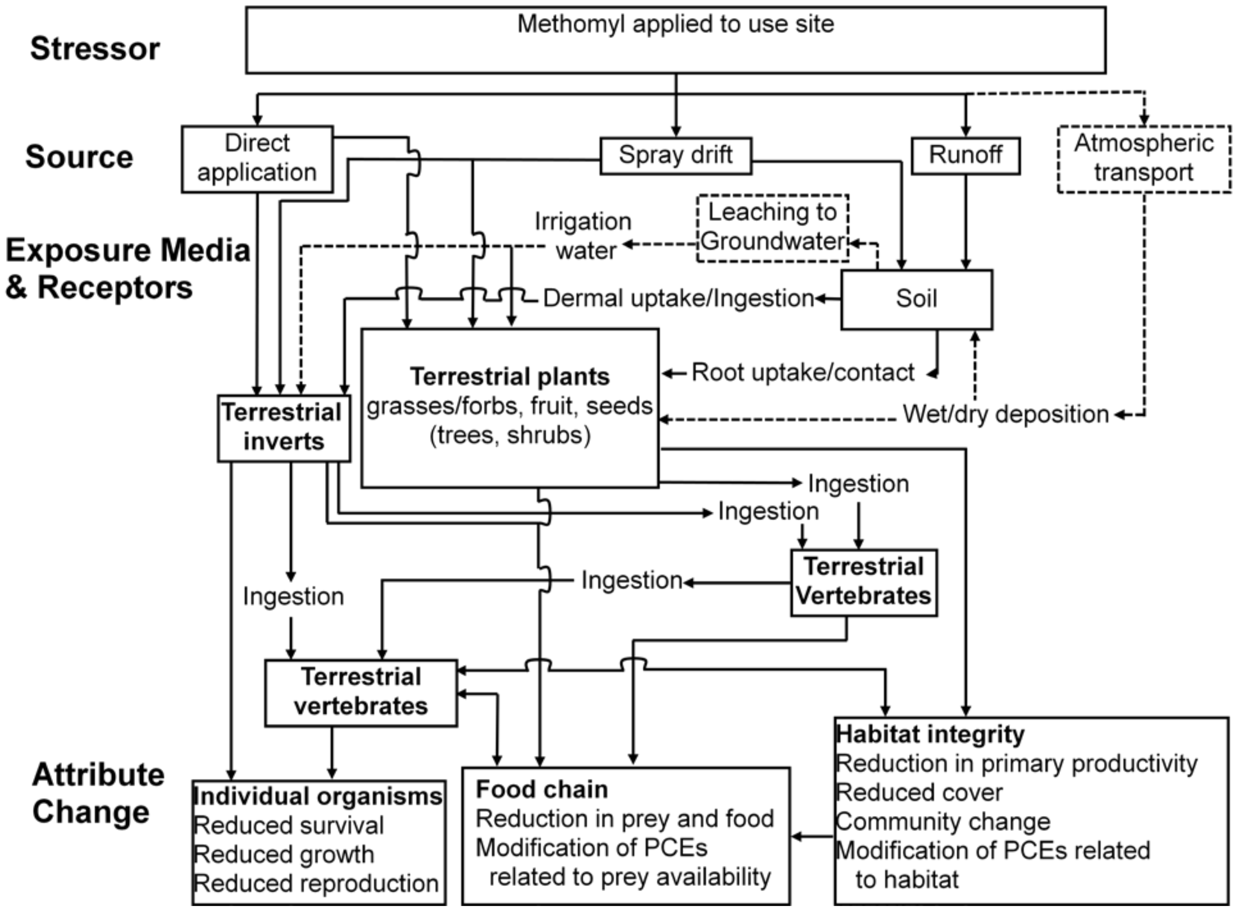

Figure 2-11. Conceptual model depicting stressors, exposure pathways, and potential effects to terrestrial organisms from the use of methomyl.
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

2.10. Analysis Plan

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

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

2.10.1. Measures of Exposure

The environmental fate properties of methomyl along with available monitoring data indicate that water and sediment runoff and spray drift are the principle potential transport mechanisms of methomyl to the aquatic and terrestrial habitats. Methomyl has the potential to persist in pH's 7 and below.

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

2.10.1.a. Estimating Exposure in the Aquatic Environment

The measure of exposure for aquatic species is the estimated environmental concentration (EEC) expected once every ten years based on 30 years of simulations. The 1-in-10 year peak concentration is used for estimating acute effects to aquatic vertebrate and invertebrate species; the 1-in-10 year 21-day mean concentration is used for assessing aquatic invertebrate chronic exposure; and the1-in-10 year 60-day mean concentration is used for assessing chronic exposure for fish (and aquatic-phase amphibians).

2.10.1.b. Estimating Exposure in the Terrestrial Environment

For the foliar uses, the terrestrial measure of exposure for vertebrate and invertebrate animals is based on the upper bound concentration of residues normalized for application rates on various dietary items. For the granular uses on corn whorls, the exposures for terrestrial vertebrates are based on the LD_{50}/ft^2 values.

2.10.2. Measures of Effect

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

2.10.3. Integration of Exposure and Effects

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

2.10.4. Data Gaps

The studies submitted to fulfill environmental fate data requirements for methomyl are not sufficient for exposure assessment. The submitted aqueous photolysis studies either have poor material balances or did not analyze for transformation products of methomyl. The submitted aerobic aquatic metabolism (MRID 43325401) and anaerobic aquatic metabolism (MRID 73214) studies have poor material balances, and therefore, do not describe the fate of methomyl in surface water bodies down gradient from terrestrial use sites. Also, since there isn't any anaerobic aquatic metabolism data, two times the anaerobic soil metabolism data is used for modeling. This is believed to be a conservative approach; however, it is an uncertainty without the actual data.

The studies submitted to fulfill environmental effects data requirements for methomyl are also not sufficient. Although many submissions have been made to provide data on the effects of methomyl to aquatic and terrestrial organisms, data gaps still exist. Data gaps include the following: avian acute oral toxicity (850.2100), avian reproduction (850.2300), terrestrial plant (850.4100, 850.4150), and aquatic plant (850.5400, 850.4400) toxicity studies. The specific data gaps are described in full in Registration Review Preliminary Problem Formulation for Methomyl (DP Barcode 374952, 2010). An update of this data since the problem formulation is that the registrant (E.I. DuPont de Nemours and Company, Inc.) requested a data waiver (MRID 48736202, DuPont project ID: 34679) for an avian (passerine) acute oral toxicity study (850.2100), which was identified as an additional data need in support of registration review of 2010. After carefully reviewing the registrant's waiver request, EFED still identifies the avian acute oral toxicity study with passerines as a critical data gap (see Response to Waiver Request memo, DP Barcode 400766, May 16, 2012).

3. Exposure Assessment

Methomyl is formulated as mainly soluble concentrates, but also includes granular, pelleted/tableted, and bait/solid formulations. Application methods for the agricultural uses of methomyl include aircraft (fixed-wing and helicopter), high and low volume ground sprayer, ultra low volume sprayer, and granule application. Risks from ground boom and aerial applications are considered in this assessment because they are expected to result in the highest off-target levels of methomyl due to generally higher spray drift levels. Ground boom and aerial modes of application tend to use lower volumes of application applied in finer sprays than applications coincident with sprayers and spreaders and thus have a higher potential for off-target movement via spray drift. Runoff associated with large rainfall events is expected to be responsible for the greatest off-target movement of methomyl.

3.1. Label Application Rates and Intervals

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

Currently, there are refinements being discussed for the methomyl registration which may lead to proposed mitigation measures. Due to the fact these are still under review, the influence of any changes are not being included in this effects determination.

Currently registered agricultural and non-agricultural uses of methomyl within California include a multitude of agricultural and non-agricultural uses. Please see Section 2.4.3 for a full list of uses. The uses being assessed are summarized in **Table 3-1**. The uses modeled below encompass the range of uses; the highest, median, and lowest application rates; and the uses where methomyl is applied the most based on information provided by BEAD.

Table 3-1. Methomyl Uses, Scenarios, and Application Information

Uses Represented by Scenario	Scenario	Application Method/ Formulation	Application Rate	Maximum Number of Applications	Application Interval	Date of First Application
Alfalfa	CAalfalfa_WirrigOP	Aerial/ soluble concentrate	0.9	4*	5	28-Dec
Avocado	CAAvocadoRLF_V2	Aerial/ soluble concentrate	0.9	1	NA	21-Nov
Cabbage (encompasses cauliflower, Chinese broccoli, Chinese cabbage, collards, leafy green vegetables, Broccoli, Broccoli raab, Brussels sprouts)	CAColeCropRLF_V2	Aerial/ soluble concentrate	0.9	8*	2	22-Feb
Celery (encompasses endive/escarole, leafy green vegetables, lettuce, spinach)	CA lettuce STD	Aerial/ soluble concentrate	0.9	8*	5	1-Apr

Uses Represented by Scenario	Scenario	Application Method/ Formulation	Application Rate	Maximum Number of Applications	Application Interval	Date of First Application
Corn[2] (encompasses barley, oats, rye, sorghum, wheat)	CAcornOP	Aerial/ soluble concentrate	0.45	14 (due to max lbs a.i./year when divided by max rate.)	1	27-Jul
Corn [2]	CAcornOP	Aerial/ soluble concentrate	0.24	26 (Can apply at a lower rate 28 times -26 is all PRZM/EXAMS can handle)	1	27-Jul
mint	CARowCropRLF_V2	Aerial/ soluble concentrate	0.9	5*	5	1-Apr
onions (encompasses Garlic)	CAonion_WirrigSTD	Aerial/ soluble concentrate	0.9	6*	5	1-Jun
Scatter bait	CA residential/impervious	Ground/ granular	0.22	26 (label doesn't specify how many apps are allowed, this is max PRZM/EXAMs can handle)	5	1-Jan
Sorghum * lowest methomyl use rate	CAcornOP	Aerial/ soluble concentrate	0.45	2	5	27-Jul
Turf - sod farms only (encompasses bermuda grass)	CATurfRLF	Aerial/ soluble concentrate	0.9	4	5	2-Jan

1 Uses assessed based on memorandum from Pesticide Re-evaluation Division (PRD) dated May 31, 2012 and EFED Label Data report and associated Label Use Information Reports prepared on April 13, 2012.
2: Corn was run twice to show if EECs generated would be higher applying methomyl at the maximum number of times allowed on the label at a lower rate in order to not exceed the yearly maximum, or apply methomyl at the maximum application rate with fewer applications to not exceed the yearly maximum application rate.
*It was found from running corn as explained in footnote 2, that running the crops at the maximum application rate fewer times than allowed on the label in order to not exceed the yearly maximum application rate resulted in higher EECs. As a result, the crops with the * after the maximum number of applications denotes crops run with fewer applications in order to not exceed the yearly rate.
**Grouping crops results in some crops receiving a more conservative EEC.

a. Cole Crops – Chinese cabbage, collards and broccoli Raab RTI=5 days, brussels sprouts max rate 5.4 lbs ai/A/yr.
b. Lettuce – endive max rate 4.5 lbs ai/A/yr. Head Lettuce RTI = 2 days.
c. Corn – sweet corn has RTI of 1 day, while others have RTI of 5 days. Barley, oats, rye, and wheat max rate is 1.8 lb/A/yr. Remove sorghum (covered in Table later).
d. Row crop for mint – modeled 5 apps at 0.9 lbs ai/A, or 4.5 lbs ai/A/yr. Table 2-6 indicates that for mint you would expect a max of 3.6 lbs ai/A/yr.
e. Onions – garlic has a max rate of 0.45 lbs ai/A w/ a total annual of 2.7 lbs ai/A/yr.

3.2. Aquatic Exposure Assessment

3.2.1. Modeling Approach

The EECs (Estimated Environmental Concentrations) are calculated using the EPA Tier II PRZM (Pesticide Root Zone Model) and EXAMS (Exposure Analysis Modeling System) with the EFED Standard Pond environment. PRZM is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field, and EXAMS estimates environmental fate and transport of pesticides in surface water. Aquatic exposure is modeled for the parent alone.

The most recent PRZM/EXAMS linkage program (PE5, PE Version 5, dated Nov. 15, 2006) was used for all surface water simulations. Linked crop-specific scenarios and meteorological data were used to estimate exposure resulting from use on crops and turf.

California-specific PRZM crop scenarios, which consist of location-specific soils, weather, and cropping practices, were used in the simulations to represent labeled agricultural uses of methomyl. These scenarios were developed to represent high-end exposure sites in terms of vulnerability to runoff and erosion and subsequent off-site transport of pesticide. Methomyl is registered on a wide variety of field, vegetable and orchard crops (see **APPENDIX B**). Registered uses were grouped into categories according to similarity of growth, morphology, product use and cropping area and representative PRZM scenarios for each category were used for modeling. Particular attention was given to grouping crops according to the areas in which they are grown because rainfall is understood to be a driving variable in the PRZM model. A summary of the output files used to estimate methomyl concentrations in the aquatic systems for ecological risk assessment can be found in **APPENDIX D**.

For the scatter bait use pattern, a conceptual model was developed and the impervious and residential scenarios were post-processed to obtain the EECs. The conceptual model includes the assumption that 50% of the modeled area is impervious, and 3% of the impervious area is treated, while the remaining 50% of the residential area was treated. Details of the conceptual model are in **APPENDIX N**. This approach is consistent with the approach taken in the California Red Legged Frog Litigation Assessment (USEPA 2007).

PRZM/EXAMS modeling was completed using the maximum seasonal use pattern for each category. Methomyl product labels, however, specify application rates on a per crop basis and not on a per annual basis. Information from BEAD indicates that many crops can be grown more than one time/year in California (**APPENDIX O**). Since standard PRZM scenarios consist of one crop per year, applications to one crop per year were modeled (discussed further in Section 2.4.3). Even though methomyl is short-lived in water, it is moderately persistent in soils. Any carry-over in the soil from a previous crop may be available for runoff and may result in runoff loadings that are larger than EECs modeled in this assessment (See Section 6.1.2).

Use-specific management practices for all of the assessed uses of methomyl were used for modeling, including application rates, number of applications per year, application intervals, buffer widths and resulting spray drift values modeled from AgDRIFT, and the first application date for each use. Application-specific and chemical-specific input parameters are listed in **Tables 3.1** and **3.2,** respectively. Modeling inputs were selected according to EFED's Input Parameter Guidance (USEPA 2009). Pesticide applications were simulated as aerial spray applications or ground spray as prescribed by product labels. Foliar applications (PRZM chemical application method, CAM = 2) were simulated and spray drift estimates were

calculated with AgDRIFT corresponding to the label-required buffers of 100 ft and 25 ft for aerial and ground spray applications, respectively. Tier I aerial and ground models were run assuming ASAE Very Fine to Fine droplet size distribution and a high boom assumption for ground spray to determine the spray drift values. The date of first application was developed based on several sources of information including data provided by BEAD, a summary of individual applications from the CDPR PUR data, and Crop Profiles maintained by the USDA. More detail on the crop profiles and the previous assessments may be found at: http://www.ipmcenters.org/CropProfiles/
The first day of application was chosen to correspond to the wetter portion of the year, which tends to be winter/early spring.

3.2.2. Model Inputs

The appropriate PRZM and EXAMS input parameters for methomyl and related compounds were selected from the environmental fate data submitted by the registrant and in accordance with US EPA-OPP EFED water model parameter selection guidelines, *Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1*, October 22, 2009 and *PE5 User's Manual. (P)RZM (E)XAMS Model Shell, Version (5)*, November 15, 2006. Input parameters can be grouped by physical-chemical properties and other environmental fate data, application information, and use scenarios. Physical and chemical properties relevant to assess the behavior of methomyl and related compounds in the environment are presented in **Table 2-2** and **Table 2-3** and application information from the label in **Table 2-6** and **Table 3-1**. The input parameters for PRZM and EXAMS are in **Table 3-2**. **Appendix D** contains example model output files and tables showing the data used to calculate input values.

Table 3-2. Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs for Methomyl Endangered Species Assessment[1]

Fate Property	Value (unit)	MRID (or source)
Molecular Weight	162.2 g/mol	(calculated)
Henry's constant	2.1×10^{-11} atm-m^3/mol	(calculated)
Vapor Pressure	5.4×10^{-6} torr	MRID 41209701
Solubility in Water	5.5×10^{4} mg/L	MRID 41402101
Photolysis in Water	50 days	MRID 43823305
Aerobic Soil Metabolism Half-lives	26.1 days	Upper 90% confidence bound on the mean of 5 half-life values. MRIDs 00008568, 43217901, 45473401
Hydrolysis Half-lives	Stable	MRID 00131249
Aerobic Aquatic Metabolism Half-life (water column)	5.2 days	Upper 90% confidence bound on the mean of 2 half-life values. MRID 43325401

Fate Property	Value (unit)	MRID (or source)
Anaerobic Aquatic Metabolism Half-life (benthic)	28 days	2X anaerobic soil metabolism single value of 14 days. (calculated from MRID 43217902)
Organic-carbon water partition coefficient (K_{OC}, L/kg OC)	46 L/kg_{oc}	Mean of four K_{oc} values. MRID 00161884
Application rate and frequency	See Table 3.1	See Table 3.1
Application intervals	See Table 3.1	See Table 3.1
Chemical Application Method (CAM)	2	Input Parameter Guidance
Application Efficiency	0.99 (scatter bait) 0.95 aerial	Input Parameter Guidance
Spray Drift Fraction	0.01 (scatter bait) 0.0511 aerial	Draft Guidance on Modeling Offsite Deposition of Pesticides via Spray Drift for Ecological and Drinking Water Assessments for the Environmental Fate and Effects Division
Incorporation Depth	NA	NA
Foliar degradation rate (1/day)	0.309 (1/day)	Upper 90% confidence bound on the mean of two rate constants. Kiigemagi and Deinzer, 1979, Sheets *et al.*, 1982

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

3.2.3. Results

The aquatic EECs for the various scenarios and application practices are listed in **Table 3-3**. The example output from PRZM-EXAMS is provided in **APPENDIX D**. The maximum peak, 21 day average, and 60 day average EECs are associated with cole crops, specifically cabbage for the peak and 21 day average (61.9 µg/L, 42.6 µg/L respectively) with scatter bait having the highest EECs for the 60 day average (32.0 µg/L) and sorghum having the lowest EECs for all EEC categories (2.5 µg/L, 1.1 µg/L, 0.4 µg/L respectively). Please see **Table 3-3** for a list of all EECs and modeled methomyl uses.

Table 3-3. Aquatic EECs (µg/L) for Methomyl Uses in California

Scenario (Application Method/ Formulation)	Crops/Uses Represented	Application Rate (lb a.i./A)	Number of Applications	Application Interval (days)	Date of First Application	Peak EEC (µg/L)	21-day average EEC (µg/L)	60-day average EEC (µg/L)
CAalfalfa_WirrigOP (Aerial/ soluble concentrate)	Alfalfa	0.9	4	5	28-Dec	26.5	20.1	11.4
CAAvocadoRLF_V2 (Aerial/ soluble concentrate)	Avocado	0.9	1	NA	21-Nov	5.6	3.2	1.5

Scenario (Application Method/ Formulation)	Crops/Uses Represented	Application Rate (lb a.i./A)	Number of Applications	Application Interval (days)	Date of First Application	Peak EEC (µg/L)	21-day average EEC (µg/L)	60-day average EEC (µg/L)
CAColeCropRLF_V2 (Aerial/ soluble concentrate)	Cabbage (encompasses cauliflower, Chinese broccoli, Chinese cabbage, collards, leafy green vegetables, Broccoli, Broccoli raab, Brussels sprouts)	0.9	8	2	22-Feb	61.9	42.6	23.9
CA lettuce STD (Aerial/ soluble concentrate)	Celery (encompasses endive/escarole, leafy green vegetables, lettuce, spinach)	0.9	8	5	1-Apr	21.4	16.8	10.4
CAcornOP (Aerial/ soluble concentrate)	Corn (encompasses barley, oats, rye, sorghum, wheat)	0.45	14	1	27-Jul	10.2	6.6	3.1
CAcornOP (Aerial/ soluble concentrate)	Corn **	0.24	26	1	27-Jul	6.7	5.5	3.0
CARowCropRLF_V2 (Aerial/ soluble concentrate)	mint	0.9	5	5	1-Apr	14.6	11.8	7.2
CAonion_WirrigSTD (Aerial/ soluble concentrate)	onions (encompasses Garlic)	0.9	6	5	1-Jun	9.1	4.7	2.5
CA residential /impervious (Ground/ granular)	Scatter bait	0.22	26[2]	5	1-Jan	42.9	36.3	32.0
CAcornOP (Aerial/ soluble concentrate)	Sorghum * lowest methomyl use rate	0.45	2	5	27-Jul	2.5	1.1	0.4
CATurfRLF (Aerial/ soluble concentrate)	Turf - sod farms only (encompasses bermuda grass)	0.9	4	5	2-Jan	19.3	14.2	8.9

[1] Drift values calculated with AgDRIFT according to 100 ft and 25 ft buffers for aerial and ground spray applications as directed by product labels
[2] Not specified on the label. 26 applications per year is the most PRZM can process.
*See Table 3-1 for more information.

3.2.4. Existing Monitoring Data

A critical step in the process of characterizing EECs is comparing the modeled estimates with available surface water monitoring data. Included in this assessment are methomyl data from the USGS NAWQA program (http://water.usgs.gov/nawqa) and data from the California Department of Pesticide Regulation (CDPR). In addition, air monitoring data for methomyl was looked for, but no data was found. For a summary of all monitoring data on methomyl, please see **APPENDIX M**.

3.2.4.a. USGS NAWQA Surface Water Data

The USGS NAWQA surface water database ((http://infotrek.er.usgs.gov/apex/f?p=136:1:0::NO:::) was evaluated for available monitoring data. A total of 394 water samples were analyzed for methomyl in California alone. Of these samples, 19 (21%) had positive detections of methomyl. The maximum concentration detected was 0.67 µg/L in the Salt Slough at Highway 165 near Stevinson, California. Methomyl was detected in the Salt Slough in four samples with concentrations ranging 0.13 -0.67 µg/L. Methomyl was also detected in the San Joaquin River near Vernalis, California (three samples ranging in concentration 0.0052 – 0.0723 µg/L), the Orestimba Creek at River Road near Crows Landing, California (10 samples ranging in concentration 0.0043 – 0.33 µg/L) and at Merced River at River Road bridge new Newman, California (one sample at 0.01 µg/L).

3.2.4.b. USGS NAWQA Groundwater Data

The USGS NAWQA groundwater database (http://infotrek.er.usgs.gov/nawqa_queries/jsp/gwmaster.jsp) was evaluated for available monitoring data in California. One sample was taken looking for the degradate methomyl oxime, and 459 samples from 339 sites were taken for the parent methomyl. No detects were found of methomyl or the methomyl oxime in groundwater in California. However, there are detections of methomyl in groundwater at concentrations up to 20 µg/L from other sources in other states. For national groundwater information, please see **APPENDIX M** which has a summary of all monitoring data for methomyl. This assessment focuses on the state of California.

3.2.4.c. California Department of Pesticide Regulation (CDPR) Data

The CDPR surface water database (http://www.cdpr.ca.gov/docs/emon/surfwtr/surfcont.htm) was evaluated for available monitoring data. CDPR focuses on monitoring data just for the state of CA. A total of 1,118 water samples were analyzed for methomyl. Of these, 191 samples (17%) had positive detections of methomyl. The maximum concentration reported was 5.4 µg/L in the Ingram/Hospital Creek (tributary to the San Joaquin River). Methomyl was detected at 21 sites (out of a total of 84) in Imperial, Merced, Stanislaus, and Yolo Counties at concentrations ranging between 0.05 – 5.4 µg/L.

3.2.4.d. Atmospheric Monitoring Data

The January 2008 report by the Western Contaminants Assessment Project (WACAP) yielded no detects of methomyl in the atmosphere or evidence of long range transport. A copy of the report can be found at http://www.nature.nps.gov/air/studies/air_toxics/wacap.cfm.

A report generated by Daly *et al.* and published by the American Chemical Society in 2007 titled Pesticides in Western Canada Mountain Air and Soil did not sample for methomyl which is expected since long range transport and volatilization of methomyl are not expected to be major pathways of concern.

3.3. Terrestrial Animal Exposure Assessment

3.3.1. Exposure to Residues in Terrestrial Food Items

T-REX (Version 1.5) is used to calculate dietary and dose-based EECs of methomyl for birds (including terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. T-REX simulates a 1-year time period. T-HERPS is used as a refinement of dietary and dose-based EECs for snakes and amphibians when risk quotients from T-REX are higher than LOCs. T-HERPS was also set up to simulate a 1-year time period. For this assessment, spray, granular, and scatter bait applications of methomyl are considered. Terrestrial EECs were derived for the uses previously summarized in **Table 2-6**. Exposure estimates generated using T-REX and T-HERPS are for the parent alone.

Granular applications to corn whorls using methomyl 5G Granules formulation were calculated using the LD_{50}/ft^2 option in T-REX v. 1.5 for birds and mammals. Additional information is provided in the risk characterization section for each taxonomic group.

Similarly, scatter bait applications using Stimukil fly bait formulation were calculated using the LD_{50}/ft^2 option in T-REX v. 1.5 for birds and mammals. According to the Stimukil fly bait label, the scatterbait is applied at a rate of ¼ lb per 500 ft^2, which is 21.78 lb of formulation/Acre and 0.2178 lbs a.i./A. Although the bait may be reapplied at 3-5day intervals, the T-REX model analysis for LD_{50}/ft^2 which is used to calculate the RQs, estimates exposure based on only a single application of the product. Furthermore, the RQ represents an area confined by one square foot and is not intended to represent the dispersal of the product across an acre. Further discussion of uncertainties about this use is located in Section 50.2.5.

Terrestrial EECs for foliar formulations of methomyl were derived for the uses summarized in Table 3-4. A foliar dissipation half-life of 2.5 days is used based on the submitted foliar degradation data (Sheets *et al.* 1982) on Bermuda grass. In order to be consistent with the CA red-legged frog assessment, a foliar dissipation half-life of 3 days would have been used. A recalculation of RQs (using 3 days instead of 2.5 days) for a subset of data (the 20g bird consuming arthropods – *i.e.*, values with the least number of acute and chronic dietary LOC exceedances for the given uses) indicated that although the RQs increased slightly, risk conclusions did not change. Use specific input values, including number of applications, application rate, foliar half-life and application interval are provided in Table 3-4. An example output from T-REX and T-HERPS is available in **APPENDIX E**.

Table 3-4. Input Parameters for Foliar Applications Used to Derive Terrestrial EECs for Methomyl with T-REX and T-HERPS

Use (Application method)	Max. Single App. Rate (lbs a.i./A)	Number of Applications per Year	Application Interval (days)	Max. Annual App. Rate (lbs a.i./A)	Foliar Dissipation Half-Life
Bulbs[a]	0.9	6	5	5.4	2.5 days
Cereal grains[b]	0.45	14[h]	1	6.3	2.5 days
Cereal grains[b]	0.225	28[h]	1	6.3	2.5 days
Cereal grains (sp. sorghum)[c]	0.45	2	5	0.9	2.5 days
Cole crops[d]	0.9	8	2	7.2	2.5 days
Grasses[e]	0.9	4	5	3.6	2.5 days
Herbs[f]	0.9	5	5	4.5	2.5 days
Leguminous forage (alfalfa)	0.9	4	5	3.6	2.5 days
Non-cole leafy crops[g]	0.9	8	5	7.2	2.5 days
Avocado	0.9	1	N/A	0.9	2.5 days
Corn (sweet) - granular	0.15	1	N/A	N/A	N/A
Scatter bait – as granular[j]	0.2178	1	N/A	N/A	N/A

n/a = Not applicable
n/s = Not specified in label
[a]Onions (encompasses garlic)
[b]Corn (encompasses barley, oats, rye, sorghum, wheat) is the highest methomyl rate
[c]Sorghum is the lowest methomyl rate
[d] Cabbage (cauliflower, Chinese broccoli, Chinese cabbage, collards, leafy green vegetables, broccoli, broccoli raab, Brussels sprouts)
[e]Sod (encompasses Bermuda grass)
[f]Anise (encompasses mint)
[g]Celery (encompasses endive/escarole, leafy green vegetables, lettuce, spinach)
[h]The compound can be applied at two rates: 14 times at a higher rate of 0.45 lbs a.i./A or 28 times at a lower rate of 0.225 lbs a.i./A . Since PRZM/EXAMS can only account for 26 applications, the third option is to apply the pesticide 26 times at 0.24 lbs a.i./A in order to maintain consistency with the aquatic exposure model run. However, the third option is not run for terrestrial exposure as the terrestrial models can account for 28 applications.
[i] This use is a granular application on corn whorls using Methomyl 5G Granules. Reapplication is 10 times and a maximum application rate per year is reported as 18.9 lbs a.i./A in the verification memo (Appendix B). However, the T-REX model analysis for LD_{50}/ft^2could only capture a single application of the product
[j] This use was modeled as a broadcast granular application using Stimukil fly bait formulation.The bait may be reapplied at 3-5day intervals, but the T-REX model analysis for LD_{50}/ft^2could only capture a single application of the product.

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

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

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

For the foliar uses, upper-bound Kenaga nomogram values reported by T-REX are used for derivation of dietary EECs for the CTS, CCR, SFGS, and their potential prey (**Table 3-5**).

EECs in T-REX that are applicable to direct effects to the CCR are for small (20 g, juveniles) and medium (100 g, adult) birds consuming a variety of dietary items. The most conservative EEC for the CCR is for the small bird consuming short grass. EECs in T-REX that are applicable to assess direct effect to the terrestrial-phase CTS, SFGS, and AW are for small birds (20g) consuming short grass[7]. For birds (surrogates for amphibians and reptiles), EECs and for acute dose based and chronic dietary based exposure are calculated as these are the most conservative values. If the LC_{50} is lower than the LD_{50}, the highest acute dietary EECs are shown as well. For mammals, EECs for acute dose based and chronic dose based exposure are calculated as these are typically the most conservative values.

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

Table 3-5. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Birds and Mammals Derived Using T-REX for Methomyl: Accounting for direct effects with most sensitive size classes for acute exposure

Use(s), Type of Application[a]	App Rate (lb a.i./A, # Apps, Interval in days)	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds of 20g consuming short grass & arthropods)				EECs for Mammals (small mammals of 15 g consuming short grass)	
		Dietary-based EEC (mg/kg-diet)		Dose-based EEC (mg/kg-bw)		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
		Short grass	Arthropod	Short grass	Arthropod		
Bulbs	0.9, 6, 5	287.93	112.77	327.92	128.44	287.93	274.52
Cereal grains	0.45, 14, 1	436.82	171.09	497.50	194.85	436.82	416.48
Cereal grains	0.225, 28, 1	222.92	87.31	253.88	99.44	222.92	212.53
Cereal grains (sp. sorghum)	0.45, 2, 5	135.00	52.88	153.75	60.22	135.00	128.71
Cole crops	0.9, 8, 2	501.45	196.40	571.10	223.68	501.45	478.09
Grasses	0.9, 4, 5	286.88	112.36	326.72	127.97	286.88	273.51
Herbs	0.9, 5, 5	287.72	112.69	327.68	128.34	287.72	274.32
Leguminous forage (alfalfa)	0.9, 4, 5	286.88	112.36	326.72	127.97	286.88	273.51
Non-cole leafy crops	0.9, 8, 5	288.00	112.80	328.00	128.47	288.00	274.58
Avocado	0.9, 1, NA	216.00	84.60	246.00	96.35	216.00	205.94

[a] See Table 3-4 for details on the uses.

3.3.2. Exposure to Terrestrial Invertebrates Derived Using T-REX

T-REX is also used to calculate EECs for terrestrial invertebrates exposed to methomyl from foliar uses. Available acute contact toxicity data for bees exposed to methomyl (in units of µg a.i./bee), are converted to µg a.i./g (of bee) by multiplying 1 bee by 0.128 g (the average weight on an adult honey bee). In this case, the acute contact LD_{50} is 0.16 µg a.i./bee for the honey bee (*Apis mellifera*, MRID 45093001), which results in an adjusted toxicity value of 1.25µg a.i./g of bee. Dietary-based EECs calculated by T-REX for arthropods (units of µg a.i./g of bee) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs.

The exposure values are applicable to direct effects to the VELB and BCB and in estimating indirect effects based on reduction in prey to the CCR, SFGS, and CTS. An example output from T-REX v. 1.5 is available in **APPENDIX E**.

Table 3-6. Summary EECs Used for Estimating Risk to Terrestrial Invertebrates and Derived Using T-REX ver. 1.5. for Methomyl

Use, Method of Application[a]	Application Rate (lbs a.i./acre), # of app, App interval (days)	Arthropod EEC (in µg a.i./g of bee, or ppm)
Bulbs	0.9, 6, 5	112.77
Cereal grains	0.45, 14, 1	171.09
Cereal grains	0.225, 28, 1	87.31
Cereal grains (sp. sorghum)	0.45, 2, 5	52.88
Cole crops	0.9, 8, 2	196.40
Grasses	0.9, 4, 5	112.36
Herbs	0.9, 5, 5	112.69
Leguminous forage (alfalfa)	0.9, 4, 5	112.36
Non-cole leafy crops	0.9, 8, 5	112.80
Avocado	0.9, 1, NA	84.60
[a] See Table 3-4 for details on the uses.		

3.3.2.a. Dietary Exposure to Amphibians and Reptiles Derived Using T-HERPS

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

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

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

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

Because the existing risk assessment process is driven by the dietary route of exposure, a finding of safety for birds, with their much higher feeding rates and, therefore, higher potential dietary exposure is reasoned to be protective of terrestrial-phase amphibians consuming similar dietary items. For this not to be the case, terrestrial-phase amphibians would have to be 40 times more sensitive than birds for the differences in dietary uptake to be negated. However, existing dietary toxicity studies in terrestrial-phase amphibians for methomyl are lacking. To quantify the potential differences in food intake between birds and terrestrial-phase CTS and amphibians, food intake equations for the iguanid lizard were used to replace the food intake equation in T-

REX for birds, and additional food items of the CTS and amphibians were evaluated. These functions were encompassed in a model called T-HERPS. T-HERPS is available at: http://www.epa.gov/oppefed1/models/terrestrial/index.htm. EECs calculated using T-HERPS are shown in this Section and potential risk is further discussed in the risk characterization.

EECs in T-HERPS that are applicable to the CTS are small (2 g, juveniles) amphibians consuming small and large insects and medium (20 g) amphibians consuming small and large insects, small herbivorous and insectivorous mammals, and amphibians. The dietary item that results in the highest EEC for CTS (all DPS) is the small herbivore mammal. EECs calculated using T-HERPS for the CTS are shown in **Table 3-7**.

Table 3-7. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians and Reptiles Derived Using T-HERPS for Methomyl: CTS specific

Use(s), Type of Application[a]	App Rate (lb a.i./A), # App, Interval (days)	EEC for Small CTS (2g) (small birds 2g consuming small insects)		EEC for Medium CTS (20g) (medium birds 20g consuming small/medium herbivorous mammals of 1.33g/13.33)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)[b]	Dose-based EEC (mg/kg-bw)
Bulbs	0.9, 6, 5	161.96	8.99	288.98	192.66
Cereal grains (corn-14x)	0.45, 14, 1	245.71	13.65	438.42	292.28
Cereal grains (corn-28x)	0.225, 28, 1	125.39	6.96	223.73	149.15
Cereal grains (sp. sorghum)	0.45, 2, 5	75.94	4.22	135.49	90.33
Cole crops	0.9, 8, 2	282.07	15.66	503.29	335.52
Grasses	0.9, 4, 5	161.37	8.96	287.93	191.95
Herbs	0.9, 5, 5	161.84	8.99	288.77	192.52
Leguminous forage (alfalfa)	0.9, 4, 5	161.37	8.96	287.93	191.95
Non-cole leafy crops	0.9, 8, 5	162.00	9.00	289.05	192.70
Avocado	0.9, 1, NA	121.50	6.75	216.79	144.53
[a] See Table 3-4 for details on the uses. [b]EEC for medium-sized herbivorous mammal (of 13.33g)					

T-REX may underestimate exposure to snakes when birds are used as a surrogate and are assumed to eat similar dietary items because of the large meal size a snake may consume on a single day.[8] That is why birds consuming short grass in T-REX are used as the screen to determine whether further refinement in T-HERPS is needed for snakes. T-HERPS was

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

modified (version 1.1) to estimate exposure to snakes based on the maximum size prey item they could consume and is used to refine a risk estimate when LOCs are exceeded for small birds consuming short grass based on RQs estimated in T-REX. The following allometric equation was used to estimate the maximum size prey items for snakes (King, 2002).

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

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

EECs in T-HERPS that are applicable to the SFGS are small (2 g, juveniles) snakes consuming small and large insects and medium (20 g) snakes consuming small and large insects, small herbivorous and insectivorous mammals, and amphibians. The most sensitive EECs and RQs for SFGS are for the medium animal consuming small herbivorous mammals. EECs calculated using T-HERPS for the SFGS are shown in **Table 3-8**.

Table 3-8. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians and Reptiles Derived Using T-HERPS for Methomyl: SFGS specific

Use(s), Type of Application[a]	App Rate (lb a.i./A), # App, Interval (days)	EEC for Small SFGS (2g) (small bird 2g consuming small insects)		EEC for Medium SFGS (20g) (medium bird 20g consuming small/medium herbivorous mammals of 2.10g/24.74g)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)[b]	Dose-based EEC (mg/kg-bw)
Bulbs	0.9, 6, 5	161.96	8.99	220.71	273.02
Cereal grains (corn-14x)	0.45, 14, 1	245.71	13.65	334.85	414.21
Cereal grains (corn-28x)	0.225, 28, 1	125.39	6.96	170.87	211.37
Cereal grains (sp. sorghum)	0.45, 2, 5	75.94	4.22	103.48	128.01
Cole crops	0.9, 8, 2	282.07	15.66	384.38	475.49
Grasses	0.9, 4, 5	161.37	8.96	219.90	272.02
Herbs	0.9, 5, 5	161.84	8.99	220.55	272.82
Leguminous forage (alfalfa)	0.9, 4, 5	161.37	8.96	219.90	272.02
Non-cole leafy crops	0.9, 8, 5	162.00	9.00	220.76	273.08
Avocado	0.9, 1, NA	121.50	6.75	165.57	204.82

[a] See Table 3-4 for details on the uses.
[b]EEC for medium-sized herbivorous mammal (of 24.74g)

3.4. Terrestrial Plant Exposure Assessment

TerrPlant (Version 1.1.2) is typically used to calculate EECs for non-target plant species inhabiting dry and semi-aquatic areas. However, the TerrPlant model was not run because no acceptable studies (*i.e.,* a vegetative vigor and seedling emergence studies) are available for methomyl. Although there are no acceptable terrestrial plant guideline toxicity studies available for methomyl, several efficacy studies that were conducted to test the effects of methomyl on a variety of target and non-target invertebrate pests also supplied information on effects to plants after methomyl applications. Due to a lack of information on study design and data analyses, these efficacy studies are classified as 'supplemental' and are not adequate for plant (or terrestrial invertebrate) RQ calculation.

4. Effects Assessment

This assessment evaluates the potential for methomyl to directly or indirectly affect SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG or modify their designated critical habitat. Assessment endpoints for the effects determination for each assessed species include direct toxic effects on the survival, reproduction, and growth, as well as indirect effects, such as reduction of the prey base or modification of its habitat. In addition, potential modification of critical habitat is assessed by evaluating effects to the PCEs, which are components of the critical habitat areas that provide essential life cycle needs of each assessed species. Direct effects to the aquatic-phase CA tiger salamander are based on toxicity information for freshwater fish, while terrestrial-phase amphibian effects (CA tiger salamander) and reptiles (San Francisco garter snake) are based on avian toxicity data, given that birds are generally used as a surrogate for terrestrial-phase amphibians and reptiles.

As described in the Agency's Overview Document (USEPA, 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include freshwater fish (used as a surrogate for aquatic-phase amphibians), freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrates, birds (used as a surrogate for terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. No registrant-submitted data for the aquatic and terrestrial plants are available. However, an open literature study and registrant submitted data on other carbamates are available to inform risk characterization for aquatic plants (see Section 5.1.1e). Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and open literature (where available) on methomyl. This section summarizes the ecotoxicity data available on methomyl.

4.1. Ecotoxicity Study Data Sources

Toxicity endpoints are established based on data generated from guideline studies submitted by the registrant, and from open literature studies that meet the criteria for inclusion into the ECOTOX database maintained by EPA/Office of Research and Development (ORD) (USEPA, 2004). Open literature data presented in this assessment were obtained from ECOTOX information originally compiled Oct. 13, 2004 and refreshed Jan. 2010. In order to be included in the ECOTOX database, papers must meet the following minimum criteria:

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

Open literature toxicity data for other 'target' insect species (not including bees, butterflies, beetles, and non-insect invertebrates including soil arthropods and worms), which include efficacy studies, are not currently considered in deriving the most sensitive endpoint for terrestrial insects. Efficacy studies do not typically provide endpoint values that are useful for risk assessment (*e.g.*, NOAEC, EC50, *etc.*), but rather are intended to identify a dose that maximizes a particular effect (*e.g.*, EC100). Therefore, efficacy data and non-efficacy toxicological target insect data are not included in the ECOTOX open literature summary table provided in **APPENDIX I**. For the purposes of this assessment, 'target' insect species are defined as all terrestrial insects with the exception of bees, butterflies, beetles, and non-insect invertebrates (*i.e.*, soil arthropods, worms, *etc.*) which are included in the ECOTOX data presented in **APPENDIX I**.

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

Citations of all open literature not considered as part of this assessment because they were either rejected by the ECOTOX screen or accepted by ECOTOX but not used (*e.g.*, the endpoint is less sensitive) are included in **APPENDIX H.** Appendix H also includes a rationale for rejection of those studies that did not pass the ECOTOX screen and those that were not evaluated as part of this endangered species risk assessment.

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

4.2. Toxicity of Methomyl to Aquatic Organisms

Table 4-1 summarizes the most sensitive aquatic toxicity endpoints, based on an evaluation of both the submitted studies and the open literature, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the SFGS, CCR, CTS, DS, CFS, and TG is presented below. Additional information is provided in **APPENDIX G**.

Based on the available data, methomyl is characterized as very highly toxic to freshwater fish and invertebrates (freshwater and estuarine/marine) and moderately toxic to estuarine/marine fish on an acute exposure basis. An open literature study (Record #: 118717, Pereira *et al.*2009) quantifying the growth inhibition in *Pseudokirchneriella subcapitata* (a microalgae) after Lannate (200g a.i./L methomyl formulation) and methomyl (99.5% purity) exposure indicates a 96-hour EC_{50} of 184 mg a.i./L (95% CI of 164-206 mg a.i./L for Lannate) and a 96-hour EC_{50} of 108 mg a.i./L (95% CI of 87-126 mg a.i./L for methomyl a.i.). For additional discussion, refer to Section 5.1.1.e.

Regarding chronic exposure, toxicity data for methomyl are available for freshwater fish, estuarine/marine fish, freshwater invertebrates, and estuarine/marine invertebrates. No toxicity data from chronic exposure to methomyl are available for the most acutely sensitive freshwater fish species, the channel catfish (*Ictalurus punctatus*) (LC_{50} = 0.320 mg a.i./L). Therefore, an acute-to-chronic ratio (ACR) is used to calculate a chronic freshwater fish endpoint using acute and chronic data from the fathead minnow (for which both acute and chronic toxicity data are available). The most sensitive no observed adverse effect concentration (NOAEC) and lowest observed adverse effect concentration (LOAEC) for freshwater fish [fathead minnows (*Pimephales promelas*)] are 0.057 and 0.117 mg a.i./L, respectively, based on reduced survival (MRID 131255). The ACR for fathead minnow, *i.e.* ACR = 26.3, results in a NOAEC of 0.012 mg a.i./L for the channel catfish [(1.5 mg/L)/(0.057 mg/L) = (0.320 mg/L)/(x mg/L)].

For estuarine/marine fish, an early life-stage toxicity study (MRID: 450132-02) with sheepshead minnows resulted in a NOAEC of 0.26 mg a.i./L, and a LOAEC of 0.49 mg a.i./L, based on both reduction in total length and wet weight. Fish with deformed bodies and lethargy/erratic swimming were noted at 1.0 mg a.i./L. No other sub-lethal effects (other than length and weight reductions) were noted at any other time or concentration.

A 21-day life-cycle toxicity study of *Daphnia magna* resulted in a NOAEC of 0.0007 mg. a.i./L and a LOAEC of 0.001 mg a.i./L based on delayed reproduction (MRID 131254). The NOAEC and LOAEC are 0.0016 and 0.0035 mg a.i./L, respectively, based on the number of young produced. No other sub-lethal effects were noted at any other concentration.

For estuarine/marine invertebrates, the most acutely sensitive species tested is the northern pink shrimp (*Penaeus duorarum*) (LC_{50} = 0.019 mg a.i./L). Since no toxicity data from chronic exposure to methomyl are available for the northern pink shrimp, an ACR is used to calculate a chronic estuarine/marine endpoint using acute and chronic data from mysid shrimp

(*Americamysis bahia*) (for which both acute and chronic data are available). The most sensitive no observed adverse effect concentration (NOAEC) and lowest observed adverse effect concentration (LOAEC) for mysid shrimp are 0.0291 and 0.0591 mg a.i./L, respectively, based on reduced number of young per surviving female (MRID 450132-03). The ACR for mysid shrimp, *i.e*. ACR = 8.07, results in a NOAEC of 0.0024 mg a.i./L for the northern pink shrimp [(0.234 mg/L)/(0.029 mg/L) = (0.019 mg/L)/(x µg/L)].

An outdoor microcosm study (MRID 437444-02) was conducted with the formulated methomyl product Lannate L [24% a.i. (methomyl)] to evaluate the fate in tank water and hydrosoil and assess the effects on populations of phytoplankton, zooplankton, macroinvertebrates, and bluegill sunfish (*Lepomis macrochirus*). Applications were performed over a period of 22 days (22 daily applications) to 28 days (4 applications with a 7-day reapplication interval); the total length of the study was 35 days. Treatment groups were defined by the amount of test substance added at each application (0.48 or 0.048 g a.i.; test vessel volume = 5,900 L; nominal treatment concentrations were not provided) and by the interval between test substance applications [1 day (total of 22 applications), 3 days (total of 8 applications), or 7 days (total of 4 applications)]. Before the start of the study, each of the 56 tanks used in the study was stocked with bluegill sunfish and inoculated with aquatic plants and animals (invertebrates) from an untreated, pre-existing pond on site, colonized by native invertebrates.

At the end of the study, phytoplankton showed no apparent methomyl-related effects. Zooplankton showed mixed results; the abundance of adult copepods and rotifers generally increased following methomyl applications, however, cladoceran abundance was reduced (to less than 1% of the abundance of the control group) in the methomyl-treated groups and their numbers did not recover during the study period. Bluegill survival was not affected in any of the microcosm treatment levels. Body length and body weight at harvest, however, were significantly reduced (up to 18.5%) at all methomyl treatment levels when compared with controls. The size reductions were attributed to a decrease in food resources, particularly cladocerans.

Table 4-1. Aquatic Toxicity Profile for Methomyl

Species	Taxa Represented	Toxicity Value	MRID #	Classification	Comment
Channel catfish (*Ictalurus punctatus)*	Freshwater fish and aquatic-phase amphibians	96-hr LC_{50} = 0.320 mg a.i./L	40098001	Supplemental	Slope = 4.2 (2.3 – 6.2)
Channel catfish (*Ictalurus punctatus)*		NOAEC = 0.012 mg a.i./L	N/A	N/A	Based an acute to chronic ratio (ACR)[1] using acute and chronic data from the fathead minnow and acute data from the channel catfish.
Daphnid (*Daphnia magna*)	Freshwater invertebrates	48-hr EC_{50} = 0.005 mg a.i./L	40098001	Supplemental	A slope could not be determined
		NOAEC = 0.0007 mg a.i./L	1312541	Acceptable	The LOAEC is 0.001 mg a.i./L based on delayed reproduction.
Sheepshead minnow	Estuarine/marine fish	96-hr LC_{50} = 1.16 mg a.i./L	41441202	Acceptable	Slope = 8.0

(*Cyprinodon variegatus*)		NOAEC = 0.260 mg a.i./L	45013202	Acceptable	The LOAEC is 0.490 mg a.i./L based on reduced growth
Eastern oyster (*Crassostrea virginica*)	Estuarine/marine invertebrates	EC_{50} >140 mg a.i./L	42074601	Acceptable	Shell deposition study; NOAEC = 0.12 mg a.i./L
Northern pink shrimp (*Penaeus duorarum*)		96-hr LC_{50} = 0.019 mg a.i./L	00009134	Acceptable	A slope could not be determined
		NOAEC = 0.0024 mg a.i./L	N/A	N/A	Based an acute to chronic ratio (ACR)[2] using acute and chronic data from mysid and acute data from the Northern pink shrimp
Non-vascular aquatic plants (*Pseudokirchneriellla subcapitata*)		96-hr EC_{50} = 184 mg a.i./L (Lannate form.) 96-hour EC_{50} = 108 mg a.i./L (methomyl a.i.)	Record #: 118717, Pereira *et al.*2009	Qualitative (Open lit.)[3]	Raw effects data and health of organisms prior to initiation not reported. Lannate (200 g a.i./L) Methomyl (99.5% purity) 95% CI of 164-206 mg a.i./L for Lannate; 95% CI of 87-126 mg a.i./L for methomyl a.i.
Vascular aquatic plants		No data available	N/A	N/A	N/A

[1] Fathead minnow LC_{50} (1.5 mg/L) divided by the NOAEC (0.057 mg/L) yields an ACR of 26.3; ACR of 26.3 in turn divided into the channel catfish LC_{50} (0.320 mg/L) yields an estimated chronic NOAEC (0.102 mg/L) for channel catfish.
[2] Mysid shrimp LC_{50} (0.234 mg/L) divided by the NOAEC (0.029 mg/L) yields an ACR of 8.07; ACR of 8.07 in turn divided into the northern pink shrimp LC_{50} (0.019 mg/L) yields an estimated chronic NOAEC (0.0024 mg/L) for northern pink shrimp.
[3] Open literature data are under a different classification scheme (quantitative, qualitative, invalid) than registrant submitted data (acceptable, supplemental, invalid). Under the qualitative categorization, this data is being used in risk characterization only and is not intended to calculate a risk quotient.

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

Toxicity to fish and aquatic invertebrates is categorized using the system shown in **Table 4.2** (USEPA, 2004). Toxicity categories for aquatic plants have not been defined.

Table 4-2. Categories of Acute Toxicity for Fish and Aquatic Invertebrates

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

4.3. Toxicity of Methomyl to Terrestrial Organisms

Table 4-3 summarizes the most sensitive terrestrial toxicity endpoints, based on an evaluation of both the submitted studies and the open literature. A brief summary of submitted data considered relevant to this ecological risk assessment is presented below. Additional information is provided in **Appendix G**.

Methomyl is classified as highly toxic to birds, mammals, and honey bees on an acute exposure basis. There are currently no methomyl vegetative vigor or seedling emergence toxicity data available for terrestrial plants (see Section 4.3.1).

An avian reproduction study was performed on methomyl with the northern bobwhite quail (*Colinus virginianus*). In this study, the LOAEC is 500 mg/kg-diet based on fewer eggs laid and eggs set and the NOAEC is 150 mg a.i./kg-diet (MRID: 41898602). In a 2-generation reproduction study with rats (*Rattus norvegicus*), the NOAEL for parental systemic toxicity is 3.75 mg/kg-bw and the LOAEL is 30 mg/kg-bw based on decreased growth (body weight) and food consumption and altered hematology parameters. The NOAEL for offspring toxicity is also 3.75 mg/kg-bw and the LOAEL is 30 mg/kg-bw based on decreases in both survival (the mean number of live pups) and growth (mean body weights of offspring) (MRIDs: 43250701, 43769401).

Table 4-3. Terrestrial Toxicity Profile for Methomyl

Species	Taxa Represented	Toxicity Value	MRID #	Classification	Comment
Bobwhite quail (*Colinus virginianus*)	Birds, reptiles, and terrestrial-phase amphibians	LD_{50} = 24.2 mg/kg-bw	00161886	Acceptable	None
		LC_{50} = 1,100 mg/kg-diet	22923	Acceptable	None
		NOAEC = 150 mg/kg-diet	41898602	Acceptable	LOAEC = 500 mg a.i./kg-diet, based on reduction in number of eggs laid/hen
Laboratory rat (*Rattus norvegicus*)	Mammals	LD_{50} = 30 mg a.i./kg-bw (female)	42140101	Acceptable	None
Laboratory rat		NOAEL = 75 mg a.i./kg-diet (3.75 mg a.i./kg/day) LOAEL = 600 mg a.i./kg-diet (30 mg a.i./kg/day)	43250701, 43769401	Acceptable	NOAEL based on decreases in both the mean number of live pups and mean body weights of offspring

Species	Taxa Represented	Toxicity Value	MRID #	Classification	Comment
Honey bee (*Apis mellifera*)	Terrestrial invertebrates	LD_{50} = 0.28 µg a.i./bee	45093001	Acceptable	Acute oral; NOAEL = 0.09 µg a.i./bee
		LD_{50} = 0.16 µg a.i./bee			Acute contact; NOAEL = 0.08 µg a.i./bee
Wasp (*Aphidius rhopalosiphi*)		48-hr LC_{50} = 0.00022 lbs a.i./acre	45133301	Supplemental (not adequate for RQ calculation)	Scientifically sound, but a non-guideline study and not adequate for RQ calculation (it involves a product not currently registered in the U.S.)
Terrestrial Plants		No data available	N/A	N/A	N/A

n/a: not applicable; ND = not determined; bw = body weight

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

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

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

4.3.1. Toxicity to Terrestrial Plants

There are no acceptable or supplemental terrestrial plant guideline toxicity studies available for methomyl; however, several efficacy studies testing the effects of methomyl on a variety of target and non-target invertebrate pests also supplied information on effects to plants after methomyl applications. Due to a lack of information on study design and data analyses, these efficacy studies are classified as 'supplemental' and are not adequate for plant (or terrestrial invertebrate) RQ calculation. None of the studies showed adverse effects to plants at the highest treatment levels tested (most of which were at or above the maximum allowable single application rate for methomyl of 0.9 lbs a.i./acre) and the NOAEC from the studies represented the highest treatment rates examined (see **Table 4-5**). However, because none of the studies addressed potential risks to monocots, or effects on seedling emergence and some N-methyl carbamates are plant auxins and are used to thin fruit (*e.g.*, carbaryl), risks to plants from the use of methomyl cannot be precluded using the available data. Furthermore, incident reports on melons indicate damage to older, treated leaves as a result of ground application of a methomyl formulation (see Section 4.5.2. Plant Incidents).

TABLE 4-5. Measures of Effects to Plants from Methomyl Efficacy Studies.

Plant Species	NOAEL	Highest level tested?[1]	Effect measured[2]	ECOTOX NO./Reference
Alfalfa (*Medicago sativa*)	≥0.9 lbs a.i./acre	Yes	Growth	88088/Laub *et al*. (1999)
Eggplant (*Solanum melongena*)	≥3.6 lbs a.i./acre	Yes	Growth Injury	74745/Morale and Kurundkar (1989)
	≥1,000 ppm	Yes	Growth	89394/Sharma *et al*. (1997)
Common Bean (*Phaseolus vulgaris*)	≥0.9 lbs a.i./acre	Yes	Injury	88838/Ghidiu (1988)
Bell pepper (*Capsicum annuum*)	≥946 ml/acre	Yes	Growth	82231/Stansly and Cawley (1993)
	≥0.9 lbs a.i./acre	Yes	Growth	82730/Schuster (1994)
	≥0.9 lbs a.i./acre	Yes	Biomass	82246/Zehnder and Speese (1992)
Cabbage (*Brassica oleracea*)	≥0.9 lbs a.i./acre	Yes	Injury	88084/Edelson *et al*. (1999)
Hybrid strawberry (*Fragaria x ananassa*)	≥0.9 lbs a.i./acre	Yes	Photosynthesis	88792/Carson *et al*. (1986)
Lettuce (*Lactuca sativa*)	≥1 lbs a.i./acre	Yes	Abundance	82237/Palumbo *et al*. (1991)
Peony (*Paeonia lactiflora*)	≥20.0 lbs a.i./acre	Yes	Abundance	89251/Schmitt *et al*. (1974)
Peach (*Prunus persica*)	≥0.23 lbs a.i./100 gallon	Yes	Injury	88091/Hull (1999)
Pigeonpea (*Cajanus cajan*)	≥0.53 lbs a.i./acre	Yes	Abundance	82560/Giraddi *et al*. (2002)
Potato (*Solanum tuberosum*)	≥1.0 lbs a.i./acre	Yes	Injury	77263/Raman and Palacios (1986)
Tomato (*Solanum lycopersicum)*	≥0.45 lbs a.i./acre	Yes	Injury	74169/Walgenbach *et al*. (1991)
	≥0.9 lbs a.i./acre	Yes	Injury	88062/Carson *et al*. (1999)
	≥0.9 lbs a.i./acre	Yes	Injury	88089/Kund *et al*. (1999)
	≥0.9 lbs a.i./acre	Yes	Injury	88089/Kund *et al*. (1999)
	≥0.45 lbs a.i./acre	Yes	Injury	88269/Stansly *et al*. (1999)
	≥4.0 lbs a.i./acre	Yes	Biomass	89472/McLeod (1972)
Wild celery (*Apium graveolens*)	≥0.9 lbs a.i./acre	Yes	Injury	82728/Carson *et al*. (1994)

[1] 'Highest Level Tested' refers to whether the NOAEL represents the highest level tested.
[2] 'Effect Measured' refers to the effect that was measured in the study. Because the NOAELs represent the highest level tested in each study, no adverse effects to plants were observed in any of the studies.

4.4. Toxicity of Chemical 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 (U.S., EPA 2004; USFWS/NMFS 2004).

Methomyl has registered products that contain multiple active ingredients. Analysis of the available acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **APPENDIX A**. The results of this analysis show that the formulated product (Stimukil fly bait, EPA Reg. No. 53871-3) is more toxic to the laboratory rat than is the technical grade active ingredient. As a result, scatter bait uses under this formulation label are modeled with the formulation toxicity data. With regard to scatter bait and remaining assessed uses, the RQs based on the technical grade active ingredient toxicity data exceed Agency LOCs; refinement to the endpoint based on the formulated product is not expected to alter risk conclusions.

A List of accepted literature on mixtures is available in **APPENDIX F**.

4.5. Incident Database Review

Preliminary reviews of the Ecological Incident Information System (EIIS, version 2.1) and the Avian Incident Monitoring System (AIMS)[9] were conducted on February 17, 2010 and again on July 23, 2012. A total of 12 EIIS incidents associated with methomyl use (not including those classified as 'unlikely' due to methomyl use) have been reported (10 involving terrestrial organisms – birds, opossums, and plants -and 2 involving aquatic organisms – all fish). The reported incidents occurred between 1978 and 2010. The certainty in which these incidents were a result of methomyl use was described as highly probable in three incidents, highly likely in two incidents, probable in four incidents, and possible in three incidents. Two of the incidents were the result of registered use, five were the result of misuse (intentional baiting); however, it is unknown if the other five incidents resulted from misuse or registered uses. Two additional cases were reported in AIMS. Specific details of the incidents are described below.

In addition to the incidents recorded in EIIS and AIMS, additional incidents have been reported to the Agency in aggregated incident reports, within the US EPA Office of Pesticide Programs Incident Data System. Pesticide registrants report certain types of incidents to the Agency as aggregate counts of incidents occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as 'minor fish and wildlife' (W-B), 'minor plant' (P-B), and 'other non-target' (ONT) incidents. 'Other non-target' incidents include reports of

[9] http://www.abcbirds.org/abcprograms/policy/pesticides/aims/aims/index.cfm

adverse effects to insects and other terrestrial invertebrates. For methomyl, as of July 23, 2012 registrants have reported 7 minor fish and wildlife incidents, all of which occurred between 1999 and 2011. The number of individual organisms affected in these incidents was not specified. Unless additional information on these aggregated incidents become available, they are assumed to be representative of registered uses of methomyl in the risk assessment.

Due to limitations with data in the EIIS, a low number or lack of reported incidents in the database cannot be construed as evidence that additional incidents have not occurred. Incident reports for non-target plants and animals typically provide information on mortality events only. Reports for other adverse effects, such as reduced growth or impaired reproduction, are rarely received. EPA's changes in the registrant reporting requirements of incidents may also account for the reduced number of reported incidents. Registrants are now only required to submit detailed information on 'major' incidents. Minor incidents are generally reported aggregately and are not included in EIIS. In addition, there have been reductions in state monitoring efforts due to lack of resources.

4.5.1. Terrestrial Incidents

Five of the terrestrial incidents (one from New York, one from Maine, two from Florida, and one from Greece) were the result of intentional baiting and involved mortality in the following birds: rock dove (*Columba livia*), egret (species not provided), crow (*Corvis* sp.), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), Eleanora's falcon (*Falco eleonorae*), and grackle (*Quiscalus spp*.) [Incident #/Event ID: (EIIS) I009064-001, I011181-001, and I017139-001; (AIMS) 1841 and 1953]. The legality of use for another of the incidents, which occurred in the British Virgin Islands and involved the death of 13 laughing gulls (*Larus articilla*) and one cattle egret (*Bubulcus ibis*), was undetermined (Incident #: I018980-010). Oxamyl, which is classified as very highly toxic to birds on an acute exposure basis, was also suspected in this incident. Two of the incidents occurred in France and involved the registered use (in France) of methomyl on cabbage (methomyl is also registered for use on cabbage in the United States). Incident # I006382-001 occurred in 1989 from a foliar spray of methomyl at a rate of 0.225 lbs a.i./acre. This incident, which was classified as 'probable', resulted in the mortality of at least 52 finches. The other French incident (I006382-002; 1992) was also classified as 'probable' and involved the registered use of methomyl (foliar spray) on cabbage. This incident involved the incapacitation of 31 birds and mortality in 35 birds (finches and linnets) after the birds were observed drinking dew from the cabbage field the day after methomyl application. An incident (I021455-003) occurred in Florida and was reported by the National Wildlife Health Center (NWHC), USGS, on 12/05/2009. The report indicates that 31 vultures and 3 Virginia opossums were found sick or dead. Diagnostic evaluation found methomyl toxicosis making methomyl as a 'highly probable' cause. There was 82% ChE inhibition with complete reversal upon incubation. Report states that no bait or human presence was found. The use site and application- whether legal or not- is unknown.

The AIMS reports indicate a couple of incidents resulted from abuse of product. An incident (Case 03-0206; Event #1953; 2003) in Hancock County, ME (East Orland) indicated that methomyl was highly likely to be responsible for the deaths of an unknown number of crows and red-tailed hawks. The other incident (Case 00-0152; Event #1841; 2000) in Seminole County, FL indicated that methomyl was highly likely to be responsible for the death of one egret. These determinations were made on the basis of a chemical residue analysis on carcasses and circumstances clearly indicative of poisoning.

4.5.2. Plant Incidents

An incident on melons was reported twice for Yuma County, AZ, once by Bayer Crop Science on 9/7/2010 (Incident # I022338-002) and again by DuPont Crop Protection on 10/21/2010 (Incident # I022338-001). On September 7, 2010 and Aug 30, 2010 a fall melon crop suffered damage to older, treated leaves after a tank mix application of the following products DuPont Lannate® S (a.i. methomyl, PC Code 090301) and Valent Danitol (a.i. Fenpropathrin, PC Code 127901) insecticides. The older leaves on the melon plants suffered very light speckling and symptoms were observed two days after the ground application. The incidents classified methomyl as a 'possible'cause and legality of the application was undetermined.

4.5.3. Aquatic Incidents

In a report from the California Fish and Game Department (Incident # I013436-001), there was a large fish kill, *i.e*., several thousand threadfin shad (*Dorosoma petenense*) and catfish (*Ictalurus spp*.), in the San Joaquin River near the town of Lathrop, California on October 16, 2001. The treatment site is unknown, and it is unknown if the kill was the result of misuse or registered use. The certainty that the kill resulted from methomyl was listed as 'possible'. However, upon further review of the incident, it was acknowledged by California Fish and Game that un-ionized ammonia was the cause of the fish kill. Analyses of composited gill samples found the presence of several pesticides (*i.e*., dioxathion = 121.1 ppm; carbaryl = 1.75 ppm; carbofuran = 4.51 ppm; fenuron = 0.78 ppm; methomyl = 5.08 ppm; monuron = 5.83 ppm). However, these pesticides were not detected in the water samples and no mention was made in the California Fish and Game report that these pesticides may have been important factors in the fish kill.

A fish kill incident occurred in Seminole County, Georgia, on June 16, 1992 (Incident # I00108-001). The treatment site was corn, and it is unknown if the kill was the result of misuse or registered use. Also, the certainty that the kill resulted from methomyl was listed as 'probable'. Upon further review of the incident report, it was assumed that runoff from a 200-acre plot of sweet corn treated with fertilizer and insecticides killed 125 bluegill, bowfin (*Amia calva*), and carp (*Cyprinus spp*). During a rainy two week period prior to the fish kill, the corn plot had been treated with 5 applications of methomyl (aerial, 1.5 pints/acre), 4 applications of chlorpyrifos, 4 applications of fertilizer, and 2 applications of borax. The suspected cause of the fish kill was methomyl, as Lannate LV, toxicosis. Measured concentrations of methomyl were found in water samples taken from the pond and pond-overflow area.

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

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

Individual effect probabilities are calculated based on an Excel spreadsheet tool IEC v1.1 (Individual Effect Chance Model Version 1.1) developed by the U.S. EPA, OPP, Environmental Fate and Effects Division (June 22, 2004). The model allows for such calculations by entering the mean slope estimate (and the 95% confidence bounds of that estimate) as the slope parameter for the spreadsheet. In addition, the acute RQ is entered as the desired threshold.

Table 4-6. Individual Effect Probabilities Using the IEC v 1.1 Model

Taxa represented	Surrogate species (most senstitive)	Endpoint (LC_{50} or LD_{50})	MRID	Uses[1] (RQ)	Slope[2]	Chance of Individual effect (~1 in…) for Min RQ[3]	Chance of Individual effect (~1 in…) for Max RQ[3]	SF Bay Species (direct effect)	SF Bay Species (indirect effect)
Freshwater fish and aquatic-phase amphibians	Channel catfish (*Ictalurus punctatus)*	96-hr LC_{50} = 0.320 mg a.i./L	40098001	Anise (0.05), turf, celery, alfalfa, scatter bait, cabbage (0.19)	4.23	5.37×10^{7}	877	TG, DS, CTS	SFGS, CCR, CTS
					2.32	787	21.2		
					6.15	1.62×10^{15}	218,000		
Freshwater invertebrates	Daphnid (*Daphnia magna*)	48-hr EC_{50} = 0.005 mg a.i./L	40098001	Sorghum (0.50), avocado, corn, onion, corn at higher app, anise, turf, celery, alfalfa, scatter bait, cabbage (12.38)	3.45	6.69	1	CFS	CFS, SFGS, CCR, CTS, TG, DS
					1.12	2.72	1.12		
					5.79	24.6	1		
Estuarine/marine fish	Sheepshead minnow (*Cyprinodon variegatus*)	96-hr LC_{50} = 1.16 mg a.i./L	41441202	Cabbage (0.05)	8.0	8.8×10^{24}	8.8×10^{24}	TG, DS	CCR
					5.16	1.05×10^{11}	1.05×10^{11}		
					10.83	4.58×10^{44}	4.58×10^{44}		
Estuarine/marine invertebrates	Northern pink shrimp (*Penaeus duorarum*	96-hr LC_{50} = 0.019 mg a.i./L	00009134	Sorghum (0.13), avocado, corn, onion, corn at higher app, anise, turf, celery, alfalfa, scatter bait, cabbage (3.26)	4.5	29,900	1.01	---	CCR, TG, DS
					2	26.2	1.18		
					9	1.31×10^{15}	1		
Birds, Reptiles, and Terrestrial-Phase Amphibians (T-REX, 20g bird consuming short grass)	Bobwhite quail (*Colinus virginianus*)	LD_{50} = 24.2 mg/kg-bw	00161886	Sorghum (0.12, dietary-based), cole crops (27.97, dose-based)	4.5	58,500	1	SFGS, CCR, CTS	SFGS, CCR, CTS
					2	30.5	1		
					9	1.73×10^{16}	1		
Birds, Reptiles, and Terrestrial-Phase Amphibians (T-REX, 20g bird consuming arthropods)	Bobwhite quail (*Colinus virginianus*)	LD_{50} = 24.2 mg/kg-bw	00161886	Bulbs, grasses, herbs, alfalfa, non-cole leafy crops (0.10, dietary-based), cole crops (10.96, dose-based)	4.5	294,000	1	SFGS, CCR, CTS	SFGS, CCR, CTS
					2	44	1.02		
					9	8.86×10^{18}	1		

Birds, Reptiles, and Terrestrial-Phase Amphibians (T-HERPS, 20g)	Bobwhite quail (*Colinus virginianus*)	LD_{50} = 24.2 mg/kg-bw	00161886	Sorghum (0.12, dietary-based), cole crops (16.44, dose based)	4.5	58,500	1	CTS [refinement]	CTS [refinement]
					2	30.5	1.01		
					9	1.73×10^{16}	1		
Birds, Reptiles, and Terrestrial-Phase Amphibians (T-HERPS, 20g)	Bobwhite quail (*Colinus virginianus*)	LD_{50} = 24.2 mg/kg-bw	00161886	Avocado (0.15, dietary-based), cole crops (23.29 dose-based)	4.5	9,560	1	SFGS [refinement]	SFGS [refinement]
					2	20.1	1		
					9	1.65×10^{13}	1		
Mammals (T-REX, 15g)	Laboratory rat (*Rattus norvegicus*)	LD_{50} = 30 mg a.i./kg-bw	42140101	Sorghum (1.95, dose-based), cole crops (7.25, dose-based)	4.5	1.11	1	---	SFGS, CCR, CTS
					2	1.39	1.04		
					9	1	1		
Terrestrial Invertebrates	Honey bee (*Apis mellifera*)	LD_{50} = 0.16 µg a.i./bee	45093001	Sorghum (42.30), cole crops (157.12)	4.33	1	1	BCB, VELB	SFGS, CCR, CTS
					3.37	1	1		
					5.30	1	1		

[1] Uses for which the acute RQ exceeds the listed species LOC for the given taxon category. The lowest exceeded RQ and the highest exceeded RQ is in brackets.
[2] Default value for slope is 4.5, with upper and lower bounds of 2 and 9
[3] Acute RQs provide a min/max range and depend on uses that exceeded acute listed species LOC of 0.05 for aquatic organisms and 0.1 for terrestrial organisms

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 SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG or for modification to their designated critical habitat from the use of methomyl in CA. The risk characterization provides an estimation (Section 5.1) and a description (Section 5.2) of the likelihood of adverse effects; articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the likelihood of adverse effects to the assessed species or their designated critical habitat (*i.e.*, “no effect,” “likely to adversely affect,” or “may affect, but not likely to adversely affect”). In the risk estimation section, risk quotients are calculated using standard EFED procedures and models. In the risk description section, additional analyses may be conducted to help characterize the potential for risk.

5.1. Risk Estimation

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

Acute and chronic risks to aquatic organisms are estimated by calculating the ratio of exposure to toxicity using 1-in-10 year EECs in **Table 3-3** based on the label-recommended methomyl usage scenarios summarized in **Table 3-1** and the appropriate aquatic toxicity endpoint from **Table 4-1**. Acute and chronic risks to terrestrial animals are estimated based on exposures resulting from applications of methomyl (**Table 3-4)**, corresponding EECs (**Tables 3-5, 3-6, 3-7,** and **3-8)** and the appropriate toxicity endpoint from **Table 4-3**. Exposures, however, were not derived for terrestrial plants, given the lack of toxicity data.

5.1.1. Exposures in the Aquatic Habitat

5.1.1.a. Freshwater Fish and Aquatic-phase Amphibians

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

Table 5-1. Acute and Chronic RQs for Freshwater Fish and/or Aquatic-Phase Amphibians and Reptiles (Surrogate: Channel Catfish)

Uses/Application Rate (in lbs a.i./A)/ Frequency (per year) / Interval (in days)	Peak EEC (mg/L)	60-day EEC (mg/L)	Acute RQ*	Chronic RQ*
Onions/0.9/6/5	0.0091	0.0025	0.03	0.21
Corn / 0.45/14/1	0.0102	0.0031	0.03	0.26
Corn/0.24/ 26/1	0.0067	0.0030	0.02	0.25
Sorghum/0.45/2/5	0.0025	0.0004	0.01	0.03
Cabbage/0.9/8/2	0.0619	0.0239	**0.19**	**1.99**
Turf/0.9/4/5	0.0193	0.0089	**0.06**	0.74
Anise/0.9/5/5	0.0146	0.0072	**0.05**	0.60
Alfalfa/0.9/4/5	0.0265	0.0114	**0.08**	0.95
Celery/0.9/8/5	0.0214	0.0104	**0.07**	0.87
Scatter bait/0.22/26/5	0.0429	0.0320	**0.13**	**2.67**
Avocado/ 0.9/1/NA	0.0056	0.0015	0.02	0.13

* = LOC exceedances (acute listed species RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded. For some uses the non-listed LOCs (0.5 for acute, 0.1 acute restricted use) are exceeded.
Acute RQ = use-specific peak EEC /LC_{50}, where LC_{50} = 0.320 mg a.i./L (MRID 40098001)
Chronic RQ = use-specific 60-day EEC /NOAEC, where NOAEC = 0.012 mg a.i./L (based on ACR)

Based on the acute and chronic RQs calculated for freshwater fish (and/or aquatic-phase amphibians), methomyl has the potential to directly affect the CTS, DS, and TG for the following uses: cabbage, turf, anise, alfalfa, celery, and scatter bait. Additionally, since the acute and chronic RQs are exceeded (see values in bold for specific uses), there is also potential for indirect effects to those listed species that rely on fish (and/or aquatic-phase amphibians) during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS).

5.1.1.b. Freshwater Invertebrates

Acute risk to freshwater invertebrates is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value for freshwater invertebrates. Chronic risk is based on 1 in 10 year 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates. Risk quotients for freshwater invertebrates are shown in **Table 5-2**.

Table 5-2. Summary of Acute and Chronic RQs for Freshwater Invertebrates. (Surrogate: *Daphnia magna*)

Uses/Application Rate (in lbs a.i./A)/ Frequency (per year) / Interval (in days)	Peak EEC (mg/L)	21-day EEC (mg/L)	Acute RQ*	Chronic RQ*
Onions/0.9/6/5	0.0091	0.0047	**1.82**	**6.71**
Corn / 0.45/14/1	0.0102	0.0066	**2.04**	**9.43**
Corn/0.24/ 26/1	0.0067	0.0055	**1.34**	**7.86**
Sorghum/0.45/2/5	0.0025	0.0011	**0.50**	**1.57**
Cabbage/0.9/8/2	0.0619	0.0426	**12.38**	**60.86**
Turf/0.9/4/5	0.0193	0.0142	**3.86**	**20.29**
Anise/0.9/5/5	0.0146	0.0118	**2.92**	**16.86**
Alfalfa/0.9/4/5	0.0265	0.0201	**5.30**	**28.71**
Celery/0.9/8/5	0.0214	0.0168	**4.28**	**24.00**
Scatter bait/0.22/26/5	0.0429	0.0363	**8.58**	**51.86**
Avocado/ 0.9/1/NA	0.0056	0.0032	**1.12**	**4.57**

* = LOC exceedances (acute listed species RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded. For some uses the non-listed LOCs (0.5 for acute, 0.1 acute restricted use) are exceeded.
Acute RQ = use-specific peak EEC /EC_{50}, where EC_{50} = 0.005 mg a.i./L (MRID 40098001)
Chronic RQ = use-specific 21-day EEC /NOAEC, where NOAEC = 0.0007 mg a.i./L (MRID 01312541)

Based on the acute and chronic RQs calculated for freshwater invertebrates, methomyl (all uses) has the potential to directly affect the CFS. Additionally, since the acute and chronic LOCs are exceeded (see values in bold for specific uses), there is also potential for indirect effects to those listed species that rely on freshwater invertebrates during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, DS, CFS, and TG).

5.1.1.c. Estuarine/Marine Fish

Acute risk to estuarine/marine fish is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine fish. Chronic risk is based on 1 in 10 year 60-day EECs and the lowest chronic toxicity value for estuarine/marine fish is used. Risk quotients are shown in **Table 5-3**.

Table 5-3. Summary of RQs for Estuarine/Marine Fish (Surrogate: Sheepshead minnow)

Uses/Application Rate (in lbs a.i./A)/ Frequency (per year) / Interval (in days)	Peak EEC (mg/L)	60-day EEC (mg/L)	Acute RQ*	Chronic RQ*
Onions/0.9/6/5	0.0091	0.0025	0.01	0.01
Corn / 0.45/14/1	0.0102	0.0031	0.01	0.01
Corn/0.24/ 26/1	0.0067	0.0030	0.01	0.01
Sorghum/0.45/2/5	0.0025	0.0004	0.00	0.00
Cabbage/0.9/8/2	0.0619	0.0239	**0.05**	0.09
Turf/0.9/4/5	0.0193	0.0089	0.02	0.03
Anise/0.9/5/5	0.0146	0.0072	0.01	0.03
Alfalfa/0.9/4/5	0.0265	0.0114	0.02	0.04
Celery/0.9/8/5	0.0214	0.0104	0.02	0.04
Scatter bait/0.22/26/5	0.0429	0.0320	0.04	0.12
Avocado/ 0.9/1/NA	0.0056	0.0015	0.00	0.01
* = LOC exceedances (acute listed species RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded. Acute RQ = use-specific peak EEC /LC_{50}, where LC_{50} = 1.16 mg a.i./L (MRID 41441202) Chronic RQ = use-specific 60-day EEC /NOAEC, where NOAEC = 0.260 mg a.i./L (MRID 45013202)				

Based on the acute and chronic RQs calculated for estuarine/marine fish, methomyl has a low potential to directly affect the DS and TG from the assessed uses. Additionally, since the acute and chronic RQs are not exceeded (a single RQ for the cabbage use is at the acute listed species LOC, however), there is also low potential for indirect effects to those listed species that rely on estuarine/marine fish during at least some portion of their life-cycle (*i.e.*, CCR).

5.1.1.d. Estuarine/Marine Invertebrates

Acute risk to estuarine/marine invertebrates is based on peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine invertebrates. Chronic risk is based on 21-day EECs and the lowest chronic toxicity value for estuarine/marine invertebrates. Risk quotients are shown in **Table 5-4**.

Table 5-4. Summary of Acute and Chronic RQs for Estuarine/Marine Invertebrates (Surrogate: Northern pink shrimp)

Uses/Application Rate (in lbs a.i./A)/ Frequency (per year) / Interval (in days)	Peak EEC (mg/L)	21-day EEC (mg/L)	Acute RQ*	Chronic RQ*
Onions/0.9/6/5	0.0091	0.0047	**0.48**	**1.96**
Corn / 0.45/14/1	0.0102	0.0066	**0.54**	**2.75**
Corn/0.24/ 26/1	0.0067	0.0055	**0.35**	**2.29**
Sorghum/0.45/2/5	0.0025	0.0011	**0.13**	0.46
Cabbage/0.9/8/2	0.0619	0.0426	**3.26**	**17.75**
Turf/0.9/4/5	0.0193	0.0142	**1.02**	**5.92**
Anise/0.9/5/5	0.0146	0.0118	**0.77**	**4.92**
Alfalfa/0.9/4/5	0.0265	0.0201	**1.39**	**8.38**
Celery/0.9/8/5	0.0214	0.0168	**1.13**	**7.00**
Scatter bait/0.22/26/5	0.0429	0.0363	**2.26**	**15.13**
Avocado/ 0.9/1/NA	0.0056	0.0032	**0.29**	**1.33**
* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded and shaded. For some uses the non-listed LOCs (0.5 for acute, 0.1 acute restricted use) are exceeded. Acute RQ = use-specific peak EEC /LC_{50}, where LC_{50} = 0.019 mg a.i./L (MRID 00009134) Chronic RQ = use-specific 21-day EEC /NOAEC, where NOAEC = 0.0024 mg a.i./L (based on ACR)				

Based on the acute and chronic RQs calculated for estuarine/marine invertebrates, methomyl (all uses) has the potential to directly affect estuarine/marine invertebrates. As a result, there is potential for indirect effects to those listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, DS, and TG).

5.1.1.e. Non-vascular and Vascular Aquatic Plants

An open literature study (Record #: 118717, Pereira *et al.*2009) quantifying the growth inhibition in *P. subcapitata* (a microalgae) after Lannate (200g a.i./L methomyl formulation) and methomyl (99.5% purity) exposure indicates a 96-hour EC_{50} of 184 mg a.i./L (95% CI of 164-206 mg a.i./L for Lannate) and a 96-hour EC_{50} of 108 mg a.i./L (95% CI of 87-126 mg a.i./L for methomyl a.i.). Additional 96-hour EC_{50} values are available for a different species, *Selenastrum capricornutum* from the following carbamates: thiodicarb (EC_{50} >8.3 mg a.i./L, MRID 42324801) and pirimicarb (EC_{50}: 120 mg a.i./L, 95% CI: 110-120 mg a.i./L, MRID 44883925). Growth and cell density inhibition were the observed effects in these studies. The definitive endpoint for the active ingredient pirimicarb is comparable to that of methomyl a.i. and falls within the confidence interval reported in the open literature study. Over a longer exposure period and with a different non-vascular species, however, sensitivity to carbamates increases. For example, 5-day EC_{50} values for *Navicula* sp. are 0.60 mg a.i./L (MRID 42431601) for carbaryl and 0.12 mg a.i./L (MRID 45546104) for oxamyl based on an effect to cell density.

A similar effect of study duration is observed in the vascular species, *Lemna gibba* (or duckweed), whereby a 7-day aldicarb study yielded an EC_{50} of 110 mg a.i./L (an extrapolated value, MRID 47904402) based on an effect on dry weight and two 14-day studies indicated a greater sensitivity (based on reduced number of fronds) to carbamates, carbaryl (1.5 mg/L, MRID 42372102) and oxamyl (30 mg a.i./L, MRID 45546103).

PRZM/EXAMS modeled peak EECs range from 0.0025-0.0619 mg a.i./L, which are 4 orders of magnitude lower than the concentrations at which the effect on the non-vascular plants was observed in the methomyl open literature study and the pirimicarb study and 1 to 4 orders of magnitude lower than the the concentrations at which the effect on the vascular plants and 5-day non-vascular plants was observed for the remaining carbamates. Based on the available lines of evidence from the open literature and data submitted for other carbamate insecticides with similar modes of action, methomyl is unlikely to result in direct effects to non-vascular and vascular plants and, by extension, indirect effects to species that rely on non-vascular plants during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, DS, CFS, and TG).

5.1.2. Exposures in the Terrestrial Habitat

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

As previously discussed in Section 3.3, potential direct effects to terrestrial species are based on foliar, granular, and scatter bait applications of methomyl. Granular applications to corn whorls using methomyl 5G Granules formulation were calculated using the LD_{50}/ft^2 option in T-REX v. 1.5. Similarly, scatter bait applications using Stimukil fly bait formulation were calculated using the LD_{50}/ft^2 option in T-REX v. 1.5.

Potential risks to birds and, thus, terrestrial-phase amphibians are evaluated using T-REX, acute and chronic toxicity data for the most sensitive bird species for which data are available, and the most sensitive dietary item and size class for that species. For terrestrial-phase amphibians, the most conservative RQ in T-REX is for the small bird consuming small insects. For birds the most conservative RQ in T-REX is for the small bird consuming short grass.

The LD_{50}/ft^2 analysis for granular application to sweet corn whorls was done for the 20g bird, assuming the following: a maximum single application rate of 0.15 lbs a.i./A with 0% incorporation. Four combinations of the row spacing (15 and 30 inches) and bandwidth (8 and 12 inches) were used under the rows/band/in-furrow granular application option; the range of RQs is 4.78-14.35 for a 20g bird, with the 30in row spacing and 8in bandwith contributing the highest RQ estimates. In addition, the broadcast granular application option, yieleded an RQ of 3.83 for a 20g bird. All RQs exceed the listed species LOC (0.1) as well as the acute and acute restricted use LOCs (0.5 and 0.2, respectively).

The LD_{50}/ft^2 analysis for scatter bait application to areas outside of certain commercial establishments (e.g., feed lots, poultry houses, livestock barns, canneries, beverage plants, meat and poultry processing establishments, commercial refuse dumpsters, and food processing plants) was also done for the 20g bird assuming the following: a maximum single application rate of 0.2178 lbs a.i./A applied only once at 0% incorporation. The broadcast granular application option yieleded an RQ of 5.55 for a 20g bird. This RQ exceeds the listed species LOC (0.1) as well as the acute and acute restricted use LOCs (0.5 and 0.2, respectively).

T-HERPS is used to assess potential risk to snakes and as a refinement to RQs for amphibians if T-REX indicates potential risk to amphibians. Small snakes and amphibians only consume insects while medium and large snakes and amphibians consume small and large insects, mammals, and amphibians. The most sensitive RQ for snakes and amphibians are for medium snakes consuming small herbivore mammals.

Potential direct acute effects to the CCR, CTS (all DPS), and SFGS are evaluated using dose- and dietary-based EECs modeled in T-REX for small (20 g, juveniles) birds consuming short grass (**Table 3-5**) and acute oral and subacute dietary toxicity endpoints for avian species (**Table 4-3**).

Potential direct acute effects to the CTS and SFGS are evaluated by considering dose- and dietary-based EECs modeled in T-HERPS for medium amphibians and/or snakes consuming small herbivorous mammals (**Tables 3-7** and **3-8**) and acute oral and subacute dietary toxicity endpoints for avian species (**Table 4-3**).

Potential indirect effects to the CCR, SFGS, and CTS may result from direct acute effects to birds and/or amphibians due to a reduction in prey. RQs for indirect effects are calculated in the same manner as those for direct effects; however, the indirect effect RQs are compared to the non-listed LOC (acute and acute restricted use LOCs, 0.5 and 0.2, respectively). The most conservative EEC calculated in T-REX is for small birds consuming short grass.

Potential direct chronic effects to the birds (including CCR), CTS (all DPS), and SFGS are evaluated by considering dietary-based EECs modeled in T-REX and T-HERPS consuming a variety of dietary items. The specific EECs for each species are for the same size birds and same dietary items as those considered for acute exposure. Chronic effects are estimated using the lowest available NOAEC from a chronic study for birds. Dietary-based EECs are divided by toxicity values to estimate chronic dietary-based RQs.

Acute and chronic RQs for the birds (including CCR), CTS (all DPS), and SFGS derived using T-REX are shown in **Table 5-5**.

Table 5-5. Acute and Chronic RQs Derived Using T-REX for Methomyl: Birds (including CCR), CTS (all DPS), and SFGS consuming short grass

Use Type	RQs for Birds (including CCR), CTS (all DPS) and SFGS (small bird 20g consuming short grass)		
	Acute Dose-Based[1]	**Acute Dietary Based[2]**	**Chronic Dietary Based[3]**
Bulbs	**16.06**	**0.26**	**1.92**
Cereal grains (corn-14x)	**24.37**	**0.40**	**2.91**
Cereal grains (corn-28x)	**12.44**	**0.20**	**1.49**
Cereal grains (sp. sorghum)	**7.53**	**0.12**	0.9
Cole crops	**27.97**	**0.46**	**3.34**
Grasses	**16.00**	**0.26**	**1.91**
Herbs	**16.05**	**0.26**	**1.92**
Leguminous forage (alfalfa)	**16.00**	**0.26**	**1.91**
Non-cole leafy crops	**16.07**	**0.26**	**1.92**
Avocado	**12.05**	**0.20**	**1.44**

*LOC exceedances (acute listed species RQ ≥ 0.1 and chronic RQ ≥ 1.0) are bolded. For some uses the non-listed LOCs (0.5 for acute, 0.2 acute restricted use) are exceeded.
[1]Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} = 24.2 mg/kg-bw (MRID 00161886)
[2]Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 1,100 mg/kg-diet (MRID 00022923).
[3]Based on dietary-based EEC and Northern bobwhite quail NOAEC = 150 mg/kg-diet (MRID 41898602)

Table 5-6. Acute and Chronic RQs Derived Using T-REX for Methomyl: Birds (including CCR), CTS (all DPS), and SFGS consuming arthropods

Use Type	RQs for Birds (including CCR), CTS (all DPS) and SFGS (small bird 20g consuming arthropods)		
	Acute Dose-Based[1]	**Acute Dietary Based[2]**	**Chronic Dietary Based[3]**
Bulbs	**6.29**	**0.10**	0.75
Cereal grains (corn-14x)	**9.54**	**0.16**	**1.14**
Cereal grains (corn-28x)	**4.87**	0.08	0.58
Cereal grains (sp. sorghum)	**2.95**	0.05	0.35
Cole crops	**10.96**	**0.18**	**1.31**
Grasses	**6.27**	**0.10**	0.75
Herbs	**6.29**	**0.10**	0.75
Leguminous forage (alfalfa)	**6.27**	**0.10**	0.75
Non-cole leafy crops	**6.29**	**0.10**	0.75
Avocado	**4.72**	0.08	0.56

*LOC exceedances (acute RQ ≥ 0.1 and chronic RQ ≥ 1.0) are bolded. For some uses the non-listed LOCs (0.5 for acute, 0.2 acute restricted use) are exceeded.
[1]Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} = 24.2 mg/kg-bw (MRID 00161886)
[2]Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 1,100 mg/kg-diet (MRID 00022923).
[3]Based on dietary-based EEC and Northern bobwhite quail NOAEC = 150 mg/kg-diet (MRID 41898602)

Based on the calculated acute and chronic RQs for 20g birds consuming short grass and arthropods, methomyl has the potential to directly affect the CCR, CTS (all DPS) and the SFGS for all uses including the granular use on sweet corn whorls and scatter bait. Additionally, since the acute and chronic RQs are exceeded, there is a potential for indirect effects to those listed species that rely on birds (and, thus, reptiles and/or terrestrial-phase amphibians) during at least some portion of their life-cycle (*i.e.*, CCR, CTS (all DPS), and the SFGS).

A refinement of the RQs for the CTS and SFGS using T-HERPS is provided below **Table 5-7** and **Table 5-8**. The amphibian CTS default weights are 2, 20, and 200g; the reptile SFGS default weights were 2, 20, and 800g. The maximum size mammal that can be consumed by the three amphibian size classes are 1.33, 13.33, and 133.33g, respectively [based on the default assumption that an amphibian can eat 2/3 of its body weight, Cook 1997]; the maximum size amphibian/reptile that can be consumed by the three reptile size classes are 2.10, 24.74, and 1285.91g, respectively [based on the equation: BW of assessed species$^{1.071}$, King 2002]. The percent water content for all herptile size classes was assumed to be 80%.

Table 5-7. Acute and Chronic RQs Derived Using T-HERPS for Methomyl: CTS (all DPS) consuming small insects and herbivorous mammals

Use Type	RQs for Small CTS (2g) (small bird 2g consuming small insects)			RQs for Medium CTS (20g) (medium bird 20g consuming small/medium herbivorous mammals of 1.33g/13.33g)		
	Acute Dose-Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]	Acute Dose-Based[1]	Acute Dietary Based[2,a]	Chronic Dietary Based[3,a]
Bulbs	**0.53**	**0.15**	**1.08**	**9.44**	**0.26**	**1.93**
Cereal grains (corn-14x)	**0.80**	**0.22**	**1.64**	**14.32**	**0.40**	**2.92**
Cereal grains (corn-28x)	**0.41**	**0.11**	0.84	**7.31**	**0.20**	**1.49**
Cereal grains (sp. sorghum)	**0.25**	0.07	0.51	**4.42**	**0.12**	0.90
Cole crops	**0.92**	**0.26**	**1.88**	**16.44**	**0.46**	**3.36**
Grasses	**0.53**	**0.15**	**1.08**	**9.40**	**0.26**	**1.92**
Herbs	**0.53**	**0.15**	**1.08**	**9.43**	**0.26**	**1.93**
Leguminous forage (alfalfa)	**0.53**	**0.15**	**1.08**	**9.40**	**0.26**	**1.92**
Non-cole leafy crops	**0.53**	**0.15**	**1.08**	**9.44**	**0.26**	**1.93**
Avocado	**0.40**	**0.11**	0.81	**7.08**	**0.20**	**1.45**

*LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded. For some uses the non-listed LOCs (0.5 for acute, 0.2 acute restricted use) are exceeded.
[1]Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} = 24.2 mg/kg-bw (MRID 00161886)
[2]Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 1,100 mg/kg-diet (MRID 00022923).
[3]Based on dietary-based EEC and Northern bobwhite quail NOAEC = 150 mg/kg-diet (MRID 41898602)
[a]RQ for medium-sized herbivorous mammal (of 13.33g)

Table 5-8. Acute and Chronic RQs Derived Using T-HERPS for Methomyl: SFGS consuming small insects and herbivorous mammals

Use Type	RQs for Small SFGS (2g) (small bird 2g consuming small insects)			RQs for Medium SFGS (20g) (medium bird 20g consuming small/medium herbivorous mammals of 2.10g/24.74g)		
	Acute Dose-Based[1]	Acute Dietary Based[2]	Chronic Dietary Based[3]	Acute Dose-Based[1]	Acute Dietary Based[2,a]	Chronic Dietary Based[3,a]
Bulbs	**0.53**	**0.15**	**1.08**	**13.37**	**0.20**	**1.47**
Cereal grains (corn-14x)	**0.80**	**0.22**	**1.64**	**20.29**	**0.30**	**2.23**
Cereal grains (corn-28x)	**0.41**	**0.11**	0.84	**10.35**	**0.16**	**1.14**
Cereal grains (sp. sorghum)	**0.25**	0.07	0.51	**6.27**	0.09	0.69
Cole crops	**0.92**	**0.26**	**1.88**	**23.29**	**0.35**	**2.56**
Grasses	**0.53**	**0.15**	**1.08**	**13.32**	**0.20**	**1.47**
Herbs	**0.53**	**0.15**	**1.08**	**13.36**	**0.20**	**1.47**
Leguminous forage (alfalfa)	**0.53**	**0.15**	**1.08**	**13.32**	**0.20**	**1.47**
Non-cole leafy crops	**0.53**	**0.15**	**1.08**	**13.38**	**0.20**	**1.47**
Avocado	**0.40**	**0.11**	0.81	**10.03**	**0.15**	**1.10**

*LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded. For some uses the non-listed LOCs (0.5 for acute, 0.2 acute restricted use) are exceeded.
[1]Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} = 24.2 mg/kg-bw (MRID 00161886)
[2]Based on dietary-based EEC and Northern bobwhite quail subacute dietary LC_{50} = 1,100 mg/kg-diet (MRID 00022923).
[3]Based on dietary-based EEC and Northern bobwhite quail NOAEC = 150 mg/kg-diet (MRID 41898602)
[a]RQ for medium-sized herbivorous mammal (of 24.74g)

Based on the calculated acute and chronic RQs for small 2g CTS/SFGS and medium 20g CTS/SFGS consuming small insects and herbivorous mammals, T-HERPS calculations further confirm that methomyl does have the potential to directly affect the CTS (all DPS) and the SFGS for all assessed uses. Additionally, since the acute and chronic RQs are exceeded, there is a potential for indirect effects to those listed species that rely on reptiles and terrestrial-phase amphibians during at least some portion of their life-cycle (*i.e.*, CTS (all DPS), and the SFGS).

5.1.2.b. Mammals

Potential risks to mammals are evaluated using T-REX, acute and chronic mammalian toxicity data, and a variety of body-size and dietary categories. As previously discussed in Section 3.3, potential direct effects to terrestrial species are based on foliar, granular, and scatter bait applications of methomyl. Granular applications to corn whorls using methomyl 5G Granules formulation were calculated using the LD_{50}/ft^2 option in T-REX v. 1.5. Similarly, scatter bait applications using Stimukil fly bait formulation were calculated using the LD_{50}/ft^2 option in T-REX v. 1.5

The LD_{50}/ft^2 analysis for granular application to sweet corn whorls was done for the 15g mammal, assuming the following: a maximum single application rate of 0.15 lbs a.i./A with 0% incorporation. Four combinations of the row spacing (15 and 30 inches) and bandwidth (8 and 12 inches) were used under the rows/band/in-furrow granular application option; the range of RQs is 1.97-5.92 for a 15g mammal, with the 30in row spacing and 8in bandwith contributing the highest RQ estimates. In addition, the broadcast granular application option, yieleded an RQ of 1.58 for a 15g mammal. All RQs exceed the listed species LOC (0.1) as well as the acute and acute restricted use LOCs (0.5 and 0.2, respectively).

The LD_{50}/ft^2 analysis for scatter bait application to areas outside of certain commercial establishments (e.g., feed lots, poultry houses, livestock barns, canneries, beverage plants, meat and poultry processing establishments, commercial refuse dumpsters, and food processing plants) was also done for the 15g mammal assuming the following: a maximum single application rate of 0.2178 lbs a.i./A applied only once at 0% incorporation. The broadcast granular application option yieleded an RQ of 4.91 for a 20g mammal. The formulation based endpoint (LD_{50}) of 14 mg a.i./kg-bw for the laboratory rat was used for the RQ calculation. When the active ingredient endpoint was used for the calculation, the RQ was 2.29. Both of these RQs exceed the listed species LOC (0.1) as well as the acute and acute restricted use LOCs (0.5 and 0.2, respectively).

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

Potential direct chronic effects to the mammals are evaluated by considering dietary-based EECs modeled in T-REX consuming a variety of dietary items. The specific EECs for each species are for the same size mammals and same dietary items as those considered for acute exposure. Chronic effects are estimated using the lowest available NOAEC from a chronic reproductive study for mammals. Dietary-based EECs are divided by toxicity values to estimate chronic dietary-based RQs.

Table 5-9. Acute and Chronic RQs Derived Using T-REX for Methomyl and Mammals

Use Type	RQs for Small Mammals (15g) (small mammals consuming short grass)			RQs for Large Mammals (1000g) (large mammal consuming short grass)		
	Acute Dose-Based	Chronic Dietary Based	Chronic Dose Based	Acute Dose-Based	Chronic Dietary Based	Chronic Dose Based
Bulbs	**4.16**	**3.84**	**33.31**	**1.91**	**3.84**	**15.25**
Cereal grains (corn-14x)	**6.32**	**5.82**	**50.53**	**2.89**	**5.82**	**23.14**
Cereal grains (corn-28x)	**3.22**	**2.97**	**25.79**	**1.48**	**2.97**	**11.81**
Cereal grains (sp. sorghum)	**1.95**	**1.80**	**15.62**	**0.89**	**1.80**	**7.15**
Cole crops	**7.25**	**6.69**	**58.01**	**3.32**	**6.69**	**26.56**
Grasses	**4.15**	**3.83**	**33.19**	**1.90**	**3.83**	**15.20**
Herbs	**4.16**	**3.84**	**33.28**	**1.90**	**3.84**	**15.24**
Leguminous forage (alfalfa)	**4.15**	**3.83**	**33.19**	**1.90**	**3.83**	**15.20**
Non-cole leafy crops	**4.16**	**3.84**	**33.32**	**1.91**	**3.84**	**15.25**
Avocado	**3.12**	**2.88**	**24.99**	**1.43**	**2.88**	**11.44**

*LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded. For some uses the non-listed LOCs (0.5 for acute, 0.2 acute restricted use) are exceeded.
[1]Based on dose-based EEC and laboratory rat acute oral LD_{50} = 30 mg/kg-bw (MRID 42140101)
[2]Based on dietary-based EEC and laboratory rat NOAEL =75 mg a.i./kg-diet (MRIDs 43250701, 43769401)
[3]Based on dose-based EEC and laboratory rat NOAEL =75 mg a.i./kg-diet (MRIDs 43250701, 43769401)

Based on calculated acute and chronic RQs for 15g and 1000g mammals consuming short grass, methomyl does have the potential to directly affect listed mammals of the sizes modeled given all the uses assessed, including the granular use on sweet corn whorls and scatter bait. Additionally, since the acute and chronic RQs are exceeded, there is potential for indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle (*i.e.*, CCR, CTS (all DPS), and the SFGS).

5.1.2.c. Terrestrial Invertebrates

In order to assess the risks of methomyl to terrestrial invertebrates, the honey bee (acute contact LD_{50} of 0.16 µg a.i./bee; MRID 45093001) is used as a surrogate for terrestrial invertebrates. The toxicity value for terrestrial invertebrates is calculated by multiplying the lowest available acute contact LD_{50} of 0.16 µg a.i./bee by 1 bee/0.128g, which is based on the weight of an adult honey bee. EECs (µg a.i./g of bee) calculated by T-REX for arthropods are divided by the calculated toxicity value for terrestrial invertebrates, which is 1.25 µg a.i./g of bee. Risk quotients are shown in **Table 5-10**.

Potential for indirect effects to the SFGS, CCR, and CTS may result from direct acute effects to terrestrial invertebrates due to a reduction in prey. RQs for indirect effects are calculated in the same manner as those for direct effects.

Table 5-10. Summary of RQs for Terrestrial Invertebrates.

Use	Arthropod RQ*
Bulbs	**90.22**
Cereal grains (corn-14x)	**136.87**
Cereal grains (corn-28x)	**69.85**
Cereal grains (sp. sorghum)	**42.30**
Cole crops	**157.12**
Grasses	**89.89**
Herbs	**90.15**
Leguminous forage (alfalfa)	**89.89**
Non-cole leafy crops	**90.24**
Avocado	**67.68**
* LOC exceedances (RQ $\geq$ 0.05) are bolded.	

Based on the RQs generated from arthropod EECs, methomyl does have the potential to directly affect the BCB and VELB for all assessed uses. Additionally, since these RQs exceed the Agency's interim terrestrial invertebrate LOC, there is a potential for indirect effects to those listed species that rely on terrestrial invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, CTS (all DPS), and the SFGS).

5.1.2.d. Terrestrial Plants

Generally, for indirect effects, potential effects on terrestrial vegetation are assessed using RQs from terrestrial plant seedling emergence and vegetative vigor EC_{25} data as a screen. Since the BCB and the VELB have an obligate relationship with specific dicot plant species, the seedling emergence and vegetative vigor EC_{05} or the NOAEC for dicots are typically used to calculate RQs for indirect effects to these species via potential effects to dicots. However, no terrestrial plant data are available for RQ calculation. Although there are no acceptable terrestrial plant guideline toxicity studies available for methomyl, several efficacy studies that were conducted to test the effects of methomyl on a variety of target and non-target invertebrate pests also supplied information on effects to plants after methomyl applications. Due to a lack of information on study design and data analyses, these efficacy studies are classified as 'supplemental' and are not adequate for plant (or terrestrial invertebrate) RQ calculation. None of the studies showed any adverse effects to plants at the highest treatment levels tested (most of which were at or above the maximum allowable single application rate for methomyl of 0.9 lbs a.i./acre) and the NOAEL from the studies represented the highest treatment rates examined (see **Table 4-5**). However, because none of the studies addressed potential risks to monocots, or effects on seedling emergence and some N-methyl carbamates are plant auxins and are used to thin fruit (*e.g.*, carbaryl), risks to plants from the use of methomyl cannot be precluded using the available data. Furthermore, incident reports on melons indicate damage to older, treated leaves as a result of ground application of a methomyl formulation (see Section 4.5.2. Plant Incidents). Given the lack of toxicity data and the results of incident reports, risk to terrestrial plants cannot be precluded. Therefore, there is a potential for indirect effects to those listed species that rely on terrestrial plants (for food, habitat, etc.) during at least some portion of their life-cycle (*i.e.*, BCB, VELB, SFGS, CCR, CTS, DS, CFS, and TG).

5.1.3. Primary Constituent Elements of Designated Critical Habitat

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

5.2. Risk Description

The risk description synthesizes overall conclusions regarding the likelihood of adverse impacts leading to a preliminary effects determination (*i.e.*, "no effect," "may affect, but not likely to adversely affect," or "likely to adversely affect") for the assessed species and the potential for modification of their designated critical habitat based on analysis of risk quotients and a comparison to the Level of Concern. The final No Effect/May Affect determination is made after the spatial analysis is completed at the end of the risk description, Section 5.2.11. In Section 5.2.11, a discussion of any potential overlap between areas where potential usage may result in LAA effects and areas where species are expected to occur (including any designated critical habitat) is presented. If there is no overlap of the species habitat and occurrence sections with the Potential Area of LAA Effects a No Effect determination is made.

If the RQs presented in the Risk Estimation (Section 5.1) show no direct or indirect effects for the assessed species, and no modification to PCEs of the designated critical habitat, a preliminary "no effect" determination is made, based on methomyl's use within the action area. However, if LOCs for direct or indirect effect are exceeded or effects may modify the PCEs of the critical habitat, the Agency concludes a preliminary "may affect" determination for the FIFRA regulatory action regarding methomyl. A summary of the risk estimation results (a preliminary effects determination of "no effect" or "may affect") are provided in **Table 5-11** for direct and indirect effects to the listed species assessed here and in **Table 5-12** for the PCEs of their designated critical habitat.

Table 5-11. Risk Estimation Summary for Methomyl - Direct and Indirect Effects

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
Freshwater Fish and Aquatic-phase Amphibians	Non-listed Species (Yes)	Acute: RQs > 0.1 for cabbage and scatter bait Chronic: RQs >1 for cabbage and scatter bait	Indirect Effects: SFGS, CCR, CTS
	Listed Species (Yes)	Acute: RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait. Chronic: RQs >1 for cabbage and scatter bait	Direct Effects: CTS, DS, TG
Freshwater Invertebrates	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses Chronic: RQs >1 for all assessed uses	Indirect Effects: SFGS, CCR, CTS, DS, CFS, TG
	Listed Species (Yes)	Acute: RQs > 0.05 for all assessed uses	Direct Effects: CFS

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
		Chronic: RQs >1 for all assessed uses	
Estuarine/Marine Fish	Non-listed Species (No)	Acute: RQs are less than 0.1 for all assessed uses Chronic: RQs are less than 1 for all assessed uses	Indirect Effects: None expected.
	Listed Species (No)	Acute: A single RQ value is at the listed species LOC of 0.05 for the use on cabbage Chronic: RQs are less than 1 for all assessed uses	Direct Effects: None expected.
Estuarine/Marine Invertebrates	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses Chronic: RQs >1 for all except one assessed use (*i.e.*, sorghum)	Indirect Effects: CCR, DS, TG
	Listed Species (Yes)	Acute: RQs > 0.05 for all assessed uses Chronic: RQs >1 for all except one assessed use (*i.e.*, sorghum)	Direct Effects: None expected. as no SF Bay species for this assessment is an estuarine/marine invertebrate.
Vascular Aquatic Plants	Non-listed Species (Yes)	RQs were not calculated given no available vascular plant data. However, a review of toxicity data using other carbamates and calculated EECs for methomyl suggests that vascular plants will likely not be exposed to concentrations at which an effect is expected.	Indirect Effects: None expected.
Non-Vascular Aquatic Plants	Non-listed Species (No)	RQs were not calculated given that the open literature study was classified as qualitative. However, a comparison of endpoints (96-hr EC_{50}: 108-184 mg a.i./L) and peak EECs (0.0025-0.0619 mg a.i./L) indicates that non-vascular plants will likely not be exposed to concentrations at which an effect is expected.	Indirect Effects: None expected.
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes)	Acute: dose-based RQs >0.5 for most if not all assessed uses for small birds consuming short grass, arthropods/small insects, and herbivorous mammals Chronic: dietary-based RQs >1 for most assessed uses (except consistently sorghum) small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals Granular: 3.83-14.35 Scatter bait: 5.55	Indirect Effects: CCR, CTS, SFGS
	Listed Species (Yes)	Acute: dose and dietary-based RQs >0.1 for most assessed uses for small and medium-sized birds consuming short grass,	Direct Effects: CCR, CTS, SFGS

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected
		arthropods/small insects, and herbivorous mammals Chronic/granular/scatter bait: Same as for non-listed (above cell)	
Mammals	Non-listed Species (Yes)	Acute: dose-based RQs >0.5 for all assessed uses. Chronic: dose- and/or dietary-based RQs>0.1 for all assessed uses. Granular: 1.58-5.92 Scatter bait: 4.91	Indirect Effects: CCR, CTS, SFGS
	Listed Species (Yes)	Acute: dose-based RQs >0.1 for all assessed uses. Chronic/ granular/scatter bait: Same as for non-listed (above cell)	Direct Effects: None as no SF Bay species for this assessment is a mammal
Terrestrial Invertebrates	Listed Species (Yes)	Arthropod RQs > 0.05 (the interim terrestrial invertebrate LOC) for all uses.	Direct/Indirect Effects: BCB, VELB (direct); CCR, CTS, SFGS (indirect)
Terrestrial Plants - Monocots	Non-listed Species (Yes)	RQs were not calculated given no available terrestrial plant data. Risk was assumed.	Indirect Effects: BCB, VELB, SFGS, CCR, CTS, DS, CFS, and TG
Terrestrial Plants - Dicots	Non-listed Species (Yes)	RQs were not calculated given no available terrestrial plant data. Risk was assumed.	Indirect Effects: BCB, VELB, SFGS, CCR, CTS, DS, CFS, and TG
	Listed Species (Yes)	RQs were not calculated given no available terrestrial plant data. Risk was assumed.	Indirect Effects: BCB, VELB, SFGS, CCR, CTS, DS, CFS, and TG

Table 5-12. Risk Estimation Summary for Methomyl – Effects to Designated Critical Habitat. (PCEs)

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
Freshwater Fish and Aquatic-phase Amphibians	Non-listed Species (Yes)	Acute: RQs > 0.1 for cabbage and scatter bait Chronic: RQs >1 for cabbage and scatter bait	CTS (SB-DPS & CC DPS), DS, TG
	Listed Species (Yes)	Acute: RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait. Chronic: RQs >1 for cabbage and scatter bait	

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
Freshwater Invertebrates	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses Chronic: RQs >1 for all assessed uses	CTS (SB-DPS & CC DPS), DS, TG
Estuarine/Marine Fish	Non-listed Species (No)	Acute: RQs are less than 0.1 for all assessed uses Chronic: RQs are less than 1 for all assessed uses	None expected.
	Listed Species (No)	Acute: A single RQ value is at the listed species LOC of 0.05 for the use on cabbage Chronic: RQs are less than 1 for all assessed uses	
Estuarine/Marine Invertebrates	Non-listed Species (Yes)	Acute: RQs > 0.1 for all assessed uses Chronic: RQs >1 for all except one assessed use (*i.e.*, sorghum)	CTS (SB-DPS & CC DPS), DS, TG
Vascular Aquatic Plants	Non-listed Species (Yes)	RQs were not calculated given no available vascular plant data. However, a review of toxicity data using other carbamates and calculated EECs for methomyl suggests that vascular plants will likely not be exposed to concentrations at which an effect is expected.	None expected.
Non-Vascular Aquatic Plants	Non-listed Species (No)	RQs were not calculated given that the open literature study was classified as qualitative. However, a comparison of endpoints (96-hr EC_{50}: 108-184 mg a.i./L) and peak EECs (0.0025-0.0619 mg a.i./L) indicates that non-vascular plants will likely not be exposed to concentrations at which an effect is expected.	None expected.
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes)	Acute: dose-based RQs >0.5 for most if not all assessed uses for small birds consuming short grass, arthropods/small insects, and herbivorous mammals Chronic: dietary-based RQs >1 for most assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals Granular: 3.83-14.35 Scatter bait: 5.55	CTS (SB-DPS & CC DPS)
	Listed Species (Yes)	Acute: dose and dietary-based RQs >0.1 for most assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals Chronic/granular/scatter bait: Same as for non-listed (above	CTS (SB-DPS & CC DPS)

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
		cell)	
Mammals	Non-listed Species (Yes)	Acute: dose-based RQs >0.5 for all assessed uses. Chronic: dose- and/or dietary-based RQs>0.1 for all assessed uses. Granular: 1.58-5.92 Scatter bait: 4.91	CTS (SB-DPS & CC DPS)
Terrestrial Invertebrates	Listed Species (Yes)	Arthropod RQs > 0.05 (the interim terrestrial invertebrate LOC) for all uses.	BCB, VELB, CTS (SB-DPS & CC DPS)
Terrestrial Plants - Monocots	Non-listed Species (Yes)	RQs were not calculated given no available terrestrial plant data. Risk was assumed.	BCB, VELB, CTS (SB-DPS & CC DPS), DS, and TG
Terrestrial Plants - Dicots	Non-listed Species (Yes)	RQs were not calculated given no available terrestrial plant data. Risk was assumed.	BCB, VELB, CTS (SB-DPS & CC DPS), DS, and TG
	Listed Species (Yes)	RQs were not calculated given no available terrestrial plant data. Risk was assumed.	BCB, VELB

Following a preliminary "may affect" determination, additional information is considered to refine the potential for exposure at the predicted levels based on the life history characteristics (*i.e.*, habitat range, feeding preferences, *etc*.) of the assessed species. Based on the best available information, the Agency uses the refined evaluation to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that are "likely to adversely affect" the assessed species and its designated critical habitat.

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

- <u>Significance of Effect</u>: Insignificant effects are those that cannot be meaningfully measured, detected, or evaluated in the context of a level of effect where "take" occurs for even a single individual. "Take" in this context means to harass or harm, defined as the following:
    - Harm includes significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.
    - Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.
- <u>Likelihood of the Effect Occurring</u>: Discountable effects are those that are extremely unlikely to occur.

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

A description of the risk and effects determination for each of the established assessment endpoints for the assessed species and their designated critical habitat is provided in Sections 5.2.1 through 5.2.10. 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. In the instance where a direct effect is not supported by the evidence, but indirect effects are, then the indirect effects will be described in the direct effects section (where appropriate). Additional indirect effects are enumerated in the indirect effects section. 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 methomyl. Finally, in Section 5.2.11, 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. Freshwater Fish and Aquatic-phase Amphibians

5.2.1.a. Direct Effects

The acute RQs (0.05-0.19) and chronic RQs (1.99-2.67) for freshwater fish and aquatic-phase amphibians exceed listed species LOCs (acute: 0.05; chronic: 1). The peak model-estimated environmental concentrations resulting from different methomyl uses range from 2.5 µg/L (sorghum) to 61.9 µg/L (cole crops, particularly cabbage). The maximum concentration reported from the USDA NAWQA database for surface water was 0.67 µg/L. The maximum concentration of methomyl reported by the CDPR surface water database was 5.4 µg/L and is roughly 11.6 times *lower* than the highest peak model-estimated environmental concentration. As a result, it is believed that PRZM/EXAMS EECs provide a conservative measure of exposure. However, one aquatic incident (I00108-001) was reported in 1992 with regard to a large fish kill as a result of methomyl runoff from a 200 acre treated corn field; 125 bluegill, bowfin, and carp were killed.

Using the lowest and highest RQs (0.05-0.19) that exceed the acute listed LOC for aquatic animals (0.05), the chance of an individual mortality for freshwater fish and aquatic phase amphibians is 1 in 5.37×10^{7} to 1 in 877 for slope of 4.23 and ranges from 1 in 787 to 1 in 21.2 and 1 in 1.62×10^{15} to 218,000 for the 95% confidence limits of 2.32 and 6.15, respectively. Furthermore, spatial distribution maps for freshwater dwelling species indicates overlap between habitat and the methomyl use footprint (**APPENDIX K**).

Lastly, because freshwater fish are being used as surrogates for aquatic-phase CTS and the most sensitive acute toxicity value for methomyl is being used, an analysis of the sensitivity of freshwater fish to methomyl on an acute exposure basis was completed. Therefore, a species sensitivity distribution (SSD) for the eight freshwater fish for which acute toxicity data are available was calculated. The eight genus mean 96-h LC_{50} values used to calculate the acute

SSD for freshwater fish are listed in **Table 5-13**. This calculation is consistent with the Office of Water's approach for generating SSDs for Ambient Water Quality Criteria (AWQC). For a specific species with multiple tests available, the geometric species mean LC_{50} value for the specific species was calculated first, and then the genus mean LC_{50} was calculated.

Table 5-13. Freshwater Fish Genus and Species Mean Acute 96-Hr LC_{50} Values.

GENUS MEAN ACUTE VALUE (µg/L)	SPECIES	NUMBER OF ACUTE VALUES USED TO CALCULATE THE SPECIES MEAN VALUE	SPECIES MEAN ACUTE VALUE (µg/L)
1,996	*Pimephales promelas* Fathead minnow	4	1,996
1,590	*Salvelinus fontinalis* Brook trout	3	1,590
1,504	*Oncorhynchus mykiss* Rainbow trout	18	1,504
1,070	*Tilapia nilotica* Tilapia	1	1,070
975	*Micropterus salmoides* Largemouth bass	2	975
964	*Salmo salar* Atlantic salmon	10	964
831	*Lepomis macrochirus* Bluegill sunfish	21	831
587	*Ictalurus punctatus*[1] Channel catfish	5	587

The genus log LC_{50} values are used to calculate a SSD using a Student's t-distribution (a t-distribution was used because toxicity values were only available for eight freshwater fish genera). Therefore, a t- distribution of genus mean log LC_{50} values and log SD values was assumed in extrapolating 5th, 50th, and 95th percentile LC_{50} values for freshwater fish. All caculations were done using Excel 2003. Using this approach, the 5th percentile LC_{50} is 526 µg/L, the 50th or median percentile LC_{50} value is 1,112 µg/L, and the 95th is 2,352 µg/L (**Figure 5-1**). Assuming that the genera tested represent the full range of freshwater fish sensitivity to methomyl, these results indicate that 5% of freshwater fish will have an LC_{50} value less than or equal to 526 µg/L, 50% less than or equal to 1,112 µg/L, and 95% less than or equal to 2,352 µg/L. Relative to this sensitivity distribution, the channel catfish LC_{50} value (320 µg/L) is a conservative estimate with over 95% of the fish being less sensitive. Even relative to the genus mean for catfish (*Ictalurus spp*. LC_{50}=587 µg/L), the value used in this assessment is conservative.

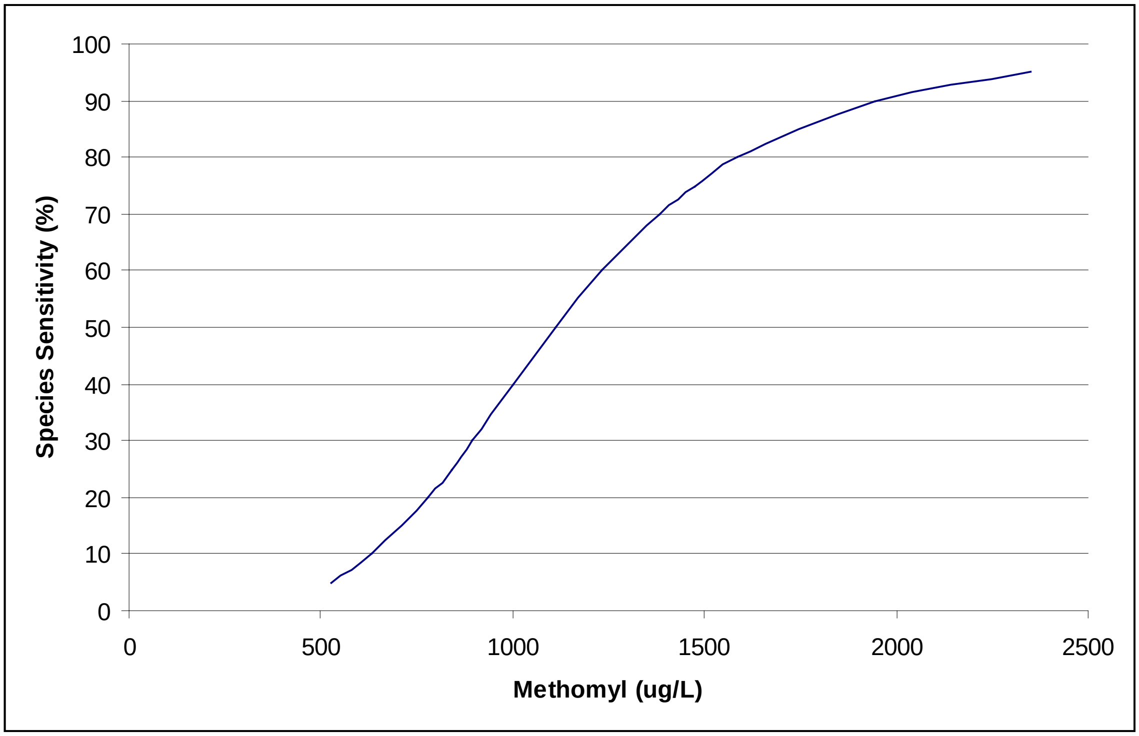

Figure 5-1. Freshwater Fish Species Sensitivity Distribution for Methomyl.

The highest 1 in ten year aquatic peak EEC for all of the agricultural, non-agricultural, and orchard scenarios for methomyl is 61.9 µg/L (for the cole crops scenario). At this EEC, and as discussed above, the Agency's acute risk to listed species LOC is exceeded using the most sensitive acute toxicity value for freshwater fish (*i.e.*, 320 µg/L). If RQs were calculated based on this EEC and the 5th percentile (*i.e.*, LC_{50} = 526 µg/L), the median percentile (*i.e.*, LC_{50} = 1,112 µg/L), and the 95th percentile (*i.e.*, LC_{50} = 2,352 µg/L) LC_{50} for freshwater fish, the RQs would equal 0.12, 0.06, and 0.03, respectively. Therefore, according to this analysis, unless aquatic-phase CTS, the DS, and TG are less sensitive to methomyl than approximately half of all freshwater fish tested, the potential for direct adverse effects (mortality) on aquatic-phase CTS, the DS, and TG from methomyl use (at maximum seasonal application rates) exists. The aquatic-phase considers life stages of the CTS that are obligatory aquatic organisms, including eggs and larvae. It also considers submerged terrestrial-phase juveniles and adults, which spend a portion of their time in water bodies that may receive runoff and spray drift containing methomyl. The remaining organisms (DS and TG) are aquatic and are directly exposed to methomyl concentrations found in water. Although aquatic-phase amphibians (including the CTS) may be less sensitive to methomyl than freshwater fish, until comparative toxicity data on amphibians are available, conclusions regarding their relative sensitivity to methomyl are uncertain; therefore, it is assumed that they are as sensitive to methomyl as freshwater fish.

Based on the above analyses, there is the **potential for risk of <u>direct effects</u> to aquatic-phase CTS, the DS, and TG from acute and/or chronic exposure to methomyl** from most registered agricultural uses of methomyl (*i.e.*, cabbage, turf, anise, alfalfa, celery, and scatter bait).

5.2.2. Freshwater Invertebrates

5.2.2.a. Direct Effects

The acute RQs (0.50-12.38) and chronic RQs (1.57-60.86) for freshwater invertebrates exceed listed species LOCs (acute: 0.05; chronic: 1) for all assessed uses. Aquatic incident data are not available for freshwater invertebrates; however, invertebrate incident data are rarely reported.

Using the lowest and highest RQs (0.5-12.38) that exceed the acute listed LOC for aquatic animals (0.05), the chance of an individual mortality for freshwater invertebrates is 1 in 6.69 to 1 in 1 for slope of 3.45 and ranges from 1 in 2.72 to 1 in 1.12 and 1 in 24.6 to 1 in 1 for the 95% confidence limits of 1.12 and 5.79, respectively. Furthermore, spatial distribution maps for freshwater dwelling species indicates overlap between habitat and the methomyl use footprint (**APPENDIX K**).

The six genus mean EC_{50} values used to calculate the acute SSD for freshwater invertebrates are listed in **Table 5-14**. For a specific species with multiple tests available, the geometric species mean EC_{50} value for the specific species was calculated first, and then the mean EC_{50} for the genus was calculated. The log EC_{50} values for available genera are assumed to be from a normal distribution and are used to calculate the parameters of this distribution, *i.e.*, mean and standard deviation (SD).

Table 5-6. Ranked Freshwater Invertebrate Genus Mean Acute Values.

RANK	GENUS MEAN ACUTE VALUE (Total µg/L)	SPECIES	NUMBER OF ACUTE VALUES USED TO CALCULATE THE SPECIES MEAN VALUE
6	886	*Gammarus pseudolimnaeus*[1] Scud	3
5	99.7	*Isogenus* sp.[2] Stonefly	2
4	64.3	*Pteronarcella* sp.[2] Stonefly	2
3	53.1	*Chironomus plumosus*[1] Midge	2
2	31.4	*Skwala* sp.[2] Stonefly	2
1	15.7	*Daphnia magna*[1] Daphnid	4

[1] Endpoints are from a 48-hr study.
[2] Endpoints are from a 96-hr study.

The genus log LC_{50} values are used to calculate a SSD using a Student's t-distribution (a t-distribution was used because toxicity values were only available for six freshwater invertebrate genera). Therefore, a t-distribution of genus mean log LC_{50} values and log SD values was assumed in extrapolating 5th, 50th, and 95th percentile LC_{50} values for freshwater invertebrates. All calculations were done using Excel 2003. Since there was a relatively small sample size, data from 48-hr and 96-hr studies were combined. This may alter the shape of the distribution curve and may result in underestimating the effects, however, the information provided by the SSD was still considered useful. Using this approach, the 5th percentile LC_{50} is 4.5 µg/L, the 50th or median percentile LC_{50} value is 73 µg/L, and the 95th is 1,174 µg/L. The cumulative EC_{50} SSD with concentration-response curves for the 5th, 50th, and 95th percentile generic species are presented in **Figure 5-2**.

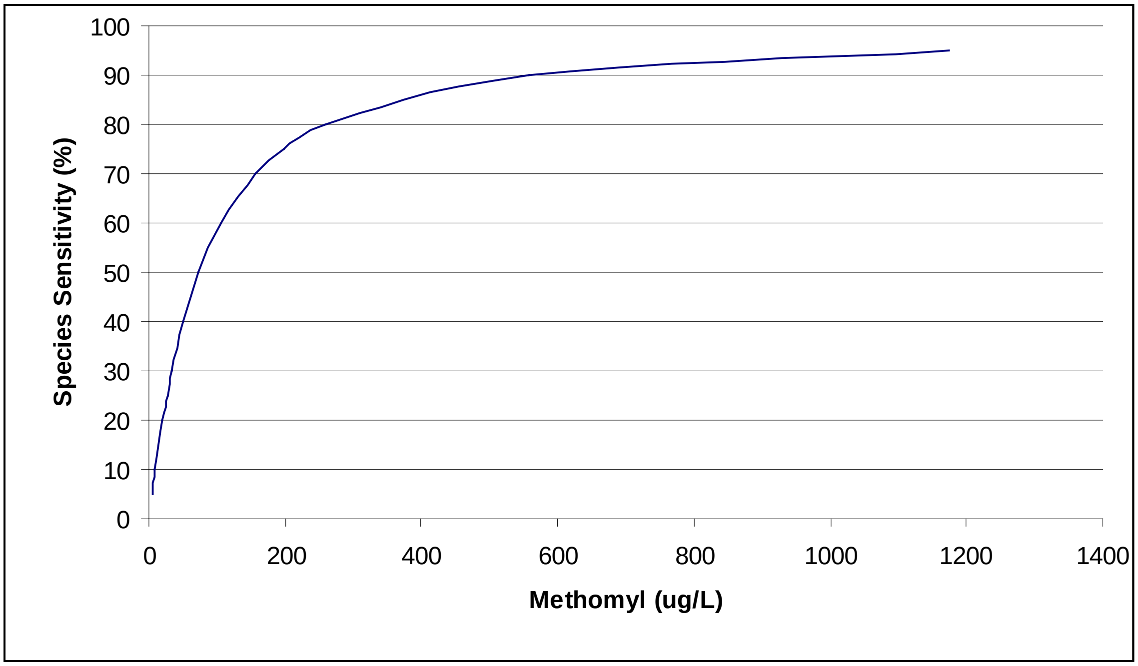

Figure 5-2. Species Sensitivity Distribution for Freshwater Invertebrates and Methomyl.

The highest 1 in ten year aquatic peak EEC for all of the agricultural, non-agricultural, and orchard scenarios for methomyl is 61.9 µg/L (for the cole crops scenario). At this EEC the Agency's acute risk to listed species LOC is exceeded using the most sensitive acute toxicity value for freshwater invertebrates (*i.e.*, 5 µg/L). The acute sensitivity distribution for freshwater aquatic invertebrates indicates that 5% of the freshwater invertebrate genera have an EC_{50} value of 4.5 µg/L or less, 50% have an EC_{50} value of 73 µg/L or less, and 95% have an EC_{50} value of 1,174 µg/L or less (assuming the invertebrates tested exhibit a full range of sensitivity to methomyl). The modeled scenarios for methomyl predict peak EECs ranging from 2.5 µg/L (sorghum) to 61.9 µg/L (cole crops). The predicted peak EECs for only one of the scenarios modeled (sorghum) is below 4.5 µg/L; 10 of the 11 modeled uses have EEC values that range from >4.5 µg/L to 73 µg/L. Therefore, based on available data and this analysis, estimated environmental concentrations of methomyl may result in 50% mortality of sensitive freshwater invertebrates for most of the modeled uses at their maximum methomyl application rates in the assessment area.

Based on the above analyses, there is the **potential for risk of <u>direct effects</u> to the CFS from acute and chronic exposure to methomyl** from all registered agricultural and scatter bait uses assessed for methomyl.

5.2.3. Estuarine/Marine Fish

5.2.3.a. Direct Effects

The only acute RQ for estuarine/marine fish that approaches or exceeds the acute listed species LOC is for the cabbage use. The remaining acute RQs and all the chronic RQs for estuarine/marine fish are below the listed species LOCs. Aquatic incident data were not submitted and are not available for estuarine/marine fish. This does not mean, however, that an estuarine/marine fish kill did not occur, but that it was potentially not reported.

Using an RQ of 0.05, the chance of an individual mortality for estuarine/marine fish is 1 in 8.8 x 10^{24} for slope of 8 and ranges from 1 in 1.05 x 10^{11} to 1 in 4.58 x 10^{44} for the 95% confidence limits of 5.16 and 10.83, respectively. Nevertheless, given all lines of evidence including that the RQs do not exceed LOCs and that there is potential for dilution in the presumably larger estuarine/marine environment**, methomyl <u>does not have the potential to directly</u> affect the DS and TG via the marine environment.**

5.2.4. Estuarine/Marine Invertebrates

5.2.4.a. Direct Effects

The acute RQs (0.13-3.26) and chronic RQs (1.33-17.75) for estuarine/marine invertebrates exceed listed species LOCs (acute: 0.05; chronic: 1) for nearly all assessed uses. No incident data are available for estuarine/marine invertebrates. This does not mean, however, that an invertebrate kill did not occur, but that it was potentially not reported.

Using the lowest and highest RQs (0.13-3.26) that exceed the acute listed LOC for aquatic animals (0.05), the chance of an individual mortality for estuarine/marine invertebrates is 1 in 29,900 to 1 in 1.01 for the default slope of 4.5 and ranges from 1 in 26.2 to 1 in 1.18 and 1 in 1.31 x 10^{15} to 1 in 1 for the default 95% confidence limits of 2 and 9, respectively. Should modeled concentrations reach the estuarine/marine environment **there is potential for <u>indirect effects</u> to the CCR, DS, and TG** from all registered agricultural and scatter bait uses assessed for methomyl**; <u>no direct effects</u> are expected to the assessed species because none belong to the marine/estuarine invertebrate taxonomic group.**

5.2.5. Aquatic vascular/non-vascular plants

5.2.5.a. Direct Effects

PRZM/EXAMS modeled peak EECs range from 0.0025-0.0619 mg a.i./L, which are 4 orders of magnitude lower than the concentrations at which the effect on the non-vascular plants was observed in the methomyl open literature study and the pirimicarb study and 1 to 4 orders of magnitude lower than the the concentrations at which the effect on the vascular plants and 5-day non-vascular plants was observed for the remaining carbamates reviewed (see Section 5.1.1.e). Based on the available lines of evidence from the open literature and data submitted for other carbamate insecticides with similar modes of action, methomyl is **unlikely to result in <u>direct</u> effects** to non-vascular and vascular plants and, by extension, **<u>indirect</u> effects** to species that rely on non-vascular plants during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, DS, CFS, and TG).

5.2.6. Birds, reptiles, and terrestrial-phase amphibians

5.2.6.a. Direct Effects

The acute RQs (dose based: 3.93-27.97; dietary based: 0.12-0.46) and chronic RQs (dietary based: 1.44-3.34) for birds, reptiles, and terrestrial-phase amphibians exceed listed species LOCs (acute: 0.1; chronic: 1) for all uses when modeling is based on consumption of short grass. The acute RQs (dose based: 1.54-10.96; dietary based: 0.10-0.18) and chronic RQs (dietary based: 1.14-1.31) for birds, reptiles, and terrestrial-phase amphibians exceed listed species LOCs (acute: 0.1; chronic: 1) for nearly all uses when modeling is based on consumption of arthropods. In either case, **there is potential for direct effects to the CCR, CTS (all DPS), and SFGS** from all assessed agricultural uses of methomyl, including the granular use on sweet corn whorls (RQs: 3.83-14.35 for a 20g bird) and scatter bait (RQ of 5.55).

A refinement of the RQs for the CTS and SFGS using T-HERPS indicates LOC exceedances for most if not all uses. On a chronic basis, the sorghum use does not lead to LOC exceedances for the CTS and SFGS; for additional exceptions that are not consistent across the size classes assessed see Table 5-9 and Table 5-10. The acute RQs (dose based: 0.13-0.92; dietary-based: 0.11-0.26) and chronic RQs (dietary based: 1.08-1.88) for a small 2g bird (surrogate for small CTS) consuming small insects exceed listed species LOCs (acute: 0.1; chronic: 1). The acute RQs (dose based: 2.31-16.44; dietary-based: 0.12-0.46) and chronic RQs (dietary based: 1.45-3.36) for a medium 20g bird (surrogate for CTS) consuming herbivorous mammals of 1.33 to 13.3g exceed listed species LOCs (acute: 0.1; chronic: 1). The acute RQs (dose based: 0.13-0.92; dietary-based: 0.11-0.26) and chronic RQs (dietary based: 1.08-1.88) for a small 2g bird (surrogate for small SFGS) consuming small insects exceed listed species LOCs (acute: 0.1; chronic: 1). The acute RQs (dose based: 6.27-23.29; dietary-based: 0.15-0.35) and chronic RQs (dietary based: 1.10-2.56) for a medium 20g bird (surrogate for SFGS) consuming herbivorous mammals of 2.10 to 24.7g exceed listed species LOCs (acute: 0.1; chronic: 1). **T-HERPS calculations further confirm that methomyl does have the potential to directly affect the CTS (all DPS) and the SFGS** from all assessed agricultural uses of methomyl.

Bird incident data indicate death by intentional baiting of the rock dove (*Columba livia*), egret (species not provided), crow (*Corvis* sp.), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), Eleanora's falcon (*Falco eleonorae*), and grackle (*Quiscalus spp.*) (Incident #/ Event ID: (EIIS) I009064-001, I011181-001, and I017139-001; (AIMS) 1841 and 1953). The AIMS reports (Event ID #: 1953, 1841) indicate deaths of crows, red-tailed hawks, and an egret resulting from abuse of product. Deaths in laughing gulls (*Larus articilla*), cattle egret (*Bubulcus ibis*), finches, linnets, and vultures were also observed from uknown use patterns, foliar spray, or drinking contaminated dew (Incident #: I018980-010, I006382-001, I006382-002, I021455-003).

Using the lowest and highest RQs (0.10-27.97) that exceed the acute listed LOC for terrestrial animals (0.10), the chance of an individual mortality for birds, reptiles, and terrestrial-phase amphibians is 1 in 294,000 to 1 in 1 for the default slope of 4.5 and ranges from 1 in 44 to 1 in 1 and 1 in 8.86×10^{18} to 1 in 1 for the default 95% confidence limits of 2 and 9, respectively.

Furthermore, spatial distribution maps for CCR, CTS, and SFGS species indicates overlap between habitat and the methomyl use footprint.

5.2.7. Mammals

5.2.7.a. Direct Effects

The acute RQs (dose based: 1.02-7.25) and chronic RQs (dietary based: 1.80-6.69; dose based: 8.14-58.01) for small 15g mammals consuming short grass exceed listed species LOCs (acute: 0.1; chronic: 1) for all uses. The acute RQs (dose based: 0.47-3.32) and chronic RQs (dietary based: 1.80-6.69; dose based: 3.73-26.56) for large 1000g mammals consuming short grass exceed listed species LOCs (acute: 0.1; chronic: 1) for all uses. Based on calculated acute and chronic RQs for 15g and 1000g mammals consuming short grass, methomyl does have the potential to directly affect listed mammals of the sizes modeled given the modeled uses. Using the lowest and highest RQs (1.95-7.25) that exceed the acute listed LOC for terrestrial animals (0.10), the chance of an individual mortality for mammals is 1 in 1.11 to 1 in 1 for the default slope of 4.5 and ranges from 1 in 1.39 to 1 in 1.04 and 1 in 1 (for low and high RQ range) for the default 95% confidence limits of 2 and 9, respectively. Mammalian incident data is sparse since only a single incident (#:I021455-003) is available, which indicates death of three Virginia opossums as a result of an unknown use site and application in Florida.

Potential direct effects to the eight species assessed for methomyl does not apply as none of the SF Bay species for this assessment is a mammal. However, **since the acute and chronic RQs are exceeded, there is potential for indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle (*i.e.*, CCR, CTS (all DPS), and the SFGS)** all assessed agricultural uses of methomyl, including the granular use on sweet corn whorls (RQs: 1.58-5.92 for a 15g mammal) and scatter bait (RQ of 4.91).

5.2.8. Terrestrial invertebrates

5.2.8.a. Direct Effects

Based on the RQs (42.30-157.12) generated from arthropod EECs, **methomyl does have the potential to directly affect the BCB and VELB** from all assessed agricultural uses of methomyl**.** Additionally, since these RQs exceed the Agency's interim terrestrial invertebrate LOC (0.05), there is a potential for indirect effects to those listed species that rely on terrestrial invertebrates during at least some portion of their life-cycle (*i.e*., CCR, CTS (all DPS), and the SFGS). Incident data were not submitted and are not available for terrestrial invertebrates. This does not mean, however, that an invertebrate kill did not occur, but that it was potentially not reported. Using the lowest and highest RQs (42.30-157.12) that exceed the interim terrestrial invertebrate LOC (0.05), the chance of an individual mortality for terrestrial inverterates is 1 in 1 for slope of 4.33 and for the 95% confidence limits of 3.37 and 5.30. Furthermore, spatial distribution maps for BCB and VELB species indicates overlap between habitat and the methomyl use footprint.

5.2.9. Terrestrial plants

5.2.9.a. Direct Effects

Although there are no acceptable terrestrial plant guideline toxicity studies available for methomyl, several efficacy studies that were conducted to test the effects of methomyl on a variety of target and non-target invertebrate pests also supplied information on effects to plants after methomyl applications. Due to a lack of information on study design and data analyses, these efficacy studies are classified as 'supplemental' and are not adequate for plant (or terrestrial invertebrate) RQ calculation. None of the studies showed any adverse effects to plants at the highest treatment levels tested (most of which were at or above the maximum allowable single application rate for methomyl of 0.9 lbs a.i./acre) and the NOAEL from the studies represented the highest treatment rates examined (see **Table 4-5**). However, because none of the studies addressed potential risks to monocots, or effects on seedling emergence and some N-methyl carbamates are plant auxins and are used to thin fruit (*e.g*., carbaryl), risks to plants from the use of methomyl cannot be precluded using the available data. Given the lack of data, risk to terrestrial plants cannot be precluded. Plant incident data are available for melons as a result of a tank mix application of the following products DuPont Lannate® S (a.i. methomyl, PC Code 090301) and Valent Danitol (a.i. Fenpropathrin, PC Code 127901) insecticides in Arizona (Incident #: I022338-002, I022338-001). The older leaves on the melon plants suffered very light speckling and symptoms were observed two days after the ground application. Furthermore, spatial distribution maps for BCB, VELB, SFGS, CCR, CTS, DS, CFS, and TG indicate overlap between habitat and the methomyl use footprint. Since effects to terrestrial plants are assumed and these species rely on plants for shelter and/or food, **there is a potential for <u>indirect effects</u> to those listed species that rely on terrestrial plants (for food, habitat, etc.) during at least some portion of their life-cycle (*i.e*., BCB, VELB, SFGS, CCR, CTS, DS, CFS, and TG)** presumably from all assessed uses**.**

5.2.9.b. Indirect Effects

i. Potential Loss of Prey

For indirect effects, since RQs exceed the acute non-listed species LOC, methomyl is likely to indirectly affect the SFGS, CCR, CTS, DS, CFS, and TG for most if not all uses. For specific uses that exceed the acute non-listed species LOC (0.5) or the acute restricted use LOC (0.1 for aquatic organisms, 0.2 for terrestrial animals) see the Risk Estimation section. Risk quotients were not calculated for aquatic and terrestrial plants given limited available data, however, risk was assumed for terrestrial plants. Therefore, indirect effects to the BCB and VELB are expected.

Table 5-7. Range of acute[1] and chronic RQs that exceed non-listed species LOCs for prey of each SF Bay Species.

SF Bay Species	Aquatic Organisms	Aquatic RQs	Terrestrial Organisms	Terrestrial RQs
SFGS* (eats invertebrates, fish, small mammals, reptiles, amphibians)	Freshwater fish	Acute: 0.13-0.19 Chronic: 1.99-2.67	Mammals[2]	Acute (sm): 1.02-7.25 Acute (lg): 0.47-3.32 Chronic (sm): 1.80-58.01 Chronic (lg): 1.80 -26.56 Granular: 1.58-5.92 Scatter bait: 4.91
	Freshwater inverts.	Acute: 0.50-12.38 Chronic: 1.57-60.86	Birds / Terrestrial-phase Amphibians	Acute[3]: 0.12-27.97 Chronic: 1.44-3.34 Acute[4],*: 0.15 -23.29 Chronic*: 1.10-2.56 Granular: 3.83-14.35 Scatter bait: 5.55
	Aquatic plants	RQs were not calculated. However, a comparison of available endpoints to peak EECs indicates that non-vascular and vascular plants will likely not be exposed to concentrations at which an effect is expected.	Terrestrial inverts.	42.30-157.12
			Terrestrial plants	No data. Risk presumed.
CCR (eats dead fish, frogs, aquatic inverts., aquatic plants, seeds, worms, spiders, small birds and mammals, terrestrial plants)	Freshwater fish	Acute: 0.13-0.19 Chronic: 1.99-2.67	Mammals[2]	Acute (sm): 1.02-7.25 Acute (lg): 0.47-3.32 Chronic (sm): 1.80-58.01 Chronic (lg): 1.80 -26.56 Granular: 1.58-5.92 Scatter bait: 4.91
	Freshwater inverts.	Acute: 0.50-12.38 Chronic: 1.57-60.86	Birds	Acute[3]: 0.12-27.97 Chronic: 1.44 -3.34 Granular: 3.83-14.35 Scatter bait: 5.55
	E/M fish	Acute: <0.1 Chronic: <1.0	Terrestrial inverts.	42.30-157.12
	E/M inverts.	Acute: 0.13-3.26 Chronic: 1.33-17.75	Terrestrial plants	No data. Risk presumed.
	Aquatic plants	RQs were not calculated. However, a comparison of available endpoints to peak EECs indicates that non-		

		vascular and vascular plants will likely not be exposed to concentrations at which an effect is expected.		
CTS* (eats freshwater snails, aquatic invertebrates, fish, frogs, algae, zooplankton, terrestrial invertebrates, worms, small mammals)	Freshwater fish	Acute: 0.13-0.19 Chronic: 1.99-2.67	Mammals[2]	Acute (sm): 1.02-7.25 Acute (lg): 0.47-3.32 Chronic (sm): 1.80-58.01 Chronic (lg): 1.80 - 26.56 Granular: 1.58-5.92 Scatter bait: 4.91
	Freshwater inverts.	Acute: 0.50-12.38 Chronic: 1.57-60.86	Birds / Terrestrial-phase amphibians	Acute[3]: 0.12-27.97 Chronic: 1.44 -3.34 Acute[5,]*: 0.12-16.44 Chronic*: 1.45-3.36 Granular: 3.83-14.35 Scatter bait: 5.55
	Aquatic plants	RQs were not calculated. However, a comparison of available endpoints to peak EECs indicates that non-vascular and vascular plants will likely not be exposed to concentrations at which an effect is expected.	Terrestrial inverts.	42.30-157.12
			Terrestrial plants	No data. Risk presumed.
DS (eats primarily planktonic copepods, cladocerans, amphipods, and insect larval; larvae feed on phytoplankton; juveniles on zooplankton)	Freshwater inverts.	Acute: 0.50-12.38 Chronic: 1.57-60.86	Terrestrial plants	No data. Risk presumed.
	E/M inverts.	Acute: 0.13-3.26 Chronic: 1.33-17.75		
	Aquatic plants	RQs were not calculated. However, a comparison of available endpoints to peak EECs indicates that non-vascular and vascular plants will likely not be exposed to concentrations at which an effect is expected.		
CFS (eats detritus – algae, aquatic	Freshwater inverts.	Acute: 0.50-12.38 Chronic: 1.57-60.86	Terrestrial plants	No data. Risk presumed.
	Aquatic plants	RQs were not		

macrophyte fragments, zooplankton, aufwuchs)		calculated. However, a comparison of available endpoints to peak EECs indicates that non-vascular and vascular plants will likely not be exposed to concentrations at which an effect is expected.		
TG (eats small benthic invertebrates, crustaceans, snails, mysids, aquatic insect larvae; juveniles may feed on unicellular phytoplankton or zooplankton)	Freshwater inverts.	Acute: 0.50-12.38 Chronic: 1.57-60.86	Terrestrial plants	No data. Risk presumed.
	E/M inverts.	Acute: 0.13-3.26 Chronic: 1.33-17.75		
	Aquatic plants	RQs were not calculated. However, a comparison of available endpoints to peak EECs indicates that non-vascular and vascular plants will likely not be exposed to concentrations at which an effect is expected.		
BCB / VELB	N/A	N/A	Terrestrial plants	No data. Risk presumed.

E/M = estuarine/marine; N/A = not applicable
*T-HERPS was run for this SF Bay species
[1]Acute restricted use LOC (0.1) and Acute LOC (0.5) were both considered as non-listed LOCs for aquatic organisms. Acute restricted use LOC (0.2) and Acute LOC (0.5) were both considered as non-listed LOCs for terrestrial organisms.
[2] Acute and chronic values for small 15g mammals (sm); acute and chronic values for large 1000g mammals (lg); chronic values include both dose-based and dietary based RQs. All values are based on consumption of short grass.
[3]Acute values include both dose-based and dietary based RQs based on consumption of short grass
[4] Acute values include both dose-based and dietary based RQs, and both acute and chronic RQ values are based on medium sized SFGS (20g) consuming small/medium herbivorous mammals of 2.10 to 24.74g
[5] Acute values include both dose-based and dietary based RQs, and both acute and chronic RQ values are based on medium sized CTS (20g) consuming small/medium herbivorous mammals of 1.33 to 13.3g

ii. Potential Modification of Habitat

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

PRZM/EXAMS modeled peak EECs range from 0.0025-0.0619 mg a.i./L, which are 4 orders of magnitude lower than the concentrations at which the effect on the non-vascular plants was observed in the methomyl open literature study and the pirimicarb study and 1 to 4 orders of magnitude lower than the the concentrations at which the effect on the vascular plants and 5-day non-vascular plants was observed for the remaining carbamates (see Section 5.1.1.e). With some uncertainty in the open literature study results, including lack of reporting of raw effects data to verify the calculated endpoints, minimal availability of data for other carbamates with a similar mode of action, methomyl is unlikely to result in modification to the aquatic plant habitat.

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

Although there are no acceptable terrestrial plant guideline toxicity studies available for methomyl, several efficacy studies that were conducted to test the effects of methomyl on a variety of target and non-target invertebrate pests also supplied information on effects to plants after methomyl applications (see **Table 4-5**). However, because none of the studies addressed potential risks to monocots, or effects on seedling emergence and some N-methyl carbamates are plant auxins and are used to thin fruit (*e.g.*, carbaryl), risks to plants from the use of methomyl cannot be precluded using the available data. In addition, incident reports on melons indicate damage to older, treated leaves as a result of ground application of a methomyl formulation (see Section 4.5.2. Plant Incidents). Given the lack of toxicity data and the available incidents reports, risk to terrestrial plants cannot be precluded. Furthermore, spatial distribution maps for BCB, VELB, SFGS, CCR, CTS, DS, CFS, and TG indicate overlap between habitat and the methomyl use footprint. Since effects to terrestrial plants are assumed and these species rely on plants for shelter and/or food, **there is a potential for <u>indirect effects</u> to those listed species that rely on terrestrial plants (for food, habitat, etc.) during at least some portion of their life-cycle (*i.e.*, BCB, VELB, SFGS, CCR, CTS, DS, CFS, and TG).**

5.2.10. Modification of Designated Critical Habitat

Based on the weight-of-evidence and particularly the output of the RQ calculations whereby direct and indirect effects are expected for certain species (see the table above), **there is a potential for the modification designated critical habitat** (*i.e.,* particularly in reference to the species with a designated critical habitat designation including BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG.)

5.2.11. Spatial Extent of Potential Effects

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

To determine this area, the footprint of methomyl's use pattern is identified, using corresponding land cover data, see Section 2.7. The land cover classes used to determine the use footprint include cultivated orchard, vineyard, pasture, hay, turf, and all urban NLCD categories based on potential uses on bulbs, cereal grians, cole crops, grasses, herbs, leguminous forage, non-cole leafy crops, avocado, and scatter bait. Actual usage is expected to occur in a smaller area as the chemical is only expected to be used on a portion of the identified area. The spatial extent of the effects determination also includes areas beyond the initial area of concern that may be impacted by runoff and/or spray drift (Use Footprint + distance down stream or down wind from use sites where organisms relevant to the assessed species may be affected). The determination of the buffer distance and downstream dilution for spatial extent of the effects determination is described below.

5.2.11.a. Spray Drift

In order to determine terrestrial and aquatic habitats of concern due to methomyl exposures through spray drift, it is necessary to estimate the distance that spray applications can drift from the treated area and still be present at concentrations that exceed levels of concern. Ground applications of methomyl granular formulations are not expected to result in any spray drift. For the flowable uses, a quantitative analysis of spray drift distances was completed using AgDRIFT (v. 2.01) using default inputs for aerial applications (*i.e*., ASABE Very Fine to Fine). The most sensitive acute and chronic endpoints for aquatic and terrestrial exposure were utilized. For terrestrial exposure, a buffer was determined for invertebrates and vertebrates.

Table 5-8. Buffers for Most Sensitive Aquatic and Terrestrial Species using AgDRIFT

Endpoint	Species	Max Application Rate	Fraction of Applied	Type of Assessment	Buffer[1]
Acute: EC50 (at 48 hrs) = 0.005 mg a.i./L	Daphnia Magna (MRID 40098001)	0.90 lb a.i./A	NA	Aquatic (Tier I)	120 feet
Chronic: NOAEC = 0.0007 mg a.i./L	Daphnia Magna (MRID 1312541)	0.90 lb a.i./A	NA	Aquatic (Tier I)	753 feet

Acute: LD50 = 24.2 mg/kg-bw	Bobwhite quail (MRID 00161886) (Non-invertebrate)	0.90 lb a.i./A	LOC/RQ = 0.004	Terrestrial (Tier 1)	>1000 feet
Chronic: NOAEL = 75 mg a.i./kg-diet (equivalent to 3.75 mg a.i./kg/day)	Lab rat (MRID 43250701, 43769401) (Non-invertebrate)	0.90 lb a.i./A	LOC/RQ = 0.15	Terrestrial (Tier 1)	162.3 feet
Acute: LD50 = 0.16 ug a.i./bee	Honey Bee (acute contact study - MRID 45093001) (Invertebrate)	0.90 lb a.i./A	LOC/RQ = 0.0003	Terrestrial (Tier 1)	>1000 feet

[1] All aerial applications already have a 100 foot buffer taken into account and was added to the buffer values determined by AgDRIFT. Therefore, the values seen in the table is the total buffer distance including the 100 foot buffer that is already on the label.

5.2.11.b. Downstream Dilution Analysis

The downstream extent of exposure in streams and rivers where the EEC could potentially be above levels that would exceed the most sensitive LOC is calculated using the downstream dilution model. To complete this assessment, the greatest ratio of aquatic RQ to LOC was estimated. Using an assumption of uniform runoff across the landscape, it is assumed that streams flowing through treated areas (*i.e.*, the Initial Area of Concern) are represented by the modeled EECs; as those waters move downstream, it is assumed that the influx of non-impacted water will dilute the concentrations of methomyl present. The highest RQ/LOC ratio and the land cover class are used as inputs into the downstream dilution model.

Using a 48-hr LC_{50} value of 5 µg/L for *Daphnia magna*, an LOC of 0.05, and a maximum peak EEC of 61.9 µg/L for cole crops from the Tier II PE5 model yields an RQ/LOC ratio of 247.6 ((61.9/5)/0.05). The downstream dilution approach is described in more detail in **Appendix K**. This value has been input into the downstream dilution model and results in a distance of 258.5 kilometers which represents the maximum continuous distance of downstream dilution from the edge of the Initial Area of Concern where LOCs may be exceeded in the aquatic environment. It is also important to note that this chemical has wide usage (*e.g.*, applied in almost all land classes, showing that the chemical can be used practically everywhere.) As a result, giving a distance may result in a limitation since it does not capture the likelihood that the stream reaches will run into adjacent land cover classes that may also have usage.

5.2.11.c. Overlap of Potential Areas of LAA Effect and Habitat and Occurrence of SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG

The spray drift and downstream dilution analyses help to identify areas of potential effect to the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG from registered uses of methomyl. The Potential Area of LAA effects on survival, growth, and reproduction for the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG from methomyl spray drift extend from the site of application to 120 feet or greater than 1000 feet from the site of application. For exposure to runoff and spray drift, the area of potential LAA effects extends up to 258.5 km downstream from the site of application. The maps presented in **APPENDIX K** indicate overlap between the habitat space in all SF Bay species assessed and the use footprint area without the downstream dilution distance incorporated into the use footprint space. However, should these distances be added to the footprint of the Initial Area of Concern (which represents potential methomyl use sites) and compared to SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG habitat, it is likely that the area of overlap will increase. The overlap between the areas of LAA effect and SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG habitat, including designated critical habitat, indicates that methomyl use in California has the potential to affect the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG. More information on the spatial analysis is available in **APPENDIX K**.

5.3. Effects Determinations

5.3.1. Assessed Species

Overall, each species includes a habitat location that overlaps with the methomyl area of effects (*i.e.*, a combination of methomyl uses assessed in this risk assessment that is represented by the 2001 NLCD data). All listed species (SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG) have the potential for direct and indirect effects as a result of methomyl exposure at the registered use rates.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for all species (SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG) and a **habitat modification determination** for their designated critical habitat (*i.e.,* particularly in reference to the species with a designated critical habitat designation including BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG.) based on the potential for direct and indirect effects and effects to the PCEs of critical habitat.

5.3.2. Addressing the Risk Hypotheses

In order to conclude this risk assessment, it is necessary to address the risk hypotheses defined in Section 2.9.1. Based on the conclusions of this assessment, none of the hypotheses can be rejected, meaning that the stated hypotheses represent concerns in terms of direct and indirect effects of methomylon the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and their designated critical habitat (*i.e.,* that of BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG.)

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 methomyl to the environment. The following risk hypotheses are confirmed in this assessment:

The labeled use of methomyl within the action area may:

- directly affect SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and/or modify their designated critical habitat by reducing or changing the composition of food supply;
- indirectly affect SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and/or modify their designated critical habitat by reducing or changing the composition of the terrestrial plant community in the species' current range;
- indirectly affect SFGS, CCR, CTS, DS, CFS, and TG and/or modify their designated critical habitat by reducing or changing aquatic habitat in their current range (via modification of water quality parameters, habitat morphology, and/or sedimentation);
- indirectly affect CTS 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

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

6.1. Exposure Assessment Uncertainties

6.1.1. Terrestrial Exposure Assessment Uncertainties

6.1.1.a. T-REX

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

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

Dietary Items	Percentage of EECs or RQs for the Specified Dietary Items and Size Class as compared to the EEC or RQ for Small Birds[1] or Small Mammals Consuming Short Grass					
Birds: Dose Based EECs and RQs						
Size Class	Small, 20 g		Mid, 100 g		Large, 1000 g	
	EEC	RQ	EEC	RQ	EEC	RQ
Short Grass	100%	100%	57%	50%	26%	19%
Tall Grass	46%	46%	26%	23%	12%	9%
Broadleaf plants	56%	56%	32%	28%	14%	11%
Fruits/pods/seeds	6%	6%	4%	3%	2%	1%
Arthropods	39%	39%	22%	20%	10%	7%
Granivores	1%	1%	0.79%	0.7%	0.35%	0.26%
Mammals: Dose-Based EECs and RQs						
Size Class	Small, 15 g		Mid, 35 g		Large, 1000 g	
	EEC	RQ	EEC	RQ	EEC	RQ
Short Grass	100%	100%	69%	85%	16%	46%
Tall Grass	46%	46%	32%	39%	7%	21%
Broadleaf plants	56%	56%	39%	48%	9%	26%
Fruits/pods/seeds	6%	6%	4%	5%	1%	3%
Arthropods	39%	39%	27%	34%	6%	18%
Granivores	1%	1%	0.96%	1%	0.22%	0.64%
Mammals and Birds: Dietary-based EECs and RQs for all Size Classes[2]						
Short Grass	100%					
Tall Grass	46%					
Broadleaf plants	56%					
Fruits/pods/seeds	6%					
Arthropods	39%					

[1] The percents of the maximum RQ shown here for birds are based on the specific scaling factor of 1.0778 for methomyl (Mineau *et al*. 1996).
[2] Percentages for dose-based chronic EECs and RQs for mammals are equivalent to the acute dose-based EECs and RQs.

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

6.1.1.b. T-HERPS

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

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

Dietary Items	Percentage of EECs or RQs for the Specified Dietary Items and Size Class as compared to the EEC or RQ for Medium Amphibians or Snakes[1] Consuming Small Herbivore Mammals					
Amphibians: Acute Dose Based EECs and RQs						
Size Class	Small, 2 g		Mid, 20 g		Large, 200 g	
	EEC	RQ	EEC	RQ	EEC	RQ
Broadleaf plants/sm Insects	5%	6%	3%	3%	2%	1%
Fruits/pods/seeds/lg insects	0.5%	0.6%	0.3%	0.3%	0.2%	0.2%
Small herbivore mammals	N/A	N/A	100%	100%	37%	31%
Small insectivore mammals	N/A	N/A	6%	6%	2%	2%
Small amphibians	N/A	N/A	2%	2%	1%	1%
Snakes: Acute Dose-Based EECs and RQs						
Size Class	Small, 2 g		Mid, 20 g		Large, 800 g	
	EEC	RQ	EEC	RQ	EEC	RQ
Broadleaf plants/sm Insects	3%	4%	2%	2%	1%	1%
Fruits/pods/seeds/lg insects	0.4%	0.4%	0.2%	0.2%	0.1%	0.1%
Small herbivore mammals	N/A	N/A	100%	100%	23%	17%
Small insectivore mammals	N/A	N/A	6%	6%	1%	1%
Small amphibians	N/A	N/A	2%	2%	1%	1%
Amphibians and Snakes: Acute and Chronic Dietary-based EECs and RQs for all Size Classes						
	Amphibians			Snakes		
Broadleaf plants/sm Insects	21%			25%		
Fruits/pods/seeds/lg insects	2%			3%		
Small herbivore mammals	100%			100%		
Small insectivore mammals	6%			6%		
Small amphibians	1%			1%		

[1] The percents of the maximum RQ shown here for amphibians and reptiles are based on the specific scaling factor of 1.0778 for methomyl (Mineau *et al*. 1996).

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

6.1.2. Aquatic Exposure Modeling of Methomyl

Several methomyl crops can be grown more than one time per year in CA (i.e., they have multiple crop cycles). Most methomyl product labels specify application rates on a per crop cycle basis (not on a per year basis). Since standard PRZM scenarios only consist of one crop per year, applications to only one crop per year were modeled. For uses where methomyl is applied for multiple cropping cycles within a year, EECs presented in this assessment may underpredict exposures.

For the scatter bait use pattern, a conceptual model was developed and the impervious and residential scenarios which assume that 50% of the modeled area is impervious, and 3% of the impervious area is treated. Although this is believed to be a conservative assumption, it is possible that aquatic exposure for the scatter bait use pattern may be over or underestimated based on where the scatter bait is being applied.

In addition, Methomyl is expected to be unstable in the presence of ferrous iron, as well as degradate more rapidly in environments where the pH is more alkaline. Therefore, in aquatic environments with a pH greater than 7 and/or environments that are iron-rich, may result more rapid degradation of methomyl. Likewise, if the pH is below 7 and the environment is iron-poor, methomyl is more stable. As a result, based on the actual aquatic conditions, the calculated EECs may be over or underestimating depending on the respective situations mentioned above.

6.1.3. Exposure in Estuarine/marine Environments

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

The Agency does not currently have sufficient information regarding the hydrology and hydrochemistry of estuarine aquatic habitats to develop alternate scenarios for assessed listed species that inhabit these types of ecosystems. The Agency acknowledges that there are unique brackish and estuarine habitats that may not be accurately captured by PRZM-EXAMS modeling results, and may, therefore, under- or over-estimate exposure, depending on the aforementioned variables.

6.1.4. Modeled Versus Monitoring Concentrations

In order to account for uncertainties associated with modeling, available monitoring data were compared to PRZM/EXAMS estimates of peak EECs for the different uses. As discussed above, several data values were available from NAWQA and CDPR for methomyl concentrations measured in surface waters receiving runoff from agricultural areas. The specific use patterns (*e.g.*, application rates and timing, crops) associated with the agricultural areas are unknown, however, they are assumed to be representative of potential methomyl use areas. The peak model-estimated environmental concentrations resulting from different methomyl uses range from 2.5 µg/L (sorghum) to 61.9 µg/L (cole crops, particularly cabbage). The maximum concentration reported from the USGA NAWQA database for surface water was 0.67 µg/L. The maximum concentration of methomyl reported by the CDPR surface water database was 5.4 µg/L and is roughly 11.6 times *lower* than the highest peak model-estimated environmental concentration. As a result, it is believed that PRZM/EXAMS EECs provide a conservative measure of exposure.

6.2. Effects Assessment Uncertainties

6.2.1. Data Gaps and Uncertainties

Although many submissions have been made to provide data on the effects of methomyl to aquatic and terrestrial organisms, data gaps still exist. Noted data gaps since the problem formulation (USEPA 2010) include the following: avian acute oral toxicity (850.2100), avian reproduction (850.2300), terrestrial plant (850.4100, 850.4150), and aquatic plant (850.5400, 850.4400) toxicity studies. The specific data gaps are described in full in Registration Review Preliminary Problem Formulation for Methomyl (DP Barcode 374952, 2010). An update of this data since the problem formulation is that the registrant (E.I. DuPont de Nemours and Company, Inc.) requested a data waiver (MRID 48736202, DuPont project ID: 34679) for an avian (passerine) acute oral toxicity study (850.2100), which was identified as an additional data need in support of registration review of 2010. After carefully reviewing the registrant's waiver request, EFED still identifies the avian acute oral toxicity study with passerines as a critical data gap (see Response to Waiver Request memo, DP Barcode 400766, May 16, 2012). No additional data were submitted since the problem formulation (USEPA 2010).

Avian Acute Oral and Reproduction Toxicity

Acceptable acute avian oral toxicity data were submitted for exposures of bobwhite quail and mallard duck to methomyl; however, data are not available for passerines, which are required under the new 40 CFR Part 158 (Jul. 1, 2010) data requirements for conventional pesticides. The new Part 158 data requirements specify that acute avian oral toxicity data be submitted for either a mallard duck or bobwhite quail and a passerine species. Therefore, an avian oral toxicity test (OCSPP Guideline 850.2100) is required for passerine birds.

Under the 40 CFR Part 158 (Jul. 1, 2010) data requirements for conventional pesticides, avian reproduction data are required on waterfowl and upland game species (OCSPP 850.2300). Currently acceptable data for methomyl are only available for an upland game species (Bobwhite quail). Data from another N-methylcarbamate (*i.e*., thiodicarb) suggest that mallard ducks may be more sensitive than Bobwhite quail on a chronic-exposure basis. The chronic toxicity data available for birds indicate that mallard ducks (NOAEC = 500 mg a.i./kg-diet; LOAEC = 1,000 mg a.i./kg-diet, based on a reduction in number of eggs laid) (MRID 43313004) are more sensitive to thiodicarb than bobwhite quail (no reproductive effects seen at any concentration tested; highest concentration tested = 1,000 mg a.i./kg-diet) (MRID 43313003). Additionally, bobwhite quail appear more sensitive to methomyl than to thiodicarb based on chronic exposure (for methomyl, NOAEC = 150 mg a.i./kg-diet; LOAEC = 500 mg a.i./kg-diet, based on fewer eggs laid and eggs set) (MRID 41898602). Therefore, based on available data, it is reasonable to assume that mallard ducks may be more sensitive to methomyl than bobwhite quail on a chronic exposure basis. Therefore, since additional avian reproduction data for methomyl could result in a more sensitive avian reproductive endpoint, and, thus, could alter the estimated level of risk for birds (and by extension to terrestrial-phase amphibians and reptiles) from the use of methomyl, we recommend requesting these data for methomyl at this time.

Terrestrial Plant Studies

Terrestrial plant toxicity studies and associated risk analysis of plants are required for registration of pesticides with outdoor uses (CFR Part 158). For terrestrial plants, Tier II studies are required when potential concerns are triggered (*i.e*., when there is some indication that there may be significant toxicity to plants). These indicators may be an herbicidal mode of action or statements on the label indicating toxicity to plants. None of these indicators are present for methomyl.

Several efficacy studies that were conducted to test the effects of methomyl on a variety of target and non-target invertebrate pests supplied information on effects to plants after methomyl applications (see **Table 4-5**). However, because none of the studies addressed potential risks to monocots, or effects on seedling emergence and some N-methyl carbamates are plant auxins and are used to thin fruit (*e.g*., carbaryl), risks to plants from the use of methomyl cannot be precluded using the available data. In addition, incident reports on melons indicate damage to older, treated leaves as a result of ground application of a methomyl formulation (see Section 4.5.2. Plant Incidents). Finally, a Tier I seedling emergence study on another carbamate, aldicarb (MRID 47904401), indicated >25% effects on shoot length and weight to ryegrass (monocot) and tomato (dicot), triggering the need for a tier II study for this chemical. It is uncertain what quantifiable toxicological effect methomyl application will have on terrestrial plants given that guideline studies for methomyl are not available.

Vascular and Non-vascular Aquatic Plant Studies

Aquatic plant toxicity studies and associated risk analysis of plants are required for registration of pesticides with outdoor uses (40 CFR Part 158). Toxicity data for both vascular and non-vascular aquatic plants (Tier I, OCSPP Guidelines 850.4400 and 850.5400) are required but are not available for methomyl. With some uncertainty in the available open literature study results, including lack of reporting of raw effects data to verify the calculated endpoints, minimal availability of data for other carbamates with a similar mode of action (see Section 5.1.1.e), methomyl is unlikely to result in modification to the aquatic plant habitat.

6.2.2. Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on methomyl are not available for aquatic-phase amphibians; therefore, freshwater fish are used as surrogate species for aquatic-phase amphibians and the CTS. Endpoints based on freshwater fish ecotoxicity data are assumed to be protective of potential direct effects to aquatic-phase amphibians including the CTS. Efforts are made to select the organisms most likely to be affected by the type of compound and usage pattern; however, there is an inherent uncertainty in extrapolating across phyla. In addition, the Agency’s LOCs are intentionally set very low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

6.2.3. Sublethal Effects

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

To determine effects of carbamates on channel catfish, Carter (1971; ref #: 14034) observed brain cholinesterase inhibition and other signs of poisoning. In a static 48-h exposure to methomyl at concentrations ranging from 100 to 1,000 μg/L, inhibition of brain cholinesterase was proportional to the concentration of methomyl and maximum inhibition occurred within 2 hours with little or no recovery in 48 hours. Sequential signs of poisoning included hyperactivity, lethargy, paralysis, scoliosis, loss of equilibrium, and opercular and mouth paralysis. Another study by Coppage (1977; ref #: 7669) in which estuarine/marine fishes (pinfish, sheepshead minnow, and sailfin molly) were exposed to methomyl, acetylcholinesterase inhibition was similar (77-89%) regardless of the species or period of exposure (4 to 48 h), when a near-median kill occurred. In the wild, effects such as those noted in the previous tests could be manifested as reduced foraging efficiency, and/or lowered predator avoidance. Alternatively, fish may sense and avoid the contaminated area. Extrapolation of these measurement endpoints to the assessment endpoints of reduced survival, growth and reproduction of individual fish in the wild is highly uncertain and because currently accepted methods are unavailable to quantitatively estimate risk (EPA 2004, USFWS/NMFS 2004), they are summarized qualitatively.

6.2.4. Aquatic non-vascular open literature data

An open literature study (Record #: 118717, Pereira *et al.*2009) quantifying the growth inhibition in *P. subcapitata* (a microalgae) after Lannate (200g a.i./L methomyl formulation) and methomyl (99.5% purity) exposure indicates a 96-hour EC_{50} of 184 mg a.i./L (95% CI of 164-206 mg a.i./L for Lannate) and a 96-hour EC_{50} of 108 mg a.i./L (95% CI of 87-126 mg a.i./L for methomyl a.i.). Elements of the protocol that are discussed in the article closely follow the OCSPP 850 guidelines for the species. (Indeed, the authors indicate that OECD guidelines were followed.) However, there are several guideline deviations. Although there are at least five test concentrations in each trial (i.e., formulation and active ingredient), these concentrations are not in geometric progression of twofold (a minimum requirement for all toxicity studies submitted to EFED). The health of organisms prior to study initiation was not reported. The temperature was maintained at 20±2^{o}C under permanent illumination, whereas OCSPP guideline 850.4500 dictates 24±2^{o}C under continuous illumination. Three replicates instead of a minimum of four were used in this study; vials were 100 mL instead of the guideline 125-500 mL flasks. Other elements were in line with the guideline requirements: 96 hr test duration, static design, initial cell density of 10^4 cells/mL, shaker speed of 100 rpm, and age of organisms was within guideline range. Growth inhibition was a calculated endpoint in this study; however, guideline recommends endpoints (NOAEC, LOAEC) for biomass yield, growth rate, and area under the curve. Furthermore, the raw effects data were not reported; this would limit verification of the cited endpoint values. However, confidence in the results is high given the consistency between formulation-based versus active ingredient-based endpoint values for a given species.

6.2.5. Granular and Scatter bait uses

Aquatic exposure for the scatter bait use pattern was assessed using a conceptual model and the impervious and residential scenarios which assume that 50% of the modeled area is impervious, and 3% of the impervious area is treated. Although this is believed to be a conservative assumption, it is possible that aquatic exposure for the scatter bait use pattern may be over or underestimated based on where the scatter bait is being applied. Furthermore, the label does not specify how many applications are allowed; therefore, 26 was used as the maximum number of applications in PRZM/EXAMS because this is the maximum number that the program can process.

Terrestrial exposure to scatter bait was assessed for birds and mammals based on information in the label for Stimukil fly bait (EPA Reg. No. 53871-3). This product is a versatile multi-a.i. formulation (1% methomyl a.i.; 0.04% (Z)-9-tricosene) which includes uses on bait stations, as scatter bait, and brush. In addition, acute mammalian oral data (MRID 44933202) are available using this formulation as a test compound. Based on submitted toxicological data, this formulation is more toxic (14 mg a.i./kg-bw) to the laboratory rat than is the technical grade active ingredient (30 mg a.i./kg-bw, MRID 42140101; see **Appendix A**). According to the label, the scatterbait is applied at a rate of ¼ lb per 500 ft^2, which is 21.78 lb of formulation/Acre and 0.2178 lbs a.i./A. The bait may be reapplied at 3-5day intervals, but the T-REX model analysis for LD_{50}/ft^2 which was used to calculate the RQs, could only capture a single application of the product. Furthermore, the RQ represents an area confined by one square foot and is not intended to represent the dispersal of the product across an acre. The limitations of the LD_{50}/ft^2 analysis for the scatter bait uses also apply for the granular uses on sweet corn whorls.

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 methomyl to SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and the designated critical habitat of BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG.

Based on the best available information, the Agency makes a May Affect, Likely to Adversely Affect determination for the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG. Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG from the use of the chemical. Given the LAA determination for SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and potential modification of designated critical habitat for BCB, VELB, CTS (CC DPS & SB DPS), DS, and TG, a description of the baseline status and cumulative effects is provided in Attachment III.

A summary of the risk conclusions and effects determinations for the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG and critical habitat, given the uncertainties discussed in Section 6 and Attachment I, is presented in Table 7-1 and Table 7-2. Use specific effects determinations are provided in Table 7-3 and Table 7-4

Table 7-1. Effects Determination Summary for Effects of Methomyl on the SFGS, CCR, BCB, VELB, CTS, DS, CFS, and TG

Species	Effects Determination	Basis for Determination
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: dose and dietary-based RQs >0.1 for most assessed uses for small and medium-sized reptiles (based on toxicity data for birds) consuming arthropodsand herbivorous mammals • Chronic: dietary-based RQs >1 for most assessed uses for small and medium-sized reptiles (based on toxicity data for birds) consuming arthropods and herbivorous mammals • Granular (RQs 3.83-14.35) and scatter bait (RQ 5.55) uses exceed LOCs (based on bird toxicity data) • Bird (surrogates for reptiles) incident data indicate numerous deaths of various species by baiting and unknown use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird toxicity data) ranges from 1 in 294,000 to 1 in 1 (at the default slope of 4.5) **Potential for Indirect Effects** • SFGS prey base is affected based on LOC exceedences; SFGS feeds on invertebrates (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; terrestrial invert RQs: 42.30-157.12), fish (freshwater fish RQs: acute: 0.13-0.19; chronic: 1.99-2.67), small mammals (15g mammal RQs: acute: 1.02-7.25; chronic: 1.80-58.01), reptiles and amphibians (bird RQs: acute: 0.12-27.97; chronic: 1.44-3.34; 20g reptile: acute: 0.15 -23.29; chronic: 1.10-2.56) • Granular (RQs 1.58-5.92) and scatter bait (RQ 4.91) uses exceed LOCs for mammals (prey of SFGS) • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: honey bee, lab rat, bird, freshwater invertebrate/fish) ranges from 1 in $5.37x\ 10^7$ to 1 in 1
California Clapper Rail (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: dose and dietary-based RQs >0.1 for most assessed uses for small and medium-sized birds consuming arthropods and herbivorous mammals • Chronic: dietary-based RQs >1 for most assessed uses for small and medium-sized birds consuming arthropods and herbivorous mammals • Granular (RQs 3.83-14.35) and scatter bait (RQ 5.55) uses exceed LOCs (based on bird toxicity data) • Bird incident data indicate numerous deaths of various species by baiting and unknown use patterns • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird toxicity data) ranges from 1 in 294,000 to 1 in 1 (at the default slope of 4.5) **Potential for Indirect Effects**

Species	Effects Determination	Basis for Determination
		• CCR prey base is affected; CCR feeds on aquatic invertebrates, worms, spiders (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; terrestrial invert RQs: 42.30-157.12; estuarine/marine invert: acute: 0.13-3.26; chronic: 1.33-17.75), dead fish (freshwater fish RQs: acute: 0.13-0.19; chronic: 1.99-2.67), small mammals (15g mammal RQs: acute: 1.02-7.25; chronic: 1.80-58.01), small birds and amphibians/frogs (bird RQs: acute: 0.12-27.97; chronic: 1.44-3.34) • Granular (RQs 1.58-5.92) and scatter bait (RQ 4.91) uses exceed LOCs for mammals (prey of CCR) • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: honey bee, lab rat, bird, freshwater invertebrate/fish, estuarine/marine invertebrate/fish) ranges from 1 in 8.8×10^{24} to 1 in 1
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Terrestrial invertebrate/ arthropod RQs > 0.05 (the interim terrestrial invertebrate LOC) for all uses. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on honey bee toxicity data) is 1 in 1 **Potential for Indirect Effects** • Habitat modification (without terrestrial plant data risk is assumed); furthermore, incident data on melons indicates damage to terrestrial plants after ground application possibly due to a methomyl formulation • The species critical habitat and/or occurrence sections overlap with the use footprint
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Terrestrial invertebrate/ arthropod RQs > 0.05 (the interim terrestrial invertebrate LOC) for all uses. • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on honey bee toxicity data) is 1 in 1 **Potential for Indirect Effects** • Habitat modification (without terrestrial plant data risk is assumed); furthermore, incident data on melons indicates damage to terrestrial plants after ground application possibly due to a methomyl formulation • The species critical habitat and/or occurrence sections overlap with the use footprint
California Tiger Salamander (*Ambystoma californiense*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** • Acute: dose and dietary-based RQs >0.1 for most assessed uses for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Chronic: dietary-based RQs >1 for most assessed uses for small and medium-sized terrestrial-phase amphibians (based on bird toxicity data) consuming arthropods and herbivorous mammals • Granular (RQs 3.83-14.35) and scatter bait (RQ 5.55) uses exceed LOCs (based on bird toxicity data)

Species	Effects Determination	Basis for Determination
		• Bird (which are surrogates for terrestrial-phase amphibians) incident data indicate numerous deaths of various species by baiting and unknown use patterns • Acute: RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait, with respect to freshwater fish (which are a surrogate for aquatic-phase amphibians) • Chronic: RQs >1 for cabbage and scatter bait, , with respect to freshwater fish (which are a surrogate for aquatic-phase amphibians) • One large fish kill attributed to methomyl was reported • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on bird and freshwater fish toxicity data) ranges from 1 in 5.37 x 10^7 to 1 in 1
		Potential for Indirect Effects
		• CTS prey base is affected; CTS feeds on algae, aquatic invertebrates/ zooplankton, freshwater snails, terrestrial invertebrates, worms (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; terrestrial invert RQs: 42.30-157.12; estuarine/marine invert: acute: 0.13-3.26; chronic: 1.33-17.75), fish (freshwater fish RQs: acute: 0.13-0.19; chronic: 1.99-2.67), small mammals (15g mammal RQs: acute: 1.02-7.25; chronic: 1.80-58.01), amphibians/ frogs (bird RQs: acute: 0.12-27.97; chronic: 1.44-3.34; 20g amphibian: acute: 0.12-16.44; chronic: 1.45-3.36) • Granular (RQs 1.58-5.92) and scatter bait (RQ 4.91) uses exceed LOCs for mammals (prey of CTS) • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: honey bee, lab rat, bird, freshwater invertebrate/fish) ranges from 1 in 5.37 x 10^7 to 1 in 1
Delta Smelt (*Hypomesus transpacificus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		• Acute: RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait, with respect to freshwater fish; a single RQ value is at the listed species LOC of 0.05 for the use on cabbage, with respect to estuarine/marine fish • Chronic: RQs >1 for cabbage and scatter bait, with respect to freshwater fish; all chronic RQs are less than 1 for estuarine/marine fish • One large fish kill was a reported incident • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on estuarine/marine and freshwater fish toxicity data) ranges from 1 in 8.8 x 10^{24} to 1 in 877
		Potential for Indirect Effects
		• DS prey base is affected; adult DS feeds on planktonic copepods, cladocerans, amphipods and insect larvae and juvenile DS feed on zooplankton (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; estuarine/marine invert: acute: 0.13-3.26; chronic: 1.33-17.75); the DS larvae feed on phytoplankton • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates:estuarine/marine and freshwater invertebrates) ranges from 1 in 29,900 to 1 in 1
California	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
Freshwater Shrimp (*Syncaris pacifica*)	Likely to Adversely Affect (LAA)	• With regard to estuarine/marine invertebrate data, Acute: RQs > 0.05 for all assessed uses Chronic: RQs >1 for all except one assessed use (*i.e.*, sorghum) • With regard to freshwater invertebrate data, Acute: RQs > 0.05 for all assessed uses Chronic: RQs >1 for all assessed uses • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on freshwater invertebrate toxicity data) ranges from 1 in 6.69 to 1 in 1
		Potential for Indirect Effects
		• CFS prey base is affected; CFS feeds on zooplankton (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86), detritus, algae, aquatic macrophyte fragments, aufwuchs • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates: freshwater invertebrates) ranges from 1 in 6.69 to 1 in 1
Tidewater Goby (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		• Acute: RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait, with respect to freshwater fish; a single RQ value is at the listed species LOC of 0.05 for the use on cabbage, with respect to estuarine/marine fish • Chronic: RQs >1 for cabbage and scatter bait, with respect to freshwater fish; all chronic RQs are less than 1 for estuarine/marine fish • One large fish kill was a reported incident • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on estuarine/marine and freshwater fish toxicity data) ranges from 1 in 8.8×10^{24} to 1 in 877
		Potential for Indirect Effects
		• TG prey base is affected; adult TG feeds on small benthic invertebrates, crustaceans, snails, mysids, aquatic insect larvae, juvenile TG feeds on unicellular zooplankton (freshwater invert RQs: acute: 0.50-12.38; chronic: 1.57-60.86; estuarine/marine invert: acute: 0.13-3.26; chronic: 1.33-17.75) or phytoplankton • The species critical habitat and/or occurrence sections overlap with the use footprint • Probability of individual effect (based on prey surrogates:estuarine/marine and freshwater invertebrates) ranges from 1 in 29,900 to 1 in 1

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

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	Habitat Modification	• Risk to terrestrial plants and thus BCB habitat (esp. dwarf plantain, purple owl's clover, exserted paintbrush) was assumed. (RQs were not calculated given no available terrestrial plant data.) • Incident data on melons indicates damage to terrestrial plants after ground application possibly due to a methomyl formulation • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)	Habitat Modification	• Risk to terrestrial plants and thus VELB habitat (esp. elderberry trees) was assumed. (RQs were not calculated given no available terrestrial plant data.) • Incident data on melons indicates damage to terrestrial plants after ground application possibly due to a methomyl formulation • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint
California Tiger Salamander (*Ambystoma californiense*) [Central CA, Santa Barbara County]	Habitat Modification	• Terrestrial arthropod RQs > 0.05 (the interim terrestrial invertebrate LOC) for all uses. • Risk to terrestrial plants and thus CTS habitat was assumed. (RQs were not calculated given no available terrestrial plant data.) • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Mammal acute dose-based RQs >0.5 for all assessed uses; chronic: dose- and/or dietary-based RQs>0.1 for all assessed uses. • Bird (surrogate for terrestrial-phase amphibians) acute dose and dietary-based RQs >0.1 (listed sp.) for most assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals; chronic dietary-based RQs >1 for most assessed uses for small and medium-sized birds consuming short grass, arthropods/small insects, and herbivorous mammals • Fish (surrogate for aquatic-phase amphibians) acute RQs ≥ 0.05 for most uses assessed including cabbage, turf, anise, alfalfa, celery, and scatter bait; chronic RQs >1 for cabbage and scatter bait • Freshwater invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all assessed uses
Delta Smelt (*Hypomesus transpacificus*)	Habitat Modification	• Risk to terrestrial plants and thus DS habitat was assumed. (RQs were not calculated given no available terrestrial plant data.) • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Freshwater invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all assessed uses • Estuarine/marine invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all except one assessed use (*i.e.*, sorghum)
Tidewater Goby (*Eucyclogobius newberryi*)	Habitat Modification	• Risk to terrestrial plants and thus TG habitat was assumed. (RQs were not calculated given no available terrestrial plant data.) • Area of overlap between species habitat/critical habitat/ or occurrence sections and the initial area of concern or use footprint • Freshwater invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all assessed uses • Estuarine/marine invertebrate acute RQs > 0.1 for all assessed uses; chronic RQs >1 for all except one assessed use (*i.e.*, sorghum)

Table 7-3. Use Specific Summary of The Potential for Adverse Effects to Aquatic Taxa

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment:									
	DS, TG and Estuarine/Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Estuarine/Marine Invertebrates[4]		Vascular Plants[5]	Non-vascular Plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic		
Bulbs /Onions	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Cereal grains /Corn	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Cereal grains /Corn	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Cereal grains (sp. Sorghum)	No	No	No	No	Yes	Yes	Yes	No	No	No
Cole crops /Cabbage	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Grasses /Turf	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Herbs /Anise/Mint	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Leguminous forage (alfalfa)	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Non-cole leafy crops /Celery	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Scatter bait	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Avocado	No	No	No	No	Yes	Yes	Yes	Yes	No	No

1 A yes in this column indicates a potential for direct effects to DS and TG and indirect effects to CCR, TG, and DS as a result of an effect to estuarine/marine fish.
2 A yes in this column indicates a potential for direct effects to DS, TG and indirect effects to SFGS, CCR, TG, and DS. A yes also indicates a potential for direct and indirect effects for the CTS-CC, CTS-SC, and CTS-SB as a result of an effect to freshwater fish.
3 A yes in this column indicates a potential for direct effects to the CFWS and indirect effects to the CFWS, SFGS, CCR, CTS-CC, CTS-SB, CTS-SC, TG, and DS as a result of an effect to freshwater invertebrates.
4 A yes in this column indicates a potential for indirect effects to CCR, TG, and DS as a result of an effect to estuarine/marine invertebrates.
5 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS.

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[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Bulbs /Onions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cereal grains /Corn	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cereal grains /Corn	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cereal grains (sp. Sorghum)	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
Cole crops /Cabbage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grasses /Turf	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Herbs /Anise/Mint	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Leguminous forage (alfalfa)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non-cole leafy crops /Celery	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Avocado	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Granular	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A	N/A	Yes	Yes
Scatter bait	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A	N/A	Yes	Yes

1 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS, and CTS-SB as a result of an effect to small mammals.
2 A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, CTS-CC, CTS-SC,and CTS-SB as a result of an effect to small birds.
3 A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS-CC, CTS-SC, CTS-SB, SFGS, CCR as a result of an effect to terrestrial-phase amphibians (for which birds serve as surrogate).

4 A yes in this column indicates the potential for direct and indirect effects to SFGS and other reptiles as a result of an effect to reptiles (for which birds serve as a surrogate).
5 A yes in this column indicates a potential for direct effect to BCB and VELB and indirect effects to SFGS, CCR, CTS-CC, CTS-SC, and CTS-SB as aresult of an effect to terrestrial invertebrates.
6 A yes in this column indicates a potential for indirect effects to BCB, VELB, SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS. For the BCB and VELB this is based on the listed species LOC because of the obligate relationship with terrestrial monocots and dicots. For other species, the LOC exceedances are evaluated based on the LOC for non-listed species.

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

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

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

8. References

A bibliography of ECOTOX references, identified by the letter E followed by a number, is located in **APPENDIX H**.

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9. MRID List

161-1 Hydrolysis

MRID		Citation Reference
8844	2056782 2056783	Harvey, J. (1964?) Exposure of S-Methyl N-?(methylcarbamoyl)oxy|- thioacetimidate in Sunlight, Water, and Soil. (Unpublished study received Dec 28, 1968 under 8F0671; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, Del.; CDL:091179-V)
73256	See 2056841	McCann, J.A. (1979) Study of the Degradation Rate of Aqueous Solu- tions of Methomyl. (U.S. Environmental Protection Agency, Chemical and Biological Investigations Branch, unpublished study)
131249	2056797	Friedman, P. (19??) Hydrolysis of 1-14C-methomyl: Document No. AMR- 109-83. (Unpublished study received Oct 3, 1983 under 352-366; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, DE; CDL:251424-B)
45473403	DER not located	Pedersen, C. (2001) Hydrolysis of ?1-(Carbon 14)U Methomyl (DPX-X1179) Technical in pH 4, 5, and 6 Buffer Solutions at High Temperatures: Lab Project Number: DUPONT-5772. Unpublished study prepared by E.I. du Pont de Nemours and Company. 34 p.

161-2 Photodegradation-water

MRID		Citation Reference
161885	2056803 2056804	Harvey, J. (19??) Photolysis of [1-Carbon 14] Methomyl: Document No. AMR-121-83. Unpublished study prepared by E. I. du Pont de Nemours and Co., Inc. 14 p.
43823305	DER not located	Armbrust, K.; Reilly, D. (1995) Indirect Photodegredation of Methomyl in Aqueous Solutions: Lab Project Number: AMR 2975-94. Unpublished study prepared by DuPont Agricultural Products. 103 p.
22439		Harvey, J., Jr. (1949?) Decomposition of 14-C-Methomyl in Aerated River Water Exposed to Sunlight. (Unpublished study received May 6, 1976 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:224073-AJ)
38327	See 22439	Harvey, J., Jr. (19??) Decomposition of 14-C-Methomyl in Aerated River Water Exposed to Sunlight. (Unpublished study received May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229712-P)

161-3 Photodegradation-soil

MRID		Citation Reference
8568	2056779 2056780	Harvey, J., Jr. (1977) Degradation of 14C-Methomyl in Flanagan Silt Loam in Biometer Flasks. (Unpublished study received Feb 28, 1977 under 352-342; prepared in cooperation with Univ. of Delaware, Soil Testing Laboratory, submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:096026-B)
133184		Harvey, J. (19??) Stability of S-methyl N-?(methylcarbamoyl)oxy|- thioacetimidate in Sunlight. (Unpublished study received Jun 29, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, DE; CDL:115397-A)
163745	2056835 2056805 2056806 2056807	Swanson, M. (1986) Photodegradation of [1-Carbon 14]Methomyl on Soil: Document No. AMR-611-86. Unpublished study prepared by E.I. du Pont de Nemours and Co., Inc. 25 p.

161885	2056803 2056804	Harvey, J. (19??) Photolysis of [1-Carbon 14] Methomyl: Document No. AMR-121-83. Unpublished study prepared by E. I. du Pont de Nemours and Co., Inc. 14 p.

161-4 Photodegradation-air

MRID		Citation Reference
8844	2056782 2056783	Harvey, J. (1964?) Exposure of S-Methyl N-?(methylcarbamoyl)oxy|- thioacetimidate in Sunlight, Water, and Soil. (Unpublished study received Dec 28, 1968 under 8F0671; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, Del.; CDL:091179-V)

162-1 Aerobic soil metabolism

MRID		Citation Reference
8568	2056779 2056780	Harvey, J., Jr. (1977) Degradation of 14C-Methomyl in Flanagan Silt Loam in Biometer Flasks. (Unpublished study received Feb 28, 1977 under 352-342; prepared in cooperation with Univ. of Delaware, Soil Testing Laboratory, submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:096026-B)
8262	2056775	E.I. du Pont de Nemours and Company (1972) Summary of studies 093330-B through 093330-H. (Unpublished study received Mar 10, 1972 under 1F1021; CDL:093330-A)
155756 5012954	2056800 2056820	Harvey, J.; Pease, H. (1973) Decomposition of methomyl in soil. J. Agr. Food Chem. 21(5):10-12.
43217901	2056830	Malik, N.; Zwick, T. (1990) Aerobic Metabolism of (1-carbon 14) Methomyl in Madera, California Soil: Final Report: Lab Project Number: SC890027: AMR/1543/89. Unpublished study prepared by Battelle Memorial Institute. 40 p.
43325402	Open lit	Smelt, J.; Dekker, A.; Leistra, M.; et al. (1983) Conversion of four carbamoyloximes in soil samples from above and below the soil water table**. Pesticide Science 14:173-181.**
45473401	DER not located	Shaw, D. (2001) (Carbon 14)-Methomyl: Rate of Degradation in Three Aerobic Soils: Lab Project Number: DUPONT-5511: DPT/583: Unpublished study prepared by Huntingdon Life Sciences Ltd. 76 p.
45473402	DER not located	Shaw, D. (2001) (Carbon 14)-Methomyl Oxime: Rate of Degradation in Three Aerobic Soils: Lab Project Number: DUPONT-5512: DPT/584. Unpublished study prepared by Huntingdon Life Sciences Ltd. 60 p.
8567	2056778 2056777	Harvey, J., Jr. (1977) Decomposition of 14C-Methomyl in a Sandy Loam Soil in the Greenhouse. (Unpublished study received Feb 28, 1977 under 352-342; prepared in cooperation with Univ. of Delaware, Soil Testing Laboratory, submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:096026-A)

162-2 Anaerobic soil metabolism

MRID		Citation Reference
43217902	2056832	Malik, N.; Zwick, T. (1990) Anaerobic Metabolism of (1-carbon 14) Methomyl in Madera, California Soil: Final Report: Lab Project Number: SC890028: AMR/1544/89. Unpublished study prepared by Battelle Memorial Institute. 45 p.
43325403	Open lit	Bromilow, R.; Briggs, G.; Williams, M. et al. (1986) The role of ferrous ions in the rapid degradation of oxamyl, methomyl, and aldicarb in anaerobic soils. **Pesticide Science 17:535-547.**
73214	2056796 2056772	Harvey, J., Jr. (1977) Decomposition of ^14IC-Methomyl in Flooded Anaerobic Soils. (Unpublished study received Mar 27, 1979 under 352-342; submitted by E.I. du Pont de

Nemours & Co., Wilmington, Del.; CDL:237906-A)

162-4 Aerobic aquatic metab.

MRID		Citation Reference
43325401	2056831	Mayo, B. (1994) Degradability and Fate of (1-(carbon 14))Methomyl in Water/Sediment Systems: Lab Project Number: DPT/295/932544: AMR/2590/92. Unpublished study prepared by Huntingdon Research Centre, Ltd. 112 p.

163-1 Leach/adsorp/desorption

MRID		Citation Reference
8259	Registrant summary	E.I. du Pont de Nemours and Company (1971) Environmental Safety of Lannate Methomyl Insecticide. Summary of studies 095024-B through 095024-K. (Unpublished study received Apr 9, 1971 under 1F1021; CDL:095024-A)
8844	2056782 2056783	Harvey, J. (1964?) Exposure of S-Methyl N-?(methylcarbamoyl)oxy|- thioacetimidate in Sunlight, Water, and Soil. (Unpublished study received Dec 28, 1968 under 8F0671; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, Del.; CDL:091179-V)
9324 Or 155756	2056786 2056800	Harvey, J., Jr.; Pease, H.L. (1971?) Decomposition of Methomyl in Soil. (Unpublished study received May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229711-D)
9325	2056787 2056788	Harvey, J., Jr. (19??) Decomposition of 14C-Methomyl in a High Organic Matter Soil in the Laboratory. (Unpublished study re- ceived May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229711-E)
44306 or 161884	2056795	Khasawinah, A.M.; Holsing, G.C. (1976) UC 51762 Pesticide: Mobility on Soil Thin-Layer Chromatograms: File No. 22754. (Unpub- lished study received Sep 10, 1980 under 264-341; submitted by Union Carbide Agricultural Products Co., Ambler, Pa.; CDL: 099602-J)
133186	See 2056855 – not reviewed- dupe of 8844	Harvey, J. (19??) Disappearance of the S-methyl N-?(methylcar- bamoyl)oxy|- thioacetimidate from Soil in the Laboratory. (Un- published study received Jun 29, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, DE; CDL: 115397-C)
161884	2056802 2056770 2061311	Priester, T. (19??) Batch Equilibrium (Adsorption/desorption) and Soil Thin-layer Chromatography Studies with Methomyl: Document No. AMR-174-84. Unpublished study prepared by E.I. du Pont de Nemours and Co., Inc. 44 p.
42201605	Open lit	Karickhoff, S.; Morris, K. (1984) Sorption dynamics of hydrophobic pollutants in sediment suspensions. **Environmental Toxicology and Chemistry 4(1985):469-479.**
133187	2056800	E.I. du Pont de Nemours & Co., Inc. (1964) Disappearance of S- methyl 1-C14-N-?(methylcarbamoyl)oxy|-thioacetimidate in Three Soils in the Laboratory. (Unpublished study received Jun 29, 1977 under 352-342; CDL:115397-D)
5010422	2056818	

164-1 Terrestrial field dissipation

MRID		Citation Reference
8844	2056782 2056783	Harvey, J. (1964?) Exposure of S-Methyl N-?(methylcarbamoyl)oxy|- thioacetimidate in Sunlight, Water, and Soil. (Unpublished study received Dec 28, 1968 under 8F0671; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, Del.; CDL:091179-V)
9324	2056786	Harvey, J., Jr.; Pease, H.L. (1971?) Decomposition of Methomyl in Soil. (Unpublished study

		received May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229711-D)
05012954	2056820	Similar to above title
9326	2056789 2056791	E.I. du Pont de Nemours & Company (1971) Methomyl Decomposition in Muck Soil--A Field Study. (Unpublished study received May 5, 1977 under 352-342; CDL:229711-F)
51093	Letter	Pease, H.L. (1970) Letter sent to H.M. Baker dated Aug 19, 1970: Run-off studies with Methomyl. (Unpublished study received Apr 9, 1971 under 1F1021; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, Del.; CDL:095024-E)
51134	Letter	Harvey, J., Jr. (1976) Letter sent to D.C. Drake dated Jul 28, 1976 ?Methomyl in soil|. (Unpublished study received May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilm- ington, Del.; CDL:229725-A)
92960	See 2056855 pg 6 – study not reviewed- no methomyl data	Burkhardt, C.C.; Fairchild, M.L. (1967) Bioassay of field-treated soils to determine bioactivity and movement of insecticides. **Journal of Economic Entomology 60(6):1602-1610.** (Also~In~un- published submission received Sep 8, 1970 under unknown admin. no.; submitted by American Cyanamid Co., Princeton, N.J.; CDL: 120350-C)
133188	2056799	Harvey, J. (1964) Disappearance of S-methyl 1-C14-N-?(methylcar- bamoyl)oxy|thioacetimidate in Field Soil. (Unpublished study received Jun 29, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, DE; CDL:115397-E)
41623901	2056828	Kennedy, S. (1989) Field Soil Dissipation of Lannate L Insecticide: Lab Project Number: ML88/0078/DUP. Unpublished study prepared by Morse laboratories, Inc. 84 p.
41623902	2056828 2056849	Kennedy, S. (1989) Field Soil Dissipation of Lannate L insecticide: Lab Project Number: ML88/0078/DUP. Unpublished study prepared by Morse Laboratories, Inc. 41 p.
42288001	2056829 2056833	Kennedy, C. (1991) Field Soil Dissipation of Lannate L Insecticide--a 1991 Study: Lab Project Number: AMR-1921-91: ML91-0242-DUP: 9100135. Unpublished study prepared by Morse Labs and Harris Environmental Technologies, Inc. 64 p.
42345601	Same as 42288001	Kennedy, C. (1991) Field Soil Dissipation of Lannate L Insecticide--A 1991 Study: Lab Project Number: AMR-1921-91: ML91-0242-DUP: 9100135. Unpublished study prepared by Morse Laboratories, Inc. 64 p.
43217903	Supplement to 42288001	Kennedy, C. (1992) Field Soil Dissipation of Lannate L Insecticide: A 1991 Study: Supplement: Lab Project Number: AMR/1921/91: ML91/02420DUP: 9100135. Unpublished study prepared by Morse Lab., Inc.; Harris Environmental Technologies, Inc. 34 p.
8260	2056775	Pease, H.L. (1968) Methomyl Residue Analyses--Soils. (Unpublished study received Apr 9, 1971 under 1F1021; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, Del.; CDL:095024-D)
8836	2056776	Harvey, J., Jr.; Buchanan, J.B. (1967?) Absence of S-Oxide and S, S Dioxide as Potential Metabolites of Methomyl in Soil, Tobacco and Rats. (Unpublished study received Dec 28, 1968 under 8F0671; submitted by E.I. du Pont de Nemours & Co., Inc., Wil- mington, Del.; CDL:091179-F)
9325	2056787	Harvey, J., Jr. (19??) Decomposition of 14C-Methomyl in a High Organic Matter Soil in the Laboratory. (Unpublished study re- ceived May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229711-E)
9326	2056791	E.I. du Pont de Nemours & Company (1971) Methomyl Decomposition in Muck Soil--A Field Study. (Unpublished study received May 5, 1977 under 352-342; CDL:229711-F)

164-2 Aquatic field dissipation

MRID		Citation Reference
43325401	2056831	Mayo, B. (1994) Degradability and Fate of (1-(carbon 14))Methomyl in Water/Sediment Systems: Lab Project Number: DPT/295/932544: AMR/2590/92. Unpublished study prepared by Huntingdon Research Centre, Ltd. 112 p.

165-0 Accumulation Studies -- General

MRID		Citation Reference
73215	Not reviewed –see 2056855	E.I. du Pont de Nemours & Company (1979) Ecosystem Study. (Unpub- lished study received Mar 27, 1979 under 352-342; CDL:237906-B)
131250	Not reviewed –see 2056855	E.I. du Pont de Nemours & Co., Inc. (1979) Ecosystem Residue Study: Spruce/Fir Forest and Cedar Swamp, Princeton, Maine, 1978. (Compilation; unpublished study received Oct 3, 1983 under 352- 366; CDL:251424-D)
131251	2056798	E.I. du Pont de Nemours & Co., Inc. (1972) ?Residues: Lannate in Rainbow Trout (Salmo gairdneri)|. (Compilation; unpublished study received Oct 3, 1983 under 352-366; CDL:251424-E)

Non Guideline

43568301	2084132 pg 13 – summary and 2057033	Russell, M.; Hiscock, A.; DeMartinis, J.; et al. (1995) A Small-Scale Prospective Groundwater Monitoring Study for Methomyl: Final Report: Lab Project Number: AMR/2311/92: ML92/0335/DUP: 423/04. Unpublished study prepared by Blasland, Bouck & Lee, Inc. and other facilities. 619 p.
43599801	2057033 2056838	Russell, M.; Bergstrom, L. (1995) Modeling of the Results from a Small-Scale Prospective Groundwater Study for Methomyl: Lab Project Number: 423.13: AMR 3405-95. Unpublished study prepared by Blasland, Bouck & Lee, Inc. and DuPont Agricultural Products. 136 p.
43099601	2057025- interim report	Rigsby, D.; Hiscock, A.; DeMartinis, J. et al. (1993) A Small-Scale Prospective Groundwater Study for Methomyl: Lab Project Number: AMR 2311-92: 423-04. Unpublished study prepared by Blasland & Bouck Engineers, P. C., in association with Hickey's Agri-Service, Harris Laboratories, A&L Mid West Labs, and others. 483 p.
19947	2056794	Harvey, J., Jr. (1977?) Crop Rotation Study with 14C-Methomyl in the Greenhouse. (Unpublished study received Jan 19, 1978 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:232720-A)
43708803	2057034	Armbrust, K. (1995) An Aquatic Residue Monitoring Study of Methomyl in and Around Cucurbit Fields in California: Lab Project Numbers: AMR 2469-92: 92195: ML93-0445-DUP. Unpublished study prepared by DuPont Agricultural Products; Morse Labs.; and ABC Labs., Inc. 432 p.
43708805	2057034	Ruehl, J. (1995) Dissipation of Methomyl on Plastic Ground Cover Following Multiple Applications of Lannate L Insecticide to Tomato: Lab Project Number: AMR 2346-92. Unpublished study prepared by DuPont Agricultural Products. 189 p.
43708804	2057034	Leva, S.; McKelvey, S. (1995) An Aquatic Residue Monitoring Study of Methomyl in and Around Lettuce Fields in Florida: Lab Project Numbers: AMR 2512-92: ML93-0423-DUP: 112-333. Unpublished study prepared by DuPont Agricultural Products; Morse Labs.; and Wildlife Int'l, Inc. 475 p.
43708801	2057034	Naylor, M.; Palmer, D.; Krueger, H. (1994) An Aquatic Residue Monitoring Study of Methomyl in and Around Apple Orchards in Michigan: Lab Project Numbers: 112-292: AMR 2278-92: 91-4-3722. Unpublished study prepared by DuPont Agricultural Products; Morse Labs.; and Wildlife Int'l. Ltd. 555 p.
43744401	2057034	Leva, S.; McKelvey, S. (1995) An Aquatic Residue Monitoring Study of Methomyl in and Around a Sweet Corn Field in Georgia: Lab Project Number: AMR 2513-92: ML93-0424: 112-335. Unpublished study prepared by Morse Labs and Wildlife International Ltd. 395 p.
42271701	2056851	Eble, J.; Tomic, D. (1991) Foliar Half-life of Methomyl in Cotton Leaves: Lab Project Number: AMR 1871-90: 907005. 0-1,2,3,4. Unpublished study prepared by Siemer Analytical Laboratory 90 p.
7684	2056774	Pease, H.L. (1971?) Rapid Loss of Surface Residues of Methomyl on Treated Plants. (Unpublished study received Sep 2, 1972 under 2F1247; submitted by E.I. du Pont de Nemours & Co., Inc., Wil- mington, Del.; CDL:091771-E)
8581	2056781	Peeples, J.L. (1977) Effect of Methomyl on Soil Microorganisms. (Unpublished study received Mar 24, 1977 under 352-342; sub- mitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL: 228749-A)

9327	2056790	Belasco, I.J. (19??) Effect of Methomyl on the Activity of Sewage Microorganisms. (Unpublished study received May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229711-G)
157991	2056801	Collins, R.; Kenney, F. (1986) Octanol-water Partition Coefficient of Nudrin Insecticide, Code 5-8-0-0: RIR-25-009-86. Unpublished study prepared by Shell Development Co. 9 p.
5008165	2056808	Citation not found in OPPIN
5008174	2056809	Citation not found in OPPIN
5008203	2056810	Citation not found in OPPIN
5008448	2056814	Citation not found in OPPIN
5009351	2056816	Citation not found in OPPIN
5018583	2056825	Citation not found in OPPIN

71-1 Avian Single Dose Oral Toxicity

MRID		Citation Reference
7174	DER not located	Holsing, G.C. (1969) Final Report: Acute Oral--Coturnix Quail: Project No. 201-242. (Unpublished study received Jan 12, 1971 under 352-342; prepared by Hazleton Laboratories, Inc., submit- ted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL: 106655-D)
9184		E.I. du Pont de Nemours & Company (1972) Carbamic acid, Methyl ester with Oxime Function of Thiolacetohydroxamic acid, S-Methyl ester (5% Granules): (INX-1179-211): Haskell Laboratory Report No. 332-72. (Unpublished study received Jul 29, 1976 under 352-342; CDL:224800-H)
161886	2045980	Beavers, J. (1983) An Acute Oral Toxicity Study in the Bobwhite with H-15,000: Final Report: Project No.: 112-142. Unpublished study prepared by WIldlife International Ltd. 15 p.
160000	2045963	Hudson, R.; Tucker, R.; Haegele, M. (1984) Handbook of toxicity of pesticides to wildlife: Second edition. US Fish and Wildlife Service: Resource Publication 153. 91 p.
ACC 233993	2046011	Oral Tox to Starling. Chukar, Pidgeon and Japanese Quail, may be the same studies as summarized in 160000 above

71-2 Avian Dietary Toxicity

MRID		Citation Reference
7016	2057859	Kinzer, D. (1977) Methomyl Fly Bait: Feed Preference Study for Ground Feeding Birds (Bobwhite Quail): Report No. TR-442. (Un- published study received Apr 20, 1977 under 2724-274; submitted by Zoecon Industries, Inc., Dallas, Tex.; CDL:229392-B)
7819	2045953	Holsing, G.C. (1969) Final Report: Dietary Administration--Coturnix Quail: Project No. 201-245. (Unpublished study received Sep 10, 1969 under 352-342; prepared by Hazleton Laboratories, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:003008-A)
7820	2057845 thru 2057849	Busey, W.M. (1967) Final Report: Acute Aqueous Exposure--Goldfish, Bluegill, and Rainbow Trout: **Acute Dietary Administration--Pekin Ducks and Bobwhite Quail: Project No. 20-175**. (Unpublished study received Jul 23, 1968 under 352-342; prepared by Hazleton Laboratories, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:002998-A)
9231	DER not located	E.I. du Pont de Nemours & Company, Incorporated (1969) Methomyl Di- etary Administration to Bobwhite Quail. (Unpublished study in- cluding letter dated Mar 25, 1965 from D.E. Rosen to Harold G. Alford, received May 5, 1977 under 352-342; CDL:229723-A)

45299801	2082590	Medlicott, B.; Harris, T. (2000) Methomyl (DPX-X1179) Technical: Avian Acute Dietary Toxicity Test with Northern Bobwhite (Colinus virginianus): Lab Project Number: DUPONT-4378: 00022. Unpublished study prepared by Genesis Laboratories, Inc. 51 p.
45299802	2082591	Medlicott, B.; Harris, T. (2000) Methomyl (DPX-X1179) Technical: Avian Acute Dietary Toxicity Test with the Mallard Duck (Anas platyrhynchos): Lab Project Number: DUPONT-4379: 00023. Unpublished study prepared by Genesis Laboratories, Inc. 51 p.
00022923	2045966	Hill, E.F.; Heath, R.G.; Spann, J.W.; et al. (1975) Lethal Dietary Toxicities of Environmental Pollutants to Birds: Special Scientific Report--Wildlife No. 191. (U.S. Dept. of the Interior, Fish and Wildlife Service, Patuxent Wildlife Research Center; unpublished report)
ACC 232017	2017812	Methomyl/Tricosene Mixture tests with Bobwhite and Mallard
62189 Or 10330?	See Page 4 of 2056939	Heath, R.G.; Spann, J.W.; Hill, E.F.; et al. (1972) Comparative Di- etary Toxicities of Pesticides to Birds. By U.S. Fish and Wild- life Service, Patuxent Wildlife Research Center. Washington, D.C.: USFWS. (Special scientific report--wildlife no. 152; Chemagro report no. 33423; available from: U.S. Government Printing Office, Washington, D.C.; 1971 O--460-531; published study; CDL:092011-V

71-3 Small and Wild mammal Data

TNM 015 and TNM 021	See Fed Lab Data	Rat Dietary Studies at USEPA Beltsville Lab Test Numbers 015 and 021
0160000	2045963	Hudson, R.; Tucker, R.; Haegele, M. (1984) Handbook of toxicity of pesticides to wildlife: Second edition. US Fish and Wildlife Service: Resource Publication 153. 91 p. **Mule deer – oral test**

71-4 Avian Reproduction

MRID		Citation Reference
41898601	2045986	Beavers, J.; Hawrot, R.; Lynn, S.; et al. (1991) H-17940: A One- Generation Reproduction Study with the Mallard (Anas platyrhyn- chos): Lab Project Number: 112-228. Unpublished study prepared by Wildlife International Ltd. 166 p.
41898602	2045987	Beavers, J.; Hawrot, R.; Lynn, S.; et al. (1991) H-17940: A One- Generation Reproduction Study with the Northern Bobwhite (Coli- nus virginianus): Lab Project No: 112/227. Unpublished study prepared by Wildlife International Ltd. 168 p.

71-5 Simulated or Actual Field Testing

MRID		Citation Reference
7170	2045954 2057850 2057854	Wright, P.L. (1971) Report to E.I. du Pont de Nemours & Company: Field Wildlife Study with Lannate Methomyl Insecticide in Quail and Rabbits: IBT No. J9836. (Unpublished study received Jun 24, 1971 under 352-342; prepared by Industrial Bio-Test Labora- tories, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:007040-A)
10331	Not a Tox study it would appear	Aftosmis, J.G. (1973) Carbamic acid, Methyl ester with Oxime Func- tion of Thiolacetohydroxamine acid, S-Methyl ester (25% Active Ingredient): (Lannate^R)I l Methomyl Insecticide): Haskell Lab- oratory Report No. 354-73. (Unpublished study received May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229730-A)
48324	Summary- no DER located	Pearce, P.A. (1970) Summary of Canadian Wildlife Service Supported Projects--1970 New Brunswick Spruce Budworm Control Program: Re- port No. 28788. (**Canada, Wildlife Service, Dept. of Indian Af- fairs and Northern Development**, unpublished study;

		CDL:226511-P)
89148	No DER located	Hinkle, S.; Cameron, J.T. (1980) Final Report: Simulated Field Trial in Bobwhite Quail: Project No. 20-531. (Hazleton Labora- tories, Inc.; unpublished study)
9183		Sherman, H.; Aftosmis, J.G. (1972) Effect of Methomyl-Treated Bait on Bobwhite Quail: Haskell Laboratory Report No. 405-72. (Un- published study received Jul 29, 1976 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL: 224800-F)
8829	2045956	Treated bait with BWQ

72-1 Acute Toxicity to Freshwater Fish

MRID		Citation Reference
69574	Open lit	El-Refai, A.; Fahmy, F.A.; Abdel-Lateef, M.F.A.; et al. (1976) Toxicity of three insecticides to two species of fish. **Inter- national Pest Control 18(6):4-8.** (Also~In~unpublished submis- sion received Mar 22, 1977 under 876-20; submitted by Velsicol Chemical Corp., Chicago, Ill.; CDL:244425-A)
78426	DER not located	Smith, E.J. (1978) 96-hour LC50 to Bluegill Sunfish: Haskell Labo- ratory Report No. 55-78. (Unpublished study received Aug 28, 1981 under 1E2556; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, Del.; CDL:070247-F)
79175	Summary report	Mann, ? (1974) Report on Determinations of Toxicity of Co 755. (Unpublished study received Jun 25, 1981 under 35902-EX-1; pre- pared by Bundesforschungsanstalt fur Fischerei, West Germany, submitted by Wacker Chemie GmbH, Munich, W. Germany; CDL: 245338-V)
79176	Summary report	Mann, ? (1974) Report on Investigations into the Toxicity of Co 755 to Rainbow Trout and~Idus idus melanotus~. (Unpublished study received Jun 25, 1981 under 35902-EX-1; submitted by Wacker Chemie GmbH, Munich, W. Germany; CDL:245338-W)
131251	Residue study	E.I. du Pont de Nemours & Co., Inc. (1972) ?**Residues**: Lannate in Rainbow Trout (Salmo gairdneri)|. (**Compilation**; unpublished study received Oct 3, 1983 under 352-366; CDL:251424-E)
135772	Range test	Waggy, G. (1974) Agricultural Chemicals: Range Finding: Fish Bio- assay of Experimental Insecticides (Methomyl UC 45650 Only): Project No. 111B20. (Unpublished study received Nov 17, 1978 under 1016-EX-52; submitted by Union Carbide Corp., Research Triangle Park, NC; CDL:097646-B)
5010817	2045981	Coppage, D.L. (1977) Anticholinesterase action of pesticidal carbamates in the central nervous system of poisoned fishes. Pages 93-102,~In~Physiological Responses of Marine Biota to Pollutants, Proceedings of a Symposium; Nov, 1975, Milford, Connecticut. Edited by F.J. Vernberg, A. Calabrese, F.P. Thurberg and W.B. Vernberg. New York: Academic Press.
7820	2057845 thru 2057849	Busey, W.M. (1967) Final Report: **Acute Aqueous Exposure--Goldfish, Bluegill, and Rainbow Trout:** Acute Dietary Administration--Pekin Ducks and Bobwhite Quail: Project No. 20-175. (Unpublished study received Jul 23, 1968 under 352-342; prepared by Hazleton Laboratories, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:002998-A)
40098001	2049421	Mayer, F.; Ellersieck, M. (1986) Manual of Acute Toxicity: Inter- pretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals. US Fish & Wildlife Service, Resource Pub- lication 160. 579 p.
9007	2045957	U.S. Fish and Wildlife Service, Columbia National Fishery Research Laboratory (1978?) Methomyl: Summary of Acute Toxicity. (Unpub- lished study received Dec 26, 1978 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:236680-C)
9061	2045958	Schneider, P.W., Jr. (1976) 96-Hour LCI50^ to Bluegill Sunfish: Haskell Laboratory Report No. 710-76. (Unpublished study received Jun 21, 1979 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:238781-A)
9132 or 38324	Summary	E.I. du Pont de Nemours & Company (1968?) LCI50^ Values (p.p.b.). (Unpublished study received May 6, 1976 under 352-342; CDL: 224073-AG)

9133 or 38325	In citations see 2056855	Sleight, B.H., III (1971) Research Report: Continuous Exposure of Rainbow Trout (?~Salmo gairdneri) to Lannate^(R)I in Water. (Unpublished study received May 6, 1976 under 352-342; prepared by Bionomics, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:224073-AH)
9226	2045961	McCain, J.C. (1971) Final Report: Acute Fish Toxicity Study--Static Freshwater: Project No. 201-254. (Unpublished study received May 5, 1977 under 352-342; prepared by Hazleton Laboratories, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229714-A)
20053	DER not located	Buccafusco, R.J. (1976) Acute Toxicity **of SX-70** to Rainbow Trout (?~Salmo gairdneri~?). (Unpublished study received Apr 21, 1978 under 270-133; prepared by EG&G, Bionomics, submitted by Farnam Cos., Inc., Phoenix, Ariz.; CDL:233828-D)
20054	DER no located	Buccafusco, R.J. (1976) Acute Toxicity of **SX-70** to Bluegill (?~Le~- ?~pomis macrochirus~?). (Unpublished study received Apr 21, 1978 under 270-133; prepared by EG&G, Bionomics, submitted by Farnam Cos., Inc., Phoenix, Ariz.; CDL:233828-E)
60949	2045969 TN 1114 in Fed Lab data in SAN	McCann, J.A. (1977) Methomyl (Lannate): Toxicity to Bluegill (?~Lepomis macrochirus~?): **Test # 1114**. (U.S. Environmental Protection Agency, Animal Biology Laboratory, unpublished study)
60950	2045970 TN 1034 in Fed Lab data in SAN	McCann, J.A. (1976) Lannate L Methomyl: Toxicity to Bluegill (?~Lepomis macrochirus~?): **Test # 1034.** (U.S. Environmental Protection Agency, Animal Biology Laboratory, unpublished study)
73256	Degradation study	McCann, J.A. (1979) Study of the **Degradation Rate of Aqueous Solu- tions of Methomyl.** (U.S. Environmental Protection Agency, Chemical and Biological Investigations Branch, unpublished study)
73793	2045972	McCann, J.A. (1972) ?DuPont Lannate Methomyl Insecticide: Rainbow Trout (~Salmo~gairdneri**~)|: Test No. 474.** (U.S. Agricultural Research Service, Animal Biology Laboratory; unpublished study; CDL:130311-A)
77271 Same as 73793	see Fed Lab Data in SAN	McCann, J.A. (1971) Lannate Methomyl: Toxicity to Rainbow Trout (?~Salmo gairdneri~?): **Test No. 474**. (U.S. Agricultural Re- search Service, Pesticides Regulation Div., Animal Biology Labo- ratory, unpublished study)
77272	2045973 TN 427 in Fed Lab Data in SAN	McCann, J.A. (1971) Lannate Methomyl: Toxicity to Rainbow Trout (?~Salmo gairdneri~?): **Test No. 427**. (U.S. Agricultural Re- search Service, Pesticides Regulation Div., Animal Biology Labo- ratory, unpublished study)
77273	2045974 TN 351 in Fed Lab data	McCann, J.A. (1971) Lannate Methomyl: Toxicity to Bluegill (?~Lepomis macrochirus~?): **Test No. 351**. (U.S. Agricultural Re- search Service, Pesticides Regulation Div., Animal Biology Labo- ratory, unpublished study)
9226	2045961	McCain, J.C. (1971) Final Report: Acute Fish Toxicity Study--Static Freshwater: Project No. 201-254. (Unpublished study received May 5, 1977 under 352-342; prepared by Hazleton Laboratories, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229714-A)
19978	2046011	Drake, D.C.; Woodward, D.F. (1978) Acute Toxicity Studies: Cut- Throat Trout and Stonefly Larvae. (Unpublished study received May 22, 1978 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:233993-D)
ACC 106658	TN 257 see Fed Lab Data in SAN	TN 257 USEPA Beltsville Lab MRID not located

72-2 Acute Toxicity to Freshwater Invertebrates

MRID		Citation Reference
79177	Butocarboxime	Wacker Chemie GmbH (1975) Determination of LCI50^ with Water-fly (~Daphnia pulex~) with **Butocarboxime** (Code No.: Co 755). (Un- published study received Jun 25, 1981 under 35902-EX-1; CDL: 245338-X)
46015301	DER not located	Hoke, R. (2003) Methomyl (DPX-X1179) 20SL: A Study to Determine the Effects on Adult Daphnia magna and their Neonates Under Time-Varied Exposure. Project Number: 14123,

		1485, DUPONT/11049. Unpublished study prepared by DuPont Haskell Laboratories.49 p.
46015302	DER not located	Hoke, R. (2003) Methomyl (DPX-X1179) 20SL: Static, Acute, 48-Hour EC50 to Daphnia magna. Project Number: 14123, 241, DUPONT/10461. Unpublished study prepared by DuPont Haskell Laboratory. 36 p.
46015303	DER not located	Ward, T.; Wyskiel, D.; Boeri, R. (2001) Methomyl 20 SL: Static, Acute, 48-Hour EC50 to Daphnia magna. Project Number: 163/DU, DUPONT/3726, 3726. Unpublished study prepared by T.R. Wilbury Laboratories, Inc. 45 p.
40098001	2049421	Mayer, F.; Ellersieck, M. (1986) Manual of Acute Toxicity: Inter- pretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals. US Fish & Wildlife Service, Resource Pub- lication 160. 579 p.
40094602	2079104	Johnson, W.; Finley, M. (1980) Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates: Resource Publi- cation 137. US Fish and Wildlife Service, Washington, D.C. 106 p.
19977	2045965	Goodman, N.C. (1978) 48-Hour LC50^2I to~Daphnia magna~: Haskell Laboratory Report No. 165-78. (Unpublished study received May 22, 1978 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:233993-B)

72-3 Acute Toxicity to Estuarine/Marine Organisms

MRID		Citation Reference
41441201	2045983	Ward, T.; Boeri, R. (1989) Static Acute Toxicity of Methomyl to the Mysid, Mysidopsis bahia: Lab Project Number: 8963-DU. Unpub- lished study prepared by EnviroSystems Div., Resource Analysts, Inc. 32 p.
41441202	2045984	Boeri, R.; Ward, T. (1989) Static Acute Toxicity of Methomyl to the Sheepshead Minnow, Cyprinodon variegatus: Lab Project Number: 8964-DU. Unpublished study prepared by EnviroSystems Div., Resource Analysts, Inc. 32 p.
41611301	2045985	Ward, T.; Boeri, R. (1990) Static Acute Toxicity of Methomyl to Bi- valve Mollusc Embryos and Larvae: Lab Project Number: 8965-DU. Unpublished study prepared by Resource Analysts, Inc., Enviro- Systems Div. 31 p.
42074601	2045988 2045989	Ward, T. (1991) Acute Flow-through Mollusc Shell Deposition with DPX-X1179-394 (Methomyl): Lab Project Number: MR-8808-001. Unpublished study prepared by EnviroSystems, Inc. in coop. with Dupont Haskell Labs. 31 p.
9230	2045962	Bentley, R.E. (1973) Acute Toxicity of H-8385 to Grass Shrimp (?~Palaemonetes vulgaris~?) and Fiddler Crab (?~Uca pugil~?- ?~ator~?). (Unpublished study received May 5, 1977 under 352- 342; prepared by Bionomics, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229718-A)
38326	2057857	Sleight, B.H., III (1973) Bioassay Report Submitted to E.I. du Pont de Nemours & Company, Newark, Delaware: Acute Toxicity of H-7946,MR-581 to Grass Shrimp (?~Palaemonetes vulgaris~?), Pink Shrimp (?~Penaeus duorarum~?) and Mud Crab (?~Neopanope~ ?~texana~?). (Unpublished study received May 5, 1977 under 352- 342; prepared by Bionomics, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229712-O)

72-4 Fish Early Life Stage/Aquatic Invertebrate Life Cycle Study

MRID		Citation Reference
118511 or 131255	2045975 2045976	Muska, C.; Driscoll, R. (1982) Early Life Stage Toxicity of Methomyl to Fathead Minnow: Haskell Laboratory Report No. 528- 82. (Unpublished study received Dec 3, 1982 under 352-342; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, DE; CDL:071268-A)
118512	2045977	Muska, C.; Brittelli, M. (1982) Chronic Toxicity of Methomyl to Daphnia magna: Haskell Laboratory Report No. 46-82. (Unpub- lished study received Dec 3, 1982 under 352-342;

		submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, DE; CDL: 071268-B)
45013202	2045992	Boeri, R.; Magazu, J.; Ward, T. (1998) Methomyl Technical: Flow-Through Early Life Stage Toxicity to the Sheepshead Minnow, Cyprinodon variegatus: Lab Project Number: DUPONT-1156: 1627-DU. Unpublished study prepared by T.R. Wilbury Laboratories, Inc. 49 p.
45013203	2045993	Ward, T.; Magazu, J.; Boeri, R. (1999) Methomyl Technical: Flow-Through Chronic Toxicity to the Mysid, Americamysis bahia (Formerly Known as Mysidopsis bahia): Lab Project Number: DUPONT-1157: 1626-DU. Unpublished study prepared by T.R. Wilbury Laboratories, Inc. 56 p.
131254	2045979	Britelli, M.; Muska, C. (1982) Chronic Toxicity of Methomyl to Daphnia magna: Haskell Laboratory Report No. 46-82; MR No. 0581- 930. (Unpublished study received Oct 3, 1983 under 352-366; submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, DE; CDL:251426-B)
46015305	DER not located	Howard, T.; Rhodes, J.; Mihalik, R. (1991) Early Life-Stage Toxicity of IN X1179-394 to the Fathead Minnow (Pimephales promelas) Under Flow-Through Conditions: Final Report. Project Number: 39292, 9006/02, HLO/7052/91. Unpublished study prepared by Analytical Bio-Chemistry Labs., Inc. 494 p.

72-5 Life cycle fish

MRID		Citation Reference
43072101	2045990 Draft copy	Strawn, T.; Rhodes, J.; Leak, T. (1993) Full Life-Cycle Toxicity of DPX-X1179-394 (Methomyl) to the Fathead Minnow (Pimephales promelas) Under Flow-Through Conditions: Final Report: Lab Project Number: 39293: HLO 47-93. Unpublished study prepared by ABC Laboratories, Inc. 3582 p.

72-7 Simulated or Actual Field Testing

MRID		Citation Reference
43708801	2057034 in F001936	Naylor, M.; Palmer, D.; Krueger, H. (1994) An Aquatic Residue Monitoring Study of Methomyl in and Around Apple Orchards in Michigan: Lab Project Numbers: 112-292: AMR 2278-92: 91-4-3722. Unpublished study prepared by DuPont Agricultural Products; Morse Labs.; and Wildlife Int'l. Ltd. 555 p.
43708802	2057034 in F001936	Leva, S. (1995) An Aquatic Residue Monitoring Study of Lannate L Insecticide in and Around Sweet Corn Fields in Illinois. Unpublished study prepared by DuPont Agricultural Products; Morse Labs.; and Wildlife Int'l. Ltd. 584 p.
43708803	2057034 in F001936	Armbrust, K. (1995) An Aquatic Residue Monitoring Study of Methomyl in and Around Cucurbit Fields in California: Lab Project Numbers: AMR 2469-92: 92195: ML93-0445-DUP. Unpublished study prepared by DuPont Agricultural Products; Morse Labs.; and ABC Labs., Inc. 432 p.
43708804	2057034 in F001936	Leva, S.; McKelvey, S. (1995) An Aquatic Residue Monitoring Study of Methomyl in and Around Lettuce Fields in Florida: Lab Project Numbers: AMR 2512-92: ML93-0423-DUP: 112-333. Unpublished study prepared by DuPont Agricultural Products; Morse Labs.; and Wildlife Int'l, Inc. 475 p.
43744402	See page 2 of 2057048	Samel, A. (1995) An Evaluation of the Effects and Fate of Methomyl Insecticide Exposure in Outdoor Microcosms: Lab Project Number: AMR 2389-92: ML93-0445-DUP: 112-299. Unpublished study prepared by Morse Labs and Wildlife International, Ltd. 877 p.

123-2 Aquatic plant growth

MRID		Citation Reference

43679310	Open lit	Ibrahim, A. (1984) Effect of growth rate of the microscopic algae Ankistrodesmus falcatus (Corda) ralfs, Scenedesmus quadricauda (Turp.) breb. and Phaeodactylum tricornutum (bohlin). **Aqua 5:303-306.**

141-1 Honey bee acute contact

MRID		Citation Reference
44262001		Atkins, E.; Kellum, D.; Neuman, K.; et al. (1975) Effect of Pesticides on Apiculture: 1975 Annual Report: Lab Project Number: 1499. Unpublished study prepared by University of California, Riverside. 33 p.
45093001	2045994	Schur, A. (2000) Methomyl Technical: Acute Oral and Contact Toxicity to the Honeybee, Apis mellifera L.: Final Report: Lab Project Number: 99263/01-BLEU: DUPONT-2738. Unpublished study prepared by GAB Biotechnologie GmbH & IFU Umweltanalytik GmbH. 38 p. {OPPTS 850.3020}
40601		Atkins, E.L.; Greywood-Hale, E.A.; Macdonald, R.L.; et al. (1974) Effect of Pesticides on Apiculture: 1974 Annual Report: Project No. 1499. (Unpublished study received Oct 21, 1976 under 6F1696; prepared by Univ. of California--Riverside, Agricultural Experiment Station, Dept. of Entomology, Citrus Research Center, submitted by E.I. du Pont de Nemours & Co., Inc., Wilmington, Del., CDL:095326-K)
40602		Johansen, C.; Mayer, D.; Baird, C. (1973) Bee Research Investiga- tions, 1973. (Incomplete, unpublished study received Oct 21, 1976 under 6F1696; prepared by Washington State Univ., Dept. of Entomology in cooperation with Alfalfa Seed Pest Management Project, submitted by E.I. du Pont de Nemours & Co., Inc., Wil- mington, Del.; CDL:095326-M)
79174	Letter - preliminary test	Stute, ? (1972) Letter sent to Wacker Chemie GmbH dated Jan 21, 1972: Preliminary test of the harmful effect of Co 755 on bees in response to your letter of 3rd Dec. 1971. (Translation; un- published study, including German text, received Jun 25, 1981 under 35902-EX-1; prepared by Bundesforschungsanstalt fur Klein- tierzucht, West Germany, submitted by Wacker Chemie GmbH, Munich, W. Germany; CDL:245338-T)
14715	2029428	Sakamoto, S.S.; Johansen, C.A. (1971) Toxicity of Orthene to Honey Bees (?~Apis mellifera?~); Alfalfa Leaf Cutter Bees (?~Megachile rotundata?~); Alkali Bees (?~Nomia melanderi?~); Bumble Bees (?~Bombus auricomus?~). (Unpublished study received Jun 21, 1972 under 239-EX-61; prepared in cooperation with Washington State Univ., Entomology Dept., submitted by Chevron Chemical Co., Richmond, Calif.; CDL:223505-AT)
ACC 224800	2057851	Honeybee acute contact with formulation -Possibly MRID 9180? E.I. du Pont de Nemours & Company (19??) Bee Statement. Summary of study 224800-C. (Unpublished study received Jul 29, 1976 under 352-342; CDL:**224800-B)**
5000837	2029430 Open lit	Johansen, C.A. (1972) Toxicity of field-weathered insecticide residues to four kinds of bees. **Environmental Entomology 1(3):393-394.**
9129	2029420	Johansen, C.; Retan, A.H. (1973) Insecticide Toxicity to Alfalfa- Pollinating Bees. Rev. Pullman: Washington State Univ., Coop- erative Extension Service. (E.M. 2784; also~In~unpublished submission received May 6, 1976 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:224073-W)
9181	2057851	Atkins, E.L., Jr.; Anderson, L.D.; Greywood, E.A. (1969) Effect of Pesticides on Apiculture: Project No. 1499. (Unpublished study received Jul 29, 1976 under 352-342; prepared by Univ. of Cali- fornia--Riverside, Dept. of Entomology, submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:224800-C)
5009359	2029443	

141-2 Non Target Beneficial Insect Toxicity

45125501	2045995	Adelberger, I. (2000) Methomyl 20L: A Dose/Response Test to Evaluate the Effects on the Predatory Mite, Typhlodromus pyri Scheuten (Acri, Phytoseiidae) in the Laboratory: Lab Project Number: 2668: 99205/01-NLTP. Unpublished study prepared by IFU Umweltanalytik GmbH. 33 p.

45125502	2045996	Adelberger, I. (2000) Methomyl 25 WP: A Dose/Response Test to Evaluate the Effects on the Predatory Mite, Typhlodromus pyri Scheuten (Acri, Phytoseiidae) in the Laboratory: Lab Project Number: 2914: 99342/01-NLTP. Unpublished study prepared by IFU Umweltanalytik GmbH. 33 p.
45133301	2045997	Schuld, M. (2000) Methomyl 20L: A Dose/Response Test to Evaluate the Effects on the Aphid Parasitoid Aphidius rhopalosiphi (Hymenoptera, Braconidae) in the Laboratory: Lab Project Number: 99205/01-NLAP: 2669. Unpublished study prepared by IFU Umweltanalytik GmbH. 39 p.
45133302	2045998	Schuld, M. (2000) Methomyl 25 WP: A Dose/Response Test to Evaluate the Effects on the Aphid Parasitoid Aphidius rhopalosiphi (Hymenoptera, Braconidae) in the Laboratory: Lab Project Number: 2915: 99342/01-NLAP. Unpublished study prepared by IFU Umweltanalytik GmbH. 38 p.
47796306	Open lit	Marletto, F.; Patetta, A.; Manino, A. (2003) Laboratory Assessment of Pesticide Toxicity to Bumblebees. **Bulletin of Insectology 56(1): 155-158**.
5008149	2029433 Open lit	Gholson, L.E.; Beegle, C.C.; Best, R.L.; Owens, J.C. (1978) Effects of several commonly used insecticides on cornfield carabids in Iowa. **Journal of Economic Entomology 71(3):416-418.**
40098001	2049421	Mayer, F.; Ellersieck, M. (1986) Manual of Acute Toxicity: Inter- pretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals. US Fish & Wildlife Service, Resource Pub- lication 160. 579 p. **Aquatic insect larvae**
5003536	2029431 Open lit	Elsey, K.D. (1973) ?~Jalysus spinosus?~: effect of insecticide treatments on this predator of tobacco pests. Environmental Entomology 2(2):240-243.
5009819	2029446 Open lit	Tomlin, A.D. (1975) The toxicity of insecticides by contact and soil treatment to two species of ground beetles (Coleoptera: Carabidae). **Canadian Entomologist 107(5):529-532.**
5010807	2029451 Open lit	Turnipseed, S.G.; Todd, J.W.; Campbell, W.V. (1975) Field activity of selected foliar insecticides against geocorids, nabids and spiders on soybeans. Journal of the **Georgia Entomological Society 10(3):272-277.**

142-3 Simulated or Actual Field Testing

MRID		Citation Reference
9033	2029403	Asquith, D.; Colburn, R. (1973) 1973 Laboratory Evaluation of Vari- ous Pesticides on~Stethorus~punctum~Adults. (Unpublished study received Mar 13, 1978 under CO 78/5; prepared by Pennsylvania State Univ., Fruit Research Laboratory, submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:236817-F)
9040	DER not located efficacy?	McCall, G.L.; Nash, C.; Black, H. (1974) Lannate/Alfalfa: Control of Pea Aphid and Effect on Predators. (Unpublished study re- ceived Oct 12, 1978 under 352-342; prepared in cooperation with Kern Co., submitted by E.I. du Pont de Nemours & Co., Wilming- ton, Del.; CDL:236883-A)
9041	DER not located Efficacy	Tuttle, D.M.; Arvizo, G.L. (1976) Evaluation of Insecticide Sprays on Alfalfa, 1976. (Unpublished study received Oct 12, 1978 under 352-342; prepared by Univ. of Arizona, Experiment Station, Dept. of Entomology, submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:236883-B)
9042	2029415	Burkhardt, C.C.; Puterka, G.J.; Michels, G.J., Jr. (1977) Impact of Insecticides on Beneficial Insects in an Experimental Plot Used to Control Alfalfa Weevil, Lygus Bugs, and Pea Aphids on Alfalfa. (Unpublished study received Oct 12, 1978 under 352- 342; prepared by Univ. of Wyoming, Agricultural Substation, sub- mitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL: 236883-C)
14038	Efficacy	Atkins, E.L., Jr. (1969) Product Performance Report. (Unpublished study received Mar 5, 1970 under 0F0956; prepared by Univ. of California--Riverside, Dept. of Entomology; submitted by Chevron Chemical Co., Richmond, Calif.; CDL:093266-AJ)
77052	DER not located	Atkins, L. (1981) Field Trials on Cotton and Alfalfa and Foliage Residue Trials To Assess Toxicity to Honeybees: **Mavrik 2E**. Fi- nal rept. (Unpublished study received May 13, 1981

		under 20954- EX-18; prepared by Univ. of California--Riverside, Dept. of Entomology, submitted by Zoecon Corp., Palo Alto, Calif.; CDL: 070100-L)
5000837	2029420	Johansen, C.A. (1972) Toxicity of field-weathered insecticide residues to four kinds of bees. **Environmental Entomology 1(3):393-394.**
5008360		Hoy, M.A.; Flaherty, D.; Peacock, W.; Culver, D. (1979) Vineyard and laboratory evaluations of methomyl, dimethoate, and permethrin for a grape pest management program in the San Joaquin Valley of California. Journal of Economic Entomology 72(2):250-255.

Non Guideline Section Selections

7020	2045952	Murphy, D.L.; Boyd, J.P. (1975) A Comparative Quail Feeding Pre- ference Study: Report No. TR-344. (Unpublished study received Apr 20, 1977 under 2724-274; prepared by Thuron Industries, Inc., submitted by Zoecon Industries, Inc., Dallas, Tex.; CDL:229393-C)
9005	summary pg 1 of 2029469	Brown, H.L. (1978) The Effects of Lannate LV on Singing Male Song- birds in Maine in 1978. (Unpublished study received Dec 26, 1978 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:236680-A)
9006	Summary see 2029469	Drake, D.C. (1978) Evaluation of Non-Target Animals Including Ter- restial Insects and Aquatic Animals. (Unpublished study re- ceived Dec 26, 1978 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:236680-B)
9021	DER not located	Gilliland, F. (1977) Test Record: Evaluation of Lannate (Methomyl) on Beneficial Arthropods in Cotton Fields. (Unpublished study received Mar 2, 1979 under 352-342; prepared by Agricon, Inc., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:237735-H)
9023	2029407	Welch, A. (1978) Numbers of Selected Beneficial Insects Found, be- fore and at Various Intervals after Treatment with 0.125 # AI/A Lannate L^(TM)I in a Cotton Insecticide Experiment at Friars Point, MS, 1978. (Unpublished study received Mar 2, 1979 under 352-342; prepared in cooperation with Ag-Test, submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:237735-J)
9183	2045960 2057852	Sherman, H.; Aftosmis, J.G. (1972) Effect of Methomyl-Treated Bait on Bobwhite Quail: Haskell Laboratory Report No. 405-72. (Un- published study received Jul 29, 1976 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL: 224800-F)
19977	2045965	Goodman, N.C. (1978) 48-Hour LC50^2I to~Daphnia magna~: Haskell Laboratory Report No. 165-78. (Unpublished study received May 22, 1978 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:233993-B)
19978	Pg 5 of 2046011 ES-VII- G & H	Drake, D.C.; Woodward, D.F. (1978) Acute Toxicity Studies: Cut- Throat Trout and Stonefly Larvae. (Unpublished study received May 22, 1978 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:233993-D)
19979	DER not l;ocated	Orpin, R. (1971) Methomyl--Study of Effects on Wild Life. (Unpub- lished study received May 22, 1978 under 352-342; prepared by Farm Protection, Ltd., submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:233993-E)
35790	Pg 8 2056933	Johansen, C.A. (1971) How To Reduce Poisoning of Bees from Pesti- cides. Pullman, Wash.: Washington State Univ., Cooperative Extension Service. (EM 13473; also~In~unpublished submission received May 6, 1976 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:224073-V)
38320 see 35790-same study?	Pg 8 2056933	Johansen, C.A. (19??) How To Reduce Poisoning of Bees from Pesti- cides. Pullman, Wash.: Washington State Univ., Cooperative Ex- tension Service. (Also~In~unpublished submission received May 5, 1977 under 352-342; submitted by E.I. du Pont de Nemours & Co., Wilmington, Del.; CDL:229712-C)
50459		E.I. du Pont de Nemours & Company (1971) Environmental and Wildlife Information Relating to the Use of Lannate Methomyl Insecticide in Pineapple in Hawaii. (Reports by various sources; unpub- lished study including published data, received Jan 6, 1981 un- der 352-EX-106; CDL:099858-A)
131008	Check EIIS	Stone, W. (1980) Bird Deaths Caused by Pesticides Used on Turf- grass: ?Diazinon and Others|. (Unpublished study received Sep 2, 1983 under 100-461; prepared by New York

		State Dept. of Envi- ronmental Conservation, submitted by Ciba-Geigy Corp., Greens- boro, NC; CDL:251139-C)
138668	DER not located	Erickson, E.; Hanny, B.; Harvey, J.; et al. (1980) Residues of Lannate ... in Honey Bees ... and Its Persistence in Bee Prod- ucts. (Unpublished study received Jan 11, 1984 under 4581-292; submitted by Agchem Div., Pennwalt Corp., Philadelphia, PA; CDL:252448-H)
5009819	2029446 pg 2 Open lit	Tomlin, A.D. (1975) The toxicity of insecticides by contact and soil treatment to two species of ground beetles (Coleoptera: Carabidae). **Canadian Entomologist 107(5):529-532.**
5008724	Open lit	Simpson, G.R.; Bermingham, S. (1977) Poisoning by carbamate pesticides. **Medical Journal of Australia 2(5):148-149.**
5019097	DER not located	Lindquist, R.K.; Wolgamott, M.L. (1978) Phytotoxicity evaluation on greenhouse flowering and foliage plants during 1977. Pages 8-9,~In~**Ohio Florists' Association Bulletin No. 584. Columbus, Ohio: Ohio Florists' Association.**
43731502	DER not located Open lit	Aboul-Ela, I.; Khalil, M. (1987) The acute toxicity of three pesticides on organisms of different trophic levels as parameters of pollutions in Lake Wad El Rayan, El Fayoum, **Egypt. Proc. Zool. Soc A.R. Egypt 13:31-36.**
43823301	2057034 Registrant assessment	Layton, R. (1995) Methomyl: An Aquatic Ecological Assessment Based on Major Product Uses in the United States: Lab Project Number: AMR 3526-95. Unpublished study prepared by DuPont Agricultural Products. 40 p.
43823302	2057047 pg 48 and 2057034	Williams, W.; Ritter, A.; Cheplick, J.; et al. (1995) Probabilistic Modeling of Methomyl Exposure to Aquatic Nontarget Organisms Associated with Lannate Use on Sweet Corn: Lab Project Number: WEI 387.07: AMR 3573-95. Unpublished study prepared by Waterborne Environmental, Inc. 334 p.
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