REREGISTRATION ELIGIBILTY DECISION

ENVIRONMENTAL FATE AND EFFECTS SCIENCE CHAPTER

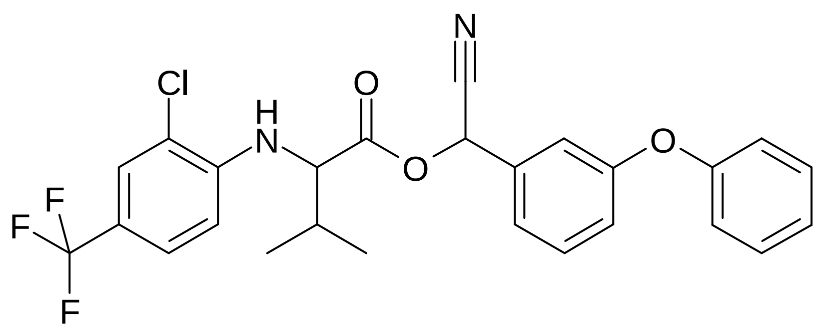
Environmental Fate and Ecological Risk Assessment

For

TAU-FLUVALINATE
(CAS No.69409-94-5)

IUPAC Name
(RS)-α-Cyano-3-phenoxybenzyl N-(2-chloro-α,α,α-trifluoro-p-tolyl)-DL-valinate.

CAS Name
Cyano(3-phenoxyphenyl)methyl N-[2-chloro-4-(trifluoromethyl)phenyl]-DL-valinate.



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1 Executive Summary

1.1 Nature of Chemical Stressor

Tau-fluvalinate ((RS)-α-cyano-3-phenoxybenzyl (R)-2-(2-chloro-4-trifluoromethylanilino)-3-methylbutanoate), also referred to as "Half Resolved fluvalinate" (a mixture of two insecticidally active isomers) is a synthetic pyrethroid used as an insecticide and miticide for empty beehives, eugenia, pepper tree, greenhouses, building perimeters, flower and foliage cuttings, interior landscapes, ant mounds, and ornamentals. There is a 24(c) Special Local Need (SLN) registration for carrots grown for seed and brassica/cole crops in California, and the registrant has dropped the SLN use for carrot seeds in Oregon. The Environmental Fate and Effects Division (EFED) has relied on modeling for estimating exposures to non-target aquatic and terrestrial organisms. For aquatic exposures, EFED has modeled *tau*-fluvalinate on carrots as a surrogate for both SLN registrations and has modeled ornamentals to represent all other outdoor uses except beehives (apiary strips) and ant mounds (spot treatment) which, along with indoor uses, are not expected to result in significant aquatic exposures.

According to information provided by the registrant, *tau*-fluvalinate is used primarily for control of aphids, whiteflies, mites, thrips, caterpillars, beetles, mealybugs and root weevils when applied for commercial use in greenhouses, interior landscapes, and outdoor ornamental plantings, and for control of the Lygus bug in carrots grown for seed. *Tau*-fluvalinate is a synthetic pyrethroid that acts to inhibit sodium channel modulators. In general, the pyrethroids share similar modes of action, resembling that of DDT, and are considered axonic poisons (Ware and Whitacre, 2004).

Major degradates of *tau*-fluvalinate are 3-Phenoxy-benzaldehyde **(3-PB Aldehyde)**, 2-(2-Chloro-4-carboxyl)anilino-3-methylbutanoic acid, 2-[4-Carboxyl-2-(chloro)anilino]-3-methylbutanoic acid **(Diacid)**, 2-(2-Chloro-4-trifluoromethyl)-anilino-3-methylbutanoic acid, 2-[2-Chloro-4-(trifluoromethyl)-anilino]-3-methylbutanoic acid **(Anilino acid)**, 2-Chloro-4-trifluoromethylaniline **(Haloaniline)**, and **Cyanohydrin**. Degradate structures are provided in **Appendix A**. The Health Effects Division (HED) has determined that none of these are of toxicological concern for the human health risk assessment. For two of the major degradates, the risk to aquatic animals and non-vascular aquatic plants is likely to be less than that of the parent. One of the degradates, cyanohydrin, may be more acutely toxic to mammals than the parent; however, due to a lack of a consistent dose-mortality relationship, meaningful confidence limits could not be estimated.

Based on the available pesticide usage information for the years of 1992 through 2001, as received from the registrant and agreed to by the Agency, total annual domestic usage of *tau*-fluvalinate averaged approximately 11,000 pounds of active ingredient (a.i.) for less than 30,000 acres treated. Formulation types include flowable concentrate and impregnated strip. Application methods include aerial (in six California counties for carrots and all of California for brassica/cole crops), dipping, spray, fogger, crack and crevice treatment, by spoon, and by drench.

1.2 Potential Risks to Non-target Organisms

EFED has conducted a screening level risk assessment for the use of *tau*-fluvalinate on ornamentals in outdoor nurseries, greenhouses, and shade houses, for use on eugenia/pepper trees, empty beehives, building perimeters, interior landscapes, ant mounds and for selected SLN use on carrots and brassica/cole crops. EFED's screening level assessment was conducted using all available acceptable and supplemental data submitted in accordance with Subdivision N of 40 CFR Part 158 in conjunction with acceptable ecotoxicity data from the open literature. Based on the available data, EFED has identified potential acute and chronic risks to aquatic organisms and mammals. There is also a concern for non-target terrestrial invertebrates. There are significant data gaps for this assessment which limit EFED's ability to assess acute risk to aquatic organisms, aquatic plants, and terrestrial plants and chronic risk to marine/estuarine invertebrates. Based on the available data, EFED's screening level risk assessment does not indicate a concern for birds. The use pattern for *tau*-fluvalinate suggests that the potential risks are likely to be limited to those geographic areas where the chemical is used the most, including use on ornamentals in California, Oregon, Michigan, Florida, Pennsylvania, and Texas. However, information on where *tau*-fluvalinate is used is limited and does not allow for further refinement for the non-SLN uses. The SLN uses on carrots are limited to six counties and can be defined down to the one-mile section. *Tau*- fluvalinate use on brassica/cole crops is also limited to California only, but is not county-specific although most brassica/cole crops are grown in the Salinas Valley and Imperial County and are also available at one-mile sections. A summary of the potential risks to non-target aquatic organisms is presented in **Table 1.1** and a summary of potential risks to non-target terrestrial organisms is presented in **Table 1.2.** A more complete discussion of the potential risks is provided in **Section 4.2.**

Table 1.1. Summary of Environmental Risk Conclusions for Aquatic Organisms and Plants for *Tau*-Fluvalinate		
Assessment Endpoint	**Use Patterns with LOC Exceedances[a]**	**Summarized Risk Characterization and Important Uncertainties**
Acute Risk to Freshwater Fish	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	No acceptable acute freshwater fish data submitted for the TGAI. Using supplemental data, acute LOCs exceeded for both carrot and ornamental uses; however, magnitude of risk unknown. RQs likely underestimated. Significant uncertainties associated with test concentrations in ecotoxicity studies; it is likely that RQs will be even greater.
Chronic Risk to Freshwater Fish	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	No acceptable chronic freshwater fish data submitted for the TGAI. Using supplemental data, chronic LOCs exceeded for both carrot and ornamental uses; however, magnitude of risk unknown. Significant uncertainties associated with test concentrations in ecotoxicity study.
Acute Risk to Freshwater Invertebrates	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	No acceptable acute freshwater fish data submitted for the TGAI. Using supplemental data, acute LOCs exceeded for both carrot and ornamental uses; however, magnitude of risk unknown. RQs likely underestimated. Significant uncertainties associated with test concentrations in ecotoxicity studies; it is likely that RQs will be even greater.
Chronic Risk to Freshwater Invertebrates	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	No acceptable chronic freshwater invertebrate data submitted for the TGAI. Using supplemental data, chronic LOCs exceeded for both carrot and ornamental scenarios; however, magnitude of risk unknown. Significant uncertainties associated with test concentrations in ecotoxicity study.
Acute Risk to Estuarine/Marine Fish	Uncertain risk with all outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	No acceptable acute freshwater fish data submitted for the TGAI. Using supplemental data, acute LOCs not exceeded for either carrot or ornamental uses; however, due to significant uncertainties associated with test concentrations in ecotoxicity studies, it is likely that RQs will be even greater.

Table 1.1. Summary of Environmental Risk Conclusions for Aquatic Organisms and Plants for *Tau*-Fluvalinate		
Assessment Endpoint	**Use Patterns with LOC Exceedances[a]**	**Summarized Risk Characterization and Important Uncertainties**
Chronic Risk to Estuarine/Marine Fish	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	Chronic LOC exceeded for both uses.
Acute Risk to Estuarine/Marine Invertebrates	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	No acceptable acute marine/estuarine invertebrate data submitted for the TGAI. Using supplemental data, acute LOCs for mysid shrimp exceeded for both carrot and ornamental scenarios. Using supplemental data, acute LOCs for mollusks were not exceeded for either carrot or ornamental uses. Significant uncertainties associated with test concentrations in ecotoxicity studies for both groups; it is likely that RQs will be even greater.
Chronic Risk to Estuarine/Marine Invertebrates	No data available	No acceptable chronic freshwater invertebrate data submitted for the TGAI. No risk calculated. Due to uncertainties associated with test concentrations, a comparison of freshwater and marine/estuarine values not deemed appropriate.
Risk to Benthic organisms	No data available	*Tau*-fluvalinate is expected to partition to the sediment and is very highly toxic to other aquatic organisms. Therefore, there may be potential risk to sediment-dwelling organisms.

Table 1.2. Summary of Environmental Risk Conclusions for Terrestrial Organisms and Plants for *Tau*-Fluvalinate		
Assessment Endpoint	**Use Patterns with LOC Exceedances[a]**	**Summarized Risk Characterization and Important Uncertainties**
Acute Risk to Birds	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	Acute LOCs are not exceeded for either carrot or ornamental use; however, there is a concern for sublethal effects (lethargy), particularly as it relates to ability to escape from predators.
Chronic Risk to Birds	None	Chronic LOC not exceeded for either carrot or ornamental use.
Acute Risk to Mammals	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds)	Acute LOC exceeded for 15 g mammals eating short grass.
Chronic Risk to Mammals	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	Chronic RQs exceed chronic LOC in most food categories. Uncertainties related to dosage in chronic mammalian data.
Non-target Insects	All outdoor uses (excludes indoor uses, apiary strips, and ant mounds) and SLN registrations (carrots & brassica/cole crops)	Although quantitative risk estimates are not conducted with terrestrial invertebrates, submitted studies with honey bees and studies located in the open literature with other terrestrial invertebrates indicate significant toxicity to these taxa.

[a] California carrot application rate: 0.15 lbs/acre, up to 2 applications/year. Oregon ornamental application rate: 0.34 lbs/acre, up to 12 applications/year.

1.3 Conclusions - Exposure Characterization

The exposure assessment conducted for this risk assessment is for *tau*-fluvalinate. There are three versions of fluvalinate that have been tested or proposed for testing since the late 1970's. These forms are racemic fluvalinate consisting of four diastereoisomers (25% of each), half resolved fluvalinate consisting of two diastereoisomers (50% of each), and fully resolved fluvalinate consisting of a single diastereoisomer (S-2R). Initial testing was conducted using racemic fluvalinate, while more recently, environmental fate tests were conducted using the half resolved fluvalinate (*tau*-fluvalinate). The environmental fate profile for *tau*-fluvalinate is based on a combination of data based on a strategy for bridging data from racemic fluvalinate to *tau*-fluvalinate. Given the increasing effort at enrichment of the S-2R diastereosiomer suggests that this is the most insecticidally active isomer. The bulk of the data used in this assessment was conducted using *tau*-fluvalinate.

Based on all acceptable and supplemental data (both bridged racemic data and data for *tau*-fluvalinate) the major routes of degradation for *tau*-fluvalinate in laboratory studies are by abiotic processes (photodegradation in water and soil, and pH dependent hydrolysis) and biotic processes under aerobic conditions. *Tau*-fluvalinate is expected to be rapidly degraded in both soil and aquatic environments under aerobic conditions but is expected to be persistent under anaerobic conditions. *Tau*-fluvalinate is highly immobile, is of low solubility in sterile water, has a low potential for bioaccumulation based on its bioconcentration factors (BCF) and rapid depuration, and is not expected to be volatilized.

Given this profile, the main routes of exposure from use of *tau*-fluvalinate are expected to be runoff and spray drift. Given the high Koc of this synthetic pyrethroid, and that other pyrethroids are known to accumulate in sediment in aquatic systems, the Environmental Fate and Effects Division (EFED) has considered this route of exposure as well. Typically, EFED evaluates the potential for aquatic exposure to pesticides through an assessment of available surface water and groundwater monitoring data and modeling. For *tau*-fluvalinate, no monitoring data were available for use in this assessment, therefore, potential exposure to *tau*-fluvalinate in water was evaluated through modeling. For this assessment, EFED relied on Tier II modeling using PRZM/EXAMS. Terrestrial exposure was also assessed using TREX version 1.1 (TerrPlant modeling was not conducted due to a lack of terrestrial plant data). Copies of model input and output files are presented in **Appendix B**.

1.4 Conclusions - Effects Characterization

Significant data gaps exist for evaluation of acute toxicity of *tau*-fluvalinate to aquatic animals and plants. No acceptable acute toxicity studies on the technical material are available. The majority of the submitted acute aquatic animal toxicity studies are static bioassays using nominal concentrations. Data from studies with mean measured concentrations indicate that *tau*-fluvalinate degrades rapidly with a half-life of approximately 24 hours; therefore, exposure concentrations from the static bioassays using nominal concentrations are not reliable. The studies are all classified as supplemental; however, they are used for estimation of risk and characterized with the uncertainties associated with the test concentrations.

Chronic studies indicate that *tau*-fluvalinate can negatively affect growth in freshwater fish at levels below 0.2 ppb and growth and reproductive capacity in marine/estuarine fish at levels as low as 0.07 ppb (NOAECs $\geq$0.04 ppb). Chronic exposure to *tau*-fluvalinate can decrease size and number of offspring in freshwater invertebrates at levels less than 0.1 ppb (NOAEC: 0.044 ppb). No chronic studies are available for marine/estuarine invertebrates.

The acute oral and dietary studies conducted with either bobwhite quail and/or mallard ducks indicate that *tau*-fluvalinate is practically non-toxic to birds; however, sublethal effects were observed in acute bird studies at levels below which mortality was observed and included lethargy, slightly lower body weight gain and food consumption and reduced reactions to external stimuli. Reproduction studies in both bobwhite qual and mallard ducks indicate that *tau*-fluvalinate does not induce any reproductive effects or other sublethal effects at concentration levels up to 900 ppm..

Tau-fluvalinate is slightly to practically non-toxic to mammals following acute exposure. Although mortality is observed at higher dose levels, sublethal effects, particularly related to neurotoxicity, are noted at all dose levels tested (down to 500 mg/kg bw) in these acute toxicity studies. Following chronic exposure, *tau*-fluvalinate may induce decreases in pup body weight, slightly lower litter size, decreased litter weight and tremors in the offspring at levels as low as 10 mg/kg bw/day.

Tau-fluvalinate is highly toxic to honey bees. Open literature data indicate that it is highly toxic to other terrestrial insects as well.

Data on several degradates indicate that the risk to aquatic animals and non-vascular plants is likely to be less than that of the parent. For mammals, there are indications that at least one degradate may be more acutely toxic; however, there are significant uncertainties in the study results and this study cannot be compared to the study conducted with the parent.

From the open literature, a 22% *tau*-fluvalinate formulation did not have an effect on strawberry fruit yield and a 25% formulation improved green pea pod yield by providing a reduction in leaf damage from insects.

1.5 Uncertainties and Data Gaps

The environmental fate profile is sufficient to conduct risk assessment and estimate potential exposures due to the use of *tau*-fluvalinate. In general, the environmental fate data provides the necessary information to estimate exposures however, several studies are classified as supplemental and therefore add uncertainty to the exposure estimates. Also, there is no aerobic aquatic metabolism data and therefore, EFED has assumed a default value based on available aerobic soil metabolism data. Submission of additional data on the behavior of *tau*-fluvalinate in aerobic aquatic systems will eliminate some of the uncertainty associated with this assumption. In addition, there is no available environmental monitoring data for *tau*-fluvalinate and therefore, no direct way to compare modeled exposure estimates to actual exposures in the environment.

A significant number of data gaps and uncertainties have been identified for ecological effects. Most of the acute aquatic toxicity studies have been re-evaluated and re-classified as supplemental due to uncertainties associated with the concentrations tested in the studies. The majority of the studies utilized nominal concentrations and did not analytically measure the test concentrations. Those studies that did measure the test concentrations showed significant degradation of the test material over time. Generally, within 24 hours, only half of the test material remained in the test solution. Selected uncertainties and data gaps are discussed in **Table 1.3**.

Table 1.3 Summary of Major Uncertainties and Data Gaps in This Assessment		
Selected Uncertainty	**Value of Additional Testing**	**Comment**
Aquatic Assessment		
Acceptable acute toxicity data on freshwater fish	High	Studies classified as supplemental because nominal concentrations used in static studies and *tau*-fluvalinate rapidly degraded. Flow-through studies needed using measured concentrations with pre-conditioned test chambers. Recommended: Guideline 72-1 with Bluegill Sunfish and Rainbow Trout.
Acceptable chronic toxicity data on freshwater fish	High	Study classified as supplemental because of analytical variability and insufficient data to statistically verify the results. Flow-through study needed using measured concentrations with pre-conditioned test chambers. Recommended: Guideline 72-4 with fathead minnows.
Acceptable acute toxicity data on freshwater invertebrates	High	Study classified as supplemental because nominal concentrations used under flow-through conditions. Uncertainty over actual concentrations tested. Flow-through study needed using measured concentrations with pre-conditioned test chambers. Recommended: Guideline 72-2 with Daphnia.
Acceptable chronic toxicity data on freshwater invertebrates	High	Study classified as supplemental because conflicting resullts obtained with measured concentrations; therefore, nominal concentrations were used under flow-through conditions. Uncertainty over actual concentrations tested. Flow-through study needed using measured concentrations with pre-conditioned test chambers. Recommended: Guideline 72-2 with Daphnia.
Acceptable acute toxicity data on marine/estuarine fish	High	Study classified as supplemental because nominal concentrations used in static studies and *tau*-fluvalinate rapidly degraded. Flow-through studies needed using measured concentrations with pre-conditioned test chambers. Recommended: Guideline 72-3 with Sheephead Minnows.
Acceptable acute toxicity data on marine/estuarine invertebrates	High	Study classified as supplemental because nominal concentrations used in static studies and *tau*-fluvalinate rapidly degraded. Flow-through studies needed using measured concentrations with pre-conditioned test chambers. Recommended: Guideline 72-3 with mysid and a mollusk.

Table 1.3 Summary of Major Uncertainties and Data Gaps in This Assessment		
Selected Uncertainty	**Value of Additional Testing**	**Comment**
Toxicity data on sediment dwelling organisms are not available	Moderate to High	*Tau*-fluvalinate is expected to partition to the sediment and is very highly toxic to other aquatic organisms. Therefore, there may be potential risk to sediment-dwelling organisms. The following studies are recommended: 850.1735: Acute Sediment (freshwater); 850.1740: Acute Sediment (Estuarine/Marine); and EPA/600/R01/020: Chronic Estuarine/Marine Sediment Testing. The results of these studies could warrant conduct of additional studies. All studies should use spiked sediment that contains organic matter not exceeding 2%.
Life cycle study in mysid shrimp has not been submitted.	High	Acute toxicity studies indicate that technical *tau*-fluvalinate is likely to be very highly toxic to mysid shrimp. Recommended: Guideline 72-4 on mysid shrimp.
Toxicity data on aquatic plants have not been submitted	Moderate	The proposed update to Part 158 (Data Requirements for Conventional Pesticides) has expanded the aquatic plant data requirements to include all outdoor uses. The following Tier I study is recommended: Guideline number 122-2
Terrestrial Assessment		
Terrestrial plant toxicity data have not been submitted	Low to Moderate because significant toxicity not expected	Although the limited literature data indicate that significant toxicity to plants is unlikely, the proposed update to Part 158 (Data Requirements for Conventional Pesticides) has expanded the vegetative vigor and seedling emergence data requirements to include all outdoor uses. These studies are recommended: Guideline number 122-1
Tau-fluvalinate causes sublethal effects at doses considerably lower than the LD50	Not applicable	Sublethal neurotoxic effects have been identified in mammals that could affect survival in the wild. Therefore, risk quotients based on acute lethality may underestimate potential risk to mammals.

2 Problem Formulation

2.1 Stressor Source and Distribution

2.1.1 Source and Intensity

Tau-fluvalinate is a synthetic pyrethroid used primarily to control aphids, whiteflies, mites, thrips, caterpillars, beetles, mealybugs, root weevils, and lygus bugs on non-food crops (ornamentals, eugenia, pepper trees), residential uses (building perimeters, landscape plantings) and selected food uses (apiary strips, carrots, and brassica/cole crops). In general, *tau*-fluvalinate is applied by ground and backpack sprayers for all uses except the SLN uses on carrots and brassica/cole crops where aerial applications are allowed. Overall, based on the environmental fate profile and use pattern, *tau*-fluvalinate is expected to represent a non-point source exposure which reaches non-target organisms primarily by runoff and spray drift. However, given the limited amount of use (less than 11,000 pounds annually) and the nature of the uses, any risks to non-target organisms are expected to be geographically limited to those areas where tau-fluvalinate is used directly on outdoor crops and non-crop uses. Based on limited use information, these are expected to be principally in California, Florida, Texas, and other states with significant production of outdoor nurseries. Although use rates are generally low, the outdoor use of *tau*-fluvalinate on ornamental crops is expected to be the principal driver of potential risk because multiple applications are allowed under current labels.

2.1.2 Physical/Chemical/Fate and Transport Properties

The exposure assessment conducted for this risk assessment is for *tau*-fluvalinate. There are three versions of fluvalinate that have been tested or proposed for testing since the late 1970's. These forms are racemic fluvalinate consisting of four diastereoisomers (designated as R-2R, R-2S, S-2R and S-2S), half resolved fluvalinate consisting of two diastereoisomers (R-2R and S-2R), and fully resolved fluvalinate consisting of a single diastereoisomer (S-2R). Initial testing conducted up until the mid-1980's was conducted using racemic fluvalinate. Beginning in the mid-1980's and until recently, environmental fate tests were conducted using the half resolved fluvalinate, also known as *tau*-fluvalinate. For environmental fate data, initial testing was conducted using the racemic form of fluvalinate. However, in 1989 the registrant proposed a bridging strategy for relying on racemic fluvalinate data to support the registration of *tau*-fluvalinate. The Agency agreed in a memorandum dated January 31, 1990 that racemic fluvalinate data for the abiotic processes could be used to support *tau*-fluvalinate. However, additional data would need to be submitted for *tau*-fluvalinate for biotic processes (aerobic soil metabolism, anaerobic soil metabolism, and terrestrial field dissipation).

Based on all acceptable and supplemental data (both bridged racemic data and data for *tau*-fluvalinate) the major routes of degradation for *tau*-fluvalinate in laboratory studies are by abiotic processes (photodegradation in water and soil, and pH dependent hydrolysis) and biotic processes under aerobic conditions. *Tau*-fluvalinate is expected to be rapidly degraded in both soil and aquatic environments under aerobic conditions but is expected to be stable under anaerobic conditions. *Tau*-fluvalinate is stable to hydrolysis under acidic conditions but is rapidly hydrolyzed under alkaline conditions, degraded rapidly by aqueous photolysis, but was slightly more stable to soil photolysis. *Tau*-fluvalinate degraded rapidly in an aerobic soil metabolism study but was more persistent in a supplemental terrestrial field dissipation study, and was moderately persistent in an anaerobic aquatic metabolism study. *Tau*-fluvalinate is highly immobile, has low solubility in sterile water, and has a low potential for bioaccumulation. A complete summary of environmental fate properties is in **Appendix A**.

Common name:	*Tau*-fluvalinate
Chemical name:	(RS)-α-Cyano-3-phenoxybenzyl –(2-chloro-α,α,α-trifluoro-p-tolyl)-DL-valinate.
CAS number:	102851-06-9

Physical/Chemical Properties:

Molecular formula:	$C_{26}H_{22}ClF_3N_2O_2$
Molecular weight:	502.91g/mole
Physical state:	viscous, yellow oil
Vapor Pressure:	1×10^{-7} torr
Water solubility:	12 ug/l at 20°C
Log K_{ow}:	4.26
K_{ow}:	18000

Environmental Fate Properties:

Hydrolysis:	48 days @pH 5, 22.5 days @pH 7, 1.13 days @pH 9
Aqueous Photolysis:	< 1 day
Soil Photolysis:	18 days
Aerobic Soil Metabolism:	8 and 15 days
Anaerobic Aquatic:	84.2 and 88.3 days
Adsorption/Desorption:	Kd's from 853 to 1708

The environmental fate profile described above indicates that *tau*-fluvalinate is expected to degrade rapidly under aerobic conditions but be persistent under anaerobic conditions. *Tau*-fluvalinate is expected to be highly immobile, non-bioaccumulative, and non-volatile. Given this profile, the main routes of exposure from use of *tau*-fluvalinate are expected to be due to runoff and spray drift. Given the high Koc of this synthetic pyrethroid and that other pyrethroids are known to accumulate in sediment in aquatic systems, EFED has considered this route of exposure as well.

2.1.3 Pesticide Type, Class, and Mode of Action

Tau-fluvalinate is a synthetic pyrethroid that acts to inhibit sodium channel modulators. In general, the pyrethroids share similar modes of action, resembling that of DDT, and are considered axonic poisons (Ware and Whitacre, 2004). They apparently work by keeping open the sodium channels in neuronal membranes. Pyrethroids affect both the peripheral and central nervous system of the insect. They initially stimulate nerve cells to produce repetitive discharges and eventually cause paralysis.

Tau-fluvalinate specifically acts by altering the excitability of the neurones through a specific effect on the sodium axonic channels of nerve membranes. Blockage in conduction results in raised frequency of discharges following depolarization. The permeability of the membrane to sodium is prolonged and with an increase in entry current of sodium, and a decrease in exit current of potassium over a prolonged period, the membrane remains partially depolarized, and therefore hyper-excitable. This hyper excitability leads to death of the insect. More details may be found at http://ipmworld.umn.edu/chapters/ware.htm.

According to information provided by the registrant, *tau*-fluvalinate is used primarily for control of aphids, whiteflies, mites, thrips, caterpillars, beetles, mealybugs and root weevils when applied for commercial use in greenhouses, interior landscapes, and outdoor ornamental plantings, and for control of Lygus bug in carrots grown for seed. *Tau*-fluvalinate is also used in apiary strips to control Varroa mite parasite of domestic honeybees in hives.

Also reported by the registrant is that milder/wetter winters tend to result in higher insect pressure and more extensive use of *tau*-fluvalinate; colder/dryer winters tend to result in lower insect pressure and lower use. The key pests are given above to describe the market niches. Apistan use is driven by hive hygiene and willingness of beekeeper to monitor Varroa populations and treat only when economic threshold is met. Lygus bug pressures drive the 24-C SLN carrot for seed treatments.

2.1.4 Overview of Pesticide Usage

Tau-fluvalinate ((RS)-α-cyano-3-phenoxybenzyl (R)-2-(2-chloro-4-trifluoromethylanilino)-3-methylbutanoate), also referred to as "Half Resolved fluvalinate" (a mixture of two insecticidally active isomers) is a synthetic pyrethroid used as an insecticide and miticide for empty beehives, eugenia, pepper tree, greenhouses, building perimeters, flower and foliage cuttings, interior landscapes, ant mounds, and ornamentals. There is a 24(c) Special Local Need (SLN) registration for carrots grown for seed in six counties in California and a separate SLN registration for brassica/cole crops in all of California. The registrant has dropped the SLN use for carrot seeds in Oregon.

Based on the available pesticide usage information for the years of 1992 through 2001, as received from the registrant and agreed to by the Agency, total annual domestic usage of *tau*-fluvalinate averaged approximately 11,000 pounds of active ingredient (a.i.) for less than 30,000 acres treated. Formulation types include flowable concentrate and impregnated strip. Application methods include aerial (in six California counties for carrots and all of California for brassica/cole crops), dipping, spray, fogger, crack and crevice treatment, by spoon, and by drench.

In general, according to data supplied by the registrant for all non-apiary uses, the main use of *tau*-fluvalinate is in the Western US with 42% of all use followed by the Southeast (30%), Central (16%), and Northeast (12%). By far, the biggest use of *tau*-fluvalinate is on ornamentals with 35% applied to greenhouse uses, followed by 27% use on woody/herbaceous plants (field and landscape), and containerized nursery stock at 16%. All other uses constitute less than 10% of overall use, with the exception of apiary strips at 13%. **Figure 2.1** (all figures presented starting on **page 144**) presents the national distributions of outdoor nursery acres, which provides context to the generalized assessment on usage. This type of information suggests that the main areas of concern for *tau*-fluvalinate use are in California, Oregon, Washington, and Florida, although this figure is not specific to *tau*-fluvalinate use.

For the SLN use in California, carrots are grown predominantly in the southern portion of the state (**Figure 2.2**). However, the SLN registration is limited to six counties in north-central California (**Figure 2.3**) and carrots are grown on dispersed areas within this six county area (**Figure 2.4**). There is also a new SLN for use on brassica and cole crops in California. The brassica/cole crop use is state wide (**Figure 2.5**) but based on crop acreage information is expected to be limited mainly to the central coastal regions near Salinas and Imperial county in southern California (**Figure 2.6 and 2.7**).

2.2 Receptors

Table 2.1 gives examples of taxonomic groups and test species evaluated for ecological effects in screening level risk assessments. Within each of these very broad taxonomic groups, an acute and/or chronic endpoint is selected from the available toxicity data (see **Section 3.3**). Additional ecological effects data on honey bees (*Apis mellifera*) have been incorporated into the risk characterization as an additional line of evidence for terrestrial insects.

A complete discussion of all toxicity data available for this risk assessment and the resulting measurement endpoints selected for each taxonomic group are included in **Appendix C**.

Table 2.1 Taxonomic groups and test species evaluated for ecological effects in screening level risk assessments.	
Taxonomic group	**Example(s) of representative species**
Birds[a]	Mallard duck (*Anus platyrhynchos*) Bobwhite quail (*Colinus virginianus*)
Mammals	Laboratory rat (*Rattus norvegicus*)
Freshwater fish[b]	Bluegill sunfish (*Leopomis macrochirus*) Rainbow trout (*Oncorhynchus mykiss*) Carp (*Cyprinus carpio*) Fathead minnow (*Pimephales promelas*)
Freshwater invertebrates	Water flea (*Daphnia magna*)
Estuarine/marine fish	Sheepshead minnow (*Cyprinodon variegatus*)
Estuarine/marine invertebrates	Eastern Oyster (*Crassostrea virginica*) Mysid Shrimp (*Americamysis bahia*)

[a]Birds may be surrogates for amphibians (terrestrial phase) and reptiles.
[b]Freshwater fish may be surrogates for amphibians (aquatic phase).
[c]Four species of two families of monocots, of which one is corn; six species of at least four dicot families, of which one is soybeans.

2.2.1 Aquatic Effects

For *tau*-fluvalinate, effects on aquatic organisms are estimated from acute, subacute and chronic laboratory studies, either submitted to the Agency or found in the open literature. Acute/subacute data are available for freshwater fish (rainbow trout (*Oncorhynchus mykiss)*, bluegill sunfish (*Lepomis macrochirus*) and carp (*Cyprinus carpio*)); marine/estuarine fish (sheepshead minnow *(Cyprinodon variegatus*)); freshwater invertebrates (water flea (*Daphnia magna*), red swamp crayfish (*Procambarus clarkii*) and mosquito larvae (*Culex pipiens*)) and marine/estuarine invertebrates (mysid shrimp (*Mysidopsis bahia*) and eastern oyster (*Crassostrea virginica*)). These acute toxicity studies would normally be used as surrogates for all aquatic species and aquatic-phase amphibians; however, the majority of the studies are not used for risk calculations due to significant uncertainties associated with the test exposure concentrations. Therefore, acute effects to aquatic organisms are discussed on a qualitative basis using supplemental data and comparison data from five other pyrethroids. A minicosm study is available, which provides limited information on aquatic invertebrates; however, degradation of the test material is also a significant issue in this study.

Effects from chronic exposure are estimated from studies conducted with freshwater fish (fathead minnow (*Pimephales promelas*)), marine/estuarine fish (sheepshead minnow) and freshwater invertebrates (waterflea). The fathead minnow study would normally be used as a surrogate for all aquatic species and aquatic-phase amphibians; however, again, the study is not used for risk calculations due to significant uncertainties associated with the test exposure concentrations. Therefore, effects to freshwater aquatic organisms following chronic exposure are discussed on a qualitative basis using the supplemental data. The sheepshead minnow is used as a surrogate for all marine/estuarine fish. Significant uncertainties associated with the test exposure concentrations with the chronic daphnia study do not allow this species to be used as a surrogate for all freshwater invertebrates on a quantitative basis; however, the risk to freshwater invertebrates is discussed on a qualitative basis. In addition, this species cannot be used as a surrogate for marine/estuarine invertebrates because the acute data, plus data from other pyrethroids indicate that the results may underestimate toxicity by several orders of magnitude. No data are available on aquatic plants.

2.2.2 Terrestrial Effects

The effect of *tau*-fluvalinate on all bird species is estimated from acute, subacute and chronic studies on two species, bobwhite quail (*Colinus virginianus*) and mallard duck (*Anas platyrhynchos*). These species also act as surrogates for reptiles and terrestrial-phase amphibians. Effects on mammals are estimated from acute and chronic rat studies reviewed by the Health Effects Division (HED). Limited efficacy data on terrestrial invertebrates and plants were found in the open literature and were used in a qualitative manner.

2.2.3 Ecosystems at Risk

Ecosystems potentially at risk are identified as those in close proximity to *tau*-fluvalinate use sites and are expressed in terms of the selected assessment endpoints. The typical assessment endpoints for screening-level pesticide ecological risks are reduced survival, and reproductive and growth impairment for both aquatic and terrestrial animal species. Aquatic animal species of potential concern include freshwater fish and invertebrates, estuarine/marine fish and invertebrates, and amphibians. Ecosystems for these species could include freshwater (stream and/or lake) and saltwater (estuary and/or nearshore) habitats. Terrestrial animal species of potential concern include birds, mammals, and beneficial insects, which may inhabit forest (deciduous, coniferous, or mixed) and grasslands. For both aquatic and terrestrial animal species, direct acute and direct chronic exposures are considered. In order to protect listed species, all assessment endpoints are measured at the individual level. Although all endpoints are measured at the individual level, they provide insight about risks at higher levels of biological organization (e.g. populations and communities). For example, pesticide effects on individual survivorship have important implications for both population rates of increase and habitat carrying capacity.

For terrestrial plants, the screening assessment endpoint is the perpetuation of populations of non-target species (crops and non-crop plant species). Existing testing requirements have the capacity to evaluate emergence of seedlings and vegetative vigor. Although it is recognized that the endpoints of seedling emergence and vegetative vigor may not address all terrestrial plant life cycle components, it is assumed that impacts at emergence and in active growth have the potential to impact individual competitive ability and reproductive success.

For aquatic plants, the assessment endpoint is the maintenance and growth of standing crop or biomass. Measures of ecological effect for this assessment endpoint typically focus on algal and vascular plant (i.e., duckweed) growth rates and biomass measurements.

The ecological relevance of selecting the above-mentioned assessment endpoints is as follows: 1) complete exposure pathways exist for these receptors; 2) the receptors may be potentially sensitive to pesticides in affected media and in residues on plants, seeds, and insects; and 3) the receptors could potentially inhabit areas where pesticides are applied, or areas where runoff and/or spray drift may impact the sites because a suitable habitat is available.

2.3 Assessment Endpoints

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected." Defining an assessment endpoint involves two steps: 1) identifying the valued attributes of the environment that are considered to be at risk; and 2) operationally defining the assessment endpoint in terms of an ecological entity (i.e., a community of fish and aquatic invertebrates) and its attributes (i.e., survival and reproduction). Therefore, selection of the assessment endpoints is based on valued entities (i.e., ecological receptors), the migration pathways of pesticides, and the routes by which ecological receptors are exposed to pesticide-related contamination. The selection of clearly defined assessment endpoints is important because they provide direction and boundaries in the risk assessment for addressing risk management issues of concern.

A summary of the assessment and measurement endpoints selected to characterize potential ecological risks associated with exposure to *tau*-fluvalinate is provided in **Table 2.2**.

This ecological risk assessment considers maximum application rates on vulnerable soils, maximum number of applications (as well as single applications), and minimum intervals between application for uses on representative crops to estimate exposure concentrations. This assessment is not intended to represent a site or time-specific analysis. Instead, this assessment is intended to represent high-end exposures at a national level. Likewise, the most sensitive toxicity endpoints are used from surrogate test species to estimate treatment-related direct effects on acute mortality and chronic reproductive, growth and survival assessment endpoints. Toxicity tests are intended to determine effects of pesticide exposure on birds, mammals, fish, terrestrial and aquatic invertebrates, and plants. These tests include short-term acute, subacute, and reproduction studies and are typically arranged in a hierarchical or tiered system that progresses from basic laboratory tests to applied field studies. The toxicity studies are used to evaluate the potential of a pesticide to cause adverse effects, to determine whether further testing is required, and to determine the need for precautionary label statements to minimize the potential adverse effects to non-target animals and plants (40 CFR §158.202, 2002).

Table 2.2 Summary of assessment and measurement endpoints.	
Assessment Endpoint	**Measurement Endpoint**
1. Abundance (i.e., survival, reproduction, and growth) of birds.	1a. Bobwhite quail acute oral LD_{50}. 1b. Bobwhite quail and mallard duck subacute dietary LD_{50}. 1c. Bobwhite quail and mallard duck chronic reproduction NOAEC and LOAEC.
2. Abundance (i.e., survival, reproduction, and growth) of mammals.	2a. Laboratory rat acute oral LD_{50}. 2b. Laboratory rat developmental and chronic NOAEC and LOAEC.
3. Survival and reproduction of individuals and communities of freshwater fish and invertebrates.	3a. Rainbow trout and bluegill sunfish acute LC_{50}. 3b. Rainbow trout chronic (early-life) NOAEC and LOAEC. 3c. Water flea (and other freshwater invertebrates) acute EC_{50}. 3d. Water flea chronic (life-cycle) NOAEC and LOAEC.
4. Survival and reproduction of individuals and communities of estuarine/marine fish and invertebrates.	4a. Sheepshead minnow acute LC_{50}. 4b. Estimated chronic NOAEC and LOAEC values based on the acute-to-chronic ratio for freshwater fish. 4c. Eastern oyster and mysid shrimp acute LC_{50}. 4d. Mysid shrimp chronic (life-cycle) NOAEC and LOAEC. 4e. Estimated NOAEC and LOAEC values for mollusks based on the acute-to-chronic ratio for mysids.
5. Survival of beneficial insect populations.	6a. Honeybee acute contact LD_{50}.
6. Abundance (i.e., survival, reproduction, and growth) of earthworm populations.	7a. Acute earthworm LC_{50} values.

LD_{50} = Lethal dose to 50% of the test population.
NOAEC = No-observed-adverse-effect concentration.
LOAEC = Lowest-observed-adverse-effect concentration.
LC_{50} = Lethal concentration to 50% of the test population.

In accordance with the Overview Document, EFED considers both direct and indirect effects (U.S. EPA 2004). Risk estimations are based on the endpoints of survival, growth, and reproduction of the organism at the individual level, based on the premise that these effects on individuals can be reasonably extrapolated to impacts at a population level. While a growing body of scientific literature exists on biochemical (*e.g.*, physiological changes, endocrine disruption, immune system deficiencies) and behavioral (*e.g.*, predator avoidance, foraging activity, homing instincts) effects of pesticides, the specific impacts of these changes generally cannot be evaluated at an individual or population level, thus they are not used as quantitative endpoints.

2.4 Conceptual Model

A conceptual model provides a written description and visual representation of the predicted relationships between the stressor, potential routes of exposure, and the predicted effects for the assessment endpoint. A conceptual model consists of two major components: risk hypotheses and a diagram.

2.4.1 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 (EPA, 1998). For this assessment, the risk is stressor-linked, where the stressor is the release of *tau*-fluvalinate to the environment. The following risk hypothesis is presumed for this screening level assessment:

> *When used in accordance with registered labels, tau-fluvalinate has the potential to cause reduced survival, and reproductive and growth impairment for both aquatic and terrestrial animals.*

Adequate protection is defined as protection of growth, reproduction, and survival of aquatic and terrestrial ecological populations, and individuals of listed species, as needed.

For *tau*-fluvalinate, the risk hypothesis is driven by both the potential for exposure and the toxicity profile. The potential for exposure for *tau*-fluvalinate is expected to be via runoff and drift. The use pattern also suggests that only the registered outdoor uses of *tau*-fluvalinate are likely to be relevant to non-target organisms. Specifically, the outdoor uses on ornamentals, eugenia, and pepper trees, along with the SLN use on carrots and brassica/cole crops in California are expected to be the significant uses relative to non-target organism exposure. As such, these uses (both application rate and methods) have formed the basis of the estimation of exposure.

2.4.2 Diagram

All potential routes of exposure are considered and are presented in the conceptual site model. The conceptual site models shown in **Figure 2.8**, for non-granular, outdoor applications generically depict the potential source of *tau*-fluvalinate, release mechanisms, abiotic receiving media, biological receptor types, and effects endpoints of potential concern.

In order for a chemical to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a contaminant moves in the environment from a source to an ecological receptor. For an ecological exposure pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure. In addition, the potential mechanisms of transformation (*i.e.* how much of each degradate may form in various media) must be known, especially when the degradates are of greater toxicological concern than the parent substance. Therefore, assessment of ecological exposure pathways includes an examination of the source and potential migration pathways for constituents, and the determination of potential exposure routes, including ingestion, inhalation, and dermal absorption.

Ecological receptors that may potentially be exposed to *tau*-fluvalinate include terrestrial and semiaquatic wildlife (i.e., mammals, birds, and reptiles) and soil invertebrates. In addition to terrestrial ecological receptors, aquatic receptors (e.g., freshwater and estuarine/marine fish and invertebrates, amphibians, and aquatic plants) may also be exposed to potential migration of pesticides from the site of application to various watersheds and other aquatic environments via runoff and spray drift.

Tau-fluvalinate may be introduced to aquatic and terrestrial environments via ground and aerial spray applications to foliage (carrots and brassica/cole crops only). Additional release mechanisms, spray drift and wind erosion, which may potentially transport site-related contaminants to the surrounding air, are considered. Potential emission of volatile compounds are considered to be a viable release mechanism for pesticides, in general. However, volatilization (dashed arrows on **Figure 2.8**) is not expected to be a significant dissipation route for *tau*-fluvalinate given the low vapor pressure of this compound. In this conceptual model, spray drift and runoff are considered primary routes of exposure. In addition, because of the high potential for binding of *tau*-fluvalinate to soil and sediment the potential for exposure to soil and sediment dwelling organisms will be explored.

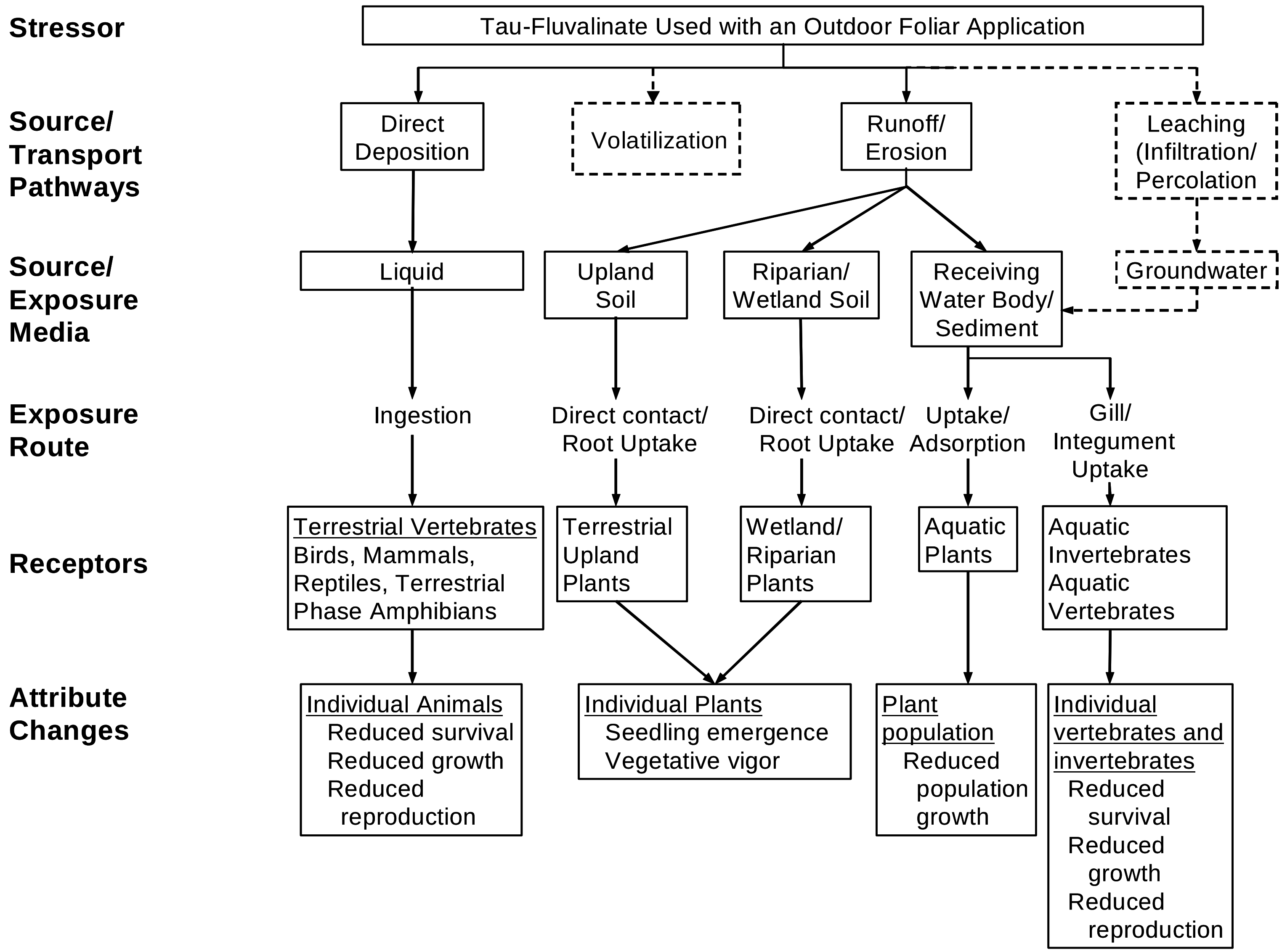

Figure 2.8. Conceptual Model for *Tau*-Fluvalinate Use on Outdoor Sites

2.5 Analysis Plan

Analysis is a process that examines the two primary components of risk (exposure and effects) and their relationships between each other and site characteristics. The objective is to provide the information necessary for determining or predicting ecological responses to pesticides uses under exposure conditions of interest. The analysis provides the basis for estimating and describing risks and identifying uncertainties in the risk characterization.

The quality of Registrant-submitted environmental fate and ecotoxicity data was evaluated in a rigorous and consistent manner. Levels of environmental exposure were predicted using computer models based on findings from scientifically sound environmental fate studies required under FIFRA to support registration for terrestrial food uses.

For this screening-level ecological risk assessment, estimated environmental concentrations (EECs) for aquatic and terrestrial systems were calculated using the maximum application rates and minimum application intervals. EECs were calculated using Tier I and Tier II exposure models, TREX (version 1.1) for terrestrial environments, and the coupled PRZM version 3.12/ EXAMS version 2.98.04 for aquatic environments. Aquatic concentrations represent values for a specific crop grown in a specific location which were chosen to represent all registered uses because estimated EECs resulting from these uses are not expected to be exceeded with a return frequency of one in ten years. When Tier II seedling emergence and vegetative vigor toxicity information is available for maximum proposed application, the TerrPlant model is used to generate EECs and calculate risk quotients for terrestrial and semi-aquatic plants, however, no terrestrial plant data is available and this model was not used in this assessment.

Estimated environmental concentrations were then compared to experimentally-determined acute or chronic toxicity parameters for surrogate aquatic and terrestrial organisms. Surrogate species were used to predict potential risks for species with no data (*i.e.* reptiles, amphibians). It was assumed that use of surrogate effects data is sufficiently conservative to apply the broad range of species within taxonomic groups. If other species are more or less sensitive to *tau*-fluvalinate and its degradates than the surrogates, risks may be under- or overestimated, respectively.

Food chain exposures for aquatic receptors and risks to semi-aquatic wildlife via consumption of pesticide-contaminated fish were evaluated but not considered significant given that bioaccumulation of *tau*-fluvalinate is low. Risks to top-level carnivores were also not evaluated due to a lack of data for these receptors. Ingestion of grass, plants, fruits, insects, and seeds by terrestrial wildlife was considered, but consumption of small mammals and birds by carnivores was not accounted for in this assessment. Inhalation and dermal pathways are not considered in deterministic risk assessments. However, these routes of exposure are considered to be negligible compared to the dietary ingestion pathways (uncertainties associated with exposure pathways for terrestrial animals are discussed in greater detail in **Section 4.5.4**).

2.5.1 Preliminary Identification of Data Gaps and Methods

There are a number of major uncertainties and information gaps that may influence the conclusions of the risk assessment. Principal amongst these is the fact that a number of toxicity studies submitted in support of *tau*-fluvalinate were deemed to be supplemental. In particular, there are limited ecotoxicity data for acute risk estimation for fish and invertebrates and there were no aquatic plant or terrestrial plant studies submitted. Additional uncertainties and data gaps are discussed throughout the assessment and are summarized in Section 4.3.

2.5.2 Measures to Evaluate Risk Hypotheses and Conceptual Model

The Analysis Plan provides a synopsis of measures that will be used to evaluate risk hypotheses. There are three categories of measures, including measures of exposure, effects, and ecosystem and receptor characteristics, which are discussed in Sections 2.5.2.1 through 2.5.2.3, respectively.

2.5.2.1 Measures of Exposure

Exposure to aquatic organisms is assumed to occur through direct contact with contaminated water. Relatively high tau-fluvalinate concentrations in surface water were estimated using runoff and spray drift models. The Pesticide Root Zone Model and the Exposure Analysis Modeling System (PRZM-EXAMS) were used for *tau*-fluvalinate runoff and spray drift modeling, and the AgDRIFT model to evaluate potential spray drift exposure. The PRZM-EXAMS modeling will reflect typical and high intensity use scenarios for soil, weather, and hydrologic conditions consistent with use sites in watersheds supporting aquatic organisms. The highest concentration resulting from runoff and spray drift likely to occur in a period of ten years of continuous use is used for this exposure assessment. This one-in-ten-year peak daily value is compared to acute toxicity data and the one-in-ten-year peak 21-day and 60-day averages are used for chronic risk assessment.

The PRZM-EXAMS model results reflect concentrations expected in a small, fixed volume, static water body (sometimes referred to as the ecological water body) while in agricultural areas the listed salmonids are found primarily in flowing water bodies. The size of the ecological water body modeled represents a generic, highly-vulnerable surface water body and, although it is static, the estimated peak concentrations are considered to be higher than in most permanent first order and larger streams. Peak *tau*-fluvalinate and degradate concentrations in the ecological water body are expected to persist longer than peak concentrations in flowing waters because dissipation occurs through being flushed downstream in addition to degradation processes, while in static water bodies dissipation is more reliant on degradation processes although partitioning to sediment may be important (Larson *et al.* 1997, chapter 5). Concentrations in smaller streams are expected to be more variable than in static water bodies, larger streams, and rivers. The only streams expected to have higher peak concentrations than the ecological water body are those streams which are small enough, and with low enough flow rates, to result in less dilution of runoff than occurs in the ecological water body. *Tau*-fluvalinate entering larger streams and rivers

would be more diluted, resulting in lower peak and average concentrations than predicted by PRZM/EXAMS. The highest surface water concentrations of *tau*-fluvalinate are expected to occur in undiluted runoff from fields treated with *tau*-fluvalinate.
PRZM-EXAMS modeling requires the selection of scenarios for simulation. A scenario represents a crop grown in a specific U.S. county, with soil conditions appropriate for the crop and county, agronomic practices consistent with the culture of the crop, and 30-years of historical meteorological data for the site. *Tau*-fluvalinate scenarios were chosen from existing PRZM-EXAMS scenarios which have undergone quality assurance and quality control by identifying scenarios which represent crops grown on which *tau*-fluvalinate may be applied.

AgDRIFT spray drift modeling requires the input of application and meteorological parameters to determine the amount of sprayed material expected to deposit downwind of application areas. *Tau*-fluvalinate product labels were used to determine the allowable conditions for *tau*-fluvalinate application. For parameters that were not found on product labels and have a relatively strong effect on downwind deposition, conservative default inputs and inputs more consistent with typical conditions were used to assess downwind deposition. Solar and Meteorological Surface Observational Network (SAMSON) weather data included in the AgDRIFT and specific to the potential *tau*-fluvalinate use sites were used to identify typical meteorological parameters. The same weather data are used in PRZM-EXAMS modeling.

The models used for exposure assessment are well evaluated exposure tools commonly used by EFED in pesticide risk assessment to estimate high-end exposures resulting from agricultural pesticide use. More information on peer review and comparisons of PRZM/EXAMS predicted concentrations with monitoring data may be found at the following websites:

http://www.epa.gov/scipoly/sap/1998/july/1part5.pdf.

http://www.epa.gov/fedrgstr/EPA-PEST/1999/November/Day-10/6044.pdf.

http://www.epa.gov/scipoly/sap/1999/may/pca_sap.pdf.

Information on aquatic exposure models, specific model versions used, and input parameter selection guidance is available on the internet at:

http://www.epa.gov/oppefed1/models/water/index.htm.

By selecting the high-intensity use scenarios, high drift conditions, and 1-in-10 year peak concentrations model estimates are expected to provide relatively high estimates of *tau*-fluvalinate concentrations in vulnerable water bodies. To evaluate the accuracy of the model results, results will be compared to monitoring data collected nationally and specifically in the expected use pattern for *tau*-fluvalinate.

Terrestrial organisms (birds, mammals, and insects) may be exposed to tau-fluvalinate in two ways, either via direct contact from spray treatments, or by coming into contact with pesticide residues on foliage. Label application rates of *tau*-fluvalinate can be used to estimate the mass of *tau*-fluvalinate depositing per unit area in the treatment zone. Exposure potential is expected to be highest in the treatment area. The *tau*-fluvalinate product labels describe application rates in units of lbs a.i./acre. These units were converted to suitable units for comparison to insect toxicity data using two approaches to estimate expected insect exposure values for insects in the treatment area at the time of application. First, the Kenaga nomogram (Fletcher *et al.* 1994), which is used to estimate dietary exposure to animals eating sprayed plants and insects, was used to estimate exposure to terrestrial insects in terms of mass of *tau*-fluvalinate contacting insects per mass of insect. Second, a representative insect size, surface area, and weight was assumed and the amount of material deposited on the surface area was estimated. This was then converted to yield the mass of tau-fluvalinate deposited per mass of insect. Exposure values are compared to registrant-submitted toxicity data on the honey bee *(Apis mellifera)*. No other insect toxicity data for *tau*-fluvalinate were identified during the literature search.

2.5.2.2 Measures of Effect

Measures of ecological effects are obtained from a suite of registrant-submitted guideline studies conducted with a limited number of surrogate species. The test species are not intended to be representative of the most sensitive species but rather were selected based on their ability to thrive under laboratory conditions. Consistent with EPA test guidelines, a suite of ecological effects data on technical grade *tau*-fluvalinate that complies with good laboratory testing requirements has been submitted. These data are summarized in Section 3.3.

A search of the open literature using EPA's Ecotoxicology database ECOTOX identified toxicity studies in the open literature with *tau*-fluvalinate on aquatic and terrestrial invertebrates, mammals and terrestrial plants. In addition, some studies on degradates were identified. These are included and discussed in this assessment. No monitoring data are available.

In the following sections, the use, environmental fate, and ecological effects of *tau*-fluvalinate are characterized and, using a risk quotient approach (ratio of exposure concentration to effects concentration), the risk of adverse effects on non-target terrestrial and aquatic animals are estimated. Further details regarding effects will be provided under **Section 3**.

2.5.2.3 Measures of Ecosystem and Receptor Characteristics

For the Tier 2 aquatic assessment using PRZM/EXAMS and the Tier 1 terrestrial assessment using TREX (version 1.1), the ecosystems that are modeled are intended to be generally representative of any aquatic or terrestrial ecosystem associated with areas where *tau*-fluvalinate is used. The receptors addressed by the aquatic and terrestrial risk assessments for *tau*-fluvalinate are summarized in **Table 2.1** above. For aquatic assessments, generally fish and aquatic invertebrates in both freshwater and estuarine/marine environments are represented. For terrestrial assessments, three different size classes of small mammals and birds are represented, along with four potential foraging categories.

3 Analysis

Analysis is a process that examines the relationship between exposure and effects, the two primary components of risk, and their relationship to site characteristics. The objective is to provide the ingredients necessary for determining or predicting ecological responses to pesticides uses under exposure conditions of interest. The products of analysis provide the basis for estimating and describing risks in risk characterization.

In addition to the analysis of exposure and effects, this section also provides a detailed summary of the characterization of the use of the pesticide.

3.1 Use Characterization

Tau-fluvalinate is used as an insecticide and miticide for empty beehives, eugenia, pepper tree, greenhouses, building perimeters, flower and foliage cuttings, interior landscapes, ant mounds, and ornamentals. There is a 24(c) SLN registration for carrots grown for seed in California, a pending 24(c) SLN for use on brassica & cole crops, and the registrant has dropped the SLN use for carrot seeds in Oregon. All currently registered uses are described **Table 3.1**. Based on available pesticide usage information for the years of 1991 through 2000, total annual domestic usage of *tau*-fluvalinate averaged approximately 48 thousand pounds of active ingredient (a.i.) for about eighty thousand acres treated. *Tau*-fluvalinate is an insecticide with its largest markets, in terms of total pounds of active ingredient, allocated to woody plants (30%) and ornamentals (25%). The crop with a high percentage of total U.S. planted acres treated include ornamentals (5%).

Formulation types include flowable concentrate and impregnated strips. Application methods include aerial (in six California counties only), dipping, spray, fogger, crack and crevice treatment, by spoon, and by drench.

Table 3.1 Summary of *Tau*-fluvalinate Registered Use Information					
Crop/Site	**Label**	**Maximum Application Rate**	**Application Method**	**Maximum No. of Applications**	**Comments**
Greenhouses (non-food plants), containerized nursery stock	Mavrik Aquaflow 2724-478	10.0 fl oz product/ 100 gal/ 20,000 sq. ft	Broadcast, fogger, bench	4/month	-
Interior plantscapes	Mavrik Aquaflow 2724-478	10.0 fl oz product/100 gal (0.5 fl oz product/5 gal/1,000 sq ft.)	Broadcast, fogger, bench	NS	-
SLN 24 (c) - CA960010 carrots grown for seed	Mavrick Aquaflow 2724-478	9.6 fl oz product/A	Restricted use (can be applied by certified applicator only); aerial, ground	NS	-
SLN 24 (c) - OR99004600 carrots grown for seed	Mavrick Aquaflow 2724-478	9.6 fl oz product/A	Restricted use (can be applied by certified applicator only); ground, spray, aerial	-	**Registrant has voluntarily cancelled this registration**
Woody and herbaceous ornamentals, plantscapes	Mavrick Aquaflow 2724-478	10.0 fl oz product/100 gal. per 20,000 sq ft	Low - pressure fan spray (on base of stem or trunk)	24/yr	-
Flower and foliage cuttings	Mavrick Aquaflow 2724-478	5.0 fl oz product/100 gal	Dipping	NS	-
Eugenia and pepper tree	Mavrick Aquaflow 2724-478	10.0 fl oz product/100 gal	Spray	2 at 14-day intervals	-

Table 3.1 Summary of *Tau*-fluvalinate Registered Use Information					
Crop/Site	**Label**	**Maximum Application Rate**	**Application Method**	**Maximum No. of Applications**	**Comments**
Building perimeters (outdoors)	Maverick Aquaflo 2724-478	3 tsp product/5 gal/1000 sq ft	Low-pressure fan spray to edge of structure	4/month	-
Mound Drench	Mavrick Aquaflow 2724-478	10 fl. oz product/100 gal; 1 gal/ mound	Drench	NS	Referred to as 'Ant Mound Treatment' on label
Bee hives	Zoecon Apistan Strip RF-318 (2724-406)	1 strip for each 5 combs of bees or less in each bee chamber	Impregnated strip: placed in empty hives with gloved hands Leave strip in hive for 6 to 8 weeks. Treat in the spring and in the fall	5 strips/yr	-

* supplemental information was extracted from labels 2724-478 and 2724-406

Historically, *tau*-fluvalinate and it's racemic precursor fluvalinate were used on a wide variety of crops. However, the use of *tau*-fluvalinate is currently reduced relative to these previous uses. Most outdoor uses are currently limited to ornamentals in nurseries and two SLN uses on carrots and brassica/cole crops. There is no specific use information to suggest how this change in use pattern has shifted for *tau*-fluvalinate use and hence exposures spatially over time. However, given the current use sites, it is expected that exposures will be limited to those areas where ornamentals are grown outdoors and in California where the SLN uses are registered or proposed for registration (in the case of brassica & cole crops).

According to the most recent pesticide use data from 2003 available from the California Department of Pesticide Regulation (CDPR) *tau*-fluvalinate was applied 314 times to a total of 12 different use sites. Of these 12 use sites, only carrots, Christmas trees, and outdoor cut flowers, outdoor grown containerized plants, and outdoor plants grown for transplanting are considered relevant to the assessment of risk to non-target organisms. A single application of *tau*-fluvalinate was reported for broccoli and oranges, while the remainder of the reported use sites (beehives, greenhouse cut flowers, greenhouse containerized plants, greenhouse transplants, and research commodity) are considered indoor uses and not likely to result in significant exposures.

The majority of the outdoor use was applied to containerized plants with 99 applications, followed by outdoor grown cut flowers with 37 applications, carrots with 13 applications, outdoor grown plants for transplanting with 12 applications, and Christmas trees with 10 applications. **Figure 3.1** presents the location of all outdoor uses of *tau*-fluvalinate in California at 1 mile square sections.

In general, *tau*-fluvalinate outdoor use is found in two general geographic locations. The first is in Southern California, and is represented by isolated uses that are generally not contiguous (**Figure 3.2**). The second cluster of use is in Central California, and is also generally isolated and not contiguous (**Figure 3.3**). This suggests that exposures to *tau*-fluvalinate in California are not likely to be widespread.

In addition, *tau*-fluvalinate was applied in 2003 in only three (Colusa, Glenn, and Sutter) counties covered under the SLN registration for carrots. **Figure 3.4** shows where all outdoor use of *tau*-fluvalinate was in these counties relative to where *tau*-fluvalinate was used on carrots. As with the previous analysis, this suggests that exposures due to this use pattern are likely to be isolated and limited.

As noted above, only one application of *tau*-fluvalinate was reported to a brassica/cole crop (broccoli) in 2003. The current use evaluated as part of this assessment is a SLN use for the entire state of California; therefore, the potential for risk exists wherever brassica/cole crops may be grown in California. **Figure 2.5** shows where brassica/cole crops are grown in California. In general, these crops are grown in the Salinas Valley in the central coast region (**Figure 2.6**) and in the Imperial Valley in southern California (**Figure 2.7**), and, as such, this SLN use is expected to be restricted to these areas.

In 2003, *tau*-fluvalinate was applied 4688 times on a variety of uses, although the majority of use was to flowers and plants grown in greenhouses and nurseries followed by landscape maintenance. In general, *tau*-fluvalinate was applied throughout the year with no apparent seasonal pattern (**Figure 3.5**). It is likely that corresponding use on ornamental plants in other states will be more seasonal in nature given the unique, climatological characteristics of California (continuous growing season); however, no data are available for other states to indicate what time of year *tau*-fluvalinate is typically applied.

3.2 Exposure Characterization

The exposure characterization describes potential or actual contact or co-occurrence of stressor (pesticide) with receptors (non-target organisms). The main objective is to develop an exposure profile that tracks the pesticide's movement in the environment (e.g., direct application, run-off, leaching, drift). The exposure characterization is based on environmental fate and transport data, modeling and monitoring information.

3.2.1 Environmental Fate and Transport Characterization

There are three versions of fluvalinate that have been tested or proposed for testing since the late 1970's. These forms are racemic fluvalinate consisting of four diastereoisomers (designated as 25% each of R-2R, R-2S, S-2R and S-2S), half resolved fluvalinate consisting of two diastereoisomers (50% each of R-2R and S-2R), and fully resolved fluvalinate consisting of a single diastereoisomer (100% of S-2R). Initial testing conducted up until the mid-1980's was conducted using racemic fluvalinate. Beginning in the mid-1980's and until recently, environmental fate tests were conducted using the half resolved fluvalinate, also known as *tau*-fluvalinate. For environmental fate data, initial testing was conducted using the racemic form of fluvalinate. However, in 1989, the registrant proposed a bridging strategy for relying on racemic fluvalinate data to support the registration of tau-fluvalinate. The Agency agreed, in a memorandum dated January 31, 1990, that racemic fluvalinate data for the abiotic processes could be used to support *tau*-fluvalinate. However, additional data would need to be submitted for *tau*-fluvalinate for biotic processes (aerobic soil metabolism, anaerobic soil metabolism, and terrestrial field dissipation). The bulk of the environmental fate data used in this assessment was conducted using *tau*-fluvalinate.

Based on all acceptable and supplemental data (both bridged racemic data and data for *tau*-fluvalinate) the major routes of degradation for *tau*-fluvalinate in laboratory studies are by abiotic processes (photodegradation in water and soil, and pH dependent hydrolysis) and biotic processes under aerobic conditions. *Tau*-fluvalinate is expected to be rapidly degraded in both soil and aquatic environments under aerobic conditions, but is expected to be stable under anaerobic conditions. *Tau*-fluvalinate is stable to hydrolysis under acidic conditions, but is rapidly hydrolyzed under alkaline conditions with a half life at pH 9 of 1.13 days. *Tau*-fluvalinate degraded rapidly by aqueous photolysis with a half life of 1 day, but was slightly more stable to soil photolysis with a half life of 18 days. *Tau*-fluvalinate degraded in an aerobic soil metabolism study with half lives of 8 and 15 days, and had a half life of 63 days in a supplemental terrestrial field dissipation study. In an anaerobic aquatic metabolism study *tau*-fluvalinate degraded with half lives of 255 and 413 days in the whole system. *Tau*-fluvalinate is highly immobile, with K_d values between 853 and 1,708 and corresponding K_{oc} values between 110,000 and 370,000, respectively. Finally, *tau*-fluvalinate is of low solubility in sterile water at 12 micrograms per liter (ug/l) and has a low potential for bioaccumulation with a reported Kow of 18,000 (log Kow = 4.26; MRID 41889711) and bioconcentration factors (BCF) of 120, 660, and 360 for the edible, non-edible and whole fish tissues, respectively. A summary of all environmental fate data for *tau*-fluvalinate is presented in **Table 3.2.**

Based on review of submitted **hydrolysis** studies (Accession No. 76691, MRID 41597303, MRID 45769201, and MRID 45769202), EFED concludes that hydrolytic degradation of *tau*-fluvalinate is expected to be pH dependent with half lives of 48 days at pH 5, 22.4 days at pH 7, and 1.13 days at pH 9. An initial study (Acc. No 76691) was submitted and deemed unacceptable. However, the registrant subsequently submitted additional data (MRID 41597303, MRID 45769201, and MRID 45769202) on the hydrolytic degradation of *tau*-fluvalinate. Review of the first study (MRID 41597303) indicated that there are acceptable hydrolysis data for pH's 5 and 9, but that the data at pH 7 were unacceptable. Based on comments received from the Agency, the registrant submitted an additional explanation (MRID 45769201) and an addendum to this study (MRID 45769202) which provides **supplemental** information on hydrolysis of *tau*-fluvalinate at pH 7. The addendum study could not be classified as acceptable at this time because no information was provided on the sterility of the test system. Given the weight of evidence of these three studies, there is sufficient information to conclude that *tau*-fluvalinate experiences rapid hydrolysis under alkaline conditions and is relatively stable to hydrolysis under acidic conditions.

Based on a review of all submitted aqueous photolysis studies (Accession No. 072938, MRID 41597305, and MRID 45769203), EFED concludes that *tau*-fluvalinate is expected to rapidly degrade by aqueous photolysis processes. The registrant originally submitted an aqueous photolysis study (Acc. No. 072938) which provided acceptable information indicating rapid degradation with a half life of less than 1 day. The registrant subsequently submitted additional data (MRID 41597305) in support of this requirement. The study was classified by EFED as potentially acceptable due to the fact that the study was only conducted at pH 5. The status also noted several other deficiencies with the results for pH 5. However, the registrant correctly noted that current guidance only requires that the study be conducted at pH 5. In addition, the registrant argued that the earlier study (Acc 072938) provides acceptable information on the rate of photo degradation of *tau*-fluvalinate, while a more recent submission (MRID 41597305) provides acceptable information on the identity of the degradation products likely to occur as a result of aqueous photolysis of *tau*-fluvalinate. The registrant has provided additional information for the pH 5 portion of the study which addresses the additional concerns of the original reviewer. This data is submitted in MRID 45769203 (an addendum to MRID 41597305). Overall, there is sufficient uncertainty in the comparability of results from the earlier study with a half life of 1 day (Acc 072938) and the subsequent studies with half lives of 10 minutes (MRID's 45769203 &

41597305) that the guideline is not fulfilled and all data is considered **supplemental**. This uncertainty could be addressed through the submission of additional data collected in a single study which addresses all of the reviewers concerns, provides an accurate estimate of the photo degradation rate, and identifies all photo degradation products in a single study.

Based on a review of all submitted soil photolysis studies (Accession No. 83757, MRID 41597307, and MRID 45769201), EFED concludes that *tau*-fluvalinate is expected to rapidly degrade by photolysis processes on soil with a half life of 12.8 days. An original study (Acc. No. 83757) was submitted and classified as unacceptable. This submission briefly summarized the results of several photodegradation experiments with *tau*-fluvalinate on glass or silica gel exposed to sunlight and a methanol solution exposed to a mercury lamp. The summary did not provide adequate detail to evaluate the quality of the results or recalculate proposed half lives.

Subsequently, the registrant submitted a new study (MRID 41597307) in order to fulfill this requirement. This submission was classified as unacceptable due to the fact that it was only conducted at pH 5 and that additional information was needed on the light source. The registrant correctly noted that given the conditions under which the study and other studies were conducted, the soil photolysis only need be conducted at pH 5. The registrant also provided additional information (MRID 45769201) that addressed issues surrounding the light source. Based on this additional information, MRID 41597307 is **acceptable** and no additional information is needed.

Based on a review of all submitted aerobic soil metabolism studies (Accession No. 126102, MRID 41889715, and MRID 45769201) EFED concludes that *tau*-fluvalinate is expected to rapidly degrade by aerobic soil metabolism processes with half lives between 8 days and 15 days. The study with Accession # 126102 was originally submitted to fulfill data needs for aerobic soil metabolism, anaerobic soil metabolism, and leaching/adsorption/desorption. The study was classified by EFED as unacceptable. This study (comprised of two studies conducted using different radiolabels) is not valid and does not meet guideline requirements for aerobic soil metabolism. This paper is a summary of several studies proposed for publication and the data presented are largely summaries of the experiments conducted. The submission does not provide adequate detail to evaluate the quality of the experiments conducted or review the conclusions.

A subsequent study with MRID # 41889715 was submitted to fulfill the need for information on the aerobic soil metabolism of *tau*-fluvalinate which was also classified by EFED as unacceptable. This study was deemed insufficient because the experimental method was inadequate, the analytical method was questionable, the material balances were not adequately determined, and the half-lives were questionable, as the two different radiolabeled parent compounds generated two different half-lives (approximately 8 and 15 days) in the same soil type and under the same conditions.

The registrant submitted additional information in an adsorption/desorption study (MRID 45769204) to address the concerns identified in the review of MRID 41889715. EFED finds the arguments in the response document (MRID 45769201) sufficient to upgrade MRID 41889715 to

acceptable. The additional aerobic soil metabolism data provided in the adsorption/desorption study (MRID 45769204) provides useful information aerobic soil metabolism for *tau*-fluvalinate and is therefore classified as **supplemental**.

Based on a review of all submitted anaerobic aquatic metabolism studies (MRID 41889715, and MRID 45769201), EFED concludes that *tau*-fluvalinate is expected to rapidly degrade by aerobic soil metabolism processes with half lives between 84.2 days and 88.3 days. These studies were given a cursory review in the April 3, 2002 EFED memorandum and were originally classified in the status memorandum as unacceptable because the analytical method was questionable, the experimental method was inadequate to capture and allow for an accurate quantification of volatiles produced in the anaerobic aquatic systems, the experimental method was questionable in some aspects, and the data reported for the sterile controls is not valid. However, because a number of the deficiencies are similar to those included in MRID 45769201 (analytical method, volatiles, differences in half lives) which have been addressed above, and *tau*-fluvalinate is persistent in these studies, EFED believes this study provides useful **supplemental** information on the anaerobic aquatic degradation of *tau*-fluvalinate. Submission of additional data may result in upgrading this study to acceptable.

Based on a review of all submitted adsorption/desorption studies (Accession No. 126102 and MRID 41597309), EFED concludes that *tau*-fluvalinate is expected to be immobile with K_d values were 1200, 1300, 1000, 1100, and 1300. Corresponding adsorption K_{oc} values were 110000, 280000, 190000, 270000, and 370000.

The study with Accession # 126102 was originally submitted to fulfill data needs for aerobic soil metabolism, anaerobic soil metabolism, and leaching/adsorption/desorption, but was classified by EFED as unacceptable. A subsequent study with MRID # 41597309 was submitted to fulfill the need for information on the adsorption/desorption of *tau*-fluvalinate which was also classified by EFED as unacceptable due to improperly sieved soil. Wellmark has submitted a new study that provides additional data (MRID 45769204) on the adsorption/desorption of *tau*-fluvalinate. This study has been classified as **supplemental**. It cannot be used to fulfill the Subdivision N Guideline §163-1 data requirements for a mobility study using unaged soil or aged soil because the soil:solution ratio used in the study was inadequate since the percent adsorbed did not fall within 20-80%, as specified by Subdivision N guidelines. In addition, a preliminary study to determine the soil:solution ratio to be used in the definitive study was not conducted, so it is not known whether other soil:solution ratios could have been used in the definitive study which would have met the 20-80% adsorption requirement. In all batch equilibrium experiments of this study, the percent adsorbed was $\geq$92.6% for all samples. Since the rationale for selecting a 1:5 soil:solution ratio (w:v) for use in the definitive study was not provided, the reviewer could not evaluate the possibility that other soil:solution ratios could not improve the percent adsorbed to meet the 20-80% adsorption requirement.

In an acceptable **bioconcentration** study in fish (MRID 92069044) fluvalinate residues accumulated in edible, nonedible, and whole fish tissues of bluegill sunfish that were exposed to radiolabeled fluvalinate at 0.1 ppb for 30 days in a flow through aquarium. The maximum bioconcentration factors were 120x for the edible tissues, 660x for the non-edible tissues, and 360x for the whole fish tissues. Maximum concentrations of total radiolabeled residues were 13 ppb for edible tissues, 72 ppb for nonedible tissues, and 40 ppb for whole fish tissues. Depuration was relatively slow with 46 to 51% of the accumulated residues eliminated from fish tissues by day 14 of the depuration phase.

A total of three terrestrial field dissipation studies (MRID 42351601, MRID 41889716l, and MRID 41996202) were submitted in support of fluvalinate, however all three studies have been classified as unacceptable (MRID 41996202 was an interim report). It should also be noted that in a summary status memorandum dated April 3, 2002 EFED indicated that there were several deficiencies with MRID 42351601 which could be addressed through the submission of additional data. The registrant chose not to respond to the listed deficiencies with MRID 42351601 in it's September 20, 2002 (MRID 45769201) response to comments letter. EFED notes that this study could easily be upgraded to acceptable if the registrant provides information on the storage stability question the other issues are minor and do not affect the validity of the study results. The registrant has submitted a waiver request and argues that based on the fate profile, previously submitted data, and the limited use pattern terrestrial field dissipation data is not needed and that the requirement should be waived. EFED does not agree with the argument based on the fate profile and previously rejected data, however, EFED does acknowledge that the current outdoor use pattern for *tau*-fluvalinate is limited and therefore agrees that the terrestrial field dissipation data are not needed at this time. However, EFED recommends that the data requirement be reserved in case the use pattern is modified in the future to include more outdoor uses. Should additional outdoor uses be proposed for tau-fluvalinate EFED recommends re-evaluation of this data requirement based on the specifics of the request.

Table 3.2 Summary of Environmental Chemistry and Fate Properties of *Tau*-fluvalinate		
Parameter	**Value (isomeric form tested)**	**Reference/Comments**
	Selected Physical/Chemical Parameters	
PC code	109302	
CAS No.	102851-06-9	http://www.intox.org/databank/documents/chemical/taufluv/ukpid81.htm
Physical state	viscous, yellow oil	http://www.intox.org/databank/documents/chemical/taufluv/ukpid81.htm
Odor	moderate or weak sweetish odor	http://www.intox.org/databank/documents/chemical/taufluv/ukpid81.htm
Chemical name	*tau*-fluvalinate	
Chemical formula	$C_{26}H_{22}ClF_3N_2O_2$	Product Chemistry
Molecular weight	502.91 g/mole	Product Chemistry
Water solubility	12 ug/l	Product Chemistry
Solubilities	0.108 mg/l in isooctane >0.631 mg/l in toluene	http://www.intox.org/databank/documents/chemical/taufluv/ukpid81.htm
Density	1.62 @ 25^0C	http://www.intox.org/databank/documents/chemical/taufluv/ukpid81.htm
Boiling point	164 ^{0}C @ 9.3 Pa	http://www.intox.org/databank/documents/chemical/taufluv/ukpid81.htm
Vapor pressure (25 °C)	1 x 10^{-7} torr 9 x 10^{-11} Pa (25^0C)	Product Chemistry
log K_{OW}	4.26	Product Chemistry

Table 3.2 Summary of Environmental Chemistry and Fate Properties of *Tau*-fluvalinate				
Parameter	**Value (isomeric form tested)**			**Reference/Comments**
	Persistence			
Hydrolysis $t_{1/2}$				
pH 5 pH 7 pH 9	48 days (fluvalinate) 22.4 days (*tau*-fluvalinate) 1.13 days (fluvalinate)			Accession No. 76691, MRID 41597303, MRID 45769201, and MRID 45769202
Photolysis $t_{1/2}$ in water	< 1 day (fluvalinate & *tau*-fluvalinate)			Accession No. 072938, MRID 41597305, and MRID 45769203
Photolysis $t_{1/2}$ on soil	18 days (fluvalinate)			Accession No. 83757, MRID 41597307, and MRID 45769201
Soil metabolism aerobic $t_{1/2}$ 24–25 °C	8 days (*tau*-fluvalinate) 15 days (*tau*-fluvalinate)			Accession No. 126102, MRID 41889715, and MRID 45769201
Soil metabolism anaerobic $t_{1/2}$	NA			NA
Aquatic metabolism aerobic $t_{1/2}$	NA			NA
Aquatic metabolism anaerobic $t_{1/2}$	84.2 days (*tau*-fluvalinate) 88.3 days (*tau*-fluvalinate)			MRID 41889715, and MRID 45769201
	Mobility/Adsorption-Desorption			
Batch equilibrium – unaged	Soil Type	Kd	Koc	Accession No. 126102 and MRID 41597309
	clay loam	1200	110000	(*tau*-fluvalinate)
	sandy loam	1300	280000	(*tau*-fluvalinate)
	silt loam (sed)	1000	190000	(*tau*-fluvalinate)
	silt loam	1100	270000	(*tau*-fluvalinate)
	sand	1300	370000	(*tau*-fluvalinate)
Laboratory volatility	NA			NA

Table 3.2 Summary of Environmental Chemistry and Fate Properties of *Tau*-fluvalinate		
Parameter	**Value (isomeric form tested)**	**Reference/Comments**
	Field Dissipation	
Terrestrial field dissipation	NA	NA
Aquatic field dissipation	NA	NA
	Bioaccumulation	
Accumulation in fish, maximum BCF	120x - edible (fluvalinate) 660x - non edible (fluvalinate) 360x - whole tissue (fluvalinate)	MRID 92069044

3.2.2 Measures of Aquatic Exposure

This section provides a synthesized interpretation of all available data related to aquatic exposure, including modeling, monitoring, field studies, and geographic information system analysis.

3.2.2.1 Aquatic Exposure Modeling

To estimate concentrations of *tau*-fluvalinate in surface water or groundwater, modeling was used in the absence of surface water or groundwater monitoring data. Typically, Tier I surface water assessments are completed by EFED for chemicals without higher tier scenarios or as a screening level assessment. In the case of *tau*-fluvalinate, higher Tier II scenarios were available for modeling of the labeled use for tau-fluvalinate on carrots and ornamentals. Therefore, surface water exposure assessments were completed using Tier II model predictions.

The registrant supported uses represented in this exposure assessment are apiary uses, building perimeters, nurseries, ornamentals, indoor landscapes and honey. Carrots grown for seed use is being supported under a special local need (SLN) Section 24-C request but is being assessed concurrently with this risk assessment. This risk assessment covers the technical *tau*-fluvalinate with 87.2% active ingredient (ai), and all formulated end use products (eup). EFED believes that these proposed uses are unlikely to limit the geographic extent of *tau*-fluvalinate use to a specific area with the exception of the Section 24(c) use on carrots grown for seed and a pending Section 24(c) use on brassica/cole crops which are restricted to California (an Oregon 24(c) registration is being eliminated). Therefore a national risk assessment has been conducted using the selected PRZM scenarios to represent all registered outdoor uses. Indoor uses, use on apiary strips, and use on ant mounds are not expected to result in significant aquatic exposures.

Surface water concentrations were estimated using the Tier II model PRZM version 3.12/ EXAMS version 2.98.04 and ground water concentrations were estimated using the Tier I model SCIGROW version 2.3. A total of three scenarios each were modeled for *tau*-fluvalinate use based on individual EFED standard surface water scenarios. The scenarios modeled were carrots in Florida, vegetables in California, and ornamentals in Oregon. The scenarios selected for use in this assessment were chosen to estimate the concentration of *tau*-fluvalinate in surface drinking water over a geographically dispersed range of areas representative of crops proposed for *tau*-fluvalinate use. The Florida carrot scenario was modeled as a surrogate for carrots in the Section 24(c) requests. The California coastal vegetable scenario was modeled for comparison with this Florida scenario and represents a general vegetable scenario in an area where carrots are likely grown in California. The two scenarios together should provide a reasonable exposure scenario for this SLN use. The scenarios chosen for this assessment represent all available PRZM/EXAMS scenarios for the use of *tau*-fluvalinate, including the Oregon ornamental which was developed specifically for the cumulative OP assessment. The scenarios developed for the cumulative OP assessment were developed in order to represent the maximum use area for the OP's and may not necessarily represent the most vulnerable setting for a particular crop. However, EFED believes that for this particular assessment the use of this OP scenario, in conjunction with selected standard scenarios, provide a reasonable representation of the potential *tau*-fluvalinate use pattern. *Tau*-fluvalinate may be applied by aerial, ground or chemigation as per the label for this product. All scenarios were modeled with aerial application which results in the highest amount of spray drift.

PRZM 3.12/ EXAMS 2.98.04 modeling was performed with the small static water body (standard pond) scenarios. Input parameters used in Tier II surface water modeling (PRZM/EXAMS) were selected using EFED guidance ("*Guidance for Chemistry and Management Practice Input Parameters for Use in Modeling the Environmental Fate and Transport of Pesticides*" dated February 28, 2002 with an interim update dated November 11, 2004). Estimated exposure concentrations (EECs) for *tau*-fluvalinate in surface water are presented in **Table 3.3**, while model inputs are presented in **Table 3.4**. Representative copies of PRZM/EXAMS model input and output files are presented in **Appendix B.**

Table 3.3 Tier II Concentrations of *Tau*-Fluvalinate in Surface Water PRZM/EXAMS Scenarios						
Crop	**Application Rate per Acre lbs/acre (label #)**	**# of Applications (intervals)**	**First Application**	**1/10 Year Peak Annual (ug/l)**	**1/10 Year 21-Day Average (ug/l)**	**1/10 Year 60-Day Average (ug/l)**
FL carrots[1]	0.15	2 (5 day interval)	May 1	0.50	0.22	0.14
CA carrots (vegetable as surrogate)	0.15	2 (5 day interval)	May 1	0.46	0.19	0.09
OR ornamental	0.34	12 (14 day intervals)	May 1	0.25	0.16	0.14

1 -. Special Local Needs registration for use on carrots is for California only. Florida carrot scenario used for characterization purposes only and is intended to provide context to California vegetable scenario and ensure scenario does not under-represent potential exposure from *tau*-fluvalinate use on carrots.

Table 3.4 PRZM/EXAMS Input Parameters for *Tau*-fluvalinate for Aquatic Ecological Exposure Assessment			
Model Parameter	**Value**	**Comments**	**Source**
Application Information	**carrots** 9.6 fl oz (0.15 lbs ai/acre) repeat as needed (1 to 2 applications typical with 5 to 21 day intervals) - aerial and ground applications **woody ornamentals** 9.6 fl oz (0.15 lbs ai/acre) up to 24 per year @ 7 to 28 day intervals - ground applications		Product Labels
Spray Drift by Scenario	aerial - 5% ground - 1%	Default Assumption[1]	
Aerobic Soil Metabolism $t_{1/2}$	22.2 days[2]	estimated upper 90 th percentile	MRID 45769201 (addendum to 41889715)
Anaerobic Soil Metabolism $t_{1/2}$	stable	no data	
Aerobic Aquatic Degradation $t_{1/2}$ (KBACW)	stable	no data	
Anaerobic Aquatic Degradation $t_{1/2}$ (KBACS)	92.6 days[3]	estimated upper 90 th percentile	MRID 00126102, 41996201, & 419301314
Aqueous Photolysis $t_{1/2}$	1 day	single value	MRID 45769203, 41597305, & 41597306
Hydrolysis $t_{1/2}$	pH 5 - 48 days pH 7 - 22.5 days		MRID 45769202 (addendum to

Table 3.4 PRZM/EXAMS Input Parameters for *Tau*-fluvalinate for Aquatic Ecological Exposure Assessment			
Model Parameter	**Value**	**Comments**	**Source**
Kd/Koc	244,000	Average value[4]	MRID 45769204 (addendum to 41597309)
Molecular Weight	502.91 g/mole		Product Chemistry
Foliar Extraction (FEXTR)	0.5	Default value[1]	
Foliar Decay Rate	stable	Default value[1]	
Water Solubility	0.120 ppm	10 times estimated value[1]	Product Chemistry
Vapor Pressure	1 x 10^{-7} torr		Product Chemistry

1- From "*Guidance for Chemistry and Management Practice Input Parameters for Use in Modeling the Environmental Fate and Transport of Pesticides*" dated February 28, 2002.
2 - Upper 90th Percentile based on acceptable aerobic metabolism half lives of 8 and 15 days.
3 - Upper 90th Percentile based on acceptable aerobic metabolism half lives of 84.2 and 88.3 days.
4 - Average of acceptable Koc values of 110000, 280000, 190000, 270000, and 370000.

An evaluation of the importance of spray drift and buffers on applications is typically conducted during refinement of any risk assessment. However, in the case of *tau*-fluvalinate, it was decided to test the impact of spray drift buffers on aquatic exposures. Specifically, for the SLN registrations on carrots and brassica/cole crops, there is a condition on the label that limits aerial applications to within 150 feet of aquatic water bodies. In order to test this condition on aquatic exposures, EFED first estimated the effect of a 150 foot spray drift buffer on the amount of *tau*-fluvalinate predicted to drift off-site. For the screening level EECs presented in Table 3.3 the default spray drift values of 5% for aerial applications and 1% for ground applications was assumed as per current Agency policy. However, the assessment of the amount of drift expected when a 150 foot buffer is applied was evaluated using the AgDRIFT model. A tier I assessment was conducted using the default assumptions in AgDRIFT (droplet size, wind speed, nozzle configuration, etc.) and an new aerial spray drift value was estimated for the SLN registrations. AgDRIFT predicted that the percentage of *tau*-fluvalinate expected to drift to aquatic water bodies when a 150 foot buffer is applied would be 4%. Applying this drift value to the previously modeled carrot scenarios (given the similarity in use rates and geographic distribution of the crop the brassica/cole crop SLN is expected to be represented by this scenario) results in a reduction in EECs by roughly 20%. The results of this analysis is presented in **Table 3.5**.

Table 3.5 Tier II Concentrations of *Tau*-fluvalinate in Surface Water PRZM/EXAMS Carrot Scenarios with 150 foot Buffer						
Crop	**Application Rate per Acre lbs/acre (label #)**	**# of Applications (intervals)**	**First Application**	**1/10 Year Peak Annual (ug/l)**	**1/10 Year 21-Day Average (ug/l)**	**1/10 Year 60-Day Average (ug/l)**
FL carrots[1]	0.15	2 (5 day interval)	May 1	0.41	0.19	0.10
CA carrots (vegetable as surrogate)	0.15	2 (5 day interval)	May 1	0.37	0.15	0.08

1 -. Special Local Needs registration for use on carrots is for California only. Florida carrot scenario used for characterization purposes only and is intended to provide context to California vegetable scenario and ensure scenario does not under-represent potential exposure from *tau*-fluvalinate use on carrots.

In order to further evaluate the importance of spray drift on potential exposures (and hence risk) EFED remodeled all scenarios assuming that no spray drift would occur. This provides a maximum estimate of the importance of spray drift and provides useful information regarding the utility of applying spray drift and runoff buffers. As with the previous assessment, EFED remodeled all scenarios and set the spray drift fraction to 0%. This essentially provides an estimate of the amount of exposure resulting exclusively from runoff. For the modeled scenarios the no-drift EECs were reduced from the 5% drift values (**Table 3.3**) by greater than 95% for the carrot/brassica/cole crop scenario and roughly 85% to 70% for the ornamental use. These values are presented in **Table 3.6.** This analysis suggests that implementation of spray drift buffers can be important for reducing aquatic exposure to *tau*-fluvalinate and that for the SLN registrations in California spray drift buffers may significantly reduce loading of *tau*-fluvalinate to aquatic systems.

Table 3.6 Tier II Concentrations of *Tau*-fluvalinate in Surface Water PRZM/EXAMS Scenarios with No Spray Drift						
Crop	**Application Rate per Acre lbs/acre (label #)**	**# of Applications (intervals)**	**First Application**	**1/10 Year Peak Annual (ug/l)**	**1/10 Year 21-Day Average (ug/l)**	**1/10 Year 60-Day Average (ug/l)**
FL carrots[1]	0.15	2 (5 day interval)	May 1	0.16	0.08	0.06
CA carrots (vegetable as surrogate)	0.15	2 (5 day interval)	May 1	0.01	0.01	0.01
OR ornamental	0.34	12 (14 day intervals)	May 1	0.08	0.03	0.02

1 -. Special Local Needs registration for use on carrots is for California only. Florida carrot scenario used for characterization purposes only and is intended to provide context to California vegetable scenario and ensure scenario does not under-represent potential exposure from *tau*-fluvalinate use on carrots.

Further analysis (presented in detail in **Appendix G**) suggest that for the most sensitive species tested (estuarine invertebrate) the spray drift buffer needed to reduce EECs from spray drift only are expected to exceed the range of the model. This suggests that while spray drift is a significant component of the total exposures for estuarine invertebrates, estimation of the effectiveness of spray drift buffers is beyond the range of the Tier I and Tier II versions of the model. There is also significant uncertainty with these estimates due to the uncertainty surrounding the toxicity values used in this assessment. The toxicity data for all aquatic species were classified as supplemental due to issues with the use of co-solvent and the potential sorption of *tau*-fluvalinate to the glass chambers. These factors suggest that the toxicity of *tau*-fluvalinate could be even greater which would result in even larger spray drift buffer estimations.

3.2.2.2 Equilibrium Partitioning and Concentration in the Sediment

In general, pyrethroid insecticides are lipophilic compounds that can adsorb readily to particulate and sediment, thus possibly limiting its exposure to aquatic life in the water column but increasing toxic exposure in the benthos. Sediment can act as a reservoir for lipophilic persistent compounds. The sediment and particulate likely adsorb a high percentage of pyrethrin, as indicated by its high K_{OC}. Therefore, coupled with *tau*-fluvalinate's expected persistence in anaerobic environments, sediment bound *tau*-fluvalinate could present a toxicity risk for benthic aquatic life and aquatic ecosystems in general. Exposure to this sediment can result in a direct impact to aquatic life through respiration, ingestion, dermal contact, as well as indirect impact through alterations of the food chain.

Pesticide compounds that bind readily to particulate and organic carbon in the water column can eventually settle onto the benthos. This increase in particulate-bound pesticides can result in an accumulation of compounds in or on the sediment that may have the potential for toxic impact to benthic and epibenthic aquatic organisms (e.g., early life stage of many invertebrates and fish, as well as crabs and shrimp). However, evaluating the risk to aquatic life from this exposure becomes problematic given the lack of adequate sediment toxicity and exposure data. Therefore, in order to assess this potential for pesticide risk to aquatic benthic systems, EFED has adopted the method used by the USEPA Office of Water (OW) that relies on equilibrium partitioning (EqP) of chemicals. Th EqP theory is based on the hydrophobicity and concentrations of the chemical normalized to organic carbon (OC) in sediment (De Toro *et al.* 1991) and holds that a nonionic chemical in sediment partitions between sediment organic carbon, interstitial (pore) water and benthic organisms. At equilibrium, if the concentration in any phase is known, then the concentration in the other phases can be predicted. A key component to this theory is the chemicals organic carbon coefficient (Koc), which is constant for every chemical and represents the ratio of the chemical concentration in water to the concentration in organic carbon. The document, " Technical Basis for the Derivation of Equilibrium Partitioning Sediment Guidelines (ESG) for the Protection of Benthic Organisms: Nonionic Organics" (USEPA, 2000a), demonstrates that biological responses of benthic organisms to nonionic organic chemicals in sediments are different when the sediment concentrations are expressed on a dry weight basis, but similar when expressed on a *u*g chemical/g organic carbon basis (ug/g_{oc}). Similar responses were also observed across sediments when interstitial water concentrations were used to normalize biological availability. The Technical Basis Document further demonstrates that if the toxic effect concentration in water is known (e.g., LC_{50}), the effect concentration in sediment on a ug/g_{oc} basis can be predicted by multiplying the effect concentration in water by the chemical K_{oc}.

$$(LC_{50}\ ug/L \times Koc\ L/kg_{oc} \times 1\ kg_{oc}/1000g_{oc} = LC_{50}\ ug/g_{oc})$$

Since EFED uses a deterministic method for its screening level risk assessment, the calculation of risk quotient values (RQ) is important for assessing possible risk. The RQ values are calculated by taking the ratio of the estimated exposure concentrations (EEC) to the toxicity effect value (e.g., LC_{50}, NOAEC). The EEC values are model generated (e.g., PRZM/ EXAMS) and reflect peer evaluated and approved scenarios for assessing pesticide exposure to an aquatic environment. However, the PRZM/ EXAMS output produces water column EEC values, as well as sediment and porewater EEC values. Therefore, in order to assess possible toxic pesticide exposure to aquatic organisms from sediments, EFED uses the PRZM/ EXAMS model, which incorporates the principles of the equilibrium partitioning theory, in order to generate EECs from sediment and porewater. By relying on sediment and/or porewater output values, EFED uses two methods to calculate RQ values for sediments by using porewater exposure values and bulk sediment values.

Risk calculations that rely on porewater concentrations can be calculated by dividing the PRZM/ EXAMS output value for porewater by the dissolved concentrations in the water column that cause toxicity in bioassays (e.g., LC_{50}).

EEC porewater ug/L / LC50 ugL

If sediment effects data are available (LC50 ug/kg_{oc}), RQs can be produced by using the PRZM/ EXAMS sediment output value for sediment.

EEC sediment ug/ugoc / LC50 ug/kg_{oc}

The following three principle observations underlie the equilibrium partitioning (EqP) approach:

- The concentrations of nonionic organic chemicals in sediments (expressed on an organic carbon basis) and in interstitial waters correlate with observed biological effects on sediment-dwelling organisms across a range of sediments.
- Partitioning models can relate sediment concentrations for nonionic organic chemicals on an organic carbon basis to freely-dissolved concentrations in interstitial water.
- The distribution of sensitivities of benthic organisms is similar to that of water column species.

The EqP approach assumes that the partitioning of a chemical between sediment organic carbon and interstitial water is at or near equilibrium. Another assumption is that the concentration in either phase can be predictive using appropriate partition coefficients and the measured concentration in the other phase. Furthermore, it is assumed that organisms receive equivalent exposure from water-only exposures and any equilibrated phase (interstitial water via respiration; from sediment via ingestion or other sediment integument exchange). The final assumption is that for nonionic compounds, effect concentrations in sediments on an organic carbon basis can be predicted using the organic carbon partition coefficient (K_{OC}) and effects concentrations in the water.

The range of EECs estimated for benthic pore water by PRZM/ EXAMS is 0.019–0.039 µg/L for the peak daily concentrations (**Table 3.7**). The range of EECs follows the pattern exhibited by the surface water EECs with the highest EECs estimated for the Oregon ornamentals standard scenario.

Table 3.7 PRZM/EXAMS output for benthic pore water EECs (ug/L) based on *Tau*-fluvalinate use on several crops.								
Crop	**App. rate (kg/ha)**	**No. of app./ interval (days)**	**Peak**	**96 Hour**	**21 Day**	**60 Day**	**90 Day**	**Annual**
OR ornamentals	0.34	12 (14 day interval)	0.039	0.039	0.038	0.037	0.036	0.030
CA carrots (vegetable as surrogate)	0.15	2 (5 day interval)	0.019	0.019	0.019	0.018	0.016	0.010

3.2.2.3 Aquatic Exposure Monitoring and Field Data

For *tau*-fluvalinate, no monitoring data were available for use in this aquatic exposure assessment. Therefore, potential exposure of non-target organisms to tau-fluvalinate in surface water was evaluated through modeling.

3.2.3 Measures of Terrestrial Exposure

Tau-fluvalinate exposure to terrestrial animals is likely considering that the proposed application methods include outdoor spray to ornamentals, eugenia/pepper tree, and spot treatment to building perimeters and ant mounds. Indoor uses (crack and crevice, greenhouse use, etc..) as well as use on apiary strips (unoccupied) are unlikely to result in exposure to terrestrial organisms. Therefore, given the limited use of tau-fluvalinate, in terms of both total pounds applied and geographic extent, terrestrial exposures are expected to be limited.

Analysis of United States Department of Agriculture (USDA) Agriculture of Census (AgCensus) data indicate that ornamental, eugenia and pepper trees are typically grown California, Texas, Florida, Washington, Michigan, and Pennsylvania (**Figure 2.1**). The SLN use on carrots is limited to the following counties (Colusa, Glenn, San Joaquin, Solano, Sutter, and Yolo) in California (**Figure 2.3**). The SLN use on brassica and cole crops in California is limited to those areas where these crops are typically grown including the Salinas Valley in Central California (**Figure 2.6**) and in Imperial county in Southern California (**Figure 2.7**).

Terrestrial wildlife exposure estimates are typically calculated for birds and mammals, which are surrogates for terrestrial-phase amphibians and reptiles. These estimates focus on potential dietary exposures to the pesticide active ingredient and are estimated assuming that organisms are exposed to a single pesticide residue on food items in a given exposure scenario.

3.2.3.1 Terrestrial Exposure Modeling

Estimation of *tau*-fluvalinate residues on wildlife food items focuses on quantifying possible dietary ingestion of residues on vegetation and insects. Residue estimates are based on a nomogram that relates food item residues to pesticide application rate. Estimated environmental concentrations (EECs) are generated from a spreadsheet-based model (TREX version 1.1) that calculates the decay of a chemical applied to foliar surfaces for single or multiple applications.

The terrestrial exposure assessment is based on the methods of Hoerger and Kenaga[1] (1972), as modified by Fletcher *et al.* (1994)[2]. Terrestrial EECs for non-granular formulations were derived for the proposed terrestrial food crops and ornamentals using the highest proposed application rate (0.34 lbs a.i./acre for ornamentals and 0.15 lbs a.i./acre for carrots/cole crops) and the shortest interval (14 days for ornamentals and 5 days for carrots/cole crops) between applications. Uncertainties in the terrestrial EECs are primarily associated with a lack of data on interception and subsequent dissipation from foliar surfaces. When data are absent, as in this case, EFED assumes a 35-day foliar dissipation half life, based on the work of Willis and McDowell (1987)[3].

Terrestrial EECs may be compared directly with dietary toxicity data or converted to an oral dose, as is the case for small mammals. The screening-level risk assessment for *tau*-fluvalinate uses upper bound predicted residues as the measure of exposure. The predicted maximum and mean residues of *tau*-fluvalinate that may be expected to occur on selected avian or mammalian food items immediately following application (at the maximum annual or seasonal label rate) for the proposed terrestrial food crops are presented in **Table 3.8.** For mammals, the residue concentration is converted to a daily oral dose based on the fraction of body weight consumed daily as estimated through mammalian allometric relationships.

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

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

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

Table 3.8 Kenaga Values for Terrestrial Organism Food Items Estimated Using TREX (version 1.1) for *Tau*-fluvalinate				
Food Type	**Maximum Kenaga Values for Ornamental Use (ppm)**	**Mean Kenaga Values for Ornamental Use (ppm)**	**Maximum Kenaga Values for Carrot/Brassica/Cole Crop Use (ppm)**	**Mean Kenaga Values for Carrot/Brassica/Cole Crop Use (ppm)**
Short Grass	324.9	115.1	54.9	19.4
Tall Grass	148.9	48.7	25.2	8.2
Broadleaf Plants/Small Insects	182.8	60.9	30.9	10.3
Fruits/Pods/Seeds/ Large Insects	20.3	9.51	3.4	1.6

3.2.3.2 Residue Studies

EFED searched the bibliographic references for residue decline data and also contacted the Health Effects Division (HED) of the Office of Pesticide Programs (OPP) to determine if any relevant and acceptable data are available to estimate exposure concentrations on plant material and to determine if foliar half lives could be estimated. There are no suitable data available to provide these estimates.

3.3 Ecological Effects Characterization

The effects characterization describes the types of effects a pesticide can produce in an organism or plant. Acute and chronic effects toxicity information for various aquatic and terrestrial animals and plants are characterized based on registrant-submitted studies and a comprehensive review of the open literature (ECOTOX) on *tau*-fluvalinate. In addition, the Ecological Incident Information System (EIIS), was searched to further refine the characterization of potential ecological effects associated with exposure to *tau*-fluvalinate; however, no incidences were found.

Toxicity data on *tau*-fluvalinate degradates, particularly, two of the major degradates, 3-phenoxy-benzaldehyde and cyanohydrin were found in registrant-submitted studies as well as in the open literature (ECOTOX).

3.3.1 Evaluation of Aquatic and Terrestrial Registrant-Submitted and Open Literature Ecotoxicity Studies

Appendix C summarizes the results of the submitted toxicity studies used to characterize effects for this risk assessment. Toxicity testing reported in this section does not represent all species of birds, mammals, or aquatic organisms. Only a few surrogate species for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. For mammals, acute studies are usually limited to the Norway rat. Estuarine/marine testing is usually limited to a crustacean, a mollusk, and a fish. Also, neither reptiles nor amphibian data are available. The risk assessment assumes that avian and reptilian toxicities are similar. The same assumption is used for fish and amphibians.

Appendix C also summarizes the additional studies that were considered as part of the open literature (ECOTOX) review of *tau*-fluvalinate and its degradates. Following implementation of the Overview document (USEPA, 2004a), EFED began developing guidelines for incorporation of open literature into ecological risk assessments (USEPA, 2004b). Toxicity data from open literature are identified via the ECOTOX search engine and maintained by EPA/ORD. Open literature data presented in this risk assessment were obtained from the data provided to EFED by ORD on 04/29/2005. In order to be included in the ECOTOX database, papers must meet the following minimum criteria:

C. the toxic effects are related to a single chemical exposure;
D. the toxic effects are on an aquatic or terrestrial plant or animal species;
E. there is a biological effect on live, whole organisms;
F. a concurrent environmental chemical concentration/dose or application rate is reported; and
G. there is an explicit duration of exposure.

Data that passes the ECOTOX screen is evaluated along with the registrant-submitted data, and may be incorporated qualitatively or quantitatively into the risk assessment. In general, effects data in the open literature that are less than or more conservative than the registrant-submitted data are considered. The degree to which open literature data is quantitatively or qualitatively characterized is dependant on whether the information is relevant to the assessment endpoints (i.e., maintenance of survival, reproduction, and growth) identified in the problem formulation. For example, endpoints such as behavior modifications are likely to be qualitatively evaluated, because it is unclear whether such modifications cause a reduction in species survival, reproduction, and/or growth. Specific open literature data that are considered include the following:

A. the endpoint is more sensitive than those identified in the registrant data;
B. the data is for under represented taxa (i.e., amphibians); and
C. the data includes endpoints not normally evaluated in registrant studies, but ecologically relevant.

Based on the reviewed registrant-submitted studies and open literature data (ECOTOX), *tau*-fluvalinate is practically non-toxic to birds and mammals, highly toxic to honeybees and other terrestrial invertebrates and very highly toxic to fish and aquatic invertebrates on an acute basis. Significant data gaps exist for evaluation of acute and chronic toxicity of *tau*-fluvalinate to aquatic animals and plants. **Tables 3.1 and 3.2** summarize the most sensitive ecological toxicity endpoints for aquatic and terrestrial species respectively. Those endpoints used for calculation of risk quotients (RQs) are noted and are based on an evaluation of both the submitted studies and the open literature (ECOTOX), as previously discussed. Discussion on the effects of *tau*-fluvalinate and its formulated products on aquatic and terrestrial taxonomic groups are presented below. Submitted studies are addressed for each taxonomic group. A summary of relevant data from ECOTOX is also provided, and discussed in greater detail in **Appendix C**.

Table 3.1 Aquatic Toxicity Profile for *Tau*-fluvalinate

Endpoint	**Environment/ Species**	**Toxicity Values**	**Reference**	**Comment**
Acute Toxicity to Fish	<u>Freshwater</u> Carp (TGAI - *half-resolved*) and 23.5 - 24.9% formulations corrected for % a.i.	96-hr LC_{50} 0.35 μg/L **Used for RQ calculations.** Formulations: 96-hr LC_{50}s ranged from 0.5 - 2.7 μg/L	MRIDs 00150125 00094604 00094605 00154543 - 0154545	**Supplemental**: Nominal concentrations. Static studies. Likely significant degradation of test material during studies.
	<u>Saltwater</u> Sheepshead minnow (TGAI - *half-resolved*) Mavrik 2F (22.3% formulation: corrected for % a.i.)	96-hr LC_{50} = 10.8 μg/L. **Used for RQ calculations**. 96-hr LC_{50} = 27.4μg/L	MRID 00155450 00160766 42284602	**Supplemental:** Nominal concentrations. Static study. Likely significant degradation of test material during study. **Acceptable**: formulation not registered for use; less toxic than parent.
Chronic Toxicity to Fish	<u>Freshwater</u> Fathead minnow (TGAI - *half-resolved*)	NOAEC = 0.064 μg/L LOAEC = 0.152 μg/L **Used for RQ calculations**	MRID 00127996	**Supplemental**: Significant analytical variability in exposure concentrations. Results couldn't be statistically verified. Growth affected at LOAEC.

Table 3.1 Aquatic Toxicity Profile for *Tau*-fluvalinate				
Endpoint	**Environment/ Species**	**Toxicity Values**	**Reference**	**Comment**
	Saltwater Sheepshead minnow (TGAI - *half-resolved*)	NOAEC = 0.036 μg/L LOAEC = 0.070 μg/L **Used for RQ calculations**	MRID 43753501	**Acceptable**: Reproduction/growth affected at LOAEC.
Acute Toxicity to Invertebrates	Freshwater Daphnia magna (TGAI - *half-resolved*) and 23.5 - 24.9% formulations corrected for % a.i. Red swamp crayfish *(half-resolved)*	48-hr EC_{50s}s ranged from 0.4 - 74 μg/L Formulations: 48-hr EC_{50s}s ranged from 2.6 - 81 μg/L 96-hr EC_{50}: 0.31 μg/L **Used for RQ calculations**	MRIDs 00094597 00127995 00079960 00094603 00154546 ECOTOX reference 366	**Supplemental**: Nominal concentrations; all static studies except 1 flow-through. Likely significant degradation of test material during study, including stock solution. **Supplemental**: Nominal concentrations, static studies. Likely significant degradation of test material.

Table 3.1 Aquatic Toxicity Profile for *Tau*-fluvalinate				
Endpoint	**Environment/ Species**	**Toxicity Values**	**Reference**	**Comment**
	Saltwater Eastern oyster *(half-resolved)* Mysid shrimp (TGAI - *half-resolved*) Eastern Oyster Mavrik 2F (22.3%) Mavrik Aquaflow (22.0%)	96-hr EC_{50} = 12 μg/L 96-hr EC_{50} = 0.018 μg/L **Used for RQ calculations** 96-hr EC_{50} >102000 a.i. μg/L 96-hr EC_{50} = 0.011 μg a.i./L	MRID 00160767 00127994 42284601 44106501	**Supplemental**: Measured concentration in oyster study: significant degradation of test material in test chamber. Mysid study nominal concentrations. Both static studies **Acceptable for formulated product.** Formulation not currently registered. Product likely significantly less toxic than parent. **Supplemental**: Test solution concentrations not analytically verified. Toxicity values extrapolated by multiplying nominal concentrations by % recoveries from stock solutions.
Chronic Toxicity to Invertebrates	Freshwater Daphnia (TGAI - *half-resolved*)	NOAEC = 0.044 μg/L LOAEC = 0.089 μg/L **Used for RQ calculations**	MRID 00127997	**Supplemental**: Measured concentrations determined by 2 inadequate methods. Conflicting results. Nominal concentrations used. Exposure concentrations not reliable.
	Saltwater No data	No data	NA	No studies were submitted or located in the open literature
Toxicity to Aquatic Plants	No data available	N/A	N/A	N/A

Table 3.2 Terrestrial Toxicity Profile for *Tau*-fluvalinate				
Endpoint	**Species**	**Toxicity Value Used in Risk Assessment**	**Reference**	**Comment**
Acute Toxicity to Birds (LD_{50})	Bobwhite quail *(half-resolved)*	LD_{50} > 2510 mg ai/kg-bw **Not used for calculation of RQs**	MRID 00085444 00104671	**Both Acceptable**. 00085444: Mortality 10% at 2510 mg/kg bw. Lethargy at 1590 - 2510 mg/kg bw. Lower limb weakness at 2510 mg/kg bw. 00104671: Mortalities not dose-related. Lethargy at 398 mg/kg bw (LDT).
Subacute Toxicity to Birds (LC_{50})	Bobwhite quail (*half-resolved*)	LC_{50} = 5627 ppm **Used for calculation of RQs**	MRID 00079964	**Acceptable:** Mortality, nostril & toe-picking at 1780 ppm. Other clinical signs at 3160 - 5620 ppm. NOAEC: 1000 ppm, LOAEC 1780 ppm.
Reproductive Toxicity to Birds	Bobwhite quail and Mallard Duck (*half-resolved*)	NOAEC = 900 ppm (highest dose tested) **Used for calculation of RQs**	MRID 00149824 00149825	**Acceptable**: No effects observed at any concentration.
Acute Toxicity to Mammals	Rat (TGAI - *half-resolved*) (Mavrik 2E, 25% formulation)	LD_{50} = 1402 (♂), 3162-5000 (♀) mg ai/kg-bw **Used for calculation of RQs** LD_{50} = 274 mg /kg-bw a.i. (♂&♀) **Used for calculation of RQs**	MRID 46521901 00094119	**Acceptable:** clinical signs of toxicity observed as low as 700 mg/kg bw a.i. No NOAEL established. **Acceptable**: Formulation more toxic than technical material. Clinical signs as low as 25 mg/kg bw a.i.
Reproductive/ Chronic Toxicity to Mammals	Rat - ***half-resolved***	NOAEC = 1.9 mg ai/kg (25 ppm) LOAEC = 9.53 mg ai/kg (125 ppm) **Used for calculation of RQs**	MRID 44596601	**Acceptable**: Parents: skin ulceration. Pups: tremors, decrease in weight, litter size, mean litter weight
Acute Toxicity to Honey Bees	Honey bee - technical not specified	LD_{50} = 0.2 µg ai/bee	MRID 41783901	**Acceptable**: Immobile bees and mortality at 0.05 µg/bee and above. NOAEL 0.025 µg/bee.

Table 3.2 Terrestrial Toxicity Profile for *Tau*-fluvalinate				
Endpoint	**Species**	**Toxicity Value Used in Risk Assessment**	**Reference**	**Comment**
Toxicity to Terrestrial Plants	Seedling Emergence Monocots	No studies available	N/A	N/A
	Seedling Emergence	No studies available	N/A	N/A

3.3.2 Aquatic Animals

3.3.2.1 Acute Effects

Fish and Aquatic-phase Amphibians

Significant data gaps exist for evaluation of acute toxicity of *tau*-fluvalinate to fish and aquatic phase amphibians. No acceptable acute toxicity studies on the technical material are available for either freshwater or marine/estuarine fish. In addition, no acceptable data on acute toxicity to either fish or aquatic-phase amphibians were found in the open literature (i.e. ECOTOX).

The majority of the fish acute toxicity studies on the technical material submitted by the registrant are static bioassays conducted with nominal concentrations. Concentrations were analytically measured in two studies and the data showed that *tau*-fluvalinate rapidly declined in the test solution with a half-life of approximately 24 hours (MRIDs 00150125 and 00154545).

There are three potential contributing factors to the rapid decline of the test material in the studies: photolysis, hydrolysis and adsorption to the glass. *Tau*-fluvalinate is a member of the pyrethroid class of chemicals. Pyrethroids are known to adsorb to glass containers in static aquatic bioassays. *Tau*-fluvalinate has a K_{oc} between 110000 and 370000. Therefore, it is likely that the rapid decline of the test material in the two bioassays is mostly due to adsorption to the glass containers.

The rapid decline in test concentrations could also be due to photolysis. The submitted aqueous photolysis studies suggest rapid photo degradation with half lives between 10 minutes and 1 day. However, as stated in the Exposure Characterization (Section 3.2), there is some uncertainty associated with the data, and the guideline is not fulfilled at this time.

The third potential contributing factor to the rapid decline is hydrolysis, which is pH dependent. Under alkaline conditions, *tau*-fluvalinate hydrolyzes rapidly; whereas, under acidic conditions, it is relatively stable. The reported half lives are 48 days at pH 5 and 1.13 days at pH 9. The two studies in which concentrations were analytically measured were conducted in a pH range of 8.0 -

8.4. Most of the other studies were conducted at a slightly lower pH range (6.9 to 7.9) with several in the pH 6.5 - 6.8 range. Of the three contributing factors, hydrolysis is likely to contribute the least to the rapid decline of the test material.

All of the studies were conducted in glass chambers, and no provisions were made concerning potential photolysis. Because adherence to the glass test chambers and rapid photolysis are likely and only nominal concentrations were provided, it is likely that the acute LC_{50}s are even lower than reported. Therefore, due to the uncertainties associated with the test exposure concentrations, all of the static studies are classified as supplemental. These studies are being used to calculate risk (RQs), and the risks are characterized using the uncertainties described above.

Acute toxicity studies on two 23 - 25% formulations with freshwater and marine/estuarine fish have been submitted. As with the studies conducted with the technical material, most of these studies are static studies conducted with nominal concentrations. Neither of the formulations tested, Mavrik 2F and Mavrik 2E are currently registered. The acute LC_{50}'s with these formulations are 0.5 and 2.7 μg a.i./L for freshwater fish and 27.4 μg a.i./L for marine/estuarine fish. Since the LC_{50}s for these formulations are greater than the most conservative values for the technical material (0.35 μg a.i./L and 10.8 μg a.i./L for freshwater and marine/estuarine fish, respectively), RQs are not calculated for the formulations.

Although there are uncertainties associated with the exposure concentrations in the fish studies conducted with *tau*-fluvalinate, available acute toxicity data on fish from 5 other pyrethroids support the results. The submitted acute toxicity studies conducted with *tau*-fluvalinate on freshwater fish indicate that it is very highly toxic, with reported 96-hour acute LC_{50}s ranging from 0.35 to 14 μg/L. For marine/estuarine fish, the reported acute LC_{50} value for the technical material is 10.8 μg/L. The acute LC_{50} values from acceptable studies on both freshwater and marine/estuarine fish with the five other pyrethroids range from 0.15 - 17.5 μg/L (nominal and measured) with one high LC_{50} value of 88 μg/L. These data are summarized in **Appendix C.** When taken together, these data indicate that it is likely that the acute 96-hour LC_{50} values for technical *tau*-fluvalinate fall in a similar range as the other pyrethroids.

Aquatic Invertebrates

Significant data gaps exist for evaluation of acute toxicity of *tau*-fluvalinate to aquatic invertebrates. No acceptable acute toxicity studies on the technical material are available for either freshwater or marine/estuarine invertebrates. All of the studies utilized nominal concentrations and, as with the freshwater fish studies, the majority of the studies were static bioassays with the exception of one flow-through study. Again, due to uncertainties associated with the concentration of the test material, all of the acute toxicity studies conducted with the technical material on aquatic invertebrates are classified as supplemental. These studies are being used to calculate risk (RQs), and the risks are characterized using the uncertainties described above.

Several acute toxicity studies exist on both freshwater and marine/estuarine invertebrates with formulations with percent a.i. ranging from 22 to 25%. As with the studies conducted with the technical material, all except one of these studies are static studies conducted with nominal concentrations. Two of the tested formulations, Mavrik 2F and Mavrik 2E are not currently registered; however, Mavrik Aquaflow is registered. The acute LC_{50}'s for these formulations are 2.6 and 81 μg a.i./L for freshwater invertebrates (daphnia), 102000 μg a.i./L for eastern oysters and 0.02 μg a.i./L for mysid shrimp. Since the LC_{50}s for these formulations are either greater to or equivalent to the values for the technical material (0.4, 1.0 and 74 μg a.i./L for daphnia, 12 μg a.i./L for eastern oysters and 0.018 μg a.i./L for mysid shrimp), RQs are not calculated for the formulations.

As with the fish studies, the acute toxicity data on aquatic invertebrates from 5 other pyrethroids support the reported values for *tau*-fluvalinate. The EC_{50} ranges for the 5 other pyrethroids are as follows: 0.039 - 7.2 μg/L with one high value at 89 μg/L for daphnia, 2.15 to >1000 μg/L for mollusks and 0.002 - 0.046 μg/L for mysid shrimp. The range for mollusks is quite wide; however, the range for mysid shrimp is relatively narrow.

Acute static toxicity studies with freshwater invertebrates were found in the ECOTOX database on red swamp crayfish (*Procambarus clarkii* (ref. 366)) and mosquito larvae (*Culex pipiens* (ref. 61915)) with endpoints based on mortality. As with the daphnia studies, uncertainties exist relating to exposure concentrations in these static studies. The crayfish study was conducted in glass containers, and the mosquito study was conducted in paper cups. Nevertheless, the EC_{50} of 0.31 μg/L from the crayfish study following 96 hours exposure at a temperature of 22 °C (the same temperature as the most sensitive daphnia study) will be used for calculating risk quotients. The EC_{50} for mosquito larvae following 24 hours exposure is 57.8 μg/L, considerably higher than the other invertebrate studies (no data were available for a 48- or 96-hour exposure).

No acceptable data on acute toxicity to marine/estuarine invertebrates were found in the open literature (i.e. ECOTOX).

3.3.2.2 Chronic Effects

Fish

No acceptable studies are available for an estimation of potential chronic toxicity to freshwater fish. One flow-through early life stage study with fathead minnows was submitted. Due to analytical variability and insufficient data to statistically verify the results, this study is classified as supplemental (MRID 00127996). The results from the study will be used to estimate risk and characterized with the uncertainties relating to exposure concentrations. The study indicates that *tau*-fluvalinate affects growth of juvenile freshwater fish at concentration levels below 0.2 μg/L. At higher levels (approximately 0.5 μg/L), survival is decreased. No chronic toxicity studies with freshwater fish were found in the ECOTOX database.

An acceptable chronic study is available for marine/estuarine fish (MRID 43753501). In sheepshead minnows, reproductive capacity and growth are diminished at concentration levels 0.07 μg/L and above. At higher levels (e.g. 0.14 μg/L), lethargy was observed. This study is sufficient to estimate risk to estuarine/marine fish from chronic exposure to *tau*-fluvalinate. A search of the open literature (e.g. ECOTOX) provided no additional data on toxicity to marine/estuarine fish following chronic exposure to *tau*-fluvalinate.

Aquatic Invertebrates

No acceptable chronic studies on either freshwater or marine/estuarine invertebrates are available. One chronic study was submitted with daphnia; however, mean-measured concentrations were determined by two inadequate methods, and conflicting results were obtained (MRID 00127997). Therefore, nominal concentrations were used in reporting results. This study is classified as supplemental. The results will be used for calculating risk and characterized with the uncertainties relating to exposure concentrations. A review of the open literature (ECOTOX) did not provide any additional acceptable chronic data on aquatic invertebrates.

3.3.2.3 Sublethal Effects

Fish

Following subacute exposure to the parent and acute exposure to a formulation, observed sublethal effects include negative sensitivity to exterior movement, quiescence and loss of equilibrium. These effects were generally observed at similar concentration levels that produce mortality. Therefore, any discussion of risk based on mortality would likely apply to sublethal effects as well.

In the chronic fish studies, the NOAECs and LOAECs are based on decreased growth and/or reproductive effects. These are assessment endpoints that EFED currently uses to measure potential hazard. Decreased survival of fry and lethargy are noted at higher concentrations.

Aquatic Invertebrates

Following acute exposure (48 hours), water fleas appeared to be small in size at all concentration levels tested when compared to the controls. In addition, lethargy was observed at all concentrations tested. These sublethal effects were observed at levels where significant mortality was also observed. Lethargy was also noted in mysid shrimp at levels where significant mortality occurred. Therefore, any discussion of risk based on mortality would likely apply to sublethal effects as well.

In the chronic study with water fleas, the NOAEC and LOAEC are based on decreases in length and mean number of offspring/adult/reproductive day. Again, these are assessment endpoints that EFED currently uses to measure potential hazard. Decreased survival was observed at a higher concentration.

3.3.2.4 Aquatic Field Studies

MRID 43093001 Minicosm Study
A minicosm study was conducted in 3 x 8 x 2 ft. ponds (740 L over 10 cm of biologically active sediment per pond). Ponds were only stocked with sixteen Bluegill sunfish (*Lepomis macrochirus*) per pond. All other biota were allowed to succeed from the area surrounding the ponds and the natural reservoir pond water and biologically active hydrosoil spikes. Three formulations of fluvalinate were tested and included simulated contamination via aerial spray drift and runoff from agricultural fields: Mavrik Aquaflow (23.0% half-resolved fluvalinate), a formulation containing 22.2% fully resolved fluvalinate and a formulation containing 22.2% microencapsulated half-resolved fluvalinate, respectively. Control ponds received applications of a soil-water slurry containing no test material. Four of the six treatment groups received applications at rates simulating environmental concentrations that would be expected from off target loading due to field application rates of 0.05, 0.10, 0.15, and 0.30 lb a.i./A. Treatment was conducted every 14 days (3 treatments total for all treatment groups except for the highest nominal 0.30 lb a.i./A group, which was applied only once). Pre and post-treatment biological samples were collected at a varied intervals until test termination (56 days following the first application). Following application, mean-measured fluvalinate concentrations in the minicosm **water** ranged from 0.13 to 0.31 ppb a.i with half-lives ranging from 9.8 to 47.0 for the formulations, the longest half-life from a microencapsulated formulation. Mean-measured fluvalinate concentrations in the minicosm **sediment** ranged from 1.11 to 3.68 ppb a.i.. With the exception of the microencapsulated formulation, which persisted in the sediment, fluvalinate residues were not detectable in the top 5-cm of the minicosm sediment within 192 hours of the simulated spray drift and runoff regime. **No porewater concentrations were measured**. Neither phytoplankton nor fish were affected by treatment. For both, the NOAEC is 0.31 ppb, the highest concentration measured. Effects on zooplankton (decreased abundance of both life stages of copepods) and benthic macroinvertebrates (decreased abundance of caenidae (Mayflies)) were observed at all formulation application rates. Some of these effects were difficult to interpret because of the confounding effect of seasonal fluctuations in abundance. Therefore, the overall NOAEC is less than 0.13 ppb, the lowest noted concentration. Since formulations B and C were only applied at the 0.15 lb a.i./A rate and the water and sediment *tau*-fluvalinate concentration values were only measured for the 0.15 and 0.30 lb a.i./A rates, a comparison of the toxicities between the formulations could not be done except for at the one 0.15 lb a.i./A rate. At that rate, the NOAEC/LOAEC values for the various formulations did not appear to be significantly different. Therefore, the reported NOAEC/LOAEC values represent all the formulations tested.

3.3.2.5 Degradates

In water, the major degradates of *tau*-fluvalinate seen in environmental studies are:

- 3-Phenoxy-benzaldehyde (3-PB Aldehyde)

- 2-(2-Chloro-4-carboxyl)anilino-3-methylbutanoic acid
- 2-[4-Carboxyl-2-(chloro)anilino]-3-methylbutanoic acid (Diacid)
- 2-[2-Chloro-4-(trifluoromethyl)-anilino]-3-methylbutanoic acid (Anilino acid)
- 2-Chloro-4-trifluoromethylaniline (Haloaniline)
- Cyanohydrin

In the human health risk assessment, the Health Effects Division (HED) stated that "toxicology data for the major metabolite of *tau*-fluvalinate, 3-PBA, indicate that this compound and its conjugates are not of toxicological concern. Specific data are not available for other metabolites; however, the major plant and animal metabolites are also metabolites in the rat, and, therefore, their toxicity was assessed when the parent was studied. In addition, none of the major plant or animal metabolites contains the intact ester linkage responsible for the neurotoxicity of *tau*-fluvalinate."

An online search of ECOTOX provided an acute toxicity study on daphnia with 3-phenoxy-benzaldehyde. The 48-hour EC_{50} for daphnia (immobility) was reported as >50 μg/L, which is greater than the likely EC_{50} range for the parent Therefore, this degradate is likely to be less toxic to freshwater invertebrates than the parent. Acute toxicity studies conducted with the degradate, cyanohydrin on carp, bluegill sunfish, inland silversides, coho and chinook salmon and northern squawfish were also found in the online version of ECOTOX. The 96-hour LC_{50}s were 570 and 500 μg/L, respectively for bluegill sunfish and inland silverside. LC_{50}s at other time points were reported in the low mg/L range. Mortality was observed in other fish species in the mg/L range. These values are well above LC_{50} values for the parent. Algae studies with both 3-phenoxy-benzaldehyde and cyanohydrin were found in the open literature. These are addressed in the aquatic plant section **3.3.3**. **Appendix C** provides more data on the toxicity of the degradates.

3.3.3 Aquatic Plants

No acceptable Guideline toxicity studies are available on the parent with aquatic plants. Studies with the degradates, 3-phenoxy-benzaldehyde and cyanohydrin, on green and blue-green algae were found in the public literature (i.e. ECOTOX). The endpoints examined in the algae studies include general growth, photosynthesis, nitrogen fixation, population biomass and assimilation efficiency. These are summarized in **Appendix C**. For 3-phenoxybenzaldehyde, the most sensitive endpoint relevant to the assessment endpoints establish for aquatic plants is an EC_{50} of 2300 μg/L based on population biomass of *Anabaena variabilis* (blue-green algae; Ref. 15991)). The study was a 12-14 day static study. No studies with endpoints related to growth and perpetuation of individuals and populations of plants were found for any other degradate.

3.3.4 Terrestrial Animals

3.3.4.1 Acute Effects

Birds

Acceptable guideline studies are available to assess acute toxicity to birds. The acute oral and dietary studies conducted with bobwhite quail and/or mallard ducks indicate that *tau*-fluvalinate is practically non-toxic to birds. The acute LD_{50} values from the two bobwhite quail oral studies are both > 2510 mg/kg (MRID Nos. 00085444 and 00104671). Both studies had some mortalities. Sublethal effects consisted mainly of lethargy; however, lower limb weakness was also observed in one study at a higher dose level. The acute LC_{50} values from one bobwhite quail dietary study and both mallard duck dietary studies are all > 5620 mg/kg (MRID Nos. 00094601, 00104672 and 00079965). Sublethal effects consisted mainly of reduced body weight gain and food consumption at higher concentration levels. The acute LC_{50} from a second bobwhite quail dietary study is 5627 mg/kg (MRID 00079964). Mortality and sublethal effects were observed at the same concentration levels. This study was used to calculate an acute dietary risk quotient for birds. A search of the open literature (e.g. ECOTOX) provided no additional data on toxicity to birds following acute exposure to *tau*-fluvalinate.

<u>Mammals</u>

Acceptable guideline studies are available to assess acute toxicity to mammals. These studies are sufficient to estimate risk to mammals following acute exposure to *tau*-fluvalinate. The acute oral studies in rats indicate that *tau*-fluvalinate is slightly toxic to practically non-toxic to mammals. The acute LD_{50} values from the two rat oral studies are 1402 mg/kg (♂) and 3162 - 5000 mg/kg (♀) and > 3000 mg/kg (♂+♀) (MRID Nos. 46521901 and 46521902). The second study had 1 mortality in 5 females at 3000 mg/kg. The LD_{50} from the first study provides the most conservative endpoint for estimation of risk.

An acute oral toxicity study is available for the 25% formulation, Mavrik 2E (MRID 00094119). The LD_{50}s are 1109 (277 a.i.) mg/kg for males and 1052 (263a.i.) mg/kg for females with a combined LD_{50} of 1097 (95% C.I. 726-1656) mg/kg or 274 mg/kg a.i.(95% C.I. 181-414 mg/kg a.i.). Mortality was observed at all dose levels except the lowest, and sublethal effects were observed at all dose levels, down to 25 mg a.i./kg bw. There was no NOAEL for sublethal effects.

The studies identified by ECOTOX are either acute or subacute studies. Four of the 7 studies were conducted using intraperitoneal injection. Intraperitoneal injection is not a normal route of environmental exposure for mammals. The results from these studies cannot be compared with available studies for mammals and thus, are not used. The 3 remaining studies consist of 2 single dose gavage studies and one 21-day gavage study with rats. The 21-day gavage study in rats has a higher endpoint than the chronic rat study and is therefore not discussed. One of the single dose studies reports an acute LD_{50} of 280 - 293 mg/kg (95% C.I. 126-599 mg/kg) or 70 mg/kg a.i. (95% C.I. 31-150 mg/kg), which is lower than the acute LD_{50} value for Mavrik 2E, the 25% formulation summarized above. It is not clear whether or not these are the same formulation. These studies are summarized in **Appendix C**.

<u>Terrestrial-phase Amphibians, Reptiles, Beneficial Insects and Other Terrestrial Invertebrates</u>

Acceptable guideline studies are available to assess acute toxicity to honey bees. The acute LC_{50} is 0.2μg/bee (MRID 41783901). A search of the open literature (e.g. ECOTOX) provides mortality data for *Varroa jacobsoni* (mite in bee hives, refs. 63848-9, 67175, 63656, 58586). The data on *Varroa jacobsoni* indicate that toxicity is likely to be high, in the low μg/vial or ng/cm^2 (petri dish). Other toxicity data are available; however, they were not reported in a way that may be compared to the bee studies. The German cockroach study LD_{50} values are in the 0.05 - 0.21 μg/insect range (refs. 69961, 69972). These are further discussed later in the risk description section. Data on additional species identified in ECOTOX but not sufficiently characterized to use in a qualitative description were not summarized. Population density data are available on *Tetranychus urticae* (two-spotted spider mite), *Ctenarytaina eucalypti* (Blu gum psyllid), *Liriomyza trifilii* (serpentine leafminer) and *NR Lumbricidae* (oligochaete family). Relevant data are summarized in **Appendix C**.

3.3.4.2 Chronic Effects

Birds

Acceptable guideline studies are available to assess chronic toxicity to birds. These studies are sufficient to estimate risk to birds from chronic exposure to *tau*-fluvalinate. Reproduction studies have been conducted with both bobwhite quail and mallard ducks. In both studies, the NOAEC is 900 ppm and the LOAEC is > 900 ppm (MRID Nos.00049824 and 00049825). A search of the open literature (e.g. ECOTOX) provided no additional data on toxicity to birds following chronic exposure to *tau*-fluvalinate.

Mammals

Developmental studies on rats and rabbits as well as a reproduction study on rats are available. No developmental neurotoxicity study is available. From these studies, the NOAEL/LOAEL from the reproduction study, 1.90/9.53 mg/kg/day or 25/125 ppm, provides the most conservative value for estimation of risk (MRID 41783901) . This value is based on skin ulceration in the parental generation and decreases in pup body weight, slightly lower litter size, decreased litter weight and tremors in the offspring. The skin ulceration is due to the parasthesia (skin numbness, tingling and itching), which causes the rats to continuously scratch themselves. A developmental neurotoxicity study has not conducted with tau-fluvalinate. The HED Risk Assessment Review Committee (RARC) met on 02/09/2005 and considered the factors that both support and do not support requiring a developmental neurotoxicity study for tau-fluvalinate. After consideration of toxicological factors as well as the exposure patterns, the RARC agreed that there would not be a sufficient exposure to justify requiring a developmental neurotoxicity study with *tau*-fluvalinate (*Tau*-fluvalinate: Proposed Review and Risk Assessment Strategy Report of the Risk Assessment Review Committee (RARC1), Feb. 9, 2005).

3.3.4.3 Sublethal Effects

Birds

In the acute oral and dietary studies with bobwhite quail and mallard ducks, sublethal effects were observed both at levels where mortality was observed and levels below which mortality was observed. Noted effects at the same levels where mortality was observed include lethargy, lower limb weakness, clinical signs of neurotoxicity and reduction in body weight gain. Lethargy, slightly lower body weight gain and food consumption and reduced reactions to external stimuli were noted at levels below which mortality occurred. The lowest level where lethargy was observed is 398 mg/kg. Reduced reactions to external stimuli was observed in 1 bird at 562 ppm; however, it was not observed in any birds at higher dose levels, so there is a possibility that this is not a biologically significant effect.

No treatment-related sublethal effects were observed in any of the chronic studies.

Mammals

In acute toxicity studies in rats, sublethal effects include the classic neurological pyrethroid type clinical signs, plus additional observations. The following sublethal effects were noted, starting at 500 - 700 mg/kg: hypoactivity and/or and hyperactivity, evidence of salivation, ataxia, rigidity of the limbs, urogenital staining, labored respiration and rales, decreased and soft or mucoid feces, red material around the nose, yellow or red material around the mouth, ocular discharge (clear or red), hypothermia, prostration, scabbing, swollen prepuce and alopecia. Approximately two-thirds of the animals had gastro-intestinal abnormalities. Additional findings included reduced mean body weight, reddened kidneys, liver, lungs and adrenal glands and a hemorrhagic thymus gland.

In the open literature (ECOTOX), one acute oral gavage study on the technical material reports a LOAEL of 25 mg/kg for clinical signs of neurotoxicity.

In chronic studies (developmental and reproduction studies in rats and developmental study in rabbits), there were differences in the types of sublethal effects observed with gavage versus the dietary studies. With the gavage studies, decreased body weight, body weight gain and food consumption were observed along with clinical signs such as signs of urinary incontinence and chromorhinorrhea (red substance coming from the nose). General depression was also observed in does (maternal rabbits), plus a higher incidence of resorptions, concurrent lower fetal viability and evidence of skeletal variations. These effects were seen at levels above the NOAEL from the reproduction study that is used for calculation of risk. In the dietary study, clinical signs in the parents relate to the known parasthesia (tingling of skin) effects of pyrethroids. Since the gavage studies don't show these effects, this is likely due to the test material in the diet getting on the skin. The animals scratch and the result is ulceration and scabbing. There were also clinical signs of neurotoxicity (tremors) observed in the pups in the reproduction study as well as decreased pup weights, slightly smaller litter size with a significant decrease in litter weight when compared to the control group. The chronic RQ for mammals is based on these endpoints.

It is noted here that gavage studies with pyrethroids often induce toxicity at lower dose levels than dietary studies. For example, the endpoint from the reproduction study, which is a dietary study is not protective of the endpoint from a submitted chronic rat study which is a gavage study. In that study (MRID 92069048), abnormal stance, ruffling, and transient hyperactivity followed by hypoactivity were observed following a single gavage dose of 1.0 mg/kg. No effects were observed at 0.5 mg/kg. This study is summarized in **Appendix C** and is referred to in the risk description and endangered species sections.

3.3.4.4 Field Studies

No acceptable terrestrial field studies (Guideline §71-5) are available.

3.3.4.5 Degradates

Submitted acute oral toxicity studies are available for the following degradates:

- cyanohydrin (impurity and degradate)
- chloranilino acid (impurity and degradate)
- formanilide (photodegradation product)
- fluvalamide (soil degradate)
- m-phenoxybenzaldehyde (degradate)
- 3-chloro-4-aminobenzotrifluoride (surface photodegradation product)

For those studies with acute LD_{50}s >500 mg/kg, no treatment-related mortalities, clinical signs or decreases in body weight were observed. Since no effects were observed in these studies and the highest dose tested was 500 mg/kg, the acute toxicity of these degradates cannot be compared with the parent material. Two degradates, cyanohydrin and chloranilino acid had LD_{50}s of 519 mg/kg (males and females) and 424 (males) and 326 mg/kg (females), respectively (MRIDs 00150115 and 00150113). These two degradates may be more toxic than the parent; however, in the study on cyanohydrin, there was a lack of a consistent dose-mortality relationship and there was one questionable death in one of the dose groups. Therefore, although an LD_{50} value could be calculated, meaningful confidence limits could not be estimated. The other degradate, chloranilino acid, although described as a degradate in the submitted acute oral toxicity study in rats, was not found to be a terrestrial degradate. No data were found for mammals in the open literature in a quick online search of ECOTOX. More information is provided in **Appendix C.**

3.3.5 Terrestrial Plants

No acceptable Guideline toxicity studies are available for terrestrial plants. From the open literature (ECOTOX), efficacy studies provide limited information. In a study on the response of the two-spotted spider mite (*Tetranychus urticae*) to various pesticides on strawberries, fluvalinate 2F was found not to have an effect on fruit yield when compared to untreated fruit when applied once a week for 3 weeks at a rate of 0.09 kg a.i./ha (0.00008 lb a.i./acre) (ref. 73705).

In a second field study on the bioefficacy of various insecticides on serpentine leafminer (*Liriomyza trifolii*), infesting pea (*Pisum sativum*), Mavrik 25 EC (0.005%) was applied on leaves at the appearance of the leafminer damage (ref. 75351). Fluvalinate provided an 80% reduction in leaf damage when compared to untreated control 2 weeks after application. A increased green-pod yield was observed when compared to the control group (1.812 kg/ha compared to 1.102 kg/ha, respectively).

4 Risk Characterization

4.1 Risk Estimation - Integration of Exposure and Effects Data

For this screening level risk assessment on *tau*-fluvalinate, a deterministic approach was conducted (i.e., a single point estimate of toxicity was divided by an exposure estimate to calculate a risk quotient (RQ)). The RQ was then compared to Agency Levels of Concern (LOC's - See **Appendix D**) that serve as criteria for categorizing potential risk to non-target organisms. For acute studies on taxa where no effects were observed at any concentration level, the RQ was not calculated. For acute studies on taxa where an LC/LD_{50} was not established due to insufficient mortality but reported some mortality in the study, an RQ was not calculated and the study is discussed further in the Risk Description section.

As stated in the Characterization of Exposure section, the supported uses for *tau*-fluvalinate are apiary uses, building perimeters, nurseries, ornamentals, indoor landscapes and honey, plus special local need uses (24(c)) in California (carrots grown for seed and a proposed use on brassica/cole crops). With the exception of the California Section 24(c) uses, these proposed uses are unlikely to limit the geographic extent of tau-fluvalinate use to a specific area. Therefore, a national risk assessment is being conducted. For the aquatic EEC values to be used for calculation of RQs, three scenarios were modeled for *tau*-fluvalinate. These are carrots in Florida, vegetables in California, and ornamentals in Oregon. The scenarios selected for use in this assessment were chosen to estimate the concentration of tau-fluvalinate in surface drinking water over a geographically dispersed range of areas representative of crops proposed for *tau*-fluvalinate use. The Florida carrot scenario was modeled as a surrogate for carrots in the Section 24(c) request. This carrot scenario was used for characterization purposes only and is intended only to provide context to the California vegetable scenario and to ensure that the California vegetable scenario does not under-represent potential exposure from the *tau*-fluvalinate use on carrots. The California coastal vegetable scenario was modeled for comparison with the Florida scenario and represents a general vegetable scenario in an area where carrots are likely grown in California. The two scenarios together provide a reasonable exposure scenario for this SLN use. *Tau*-fluvalinate may be applied by aerial, ground or chemigation as per the label for this product. The ornamental uses are ground applications. All the other scenarios were modeled with aerial application which results in the highest amount of spray drift. The California coastal vegetable and the Oregon ornamental scenarios were selected to provide the most appropriate EEC values for calculation of the aquatic RQs. Terrestrial EECs (foliar) were estimated from these same scenarios and used for calculation of terrestrial RQs.

4.1.1 Non-target Aquatic Animals and Plants

No data are available for aquatic plants and for effects on marine/estuarine invertebrates following chronic exposure; therefore, no RQs are calculated for plants or for chronic effects on marine/estuarine invertebrates. Only supplemental data are available for acute effects on aquatic animals and chronic effects on freshwater fish and invertebrates. RQs are calculated for these taxa; however, due to the high potential for degradation and the tendency for pyrethroids to adsorb to glass, the reported LC_{50}s/EC_{50}s in the static acute studies conducted with nominal concentrations are likely overestimated. Therefore, the RQ values are likely underestimated. Acute RQs were calculated by dividing the 1-in-10 year peak concentrations by the selected acute LC_{50}/EC_{50} value, chronic RQs for fish were calculated by dividing the one-in-60 day mean concentrations by the chronic fish study NOAEC value and the chronic RQs for freshwater invertebrates were calculated by dividing the one-in-21 day mean concentrations by the chronic freshwater invertebrate study NOAEC value. Estimation of risk to aquatic plants for degradates are discussed in the Risk Description section under degradates. Estimation of the EECs were discussed previously in the exposure characterization section. The default spray drift assumptions were used: 5% for aerial and 1% for ground spray. EECs used for predicting risk quotients for *tau*-fluvalinate are based on the parent. The concentrations of *tau*-fluvalinate in surface water are as follows:

- 1-in-10 year peak concentrations: 0.46 ppb for carrots and 0.25 ppb for ornamentals
- 1-in-21 day mean concentrations: 0.19 ppb for carrots and 0.16 ppb for ornamentals
- 1-in-60 day mean concentrations: 0.09 ppb for carrots and 0.14 ppb for ornamentals

For the SLN registrations on carrots and brassica/cole crops, there is a condition that limits aerial applications to within 150 feet of aquatic water bodies. When the EECs for the California carrot use were estimated using the 150-foot spray drift buffer, they were reduced by approximately 20%:

- 1-in-10 year peak concentrations: 0.37 ppb
- 1-in-21 day mean concentrations: 0.15 ppb
- 1-in-60 day mean concentrations: 0.08 ppb

When the scenarios were remodeled without spray drift (i.e. spray drift fraction set to 0%), the EECs were significantly reduced. As stated in the Exposure Characterization Section, EECs based on 0% spray drift essentially provide an estimate of the amount of exposure resulting exclusively from runoff. The results suggest that implementation of spray drift buffers can be important for reducing aquatic exposure. When 0% spray drift was set, the EECs were as follows:

- 1-in-10 year peak concentrations: 0.01 ppb for carrots and 0.08 ppb for ornamentals

- 1-in-21 day mean concentrations: 0.01 ppb for carrots and 0.03 ppb for ornamentals
- 1-in-60 day mean concentrations: 0.01 ppb for carrots and 0.02 ppb for ornamentals

Fish and Aquatic-Phase Amphibians

Table 4.1 summarizes potential risks to freshwater fish and aquatic-phase amphibians following acute exposure. At the maximum rates to carrots and ornamentals, the acute LOCs for freshwater fish and aquatic-phase amphibians following exposure to *tau*-fluvalinate are exceeded for both the carrot and ornamental scenarios. The higher exceedance is with the carrot use (RQ = 1.3). The acute LC_{50} value used for calculating the risk quotients for freshwater fish was selected from a study in which the concentration of *tau*-fluvalinate in the test solutions was measured. It had a half-life of approximately 24 hours. Therefore, the LC_{50} is probably overestimated and the RQs are likely underestimated. The actual magnitude of the risk is unknown. Acute risk to freshwater fish and aquatic-phase amphibians are discussed further in the risk description section.

Table 4.1 Freshwater Fish Acute Ecotoxicity And RQ Values For *Tau*-Fluvalinate

Species	Ecotoxicity Value (ppb)	Site Location/App. Rate (lbs/acre)/# Applications/yr.	1 in 10 year Peak EEC Value (ppb)	Acute Risk Quotient[1]	Levels Of Concern Exceeded[2]
Carp *Cyprinus carpio*	LC_{50}= 0.35	CA carrots (vegetable as surrogate) 0.15 2	0.46	1.3	Yes
Carp *Cyprinus carpio*	LC_{50}= 0.35	OR ornamental 0.34 12	0.25	0.7	Yes

1. Acute Risk Quotients are calculated using the following formula: EEC/LC_{50}
2. Acute LOC for freshwater fish = 0.05 for endangered species, 0.1 for restricted use and 0.5 for non-listed species

Table 4.2 summarizes potential risks to marine/estuarine fish following acute exposure. At the maximum rates to carrots and ornamentals, the acute LOCs for marine/estuarine fish following exposure to *tau*-fluvalinate are not exceeded for either the carrot or the ornamental scenarios. Although the concentrations of *tau*-fluvalinate were not measured in the study used for estimation of risk, for the same reasons as discussed with freshwater fish, the RQs are likely underestimated and the acute LOCs could be exceeded with studies using measured concentrations. Acute risk to marine/estuarine fish are discussed further in the risk description section.

Table 4.2 Marine/Estuarine Fish Acute Ecotoxicity And RQ Values For *Tau*-Fluvalinate					
Species	**Ecotoxicity Value (ppb)**	**Site Location/App. Rate (lbs/acre)/# Applications/yr.**	**1 in 10 year Peak EEC Value (ppb)**	**Acute Risk Quotient[1]**	**Levels Of Concern Exceeded[2]**
Sheepshead minnow (*Cyprinodon variegatus)*	LC_{50}= 10.8	CA carrots (vegetable as surrogate) 0.15 2	0.46	0.04	No
Sheepshead minnow (*Cyprinodon variegatus)*	LC_{50}= 10.8	OR ornamental 0.34 12	0.25	0.02	No

[1.] Acute Risk Quotients are calculated using the following formula: EEC/LC_{50}
[2.] Acute LOC for marine/estuarine fish = 0.05 for endangered species, 0.1 for restricted use and 0.5 for non-listed species

Tables 4.3 and **4.4** summarize potential risks to fish following chronic exposure. At the maximum application rate to carrots and ornamentals, risks to freshwater and marine/estuarine fish and aquatic-phase amphibians following chronic exposure to *tau*-fluvalinate are exceeded for both the carrot and ornamental scenerios. The highest exceedance is for marine/estuarine fish with the ornamental use (RQ = 3.9) and the lowest exceedance is for freshwater fish with the carrot use (RQ = 1.4). The NOAEC for freshwater fish is based on a supplemental study in which there was significant analytical variability; again, the magnitude of the risk is unknown. Risks to freshwater and marine/estuarine fish following chronic exposure are discussed further in the risk description section.

Table 4.3 Freshwater Fish Chronic Ecotoxicity And RQ Values For *Tau*-Fluvalinate					
Species	**Ecotoxicity Value (ppb)**	**Site Location/App. Rate (lbs/acre)/#**	**60-Day EEC Value (ppb)**	**Chronic Risk Quotient[1]**	**Levels Of Concern Exceeded[2]**
Fathead minnow (*Pimephales promelas*)	NOAEC= 0.064[3]	CA carrots (vegetable as surrogate) 0.15 2	0.09	1.4	Yes
Fathead minnow (*Pimephales promelas*)	NOAEC= 0.064	OR ornamental 0.34 12	0.14	2.2	Yes

[1.] Chronic Risk Quotients are calculated using the following formula: EEC/NOAEC
[2] Chronic LOC for freshwater fish = 1
[3] Reduced growth at LOAEC of 0.152 ppb

Table 4.4 Estuarine/marine Fish Chronic Ecotoxicity And RQ Values For *Tau*-Fluvalinate					
Species	**Ecotoxicity Value (ppb)**	**Site Location/App. Rate (lbs/acre)/# Applications/yr.**	**60-Day EEC Value (ppb)**	**Chronic Risk Quotient[1]**	**Levels Of Concern Exceeded[2]**
Sheepshead minnow (*Cyprinodon variegatus)*	NOAEC= 0.036[3]	CA carrots (vegetable as surrogate) 0.15 2	0.09	2.5	Yes
Sheepshead minnow (*Cyprinodon variegatus)*	NOAEC=0.036	OR ornamental 0.34 12	0.14	3.9	Yes

1. Chronic Risk Quotients are calculated using the following formula: EEC/NOAEC

2 Chronic LOC for estuarine/marine fish = 1

3 Reduced reproductive capacity and growth at LOAEC of 0.070 ppb

Aquatic Invertebrates

Tables 4.5 - 4.7 summarize potential risks to aquatic invertebrates following acute exposure. At the maximum rates to carrots and ornamentals, the acute LOCs for freshwater invertebrates following exposure to *tau*-fluvalinate are exceeded for both the carrot and ornamental scenarios. The higher exceedance is with the carrot use (RQ = 1.5). For marine/estuarine invertebrates, the acute RQs for mysid shrimp are orders of magnitude higher than the acute LOC. The highest acute RQ is 23 for the carrot use. The acute RQs for eastern oysters do not exceed any acute LOCs for either use. The highest RQ is 0.04 for the carrot scenario. However, for similar reasons as with the fish studies, it is likely that the acute RQs for aquatic invertebrates are underestimated. The concentrations of *tau*-fluvalinate were measured in the oyster study and again, were shown to have a half-life of approximately 24 hours. This supports the likelihood that the EC_{50} for oysters is overestimated. Acute risk to aquatic invertebrates is discussed further in the risk description section.

Table 4.5 Freshwater Invertebrate Acute Ecotoxicity And RQ Values For *Tau*-Fluvalinate					
Species	**Ecotoxicity Value (ppb)**	**SiteLocation/ App. Rate (lbs a.i./acre)/ # App./Year**	**1 in 10 year Peak EEC Value (ppb)**	**Acute Risk Quotient[1]**	**Levels Of Concern Exceeded[2]**
red swamp crayfish *(Procambarus clarkii)*	EC_{50}= 0.31	CA carrots (vegetable as surrogate) 0.15 2	0.46	1.5	Yes
red swamp crayfish *(Procambarus clarkii)*	EC_{50}= 0.31	OR ornamental 0.34 12	0.25	0.8	Yes

1. Acute Risk Quotients are calculated using the following formula: EEC/EC_{50}
2. Acute LOC for freshwater invertebrate = 0.05 for endangered species, 0.1 for restricted use and 0.5 for non-listed species

Table 4.6 Marine/Estuarine Invertebrate Acute Ecotoxicity (Mysid) and RQ Values For *Tau*-Fluvalinate					
Species	**Ecotoxicity Value (ppb)**	**SiteLocation/ App. Rate (lbs a.i./acre)/ # App./Year**	**1 in 10 year Peak EEC Value (ppb)**	**Acute Risk Quotient[1]**	**Levels Of Concern Exceeded[2]**
Mysid Shrimp *Mysidopsis bahia*	EC_{50}= 0.02	CA carrots (vegetable as surrogate) 0.15 2	0.46	23	Yes
Mysid Shrimp *Mysidopsis bahia*	EC_{50}= 0.02	OR ornamental 0.34 12	0.25	12.5	Yes

1. Acute Risk Quotients are calculated using the following formula: EEC/EC_{50}
2. Acute LOC for freshwater invertebrate = 0.05 for endangered species, 0.1 for restricted use and 0.5 for non-listed species

Table 4.7 Marine/Estuarine Invertebrate Acute Ecotoxicity (Mollusk) and RQ Values For *Tau*-Fluvalinate					
Species	**Ecotoxicity Value (ppb)**	**SiteLocation/ App. Rate (lbs a.i./acre)/ # App./Year**	**1 in 10 year Peak EEC Value (ppb)**	**Acute Risk Quotient[1]**	**Levels Of Concern Exceeded[2]**
Eastern Oyster *Crassostrea virginica*	EC_{50}= 12	CA carrots (vegetable as surrogate) 0.15 2	0.46	0.04	No
Eastern Oyster *Crassostrea virginica*	EC_{50}= 12	OR ornamental 0.34 12	0.25	0.02	No

1. Acute Risk Quotients are calculated using the following formula: EEC/EC_{50}
2. Acute LOC for freshwater invertebrate = 0.05 for endangered species, 0.1 for restricted use and 0.5 for non-listed species

Table 4.8 summarizes potential risks to freshwater invertebrates following chronic exposure. At the maximum application rate to carrots and ornamentals, the chronic LOCs for freshwater invertebrates are exceeded for both the carrot and ornamental scenarios. The higher exceedance is with the carrot use (RQ = 4.3) and the lower exceedance is with the ornamental use (RQ = 3.6). No chronic RQs for marine/estuarine invertebrates are calculated. No chronic data are available for marine/estuarine invertebrates and uncertainties associated with the exposure concentrations in the acute and chronic freshwater invertebrate studies preclude estimating an acute to chronic ratio from the freshwater data to estimate a chronic NOAEC for marine/estuarine invertebrates.. Further discussion on chronic risks to aquatic invertebrates is provided in the risk description section.

Table 4.8 Freshwater Invertebrate Chronic Ecotoxicity And RQ Values For *Tau*-Fluvalinate					
Species	**Ecotoxicity Value (ppb)**	**Site Location/App. Rate (lbs/acre)/#**	**21-Day EEC Value (ppb)**	**Chronic Risk Quotient[1]**	**Levels Of Concern Exceeded[2]**
Daphnid (*Daphnia magna*)	NOAEC= 0.044	CA carrots (vegetable as surrogate) 0.15 2	0.19	4.3	Yes
Daphnid (*Daphnia magna*)	NOAEC= 0.044	OR ornamental 0.34 12	0.16	3.6	Yes

1. Chronic Risk Quotients are calculated using the following formula: EEC/NOAEC
2. Chronic LOC for freshwater invertebrates = 1

Aquatic Plants

No toxicity data are available for aquatic plants. No RQs are calculated.

4.1.2 Non-target Terrestrial Animals

RQs are based on the most sensitive acute LC_{50} for birds (bobwhite quail acute dietary study), chronic NOAEC for birds (bobwhite quail reproduction study), acute LD_{50} for mammals (rat acute oral study) and chronic NOAEC/NOAEL for mammals (rat reproduction study).

Acute dietary and chronic risk quotients for birds are based on 20-gram birds since they are assumed to consume the highest percentage (115%) of their body weight. Similarly, the chronic risk quotients for mammals (dietary) are based on the 15-gram mammal because they are also assumed to consume the highest percentage of their body weight.

The risk to birds following both acute and chronic exposure to *tau*-fluvalinate on selected food items are summarized in **Table 4.9.** None of the acute or chronic RQs exceed any Levels of Concern (LOCs) for birds for either the California carrot or the Oregon ornamental scenario. Acute oral RQs for birds were not calculated because the acute LD_{50}s (Bobwhite quail) were greater than 2510 mg/kg, the highest dose tested. However, both studies had some mortalities and will be discussed further in the Risk Description Section.

The risk to mammals following acute exposure to *tau*-fluvalinate on selected food items are summarized in **Table 4.10**. The acute RQ for 15 gram mammals eating short grass from the Oregon ornamental scenario is at the LOC for endangered species (0.1). None of the other acute RQs exceed any of the acute LOC's for mammals. **Table 4.10** summarizes acute risk with mean Kenaga residues (50^{th} percentile of residue values). The acute RQ for mammals eating short grass is below in LOC for the Oregon ornamental scenario in this case.

The risk to mammals following chronic exposure to *tau*-fluvalinate on selected food items are summarized in **Tables 4.11** through **4.15**, using both the upper bound and mean Kenaga residues. Using the upper bound Kenaga residues, the chronic RQs calculated from the dietary NOAEC of 25 ppm exceed the chronic LOC for mammals in all food categories except fruits/pods/large insects/seeds for both the California carrot and Oregon ornamental scenarios. The chronic RQs calculated from the dose-based NOAEL of 1.9 mg/kg/day exceed the chronic LOC for mammals in all food categories except for fruits/pods/large insects and seeds for the California carrot scenario, and in all food categories except for seeds with the 35 and 1000 gram mammals for the Oregon ornamental scenario.

Using the mean Kenaga residues, the dietary RQs exceed the chronic LOC for mammals in all food categories except fruits/pods/large insects/seeds for the Oregon ornamental scenario and does not exceed the chronic LOC for mammals in any food category for the California carrot scenario. The chronic dose-based RQs exceed the chronic LOC for mammals for short grass, tall grass and broadleaf plants/small insects for all mammal groups in both the carrot and ornamental scenarios. For fruits/pods/large insects, the chronic LOC for 15 and 35 g mammals is exceeded in the ornamental scenario. All remaining groups do not exceed the chronic LOC for mammals.

Table 4.9. Avian Acute and Chronic Risk Quotients for Carrot and Ornamental Uses of *Tau*-Fluvalinate Based on a Bobwhite Quail Acute LC_{50} 5627 ppm and Chronic NOAEC 900 ppm (Bobwhite Quail and Mallard Duck)						
Use/App. Method	**Application Rate lbs. ai/A App. interval (d) No. appl/year**	**Food Items**	**Upper Bound EEC (mg/kg)[a]**	**Acute RQ (EEC/ LC_{50})**	**Acute RQ (EEC/ LD_{50})[b]**	**Chronic RQ (EEC/ NOAEC)**
CA carrots (vegetable as surrogate)/ Foliar	0.15 5 2	Short grass	68.61	0.01	NA	0.08
		Tall grass	31.44	0.01	NA	0.03
		Broadleaf plants/small insects	38.59	0.01	NA	0.04
		Fruits, pods, seeds, and large insects	4.29	<0.01	NA	<0.01
OR Ornamentals/ Foliar	0.34 14 12	Short grass	325.90	0.06	NA	0.36
		Tall grass	148.91	0.03	NA	0.17
		Broadleaf plants/small insects	182.75	0.03	NA	0.20
		Fruits, pods, seeds, and large insects	20.31	<0.01	NA	0.02

[a] Estimated environmental concentrations predicted using 1st-order degradation model based on foliar dissipation.
[b] RQ not calculated because acute LD_{50} for birds (bobwhite quail) is > 2510 mg/kg. Potential risk discussed in risk description section.

Table 4.10 Mammalian Acute Risk Quotients for Carrot and Ornamental Uses of *Tau*-Fluvalinate Based on a Rat Acute LD_{50} 1402 mg/kg bw/day Using Upper Bound Kenaga Residues							
Use/App. Method	**App. Rate lbs. ai/A App. interval (d) # App./year**	**Body Weight, g**	**Mammalian Acute Risk Quotient**				
			Short Grass	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/pods/ large insects**	**Seeds**
CA carrots (vegetable as surrogate)/ Foliar	0.15 5 2	15	0.02	0.01	0.01	<0.01	<0.01
		35	0.02	0.01	0.01	<0.01	<0.01
		1000	0.01	<0.01	0.01	<0.01	<0.01
OR Ornamentals/ Foliar	0.34 14 12	15	**0.10**[a]	0.05	0.06	0.01	<0.01
		35	0.09	0.04	0.05	0.01	<0.01
		1000	0.05	0.02	0.03	<0.01	<0.01

[a] Values in **Bold** exceed acute risk level of concern (RQ $\geq$0.1)
[b] The mammalian equivalent doses are calculated using the following equation: Equivalent dose = application rate * Kenega residue * %BW consumed. Kenega residues in mg/kg for 1 lb ai/A are 240 for short grass, 110 for tall grass, 135 for broadleaf plants and insects, and 15 for seeds. Assumed percent body weights consumed for mammals are:

Mammalian Class	**% BW Consumed**		
	15 g	**35 g**	**1000 g**
Herbivores and Insectivores	95	66	15
Granivores	21	12	3

Table 4.11 Mammalian Acute Risk Quotients for Carrot and Ornamental Uses of *Tau*-Fluvalinate Based on a Rat Acute LD_{50} 1402 mg/kg bw/day Using Mean Kenaga Residues

Use/App. Method	App. Rate lbs. ai/A App. interval (d) # App./year	Body Weight, g	Mammalian Acute Risk Quotient				
			Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruits/pods/ large insects	Seeds
CA carrots (vegetable as surrogate)/ Foliar	0.15 5 2	15	0.01	<0.01	<0.01	<0.01	<0.01
		35	0.01	<0.01	<0.01	<0.01	<0.01
		1000	<0.01	<0.01	<0.01	<0.01	<0.01
OR Ornamentals/ Foliar	0.34 14 12	15	0.04	0.02	0.02	<0.01	<0.01
		35	0.03	0.01	0.02	<0.01	<0.01
		1000	0.02	0.01	0.01	<0.01	<0.01

[a] The mammalian equivalent doses are calculated using the following equation: Equivalent dose = application rate * Kenega residue * %BW consumed. Kenega residues in mg/kg for 1 lb ai/A are 240 for short grass, 110 for tall grass, 135 for broadleaf plants and insects, and 15 for seeds.

Table 4.12 Chronic RQ values for mammals feeding on short grass, tall grass, broadleaf plants/insects, and seeds exposed to *Tau*-fluvalinate based on a Rat Reproduction NOAEC of 25 ppm Using Upper Bound Kenaga Residues					
Use/App. Method	**App. Rate lbs. ai/A App. interval (d) # App./year**	**Mammalian Chronic Risk Quotient**			
		Short Grass	**Tall Grass**	**Broadleaf Plants/Insects**	**Fruits/pods/large insects/seeds**
CA carrots (vegetable as surrogate)/ Foliar	0.15 5 2	**2.74**[a]	**1.26**	**1.54**	0.17
OR Ornamentals/ Foliar	0.34 14 12	**13.00**[a]	**5.96**	**7.31**	0.81

[a] Values in **Bold** exceed chronic risk level of concern (RQ ≥ 1.0)

Table 4.13 Chronic RQ values for mammals feeding on short grass, tall grass, broadleaf plants/insects, and seeds exposed to *Tau*-fluvalinate based on a Rat Reproduction NOAEC of 25 ppm Using Mean Kenaga Residues					
Use/App. Method	**App. Rate lbs. ai/A App. interval (d) # App./year**	**Mammalian Chronic Risk Quotient**			
		Short Grass	**Tall Grass**	**Broadleaf Plants/Insects**	**Fruits/pods/large insects/seeds**
CA carrots (vegetable as surrogate)/ Foliar	0.15 5 2	0.97	0.41	0.51	0.08
OR Ornamentals/ Foliar	0.34 14 12	**4.60**[a]	**1.95**	**2.44**	0.38

[a] Values in **Bold** exceed chronic risk level of concern (RQ ≥ 1.0)

Table 4.14 Chronic RQ values for mammals feeding on short grass, tall grass, broadleaf plants/insects, and seeds exposed to *Tau*-fluvalinate based on Rat Reproduction NOAEL of 1.9 mg/kg bw/day Using Upper Bound Kenaga Residues

Use/App. Method	App. Rate lbs. ai/A App. interval (d) # App./year	Body Weight, g	Mammalian Chronic Risk Quotient[a]				
			Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruits/pods/ large insects	Seeds
CA carrots (vegetable as surrogate)/ Foliar	0.15 5 2	15	**15.66[a]**	**7.18**	**8.81**	0.98	0.22
		35	**13.38**	**6.13**	**7.53**	0.84	0.19
		1000	**7.17**	**3.29**	**4.03**	0.45	0.10
OR Ornamentals/ Foliar	0.34 14 12	15	**74.18[a]**	**34.00**	**41.73**	**4.64**	**1.03**
		35	**63.36**	**29.04**	**35.64**	**3.96**	0.88
		1000	**33.97**	**15.57**	**19.11**	**2.12**	0.47

[a] Values in **Bold** exceed chronic risk level of concern (RQ ≥ 1.0)

Table 4.15 Chronic RQ values for mammals feeding on short grass, tall grass, broadleaf plants/insects, and seeds exposed to *Tau*-fluvalinate based on Rat Reproduction NOAEL of 1.9 mg/kg bw/day Using Mean Kenaga Residues							
Use/App. Method	**App. Rate lbs. ai/A App. interval (d) # App./year**	**Body Weight, g**	**Mammalian Chronic Risk Quotient[a]**				
			Short Grass	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/pods/ large insects**	**Seeds**
CA carrots (vegetable as surrogate)/ Foliar	0.15 5 2	15	**5.53[a]**	**2.34**	**2.93**	0.46	0.10
		35	**4.75**	**2.01**	**2.51**	0.39	0.09
		1000	**2.49**	**1.06**	**1.32**	0.21	0.04
OR Ornamentals/ Foliar	0.34 14 12	15	**26.18[a]**	**11.09**	**13.86**	**2.16**	0.48
		35	**22.48**	**9.52**	**11.90**	**1.85**	0.42
		1000	**11.81**	**5.00**	**6.25**	0.97	0.19

[a] Values in **Bold** exceed chronic risk level of concern (RQ ≥ 1.0)

4.1.3 Non-target Terrestrial and Semi-aquatic Plants

No acceptable plant data are available for assessment of risk to terrestrial plants.

4.2 Risk Description

The results of this screening-level risk assessment suggest the potential for direct adverse effects to non-target fish, aquatic invertebrates and small mammals following both acute and chronic exposure to *tau*-fluvalinate through the uses with carrots (0.15 lbs/acre) and ornamentals (0.34 lbs/acre). There are no acceptable data on the technical material for effects to fish and aquatic invertebrates following acute exposure and freshwater fish and aquatic invertebrates following chronic exposure; however, lack of acceptable data do not preclude the concern for potential risk to these organisms. Risk quotients calculated from the submitted supplemental data and open literature data (ECOTOX) on *tau*-fluvalinate, supported by data from other pyrethroids, it is highly likely that there will be risk to these organisms. Although quantitative risk estimates are not conducted with terrestrial invertebrates, submitted studies with honey bees and studies located in the open literature with other terrestrial invertebrates indicate significant toxicity to these taxa. No acceptable toxicity data are available on the parent for either aquatic or terrestrial plants. Assessment of risk could not be conducted for plants, although efficacy information in the open literature indicate that *tau*-fluvalinate may not be significantly toxic to terrestrial plants. Studies on nonvascular aquatic plants were found in the open literature on two degradates of *tau*-fluvalinate. These studies indicate probable low risk to nonvascular aquatic plants following exposure to several degradates. Due to the potential risk to non-target fish, aquatic and terrestrial invertebrates and mammals following either acute or chronic exposure, there are concerns for food chain effects in both terrestrial and aquatic ecosystems.

4.2.1 Risks to Aquatic Organisms

4.2.1.1 Animals

Fish and Aquatic Phase Amphibians

Risks Following Acute Exposure

For freshwater fish, the acute RQs exceed the acute LOCs for both the carrot and ornamental scenarios. For marine/estuarine fish, the acute RQs do not exceed the acute LOCs for either scenario; however, as mentioned previously, the RQs are likely to be higher than those calculated. The acute RQs for marine/estuarine fish, especially for the use on carrots, are close to the acute LOC for endangered fish (0.02 and 0.04 versus an acute LOC of 0.05). It is likely that LC_{50}'s from flow-through studies with measured concentrations would provide RQs for marine/estuarine fish that would exceed the acute LOCs, particularly for endangered species. Data from other pyrethroids support the currently available data for *tau*-fluvalinate, indicating that it is not likely that acute LC_{50}s generated from flow-through studies with measured concentrations would be higher than those reported in the static studies conducted with nominal concentrations.

The lowest concentrations where sublethal effects were observed in freshwater fish (carp: dazed/flaccid, slight cramps, hyperexcitability, dark colored, dorsal fin slack, nystagmus) are as follows: 4.5-5.1 μg/L at the start of the study, which had degraded to 0.2-0.5 μg/L by the end of the study. These effects were observed throughout the study. The 1 in 10 year peak EEC values for carrots and ornamentals are estimated to be 0.46 and 0.25 ppb, respectively. Therefore, under both these scenarios, sublethal effects are possible for freshwater fish. These effects place the animals at risk for survival (predation).

In marine/estuarine fish, the lowest concentrations where sublethal effects were observed (sheepshead minnows: pectoral fins anteriorly extended and rapid respiration) is 1.7 μg/L. It is possible that sublethal effects will not be observed at peak concentrations for marine/estuarine fish; however, as noted, there are significant uncertainties associated with test concentrations in this study.

Application of the 150-foot buffer required for the carrot scenario decreases the 1 in 10 year peak EEC value from 0.46 ppb to only 0.37 ppb. This value would have very little impact on the risk assessment following acute exposure for aquatic organisms. If there were no spray-drift, the 1-in-10 year peak concentrations would be reduced to 0.01 ppb for carrots and 0.08 ppb for ornamentals. These values indicate that either ground application (for carrots) or a larger buffer could potentially make a significant difference in the environmental exposure and subsequent risk.

Risks Following Chronic Exposure

The chronic LOC for both freshwater and marine/estuarine fish is exceeded for both the carrot and ornamental scenarios. The chronic RQs for fish range from 1.4 to 3.9 with the carrot scenario providing the lower RQs. For freshwater fish (fathead minnows), treatment-related decreases in length and weight were observed at the LOAEC of 0.152 μg a.i./L with a NOAEC of 0.064 μg a.i./L. Decreased survival of fry was noted at a higher concentration level (0.48 μg a.i./L). There is significant uncertainty with this study due to analytical variability. In addition, the statistical analysis cannot be verified. The RQs could be higher or lower; however, the results are supported by the chronic study conducted with estuarine/marine fish.

For marine/estuarine fish, treatment-related decreases in the number of eggs produced/female/reproductive day, percent spawning frequency and length of posthatch fish were observed in sheepshead minnows at the LOAEC of 0.070 μg a.i./L and a NOAEC of 0.036 μg a.i./L. The most significant effect observed at 0.070 μg a.i./L was reduced length of posthatch fish at day 28. At the highest concentration level (0.14 μg a.i./L), lethargy in fish and larvae were also observed. This study is an acceptable study and provides more certainty to the estimation of risk.

Application of the 150-foot buffer required for the carrot scenario decreases the 60-day average

EEC value from 0.09 to 0.08 ppb. This value would have very little impact on the risk to aquatic organisms following chronic exposure. If there were no spray-drift, the 60-day average EEC values would be reduced from 0.09 ppb for carrots and 0.14 ppb for ornamentals to 0.01 ppb for carrots and 0.02 ppb for ornamentals. These values indicate that either ground application (for carrots) or a larger buffer could potentially make a significant difference in the environmental exposure and subsequent risk.

Aquatic Invertebrates

Risks Following Acute Exposure

Acute LOCs are exceeded for both freshwater invertebrates and marine/estuarine invertebrates (mysid shrimp). The acute LOCs are not exceeded for estuarine/marine mollusks; however, as discussed previously, the measured concentrations in this study show that the concentrations of *tau*-fluvalinate rapidly dissipate in the test chambers, thus indicating that the acute EC_{50} for the study is likely overestimated leading to an underestimation of RQs. Data from other pyrethroids support the reported data for *tau*-fluvalinate, indicating that it is not likely that the acute LC_{50}s generated from flow-through studies with measured concentrations would be higher than those currently available. The endpoint selected for estimating the RQs for freshwater invertebrates was obtained from the open literature (ECOTOX). The endpoint from this study conducted with crayfish is very close to the lowest EC_{50} endpoint observed with the submitted daphnia studies (0.31 μg/L for the crayfish versus 0.4 μg/L for daphnia). The endpoints for aquatic invertebrates in general reflect the diverse species in these taxonomic groups. For freshwater invertebrates, the acute EC_{50}'s are 0.4 - 74 μg/L (48 hour) for daphnia, 0.31 μg/L for crayfish (96-hour) and 57.8 μg/L (24-hour) for mosquito larvae. For the 5 other pyrethroids, the EC_{50} range for freshwater invertebrates is 0.0053 - 210 μg/L with the daphnia EC_{50}s range from 0.039 - 7.2 μg/L with one high value at 89 μg/L. For marine/estuarine invertebrates, the acute EC_{50}'s for *tau*-fluvalinate are 12 μg a.i./L for eastern oysters and 0.018 μg a.i./L for mysid shrimp. For the 5 other pyrethroids, the EC_{50} range is as low as 0.002 μg a.i./L for mysid shrimp to 2270 μg a.i./L for oysters. These data indicate significant toxicity to aquatic invertebrates; however, the magnitude of the toxicity varies widely between species. Thus, the magnitude of the risk will vary widely as well.

Sublethal effects in freshwater invertebrates following acute exposure include a decrease in size, lethargy and swimming erratically. The lowest concentration where sublethal effects (swimming erratically and lethargy in daphnia) were observed is 0.06 μg/L. Decrease in size was observed at 0.24 μg/L. The 1 in 10 year peak EEC values for carrots and ornamentals are estimated to be 0.46 and 0.25 ppb, respectively. Therefore, under both these scenarios, sublethal effects (decreases in size, swimming erratically and lethargy) are likely for freshwater invertebrates. These effects place the animals at risk for reproductive capacity (decrease in size may affect attracting a mate, fertility and other factors) and survival (predation). In addition, the decrease in size may affect the food chain because the predators will have to eat more individuals in order to meet their nutritional requirements.

Lethargy was observed at nominal concentrations of 0.018 μg/L and above in mysid shrimp following acute exposure. These effects are seen at concentrations well below the estimated 1 in 10 year peak EECs for both the carrot and ornamental scenarios and are highly likely. Lethargy will place the animals at risk for predation.

Application of the 150-foot buffer required for the carrot scenario would have very little impact on the risk assessment following acute exposure for aquatic organisms. Again, these values indicate that either ground application (for carrots) or a larger buffer could potentially make a significant difference in the environmental exposure and subsequent risk.

Risks Following Chronic Exposure

At the maximum application rate to carrots and ornamentals, the chronic LOC for freshwater invertebrates following chronic exposure to *tau*-fluvalinate is exceeded for both the carrot and ornamental scenarios. The chronic RQs are 4.3 for the carrot use and 3.6 for the ornamental use.

In the chronic daphnia study, the NOAEC is 0.044 μg a.i./L and the LOAEC is 0.089 μg a.i./L based on treatment-related decreases in daphnid length and mean number of offspring/adult/reproductive day. Survival was significantly decreased at 0.19 μg a.i./L. From a statistical standpoint, daphnid length is the most significant effect and the NOAEC is not considered to be conservative.

Application of the 150-foot buffer would have very little impact on the risk to aquatic organisms following chronic exposure; however, for reasons described previously, a larger buffer combined with ground application would significantly reduce environmental exposure.

Benthic organisms

As stated in the Exposure Characterization section, pyrethroid insecticides are lipophilic compounds that can adsorb readily to particulate and sediment, thus increasing toxic exposure in the benthos. As a member of the pyrethroid class, *tau*-fluvalinate is expected to persist in anaerobic environments. Thus, sediment bound *tau*-fluvalinate could present a toxicity risk for benthic aquatic life and aquatic ecosystems in general. Exposure to this sediment can result in a direct impact to aquatic life through respiration, ingestion, dermal contact, as well as indirect impact through alterations of the food chain. Using the PRZM/ EXAMS model, EECs for benthic pore water have been estimated to be 0.019 and 0.039 µg/L for peak daily concentrations and 0.019 and 0.038 µg/L for the 21-day EEC values. No acceptable toxicity studies are available for benthic organisms. Using the aquatic invertebrate studies as surrogates for benthic organisms, **Table 4.16** provides a range of acute RQs for benthic organisms.

Table 4.16 RQ Values For Benthic Organisms Using Surrogate Freshwater and Marine/Estuarine Values for *Tau*-Fluvalinate					
Species	**Ecotoxicity Value (ppb)**	**Site Location/ App. Rate (lbs a.i./acre)/ # App./Year**	**1 in 10 year Peak EEC Value (ppb)**	**Acute Risk Quotient[1]**	**Levels Of Concern Exceeded[2]**
red swamp crayfish *(Procambarus clarkii)*	EC_{50}= 0.31	CA carrots (vegetable as surrogate) 0.15 2	0.019	0.06	Yes
red swamp crayfish *(Procambarus clarkii)*	EC_{50}= 0.31	OR ornamental 0.34 12	0.039	0.12	Yes
Eastern Oyster *Crassostrea virginica*	EC_{50}= 12	CA carrots (vegetable as surrogate) 0.15 2	0.019	0.002	No
Eastern Oyster *Crassostrea virginica*	EC_{50}= 12	OR ornamental 0.34 12	0.039	0.003	No
Mysid Shrimp *Mysidopsis bahia*	EC_{50}= 0.02	CA carrots (vegetable as surrogate) 0.15 2	0.019	0.95	Yes
Mysid Shrimp *Mysidopsis bahia*	EC_{50}= 0.02	OR ornamental 0.34 12	0.039	1.95	Yes

1. Acute Risk Quotients are calculated using the following formula: EEC/EC_{50}
2. Acute LOC for freshwater invertebrate = 0.05 for endangered species, 0.1 for restricted use and 0.5 for non-listed species

The acute RQs exceed the acute LOCs using both the crayfish and mysid shrimp EC_{50} values but do not exceed the acute LOCs using the oyster values. These studies indicate that there is significant uncertainty associated with the acute risk to benthic organisms, and therefore, risk to benthic organisms at the labeled application rates for *tau*-fluvalinate cannot be precluded.

For chronic risk to benthic organisms, the estimated 21-day EEC pore water values of 0.019 and 0.038 µg/L (carrots and ornamentals, respectively) are used to estimate the chronic RQs. Using the NOAEC value of 0.044 μg/L from the chronic daphnia study as a surrogate, the chronic RQs (0.43 and 0.86 for carrots and ornamentals, respectively) do not exceed the chronic LOC of 1. As noted previously, there are considerable uncertainties associated with these estimations due to uncertain exposure concentrations in the chronic daphnia study and that daphnia is not a benthic organism.

Minicosm Study

The minicosm study is difficult to compare to the laboratory results because residues were measured from only one application rate, there were effects at that application rate and the half-life of fluvalinate was short. Residues of fluvalinate in the water were only tested for one selected rate, 0.15 lb a.i./A for each formulation. Mean-measured fluvalinate concentrations in the pond water ranged from 0.13 to 0.31 ppb and the half-life of the parent in the water column ranged from 9.8 to 47 hours with the microencapsulated formulation having longer half-lives. No pore water concentrations were measured and the organic carbon content of the water column was not measured Mean-measured fluvalinate concentrations in the sediment ranged from 1.11 to 3.68 ppb. With the exception of the formulation that used microencapsulated test material, residues were not detectable in the sediment within 192 hours. The microencapsulated material generally stayed in the sediment. Effects on phytoplankton, zooplankton, benthic macroinvertebrates and fish were recorded. Neither phytoplankton nor fish were affected by treatment. For both, the NOAEC is 0.31 ppb, the highest concentration measured. Effects on zooplankton (decreased abundance of both life stages of copepods) and benthic macroinvertebrates (decreased abundance of caenidae (Mayflies)) were observed at all formulation application rates. Some of these effects were difficult to interpret because of the confounding effect of seasonal fluctuations in abundance. The reported NOAEC for all formulations tested is less than 0.13 ppb. Interpretation of the study is confounded by the fact that tracking is at the family level and not at the species level; thus, it cannot be determined whether or not a single species was decimated. This is especially important with species with a long reproductive cycle. Recovery of individual species cannot be specifically tracked. In this study, Mayfly nymphs disappear and then reappear. It is uncertain as to what is happening here but may be due to sampling error. There is high variability in the control groups and there is poor power to the study. However, the study does not refute any of the findings in the risk assessment.

Using the data from the study, in comparison to the 1 in 10 year peak EECs for the carrot (0.46 ppb) and ornamental uses (0.25 ppb), it appears that acute risk to zooplankton is likely for both uses. The acute EC_{50}s for mayflies and other aquatic invertebrates for other pyrethroids are in a low range ppb level as is the acute NOAEC for zooplankton (< 0.13 ppb). The estimated peak daily EECs for benthic pore water (0.019 ppb for the carrot use and 0.039 ppb for the ornamental use) and the 21-day EEC values (0.019 ppb and 0.038 ppb for carrots and ornamentals, respectively) are both 10 times less than the LOAEC for benthic macroinvertebrates in the minicosm study (0.13 ppb). The lack of a NOAEC for these taxa in the minicosm study is an uncertainty and does not mitigate concern for benthic organisms. The minicosm study, although limited due to quick degradation, is supportive of predicted values for benthic organisms and other aquatic invertebrates. For fish and phytoplankton, the NOAEC is 0.31 ppb. Without a LOAEC and without measurements of the organic carbon content of the water column, a comparison of these results with the laboratory studies is very limited. As a comparison, the NOAEC for mortality in one of the bluegill sunfish studies is 0.33 ppb and the NOAEC for behavioral signs of toxicity in a 14-day study flowthrough study in bluegill sunfish is 0.26 ppb.

4.2.1.2 Plants

No studies are available on aquatic plants with the parent. In addition, as a reference point, no data on aquatic plants were found with the 5 other pyrethroids with which comparisons were made for aquatic organisms. Data are available on degradates with aquatic plants. For 3-phenoxybenzaldehyde, the EC_{50} is 2300 μg/L based on population biomass of *Anabaena variabilis* (blue-green algae; Ref. 15991)). This value is significantly higher than the predicted EEC values for the parent and is unlikely to pose a significant risk.

4.2.2 Risks to Terrestrial Organisms

4.2.2.1 Animals

<u>Birds</u>

Based on the results of the screening assessment, acute and chronic risks to birds are unlikely. None of the acute or chronic RQs exceed any Levels of Concern (LOCs) for birds. It is noted, however, that although the acute oral LD_{50}s (Bobwhite quail) are greater than 2510 mg/kg, (highest dose tested) and the RQs were not calculated, both studies had some mortalities. The lowest dose at which mortality was observed is 631 mg/kg bw. In order to evaluate potential lethal effects associated with acute exposure to *tau*-fluvalinate on a dose-related basis, the lowest *tau*-fluvalinate dose where mortality was observed is compared to predicted avian doses on food residues following application of *tau*-fluvalinate at 0.15 and 0.34 lb ai/A. **Table 4.17** summarizes the predicted avian doses on food residues following application of *tau*-fluvalinate at 0.15 and 0.34 lb a.i./acre.

Table 4.17. Avian doses (mg/kg-bw) following two foliar applications of *tau*-fluvalinate at 0.15 and 0.34 lb ai/A

EEC Equivalent Dose[a] (mg *tau*-fluvalinate/ kg bw/day)	Avian Classes and Body Weights Application rates = 0.15 lb ai/A // 0.34 lb ai/A		
	Small (20 g)	Medium (100 g)	Large (1000 g)
Short grass	78 // 370	45 // 211	20 // 94
Tall grass	36 // 170	20 // 97	9 // 43
Broadleaf plants/small insects	44 // 208	25 // 119	11 // 53
Fruits/pods/large insects	5 // 23	3 // 13	1 // 6

[a] EEC equivalent dose = Upper bound Kenega value * (%BW consumed/100). %BW consumed = 114%, 65%, and 29% for small, medium, and large birds, respectively.

The predicted avian doses of *tau*-fluvalinate on food residues following 2 applications at 0.15 and 0.34 lb ai/A are below 631 mg *tau*-fluvalinate/kg bw, the lowest dose where mortality was observed. The highest predicted dose is 370 mg/kg bw (small birds eating short grass) for the ornamental use and the NOAEL/LOAEL for mortality is 398/631 mg/kg bw. Therefore, there would be a concern for potential lethality to small birds only if new uses result in two times the predicted exposure concentrations in short grass.

In addition to lethal effects, sublethal effects were observed in both mallard ducks and bobwhite quail at levels below the acute LD/LC_{50}s and at levels below which mortality was observed. Lethargy and slightly lower body weight gain and food consumption were noted, with lethargy as the most sensitive endpoint. The lowest level where lethargy was observed is 398 mg/kg bw, the lowest dose tested in that particular study. With the highest predicted dose at 370 mg/kg bw, lethargy may occur with small birds eating short grass. Therefore, there is a concern for this taxonomic group for sublethal effects, particularly as it relates to ability to escape from predators.

Mammals

The screening level risk assessment indicates that there are risks to mammals, particularly following chronic exposure to *tau*-fluvalinate. Risk following acute exposure occurs with the ornamental use for small mammals eating short grass. When the Kenaga residue values are at the 90% percentile, the RQ equal to the acute LOC for endangered species. The RQ for medium sized mammals eating short grass is just below the acute LOC (0.09). Therefore, any new uses with higher application rates may increase that risk to above the LOC. When the acute RQ values are calculated using mean Kenaga values, the acute RQs are less than the LOC for 15 gram mammals eating short grass from the Oregon ornamental scenario is below the acute LOC for mammals.

The acute LD_{50} for rats with the Mavrik 2E 25% formulation is 274 mg a.i./kg bw. This is a lower value than for the technical material. Mavrik 2E is not currently used and there do not appear to be separate acute mammalian toxicity studies for Mavrik Aquaflow. If the acute toxicity to Mavrik Aquaflow is equivalent to the acute toxicity of Mavrik 2E, then the acute RQs can be estimated for the product for day 0 of exposure. Using T-REX 1.2 and assuming a single application, the day 0 exposure value is calculated for mammals and an acute RQ is estimated for this formulated product. The acute RQs using the formulated product are similar to the parent except for the ornamental scenario, where the acute RQ for 35 g mammals exceeds the acute LOC for mammals eating short grass. When using the mean Kenaga residues, as with the technical material, these RQs all drop below the acute LOC for mammals. **Tables 4.18 and 4.19** summarize the calculated RQs for the formulated product.

Table 4.18 Mammalian Acute Risk Quotients for Carrot and Ornamental Uses of *Tau*-Fluvalinate Based on a Rat Acute LD_{50} 274 mg a.i./kg bw Using Upper Bound Kenaga Residues With the Mavrik 2E Formulation

Use/App. Method	App. Rate lbs. ai/A App. interval (d) # App./year	Body Weight, g	Mammalian Acute Risk Quotient				
			Short Grass	Tall Grass	Broadleaf Plants/Small Insects	Fruits/pods/ large insects	Seeds
CA carrots (vegetable as surrogate)/ Foliar	0.15 1	15	0.06	0.03	0.03	<0.01	<0.01
		35	0.05	0.02	0.03	<0.01	<0.01
		1000	0.03	0.01	0.01	<0.01	<0.01
OR Ornamentals/ Foliar	0.34 1	15	**0.13**[a]	0.06	0.07	0.01	<0.01
		35	**0.11**	0.05	0.06	0.01	<0.01
		1000	0.06	0.03	0.03	<0.01	<0.01

[a] Values in **Bold** exceed acute risk level of concern (RQ $\geq$ 0.1)

Table 4.19 Mammalian Acute Risk Quotients for Carrot and Ornamental Uses of *Tau*-Fluvalinate Based on a Rat Acute LD_{50} 274 mg a.i./kg bw Using Mean Kenaga Residues With the Mavrik 2E Formulation							
Use/App. Method	**App. Rate lbs. ai/A App. interval (d) # App./year**	**Body Weight, g**	**Mammalian Acute Risk Quotient**				
			Short Grass	**Tall Grass**	**Broadleaf Plants/Small Insects**	**Fruits/pods/ large insects**	**Seeds**
CA carrots (vegetable as surrogate)/ Foliar	0.15 1	15	0.02	0.01	0.01	<0.01	<0.01
		35	0.02	0.01	0.01	<0.01	<0.01
		1000	0.01	<0.01	<0.01	<0.01	<0.01
OR Ornamentals/ Foliar	0.34 1	15	0.05	0.02	0.02	<0.01	<0.01
		35	0.04	0.02	0.02	<0.01	<0.01
		1000	0.02	0.01	0.01	<0.01	<0.01

[a] The mammalian equivalent doses are calculated using the following equation: Equivalent dose = application rate * Kenega residue * %BW consumed. Kenega residues in mg/kg for 1 lb ai/A are 240 for short grass, 110 for tall grass, 135 for broadleaf plants and insects, and 15 for seeds.

Mammalian sublethal effects following acute exposure start at gavage dose levels from 500 to 700 mg *tau*-fluvalinate/kg bw. These effects include clinical signs of neurotoxicity, staining and discharge around bodily orifices, labored respiration and rales, gastro-intestinal abnormalities with related clinical signs and effects from scratching due to parasthesia. Reduced body weight and microscopic findings in the kidneys, liver, lungs, adrenal glands and thymus were also observed. Since sublethal effects were observed at the lowest doses tested in these gavage studies, other submitted mammalian studies were examined in order to find a NOAEL for observed sublethal effects following an acute exposure. The lowest NOAEL/LOAEL from a mammalian study following an acute exposure was found with the gavage chronic rat study. In that study, the LOAEL is 1.0 mg/kg based on abnormal stance, ruffling, and transient hyperactivity followed by hypoactivity. The NOAEL is 0.5 mg/kg (MRID 92069048). **Table 4.20** summarizes the predicted mammalian doses on food residues following application of *tau*-fluvalinate at 0.15 and 0.34 lb a.i./acre. The highest predicted dose for mammals is 310 mg/kg bw/day (small mammals eating short grass) for the ornamental use. Although the chronic rat study is a gavage study, which would likely accentuate effects, the difference between a 310 mg/kg bw/day exposure and 1 mg/kg bw/day exposure is three hundred fold. With other pyrethroids, the differences in NOAEC/LOAECs and NOAEL/LOAELs from comparable studies with gavage versus dietary exposure as the only difference between them and clinical signs of neurotoxicity as the primary effect are not as vast as three hundred fold. With some pyrethroids, the NOAEC/LOAEC and NOAEL/LOAEL in the mammalian studies are very close when levels at which clinical signs of neurotoxicity are compared. Therefore, it is likely that there will be sublethal effects to mammals at the estimated environmental concentrations predicted for the current uses.

Table 4.20 Mammalian doses (mg/kg-bw) following 2 foliar applications of *tau*-fluvalinate at 0.15 and 0.34 lb ai/A

EEC Equivalent Dose[a] (mg *tau*-fluvalinate/ kg bw/day)	**Mammalian Classes and Body Weights Application rates = 0.15 lb ai/A // 0.34 lb ai/A**		
	Small (15 g)	**Medium (35 g)**	**Large (1000 g)**
Short grass	65//310	45//214	10//50
Tall grass	30//142	21//98	5//23
Broadleaf plants/small insects	37//174	25//120	6//28
Fruits/pods/large insects	4//19	3//13	1//3

[a] EEC equivalent dose = Upper bound Kenega value * (%BW consumed/100). %BW consumed = 95/21%, 66/15%, and 15/3% (herbivores-insectivores/granivores) for small, medium, and large mammals, respectively.

Using the upper bound Kenaga residues, the risks to mammals following chronic exposure to *tau*-fluvalinate exceed the chronic LOCs for mammals with nearly all food categories except fruits/pods/large insects/seeds. Mammals eating short grass have the highest risks, followed by broadleaf plants and small insects second and seeds with the lowest risks (for seeds, the RQ exceeds the LOC only for small mammals with the ornamental use). Using the mean Kenaga residues, the chronic dietary RQs still exceed the chronic LOC for mammals in all food categories except fruits/pods/large insects/seeds for the Oregon ornamental scenario, and the chronic dose-based RQs exceed the chronic LOC for many of the food categories for both the carrot and ornamental scenarios. Therefore, RQs based on average residue values also exceed the chronic LOC for mammals.

The NOAEL/LOAEL from the mammal reproduction study, 1.90/9.53 mg/kg/day, are based on skin ulcerations in the parental generation and decreases in pup body weight, slightly lower litter size, decreased litter weight and tremors in the offspring. The skin ulcerations are due to the parasthesia (skin numbness, tingling and itching), which causes the rats to continuously scratch themselves. These effects have been observed in other mammalian species (i.e., mice, rabbits and according to human incidence profiles, probably humans). The most directly relevant endpoints from the rat reproduction study for assessment of ecological risk to mammals are the decrease in F_2 pup weight at post-natal day 21 (↓12%, $p<0.05$) combined with a slightly lower litter size, resulting in a significant decrease (↓16%, $p<0.05$) in mean litter weight when compared to controls. Although not frank reproductive effects *per se*, these effects are toxicologically significant, may be considered relevant to reproduction (decrease in litter size and weight) and thus used as an endpoint for ecological risk to mammals.

Decreases in body weight are observed in other mammalian studies, including those where the test material was conducted by gavage. Therefore, the decreases in pup and litter weight can be considered a direct effect from exposure to *tau*-fluvalinate and not due to parasthesia in the parents and resulting failure of the dams to care for their young. It is also noted that the skin ulcerations were only observed in one dam in the P generation and in no dams in the F_1 generation. Parental males were more susceptible to the skin ulcerations.

The calculated RQs, particularly those on a mg/kg bw/day (i.e. dose) basis may be considered to be conservative because the pup effects are observed during lactation and the NOAEL and LOAEL are based on body weight and food consumption calculations from the parents, usually during the premating period. Food consumption for the dams (maternal rat) often doubles during the lactation period, thus (assuming that the test material goes into the milk) providing the pups with an extra dose. Also, the pups start eating their own food in addition to nursing about half way through the lactation period. At that time, it is likely that they are receiving a much higher dose of the test material. In support of this, in the reproduction study with *tau*-fluvalinate, tremors are seen in pups starting around lactation day 14. Tremors are not observed at any other time. During this period of time, pups are both eating and nursing and are likely receiving much more of the test material than the indicated by the reported test concentrations.

Transient tremors are a known effect from exposure to pyrethroids as a class; they are not cumulative and can be considered as an acute reaction. Upon exposure, they are generally short-lived. However, if sufficiently severe, they can lead to convulsions, thus leaving the animal at risk to predation.

The parasthesia effects and resulting skin ulcerations leave the animals at risk to infection as well as distracting them enough to alter their behavior, possibly increasing the risk of predation. Because these effects only occur following dermal exposure to residues on the diet, the risk to them is low following dietary exposure.

Terrestrial Invertebrates

Available information suggests that terrestrial insects will likely be adversely affected by *tau*-fluvalinate use. EFED currently does not estimate risk quotients for terrestrial non-target insects. However, an appropriate label statement is required to protect foraging honeybees when the LD_{50} is < 11 μg/bee. Based on the acute contact toxicity study to honeybees, the LD_{50} for *tau*-fluvalinate is 0.2 μg/bee. This classifies *tau*-fluvalinate as highly toxic to honeybees.

EFED currently has no established methodology for evaluating the potential exposure of terrestrial insects to pesticides. Refined risk estimates for terrestrial insects would be complicated by the complex and varied life histories of these types of organisms, and a lack of data on exposure pathways. Two different estimation methods were used for approximate pesticide exposure to insects present during application, neither of which are expected to be representative of all terrestrial insects. This risk characterization is based on limited toxicity data from registrant-submitted bee toxicity data and from open literature (ECOTOX) studies. A description of the qualitative risk assessment for terrestrial insects follows below.

The Kenaga nomogram (Fletcher 1994) can be used to estimate residue concentrations on seeds and pods as a surrogate for large terrestrial insects. The nomogram estimates residue levels of a pesticide on various types of plants based on a data set of field measurements. As a screening level estimate, the highest application rate (OR ornamentals, 0.34 lb a.i./acre) was used. The estimated residue for pod containing seeds at this application rate is 20.31 µg a.i./g insect.

An alternate approach to estimate insect exposure to *tau*-fluvalinate is to assume that an insect presents a particular surface area toward the depositing spray and has a fixed mass. Dimensions for representative terrestrial insects include 55 cm^2 of surface area and a mass of 0.5 g, consistent with the size and weight of a monarch butterfly with wings spread, or 1 cm^2 and a mass of 0.08 g, consistent with the size and weight of a honey bee. The resulting exposure to insects with these dimensions receiving a direct application of 0.34 lbs a.i./acre (3.8 μg *tau*-fluvalinate/cm^2) would be 418 μg/g for the butterfly and 47.5 μg/g for the honey bee.

The available terrestrial insect toxicity data, based on tests with honey bees and other insects, suggests that *tau*-fluvalinate is highly toxic to insects. Tests with honey bees provide a NOAEL of 0.025 µg/bee, a LOAEL of 0.05μg/bee and an acute LD_{50} of 0.2μg/bee. Using a typical honey bee weight of 0.08 g, this equates to a doses of 0.31, 0.63 and 2.5 µg/g, for the NOAEL, LOAEL and LD_{50}, respectively. For fall army worms, the LD_{50}s range from 0.033 to 7.13 µg/g for army worms and for german cockroaches, the reported LD_{50} is 2.65 µg/g.

Based on estimated exposure from the Kenaga nomogram, the dose is 20.31 μg a.i./g insect, which exceeds all of the LD_{50} values listed above. The values from the alternative approach are even higher. Therefore, it is likely that there is significant risk to terrestrial insects in the direct treatment area.

Due to the potential high risk for survival of terrestrial insects, food chain effects as well as effects on pollination are of a concern.

4.2.2.2 Plants

No studies are available on terrestrial plants with the parent. In addition, as a reference point, no terrestrial plant data were found with the 5 other pyrethroids with which comparisons were made for aquatic organisms.

4.2.3 Degradates

As listed stated in the Effects Characterization section **3.3.1.5**, there are 6 major degradates in water. HED had no toxicological concerns with them. A quick online search of ECOTOX provided a daphnia acute toxicity study with 3-phenoxy-benzaldehyde and several fish studies with cyanohydrin. All of the reported mortality data were in the 50 to 10000 ppb range. This range is considerably less toxic than what is predicted for the parent. Therefore, no risk estimations are being conducted for the degradates for aquatic animals. For aquatic plants, studies on algae were found in ECOTOX with phenoxybenzaldehyde and cyanohydrin. The most sensitive endpoint for both degradates was effects on population biomass with *Anabaena variabilis* (blue-green algae). The EC_{50} was 2300 μg/L. Using the highest 1 in 10 year peak EEC of 0.46 μg/L, the estimated acute RQ for non-vascular aquatic plants would be 0.0002. This is well below the acute LOC of concern. Therefore, based on this estimate, it is unlikely that there will be risks to non-vascular aquatic plants with either degradate.

For terrestrial organisms, acute oral toxicity studies in the rat were submitted on degradates (for details, refer to section **3.3.3.5**). Acute oral studies for 5 of the degradates had LD_{50}s greater than 500 mg/kg. There were no treatment-related mortalities or sublethal effects observed in these studies. Therefore, no comparison with the parent and no estimation of risk can be conducted for these 5 degradates. Two degradates, cyanohydrin and chloranilino acid have acute LD_{50}s that are lower than the parent. These two degradates may be more toxic than the parent; however, in the study on cyanohydrin, there was a lack of a consistent dose-mortality relationship and there was one questionable death in one of the dose groups. Therefore, although an LD_{50} value could be calculated, meaningful confidence limits could not be estimated. In addition, the acute LD_{50} is higher than the highest dose tested and therefore, had to be extrapolated. The uncertainty over the acute toxicity of this degradate is too great to be compared with the parent material. Thus, a discussion of risk will not be done. The second degradate, chloroanilino acid, although listed as a degradate in the study itself, is not listed as a terrestrial fate degradate and the risk will not be characterized.

4.2.4 Review of Incident Data

Incident information was searched on the Ecological Incident Information System (EIIS) database and no incident data has been reported.

4.2.5 Federally Threatened and Endangered (Listed) Species Concerns

Both acute endangered species and chronic risk LOCs are considered in the screening-level risk assessment of pesticide risks to listed species. Endangered species acute LOCs are a fraction of the non-endangered species LOCs or, in the case of endangered plants, RQs are derived using lower toxicity endpoints than non-endangered plants. Therefore, concerns regarding listed species within a taxonomic group are triggered in exposure situations where restricted use or acute risk LOCs are triggered for the same taxonomic group. The risk assessment also includes an evaluation of the potential probability of individual effects for exposures that may occur at the established endangered species LOC both in the risk characterization and the endangered species sections. This probability is calculated using the established dose/response relationship and assumes a probit (probability unit) dose/response relationship. This analysis is presented in Section **4.2.5.2.2** below.

4.2.5.1 Action Area[4]

Tau-fluvalinate is synthetic pyrethroid currently used as an insecticide in the U.S. to control undesired insects in both indoor and outdoor settings. As an insecticide marketed in the United States, EPA is required under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) to assess the chemical's potential to cause unreasonable adverse effects to the environment. The Endangered Species Act of 1973 amended FIFRA to define unreasonable adverse effects to include situations involving unreasonable hazard to the survival of a species declared by the Secretary of the Interior to be endangered or threatened (P.L. 93-205, December 28, 1987, 87 Stat. 903). This assessment follows EPA guidance on conducting ecological risk assessments (EPA 1998) and the Office of Pesticide Program's policies for assessing risk to non-target and listed organisms (OPPTS 2004 - Overview document).

The end result of the EPA pesticide registration process is an approved product label defining how the product may be used. A label represents the legal document which stipulates how and where a given pesticide may be used. Product labels, or end-use labels, describe the formulation type, acceptable methods of application, where the product may be applied, and any restrictions on how applications may be conducted. Thus, the use, or potential use, of the pesticide's technical or product labels can be considered to be "the action" being assessed. This risk assessment has been conducted using currently approved labels stipulating where, when, how and

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[4] Use the canned language in this section, which has been updated since Ed Odenkirchen's Email message, which contained action area language, was sent on November 3, 2003.

at what application rates tau-fluvalinate may be used. The following definition of the Action Area is based on currently approved labels for tau-fluvalinate.

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. At the initial screening-level, the risk assessment considers broadly described taxonomic groups and so conservatively assumes that listed species within those broad groups are collocated with the pesticide treatment area. This means that terrestrial plants and wildlife are assumed to be located on or adjacent to the treated site and aquatic organisms are assumed to be located in a surface water body adjacent to the treated site. The assessment also assumes that the listed species are located within an assumed area which has the relatively highest potential exposure to the pesticide, and that exposures are likely to decrease with distance from the treatment area. **Section 2.1.4** of this risk assessment presents the pesticide use sites that are used to establish initial collocation of species with treatment areas.

If the assumptions associated with the screening-level action area result in RQs that are below the listed species LOCs, a "no effect" determination conclusion is made with respect to listed species in that taxa, and no further refinement of the action area is necessary. Furthermore, RQs below the listed species LOCs for a given taxonomic group indicate no concern for indirect effects upon listed species that depend upon the taxonomic group covered by the RQ as a resource. However, in situations where the screening assumptions lead to RQs in excess of the listed species LOCs for a given taxonomic group, a potential for a "may affect" conclusion exists and may be associated with direct effects on listed species belonging to that taxonomic group or may extend to indirect effects upon listed species that depend upon that taxonomic group as a resource. In such cases, additional information on the biology of listed species, the locations of these species, and the locations of use sites and could be considered along with available information on the fate and transport properties of the pesticide to determine the extent to which screening assumptions regarding an action area apply to a particular listed organism. These subsequent refinement steps could consider how this information would impact the action area for a particular listed organism and may potentially include areas of exposure that are downwind and downstream of the pesticide use site.

4.2.5.2 Taxonomic Groups Potentially at Risk

4.2.5.2.1 Discussion of Risk Quotients

The Level I screening assessment process for listed species uses the generic taxonomic group-based process to make inferences on direct effect concerns for listed species. The first iteration of reporting the results of the Level I screen is a listing of pesticide use sites and taxonomic groups for which RQ calculations reveal values that meet or exceed the listed species LOCs. Endangered species LOCs were exceeded for the taxonomic groups listed below. Should estimated exposure levels occur in proximity to listed resources, the available screening level information suggests a potential concern for direct effects on these listed species associated with *tau*-fluvalinate's use sites:

- Freshwater fish - acute and chronic LOCs for California carrots and nationwide ornamentals
- Marine/estuarine fish - chronic LOC for California carrots and nationwide ornamentals
- Freshwater invertebrates - acute and chronic LOCs for California carrots and nationwide ornamentals
- Marine/estuarine invertebrates - acute LOC (mysid) for California carrots and nationwide ornamentals
- Mammals - acute LOC for small mammals feeding on short grass for nationwide ornamentals. Chronic LOC for all size mammals (short and tall grass, broadleaf plants and small insects for California carrots and nationwide ornamentals); all size mammals (fruits, pods and large insects for nationwide ornamentals); and small mammals feeding on seeds for nationwide ornamentals

In addition, submitted toxicity data on honey bees and efficacy data in the open literature (ECOTOX) on pest insects indicate that there will be considerable risk to listed terrestrial insects located where *tau*-fluvalinate is used.

4.2.5.2.2 Probit Dose Response Relationship

Based on an assumption of a probit dose-response relationship and using mean estimated slopes, the corresponding estimated chance of individual mortality associated with the listed species LOC (0.1 for birds and mammals and 0.05 for aquatic animals) was determined for all acute endpoints. It is recognized that extrapolation of very low probability events is associated with considerable uncertainty in the resulting estimates. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimates were also used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. If information is unavailable to estimate a slope for a particular study, a default slope assumption of 4.5 is used as per original Agency assumptions of typical slope cited in Urban and Cook (1986).

Fish

For freshwater fish, analysis of the raw data from the carp acute study (MRID 00150125) estimates a slope of 4.76 (95% C.I. 2.7 - 6.8). Based on this slope and the LC_{50} value of 0.35 μg/L, the individual mortality associated with the minimum and maximum calculated RQ values (0.7 and 1.3) result in an estimated chance of individual mortality of 1 in 4.3 and 1 in 1.4, respectively.

Based on this slope and the endangered species fish acute LOC of 0.05, the corresponding estimate chance of individual mortality of fish species following *tau*-fluvalinate application is 1 in 3.37 E+09. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimate (2.7 - 6.8) can be used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. These values are 1 in 4.51 E+03 and 1 in 1 E+16.

For marine/estuarine fish, analysis of the raw data from the sheepshead minnow acute study (MRID 00155450) estimates a slope of 3.46 (95% C.I. -1.01 to 7.92). Based on this slope and the LC_{50} value of 10.8 μg/L, the individual mortality associated with the minimum and maximum calculated RQ values (0.02 and 0.04) result in an estimated chance of individual mortality of 1 in 4.8 E+08 and 1 in 1.5 E+06, respectively.

Based on this slope and the endangered species fish acute LOC of 0.05, the corresponding estimate chance of individual mortality of fish species following *tau*-fluvalinate application is 1 in 2.96 E+05. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimate (-1.01 to 7.92) can be used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. These values are 1 in 1.1 and 1 in 1 E+16.

Aquatic Invertebrates

No raw data are available from the literature study on crayfish that was used for calculation of the RQs for freshwater invertebrates. Therefore, a default slope of 4.5 will be used for this study in order to estimate the probability of individual mortality. Using the default slope of 4.5 and the LC_{50} value of 0.31 μg/L, the individual mortality associated with the minimum and maximum calculated RQ values (0.8 and 1.5) result in an estimated chance of individual mortality of 1 in 3.0 and 1 in 1.3, respectively.

Based on this slope and the endangered species aquatic invertebrate acute LOC of 0.05, the corresponding estimate chance of individual mortality of aquatic invertebrate species following *tau*-fluvalinate application is 1 in 4.17 E+08.

For marine/estuarine invertebrates (mysid), analysis of the raw data from the mysid shrimp acute study (MRID 00127994) estimates a slope of 2.91 (95% C.I. 0.57 to 5.25). Based on this slope and the LC_{50} value of 0.018 μg/L, the individual mortality associated with the minimum and maximum calculated RQ values (12.5 and 23) result in an estimated chance of individual mortality of 1 in 1 for both values.

Based on this slope and the endangered species aquatic invertebrate acute LOC of 0.05, the corresponding estimate chance of individual mortality of aquatic invertebrate species following *tau*-fluvalinate application is 1 in 1.31 E+04. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimate (0.57 - 5.25) can be used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. These values are 1 in 4.4 and 1 in 2.35 E+11.

For marine/estuarine invertebrates (mollusk), analysis of the raw data from the eastern oyster acute study (MRID 00160767) estimates a slope of 1.05 (95% C.I. 0.24 to 1.86). Based on this slope and the LC_{50} value of 12 μg/L, the individual mortality associated with the minimum and maximum calculated RQ values (0.02 and 0.04) result in an estimated chance of individual mortality of 1 in 26.9 and 1 in 14.1, respectively.

Based on this slope and the endangered species aquatic invertebrate acute LOC of 0.05, the corresponding estimate chance of individual mortality of aquatic invertebrate species following *tau*-fluvalinate application is 1 in 11.6. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimate (0.24 - 1.86) can be used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. These values are 1 in 2.7 and 1 in 1.29 E+02.

Birds

None of the acute RQs exceed any Levels of Concern (LOC's) for birds for either the California carrot or the Oregon ornamental scenario. Analysis of the raw data from the Bobwhite quail acute dietary study (MRID 00079964) estimates a slope of 3.03 (95% C.I. 0.87 - 5.2). Based on this slope and the LC_{50} value of 5627 ppm, the individual mortality associated with the minimum and maximum calculated RQ values (0.01 and 0.06) result in an estimated chance of individual mortality of 1 in 1.46 E+09 and 1 in 9.35 E+03, respectively.

Based on this slope and the endangered species avian acute LOC of 0.1, the corresponding estimate chance of individual mortality of avian species following *tau*-fluvalinate application is 1 in 818. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimate (0.87 - 5.2) can be used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. These values are 1 in 5.2 and 1 in 1 E+07.

Mammals

Analysis of the raw data from the rat acute oral study (MRID 46521901) estimates a slope of 6.35 (95% C.I.). Based on this slope and the LD_{50} value of 1402 mg/kg, the individual mortality associated with the minimum and maximum calculated RQ values (0.01 and 0.1) result in an estimated chance of individual mortality of 1 in 1 E+16 and 1 in 9.25 E+09, respectively.

Based on this slope and the endangered species mammalian acute LOC of 0.1, the corresponding estimate chance of individual mortality of mammalian species following *tau*-fluvalinate application is 1 in 9.25 E+09. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimate (1.03 - 11.66) can be used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. These values are 1 in 6.6 and 1 in 1

E+16.

4.2.5.2.3 Data Related to Under-represented Taxa

The Level I screening assessment process relies on RQ calculations that use toxicity endpoints selected from the most sensitive species tested within broad taxonomic groups. In addition, fish effects data are commonly used to evaluate impacts to aquatic phase amphibians and bird effects data are used to evaluate impacts to terrestrial phase amphibians as well as reptiles. For *tau*-fluvalinate, no amphibian or reptile data were submitted, nor were any found in the open literature (ECOTOX). Therefore, the screening level RQs on fish and birds apply to amphibians and reptiles.

4.2.5.2.4 Implications of Sublethal Effects

Sublethal effects are discussed in detail in the Risk Description Section **4.2.1** and in the Ecological Effects Characterization Sections **3.3.1.3** and **3.3.3.3**. These sections are summarized here.

Fish

The acute data on fish show clinical signs of toxicity generally observed at similar concentration levels that produce mortality. Therefore, any discussion of risk based on mortality would likely apply to sublethal effects as well. The lowest concentration where sublethal effects were observed in freshwater fish was 0.2 μg/L. 1 in 10 year peak EEC values for carrots and ornamentals are in the same range. Sublethal effects are possible for freshwater fish and they place the animals at risk for survival (predation).

In marine/estuarine fish, sublethal effects (pectoral fins anteriorly extended and rapid respiration) were observed at a concentration level 3 times higher than the 1 in 10 year peak EECs. Due to uncertainties associated with the acute study conducted with sheepshead minnows, there is a possibility that sublethal effects may occur; however, the connection between these particular sublethal effects and survival or reproduction is not clear.

Aquatic Invertebrates

Following acute exposure, sublethal effects noted in water fleas are small size, lethargy and swimming erratically. These sublethal effects were also observed at levels where significant mortality occurred. The lowest concentration where lethargy and swimming erratically were noted is 0.06 μg/L. Small size was seen at 0.24 μg/L. All of these sublethal effects may occur at the 1 in 10 year peak EEC values of 0.25 and 0.46 μg/L. The effects place the animals at risk for reproductive capacity (decrease in size may affect attracting a mate, fertility and other factors) and survival (predation). In addition, the decrease in size may affect the food chain because the predators will have to eat more individuals in order to meet their nutritional requirements.

Lethargy was also observed in mysid shrimp at concentrations well below the estimated 1 in 10 year peak EECs for both the carrot and ornamental scenarios and are highly likely. Lethargy will place the animals at risk for predation.

Sublethal effects following chronic exposure include decreases in length and mean number of offspring/adult/reproductive day. Decrease in length is directly related to growth and decrease in mean number of offspring/adult/reproductive day is directly related to reproduction, both of which are environmental receptors used to measure hazard. There is concern for sublethal effects for aquatic invertebrates following chronic exposure; however, there is uncertainty associated with the concentrations at which these effects were observed.

Birds

In the acute oral and dietary studies with bobwhite quail and mallard ducks, lethargy is the most sensitive sublethal effect. The lowest level where lethargy was observed is 398 mg/kg bw. With the highest predicted EEC at 370 mg/kg bw, lethargy may occur with small birds eating short grass. Therefore, there is a concern for this taxonomic group for sublethal effects, particularly as it relates to ability to escape from predators. No treatment-related sublethal effects were observed in any of the chronic studies.

Mammals

In mammals, sublethal effects following acute exposure start at 500 to 700 mg *tau*-fluvalinate/kg bw. These effects include clinical signs of neurotoxicity and scratching due to parasthesia. Sublethal effects in another mammalian study (transient clinical signs of neurotoxicity) were observed following acute exposure at a dose as low as 1.0 mg/kg (NOAEL 0.5 mg/kg). The highest predicted dose for mammals is 310 mg/kg bw (small mammals eating short grass) for the ornamental use. Therefore, there are potential risks of sublethal effects at the estimated peak environmental concentrations predicted for the current uses. Transient clinical signs of neurotoxicity, which include tremors in this case, are a known effect from exposure to pyrethroids as a class. These are not cumulative and can be considered as an acute reaction. However, if sufficiently severe, they can lead to convulsions, thus leaving the animal at risk to predation.

Following chronic exposure, the NOAEL/LOAEL from the mammal reproduction study, 1.90/9.53 mg/kg/day, is based on skin ulcerations in the parental generation and decreases in pup body weight, slightly lower litter size, decreased litter weight and tremors in the offspring. The decreases in pup/litter weight and litter size, although not frank reproductive effects *per se* are toxicologically significant and may be considered relevant to reproduction (decrease in litter size and weight). The other observed sublethal effects, skin ulcerations and tremors are less likely to affect survival. The parasthesia effects and resulting skin ulcerations can leave the animals at risk to infection and leave them open to predation; however, the effects generally occur following dermal exposure to residues on the diet. The residues on foliage are likely to be considerably less than the levels in the diet which produced the effect.

4.2.5.3 Indirect Effects Analysis

The Agency acknowledges that pesticides have the potential to exert indirect effects upon the listed organisms by, for example, perturbing forage or prey availability, altering the extent of nesting habitat, etc. In conducting a screen for indirect effects, direct effect LOCs for each taxonomic group are used to make inferences concerning the potential for indirect effects upon listed species that rely upon non-endangered organisms in these taxonomic groups as resources critical to their life cycle.

Because screening-level acute RQs for freshwater fish, aquatic invertebrates and mammals exceed the endangered species acute LOCs, the Agency used the dose response relationship from the toxicity study used for calculating the RQ to estimate the probability of acute effects associated with an exposure equivalent to the EEC. In addition, available data on honey bees and pest insects indicate that there will be considerable risk to listed terrestrial insects located where *tau*-fluvalinate is used.

Screening-level chronic RQs for mammals, fish and aquatic invertebrates exceed the chronic LOC; therefore, there may be a potential concern for indirect effects. As such, the nature of the chronic toxicological endpoint, Services-provided "species profiles", and further evaluation of the geographical and temporal nature of the exposure are considered to determine if a rationale for a "not likely to adversely effect" determination is possible.

Each of these taxonomic groups are in the food chain for other groups. Effects on either aquatic or terrestrial invertebrate survival or reproduction will affect other groups which feed on invertebrates (i.e., other invertebrates, amphibians, mammals, birds, reptiles and fish). A decrease in terrestrial insects and mammals would also decrease pollination for plants that are dependent upon pollination via insects and mammals. A decrease in fish and amphibians will affect other fish and amphibians, mammals, reptiles and birds and a decrease in small mammals could affect other mammals, reptiles, birds and plants.

The indirect effect analyses for fish, aquatic invertebrates, mammals and terrestrial invertebrates are described in further detail below.

Fish:

The probability of an individual mortality associated with the minimum and maximum calculated RQ values for the acute freshwater fish study are 1 in 4.3 and 1 in 1.4, and for the acute marine/estuarine fish study are 1 in 4.8 E+08 and 1 in 1.5 E+06, respectively. The corresponding estimate chance of individual mortality associated with the listed fish species LOC is 1 in 3.37

E+0.09 with upper and lower estimates of 1 in 4.5 and 1 in 1 E+16 for freshwater fish, and 1 in 2.96 E+05 with upper and lower estimates of 1 in 1.1 and 1 in 1 E+16 for marine/estuarine fish.

Chronic LOCs are exceeded for fish; therefore, the potential for adverse effects on those listed species that eat fish exists. In addition, because fish are used as a surrogate for aquatic-phase amphibians, there is also potential concern for listed animals that require amphibians for food. The chronic endpoint for fish was based on growth and reproductive effects. If reproduction following *tau*-fluvalinate exposure is reduced to the extent that it has an impact on fish populations, reduction in fish populations that are used as a resource for listed species may be of concern.

Aquatic Invertebrates:

The probability of an individual mortality at the minimum and maximum calculated RQ values, the listed LOC and at the lower and upper limits of the slope of the mortality curve for aquatic invertebrates are provided in **Table 4.21**.

Table 4.21 Probability of Individual Mortality in Aquatic Invertebrates

Group	Minimum RQ	Maximum RQ	Listed LOC	Lower Slope Estimate	Upper Slope Estimate
Freshwater	1 in 3	1 in 1.3	1 in 4.2 E+08	Not available	Not available
Marine/Estuarine Mysid	1 in 1	1 in 1	1 in 1.3 E+04	1 in 4.4	1 in 2.4 E+11
Marine/Estuarine Mollusk	1 in 26.9	1 in 14.1	1 in 11.6	1 in 2.7	1 in 1.3 E+02

In addition, the data indicate that there may be risks to reproduction and survival of aquatic invertebrates following chronic exposure to *tau*-fluvalinate. Therefore, indirect effects to listed species (e.g., fish, mammals, birds, amphibians, other invertebrates and reptiles) that rely on aquatic invertebrates as a primary food source may be of concern.

Birds

No acute or chronic LOC's are exceeded for birds.

Mammals

The probability of an individual mortality associated with the minimum and maximum calculated RQ values for the acute rat study are 1 in 1 E+16 and 1 in 9.25 E+09, respectively. The corresponding estimate chance of individual mortality associated with the listed mammalian species LOC is 1 in 9.25 E+09 with upper and lower estimates of 1 in 6.6 and 1 in 1 E+16.

The chronic endpoint for mammalian species is based on decreases in pup body weight, slightly lower litter size, decreased litter weight and other sublethal effects. These are considered to be growth and reproductive effects. If reproduction following *tau*-fluvalinate exposure is reduced to the extent that it has an impact on mammalian populations, reduction in mammalian populations that are used as a resource for listed species may be of concern.

Given that acute and chronic LOCs are exceeded for mammals, indirect effects to listed species (e.g., mammals, birds, amphibians and reptiles) that rely on mammals as a primary food source may be of concern.

4.2.5.4 Critical Habitat

In the evaluation of pesticide effects on designated critical habitat, consideration is given to the physical and biological features (constituent elements) of a critical habitat identified by the U.S Fish and Wildlife and National Marine Fisheries Services as essential to the conservation of a listed species and which may require special management considerations or protection. The evaluation of impacts for a screening level pesticide risk assessment focuses on the biological features that are constituent elements and is accomplished using the screening-level taxonomic analysis (risk quotients, RQs) and listed species levels of concern (LOCs) that are used to evaluate direct and indirect effects to listed organisms.

The screening-level risk assessment has identified potential concerns for indirect effects on listed species for those organisms dependant upon **fish, amphibians, invertebrates, reptiles and mammals**. In light of the potential for indirect effects, the next step for EPA and the Service(s) is to identify which listed species and critical habitat are potentially implicated. Analytically, the identification of such species and critical habitat can occur in either of two ways. First, the agencies could determine whether the action area overlaps critical habitat or the occupied range of any listed species. If so, EPA would examine whether the pesticide's potential impacts on non-endangered species would affect the listed species indirectly or directly affect a constituent element of the critical habitat. Alternatively, the agencies could determine which listed species depend on biological resources, or have constituent elements that fall into, the taxa that may be directly or indirectly impacted by the pesticide. Then EPA would determine whether use of the pesticide overlaps the critical habitat or the occupied range of those listed species. At present, the information reviewed by EPA does not permit use of either analytical approach to make a definitive identification of species that are potentially impacted indirectly or critical habitats that is potentially impacted directly by the use of the pesticide. EPA and the Service(s) are working together to conduct the necessary analysis.

This screening-level risk assessment for critical habitat provides a listing of potential biological features that, if they are constituent elements of one or more critical habitats, would be of potential concern. These correspond to the taxa identified above as being of potential concern for indirect effects and include the following **fish, amphibians, invertebrates, reptiles, mammals and plants**. This list should serve as an initial step in problem formulation for further assessment of critical habitat impacts outlined above, should additional work be necessary.

4.2.5.5 Co-occurrence Analysis

The goal of the analysis for co-location is to determine whether sites of pesticide use are geographically associated with known locations of listed species. At the screening level, this analysis is accomplished using the LOCATES 2.4.1 database. The database uses location information for listed species at the county level and compares it to agricultural census data for crop production at the same county level of resolution. The product is a listing of federally listed species that are located within counties known to produce the crop upon which the pesticide will be used. Because the Level I screening assessment considers **both** direct and indirect effects across generic taxonomic groupings, it is not possible to exclude any taxonomic group from a LOCATES database run for a screening risk assessment. Therefore, the tables include all taxonomic groups.

Table 4.22 below reports the number of states and counties in which endangered species reside that have ornamental uses. The following crops were selected in LOCATES as ornamental uses: bedding and garden plants, floriculture crops, foliage plants (nursery), nursery and greenhouse crops, nursery crops (in the open) and nursery and greenhouse crops (other). The data suggest that there is considerable potential for exposure to a variety of endangered species, particularly fish and mammals from *tau*-fluvalinate use on ornamentals. A detailed list of endangered species from all taxa located in counties which have ornamental uses is in **Appendix E**.

Table 4.23 below reports the number of endangered species which reside in the California counties that have carrot uses. The data suggest that there appear to be only two counties in which endangered species may be impacted: San Joaquin and Yolo counties. **A detailed list of endangered species from all taxa located in counties which have carrot uses is in Appendix E**.

Table 4.24 below reports the number of counties in California in which endangered species reside that have brassica/cole crop uses. The following crops were selected in LOCATES as brassica/cole crops: broccoli, brussel sprouts, cauliflower, chinese cabbage, collards, head cabbage, kale, mustard cabbage, mustard greens, turnip greens, cabbage all, daikon, canola and watercress. The data suggest that there is considerable potential for exposure to a variety of endangered species, particularly fish, mammals and insects from *tau*-fluvalinate use on brassica crops. A detailed list of endangered species from all taxa located in counties which have ornamental uses is in **Appendix E**.

Table 4.22 Number of Counties with Ornamental Uses Where Endangered Species Are Located											
	Fish	**Birds**	**Mammal**	**Reptiles**	**Amphibian**	**Crustacean**	**Arachnids**	**Insects**	**Snails**	**Clams**	**Plants**
Affected Counties	442	106	897	202	71	53	8	139	29	265	655
Affected States	39	49	47	18	10	10	4	25	13	27	47
Affected Species	85	56	58	28	18	17	12	43	26	67	502

Table 4.23 California Counties with Carrot Uses Where Endangered Species Are Located											
Counties	**Fish**	**Birds**	**Mammal**	**Reptiles**	**Amphibian**	**Crustacean**	**Arachnids**	**Insects**	**Snails**	**Clams**	**Plants**
Colusa	-	-	-	-	-	-	-	-	-	-	-
Glenn	-	-	-	-	-	-	-	-	-	-	-
San Joaquin	2	1	3	1	1	2	-	1	-	-	3
Solano	-	-	-	-	-	-	-	-	-	-	-
Sutter	-	-	-	-	-	-	-	-	-	-	-
Yolo	4	-	-	1	1	1	-	1	-	-	3

Table 4.24 California Counties with Brassica Uses Where Endangered Species Are Located											
	Fish	**Birds**	**Mammal**	**Reptiles**	**Amphibian**	**Crustacean**	**Arachnids**	**Insects**	**Snails**	**Clams**	**Plants**
Affected Counties	27	28	23	23	24	21	-	21	1	-	28
Affected Species	14	15	21	8	6	7	-	19	1	-	155

4.3 Description of Assumptions, Limitations, Uncertainties, Strengths and Data Gaps

Assumptions, limitations, uncertainties, strengths, and data gaps have been described throughout this assessment and are summarized below.

4.3.1 Assumptions, Limitations, Uncertainties, Strengths and Data Gaps For All Taxa

Maximum Use Scenario

This screening-level risk assessment relies on labeled statements of the maximum rate of *Tau*-fluvalinate application, the maximum number of applications, and the shortest interval between applications (when applicable). Together, these assumptions constitute a maximum use scenario and can overestimate risk. However, the maximum use scenario must be considered because it is a reflection of the allowable use of *tau*-fluvalinate. The frequency at which actual uses approach these maximums is dependant on the number and timing of applications, and market forces. In addition, rates of application less than the maximum rate are also considered.

4.3.2 Assumptions, Limitations, Uncertainties, Strengths and Data Gaps For Aquatic Species

Exposure Estimates:

- Some general uncertainties are associated with the use of the PRZM/EXAMS standard runoff scenario (a 10 hectare field draining into a 1 hectare Georgia farm pond) with regional specific crop and pesticide management practices, weather, and soil types. Although there are uncertainties associated with the use of a standard runoff scenario for a regional aquatic exposure assessment, it is designed to represent pesticide exposure from an agricultural watershed impacting a vulnerable aquatic environment. Extrapolating the risk conclusions from this standard pond scenario may either underestimate or overestimate the potential risks.

- Major uncertainties associated with the standard runoff scenario include the physical construct of the watershed and representation of vulnerable aquatic environments for different geographic regions. The physicochemical properties (pH, redox conditions, etc.) of the standard farm pond are based on a Georgia farm pond. These properties are likely to be regionally specific because of local hydrogeological conditions. Any alteration in water quality parameters may impact the environmental behavior of the pesticide. The farm pond represents a well mixed, static water body. Because the farm pond is a static water body (no flow through), it does not account for pesticide removal through flow through or accidental water releases. However, the lack of water flow in the farm pond provides an environmental condition for accumulation of persistent pesticides. The assumption of uniform mixing does not account for stratification due to thermoclines (e.g., seasonal stratification in deep water bodies). Additionally, the physical construct of the standard runoff scenario assumes a watershed:pond area ratio of 10. This ratio is recommended to maintain a sustainable pond in the Southeastern United States. The use of higher watershed: pond ratios (as recommended for sustainable ponds in drier regions of the United States) may lead to higher pesticide concentrations when compared to the standard watershed:pond ratio.

- The standard pond scenario assumes that uniform environmental and management conditions exist over the standard 10 hectare watershed. Soils can vary substantially across even small areas, and thus, this variation is not reflected in the model simulations. Additionally, the impact of unique soil characteristics (e.g., fragipan) and soil management practices (e.g., tile drainage) are not considered in the standard runoff scenario. The assumption of uniform site and management conditions is not expected to represent some site-specific conditions. Extrapolating the risk conclusions from the standard pond scenario to other aquatic habitats (e.g., marshes, streams, creeks, and shallow rivers, intermittent aquatic areas) may either underestimate or overestimate the potential risks in those habitats.

- Three scenarios were modeled for tau-fluvalinate use based on individual EFED standard surface water scenarios: carrots in Florida, vegetables in California, and ornamentals in Oregon. The scenarios selected for use in this assessment were chosen to estimate the concentration of tau-fluvalinate in surface drinking water over a geographically dispersed range of areas representative of crops proposed for tau-fluvalinate use. The Florida carrot scenario was modeled as a surrogate for carrots in the California Section 24(c) requests. The California coastal vegetable scenario was modeled for comparison with this Florida scenario and represents a general vegetable scenario in an area where carrots are likely grown in California. The two scenarios together should provide a reasonable exposure scenario for this SLN use. The scenarios chosen for this assessment represent all available PRZM/EXAMS scenarios for the use of tau-fluvalinate, including the Oregon ornamental which was developed specifically for the cumulative OP assessment. The scenarios developed for the cumulative OP assessment were developed in order to represent the maximum use area for the OP's and may not necessarily represent the most vulnerable setting for a particular crop. However, EFED believes that for this particular assessment the use of this OP scenario, in conjunction with selected standard scenarios, provide a reasonable representation of the potential tau-fluvalinate use pattern. Extrapolating the risk conclusions from these scenarios may either underestimate or overestimate the potential risks.

- For an acute risk assessment, there is no averaging time for exposure. An instantaneous peak concentration, with a 1 in 10 year return frequency, is assumed. The use of the instantaneous peak assumes that instantaneous exposure is of sufficient duration to elicit acute effects comparable to those observed over more protracted exposure periods tested in the laboratory, typically 48 to 96 hours. In the absence of data regarding time-to-toxic event analyses and latent responses to instantaneous exposure, the degree to which risk is overestimated cannot be quantified.

Ecological Effects Estimates

Use of Supplemental Data with Significant Uncertainties Associated with Test Concentrations

Due to the lack of acceptable acute and chronic data in aquatic animals, the available supplemental data on *tau*-fluvalinate were used to calculate risk quotients and were characterized with the uncertainties associated with the exposure concentrations in the studies.

Use of the Most Sensitive Species Tested

A small number of surrogate species were used in this screening level risk assessment. It is not possible to determine whether the species tested are more or less sensitive than species that may be exposed to *tau*-fluvalinate. Also, it was assumed that fish are approximately as sensitive as aquatic phase amphibians. However, no data are available to support this conclusion.

Age class and sensitivity of effects thresholds

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

Testing of juveniles may overestimate toxicity at older age classes for pesticidal active ingredients because younger age classes may not have the enzymatic systems associated with detoxifying xenobiotics. The screening risk assessment has no current provisions for a generally applied method that accounts for this uncertainty. In so far as the available toxicity data may provide ranges of sensitivity information with respect to age class, the risk assessment uses the most sensitive life-stage information as the conservative screening endpoint.

Data Gaps and Uncertainties in Fish Studies

- Significant data gaps exist for evaluation of acute toxicity of *tau*-fluvalinate to fish and aquatic phase amphibians. No acceptable acute toxicity studies on the technical material are available for either freshwater or marine/estuarine fish. A quantitative risk assessment was conducted for fish and supported by existing data on fish from 5 other pyrethroids.

- A data gap exists for evaluation of chronic toxicity to freshwater fish and aquatic phase amphibians. Risks following chronic exposure are estimated using the supplemental chronic freshwater fish study and the uncertainties associated with test concentrations are described.

Data Gaps and Uncertainties in Aquatic Invertebrate Studies

- Significant data gaps exist for evaluation of acute and chronic toxicity of *tau*-fluvalinate to aquatic invertebrates. No acceptable acute or chronic toxicity studies on the technical material are available for either freshwater or marine/estuarine invertebrates. A quantitative risk assessment was conducted for aquatic invertebrates using existing studies and supported by existing data on aquatic invertebrates from 5 other pyrethroids.

- An important data gap in the aquatic risk assessment is that *tau*-fluvalinate is expected to adsorb to the sediment and has been shown to be toxic to insects and aquatic invertebrates. For this reason, submission of sediment organism toxicity data would be of high value to this assessment. Surrogate acute and chronic toxicity studies on aquatic invertebrates indicate potential acute and chronic risk for benthic organisms.

Data Gaps for Aquatic Plants

No data are available to assess risk to aquatic plants.

4.3.3 Assumptions, Limitations, Uncertainties, Strengths and Data Gaps For Terrestrial Species

Exposure Estimates:

Location of wildlife species

For screening terrestrial risk assessments for listed species, a generic bird or mammal is assumed to occupy either the treated field or adjacent areas receiving pesticide at a rate commensurate with the treatment rate on the field. Spray drift model predictions suggest that this assumption leads to an overestimation of exposure to species that do not occupy the treated field. For screening risk assessment purposes, the actual habitat requirements of any particular terrestrial species are not considered, and it assumed that species occupy, exclusively and permanently, the treated area being modeled. This assumption leads to a maximum level of exposure in the risk characterization.

Routes of exposure

Screening-level risk assessments for spray applications of pesticides consider dietary exposure alone. Other routes of exposure, not considered in this assessment, are discussed below:

- Incidental soil ingestion exposure

This risk assessment does not consider incidental soil ingestion. Available data suggests that up to 15% of the diet can consist of incidentally ingested soil depending on the species and feeding strategy (Beyer et al., 1994). A simple first approximation of soil concentration of pesticide shows the effect of not considering incidental soil ingestion:

Assuming the maximum application rate of *tau*-fluvalinate of 0.34 lb/acre (0.38 kg/ha) to a bare, very low density soil (1 g/cm^3) incorporated to 1-cm depth (actual incorporation depths may range from 5 to 20 cm), the following soil concentrations can be calculated for a depth of 1 cm:

tau-fluvalinate soil concentration =

$$\frac{0.38\ \text{kg}}{\text{ha}} \times \frac{1\text{x}10^{6}\ \text{mg}}{\text{kg}} \times \frac{1\ \text{ha}}{1\text{x}10^{8}\ \text{cm}^{3}} \times \frac{1\ \text{cm}^{3}}{0.001\ \text{kg}} = \mathbf{0.0038\ mg/kg}$$

Including this concentration into the standard screening-level method and assumptions for food item pesticide residues (e.g., 325 ppm residue assumption for short grass) shows that ingestion of soil at an incidental rate of up to 15% of the diet would not increase dietary exposure.

- Inhalation exposure

The screening risk assessment does not consider inhalation exposure. Such exposure may occur through three potential sources: (1) spray material in droplet form at the time of application (2) vapor phase pesticide volatilizing from treated surfaces, and (3) airborne particulate (soil, vegetative material, and pesticide dusts).

Available data suggest that inhalation exposure at the time of application is not an appreciable route of exposure for birds. According to research on mallards and bobwhite quail, respirable particle size in birds (particles reaching the lung) is limited to a maximum diameter of 2 to 5 microns (U.S. Environmental Protection Agency, 1990). The spray droplet spectra covering the majority of pesticide application situations (AgDrift model scenarios for very-fine to coarse droplet applications) suggests that less than 1% of the applied material is within the respirable particle size.

Theoretically, inhalation of pesticide active ingredient in the vapor phase may be another source of exposure for some pesticides under some exposure situations. However, considering its low vapor pressure value, it is very unlikely that *tau*-fluvalinate will exist in the gaseous phase at any considerable amount to cause any adverse effects via inhalation.

The impact from exposure to dusts contaminated with the pesticide cannot be assessed generically as partitioning issues related to application site soils and chemical properties render the exposure potential from this route highly situation specific.

- Dermal Exposure

The screening assessment does not consider dermal exposure, except as it is indirectly included in calculations of RQs based on lethal doses per unit of pesticide treated area. Dermal exposure may occur through three potential sources: (1) direct application of spray to terrestrial wildlife in the treated area or within the drift footprint, (2) incidental contact with contaminated vegetation, or (3) contact with contaminated water or soil.

The available measured data related to wildlife dermal contact with pesticides are extremely limited. The Agency is actively pursuing modeling techniques to account for dermal exposure via direct application of spray and by incidental contact with vegetation.

Incidental Pesticide Releases Associated with Use

This risk assessment is based on the assumption that the entire treatment area is subject to *tau*-fluvalinate application at the rates specified on the label. In reality, there is the potential for uneven application of *tau*-fluvalinate through such plausible incidents as changes in calibration of application equipment, spillage, and localized releases at specific areas of the treated field that are associated with specifics of the type of application equipment used (e.g., increased application at turnabouts when using older ground application equipment).

Residue Levels Selection

The Agency relies on the work of Fletcher et al. (1994) for setting the assumed pesticide residues in wildlife dietary items. The Agency believes that these residue assumptions reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify. It is important to note that the field measurement efforts used to develop the Fletcher estimates of exposure involve highly varied sampling techniques. It is entirely possible that much of these data reflect residues averaged over entire above ground plants in the case of grass and forage sampling. Depending upon a specific wildlife species' foraging habits, whole aboveground plant samples may either underestimate or overestimate actual exposure.

Dietary Intake - The Differences Between Laboratory and Field Conditions

The acute and chronic characterization of risk rely on comparisons of wildlife dietary residues with LC_{50} or NOAEC values expressed in concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and laboratory feed.

On gross energy content alone, direct comparison of a laboratory dietary concentration-based effects threshold to a fresh-weight pesticide residue estimate would result in an underestimation of field exposure by food consumption by a factor of 1.25 - 2.5 for most food items. Only for seeds would the direct comparison of dietary threshold to residue estimate lead to an overestimate of exposure.

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

Finally, the screening procedure does not account for situations where the feeding rate may be above or below requirements to meet free living metabolic requirements. Gorging behavior is a possibility under some specific wildlife scenarios (e.g., bird migration) where the food intake rate may be greatly increased. Kirkwood (1983) has suggested that an upper-bound limit to this behavior might be the typical intake rate multiplied by a factor of 5.

In contrast is the potential for avoidance, operationally defined as animals responding to the presence of noxious chemicals in their food by reducing consumption of treated dietary elements. This response is seen in nature where herbivores avoid plant secondary compounds.

Ecological Effects Estimates

Age class and sensitivity of effects thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. Acute dietary testing with birds is performed on juveniles, with mallard being 5-10 days old and quail 10-14 days old.

Testing of juveniles may overestimate toxicity at older age classes for pesticidal active ingredients because younger age classes may not have the enzymatic systems associated with detoxifying xenobiotics. The screening risk assessment has no current provisions for a generally applied method that accounts for this uncertainty. In so far as the available toxicity data may provide ranges of sensitivity information with respect to age class, the risk assessment uses the most sensitive life-stage information as the conservative screening endpoint.

Sublethal Effects

In the acute oral and dietary studies with bobwhite quail and mallard ducks, lethargy, slightly lower body weight gain and food consumption and reduced reactions to external stimuli were noted at levels below which mortality occurred. In mammals, clinical signs of neurotoxicity were observed at levels below which mortality occurred. These included: hypoactivity and/or and hyperactivity, evidence of salivation, ataxia, rigidity of the limbs, urogenital staining, labored respiration and rales, decreased and soft or mucoid feces, red material around the nose, yellow or red material around the mouth, ocular discharge (clear or red), hypothermia, prostration, scabbing, swollen prepuce and alopecia. These toxic responses could affect an animal's ability to survive in the wild. For example, loss of coordination or reduced reaction to external stimuli could affected an animal's ability to escape predation.

Use of the Most Sensitive Species Tested

A small number of surrogate species were used in this screening level risk assessment. It is not possible to determine whether the species tested are more or less sensitive than species that may be exposed to *tau*-fluvalinate. In the absence of toxicity data in reptiles, it was assumed that birds are approximately as sensitive as reptiles to *tau*-fluvalinate effects. However, absence of toxicity data in reptiles precludes evaluation of this assumption.

Data Gaps for Terrestrial Plants

No terrestrial plant data are available to assess risk to terrestrial plants.

V. Literature Cited

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Figures

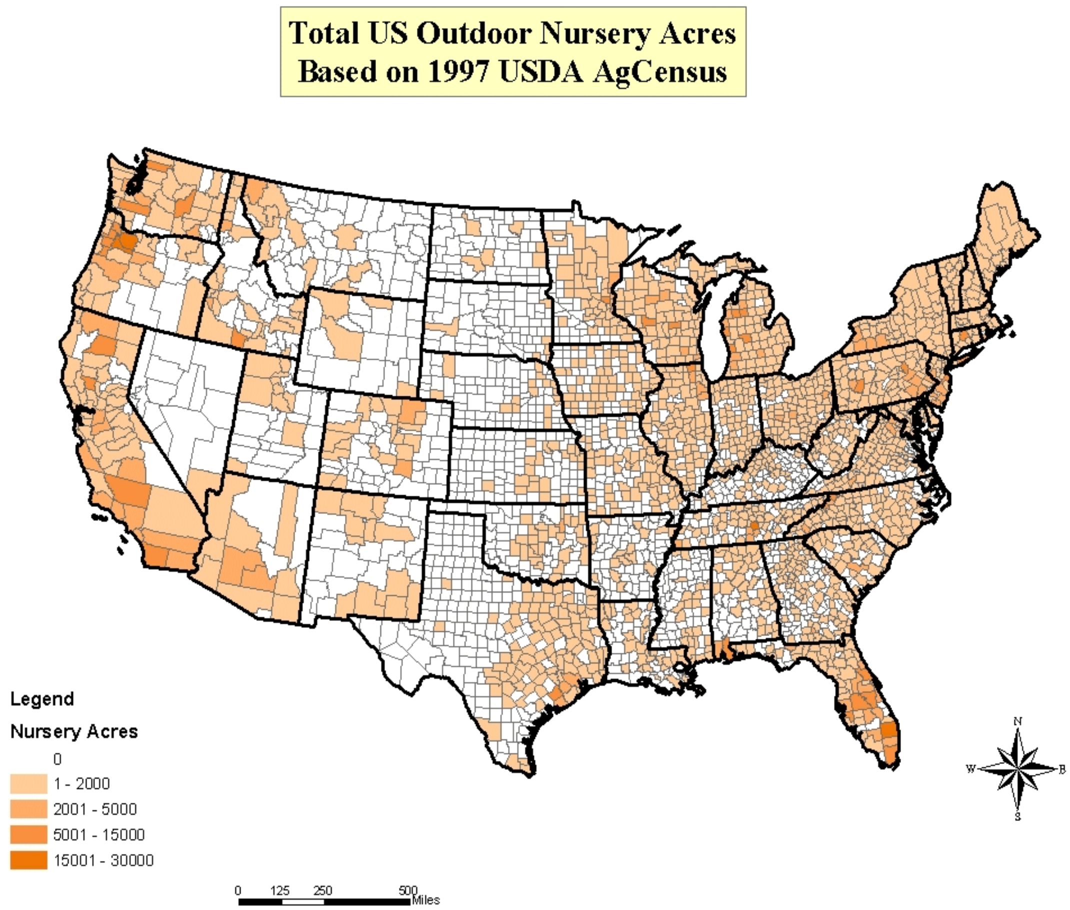


Figure 2.1 National Distribution of Outdoor Nursery Acres (USDA 1997 Ag Census)

Figure 2.2 Location of Carrot Acres in California (CDPR, 2003)

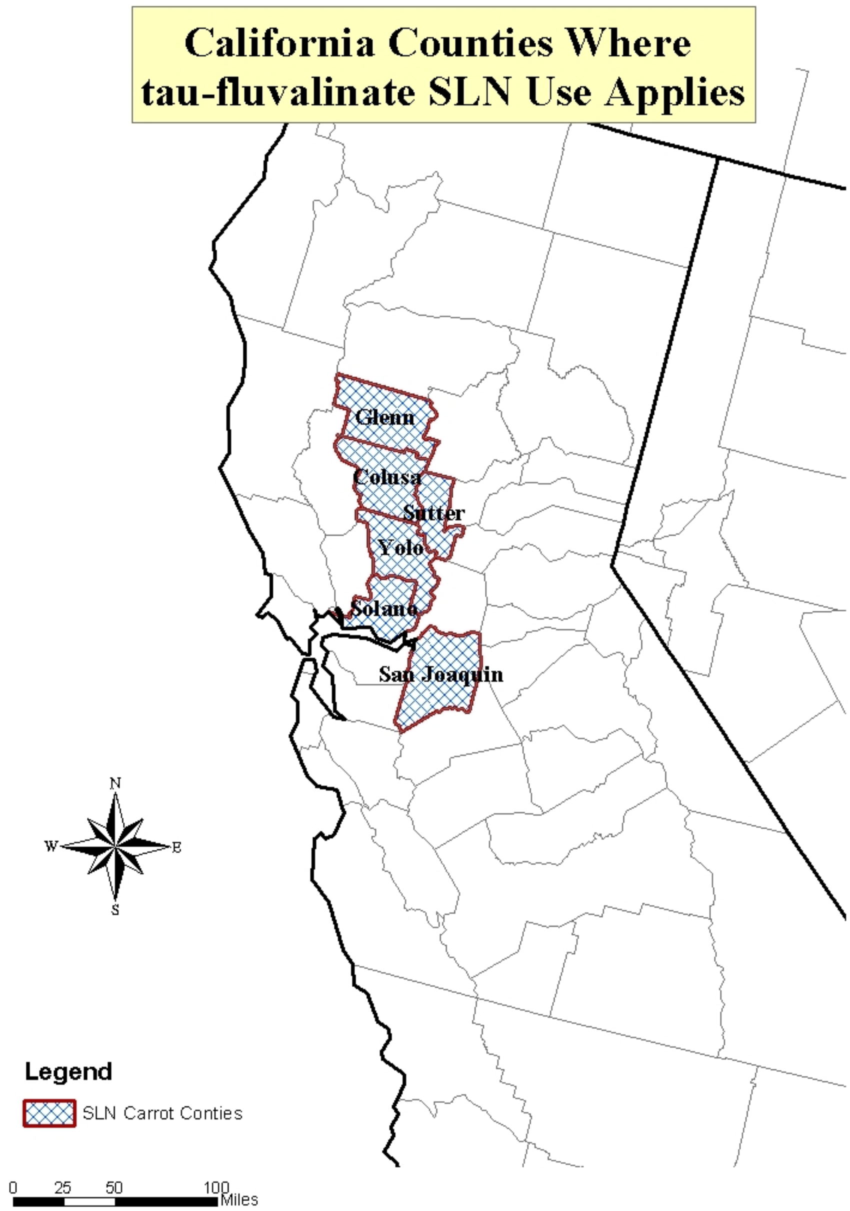


Figure 2.3 California Counties Included in Special Local Needs (SLN) Registration for Use of Tau Fluvalinate on Carrots

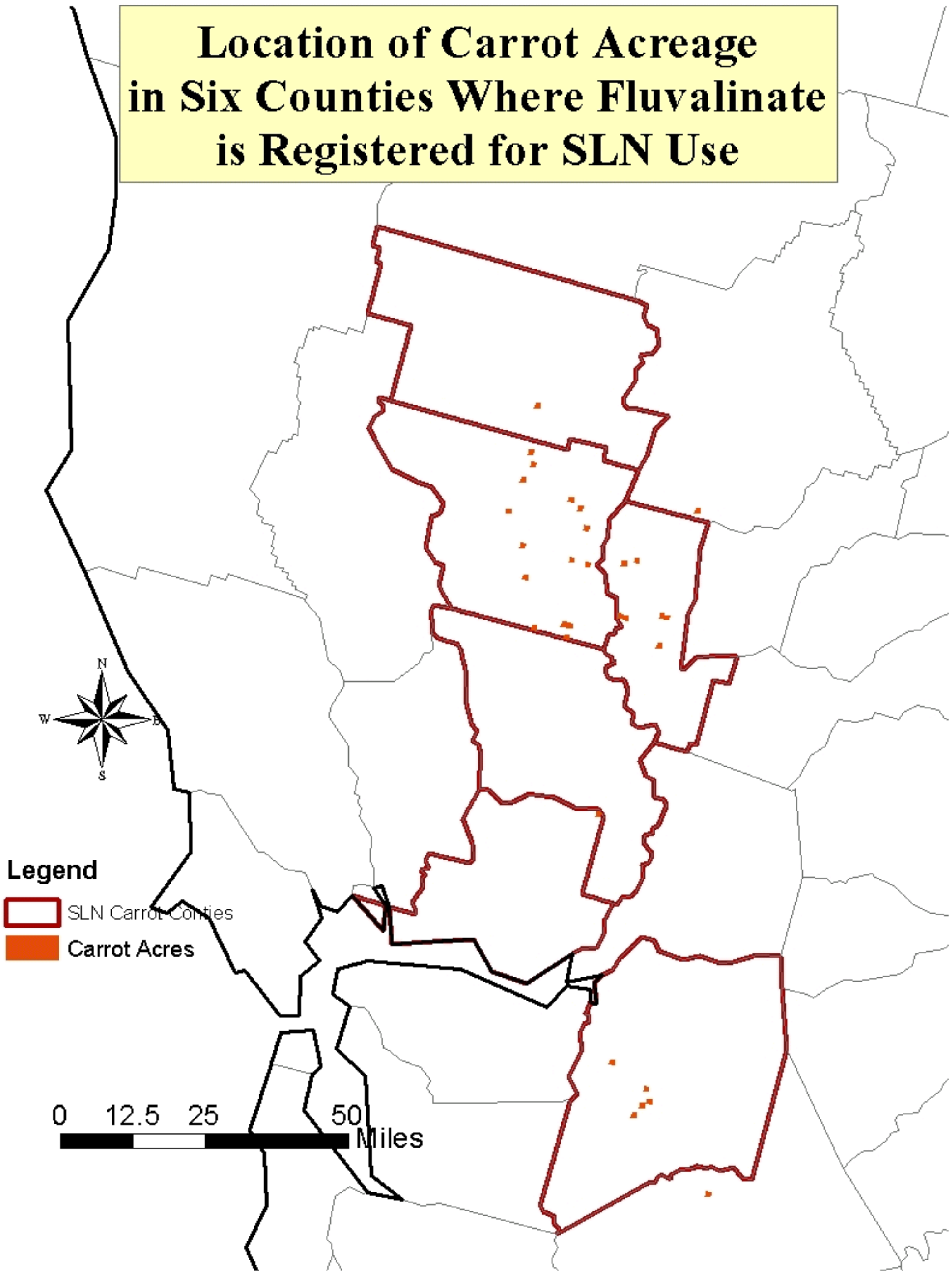


Figure 2.4 Location of One-Mile Square Sections with Carrot Acreage within Six SLN Counties

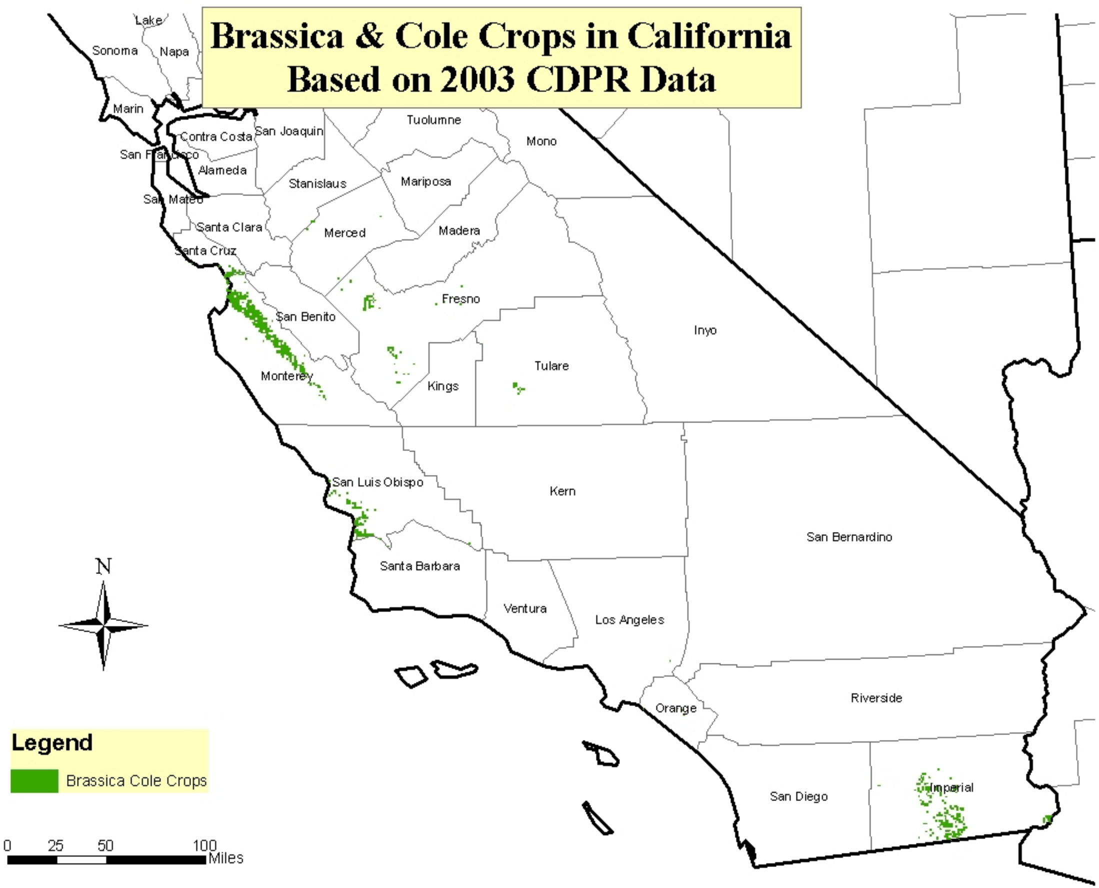


Figure 2.5 Location of One-Mile Square Sections in California with Brassica & Cole Crops (CDPR, 2003)

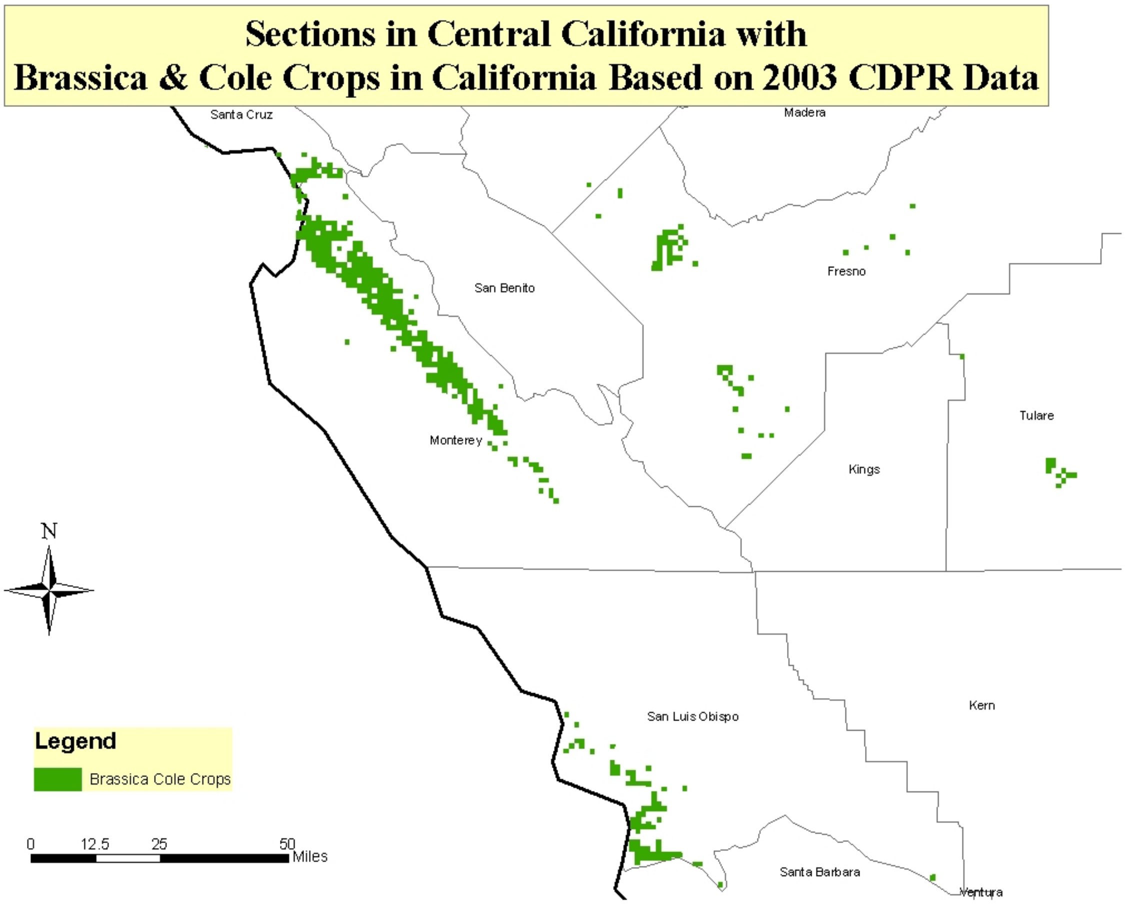


Figure 2.6 Location of One-Mile Square Sections within Central California with Brassica & Cole Crops (CDPR, 2003)

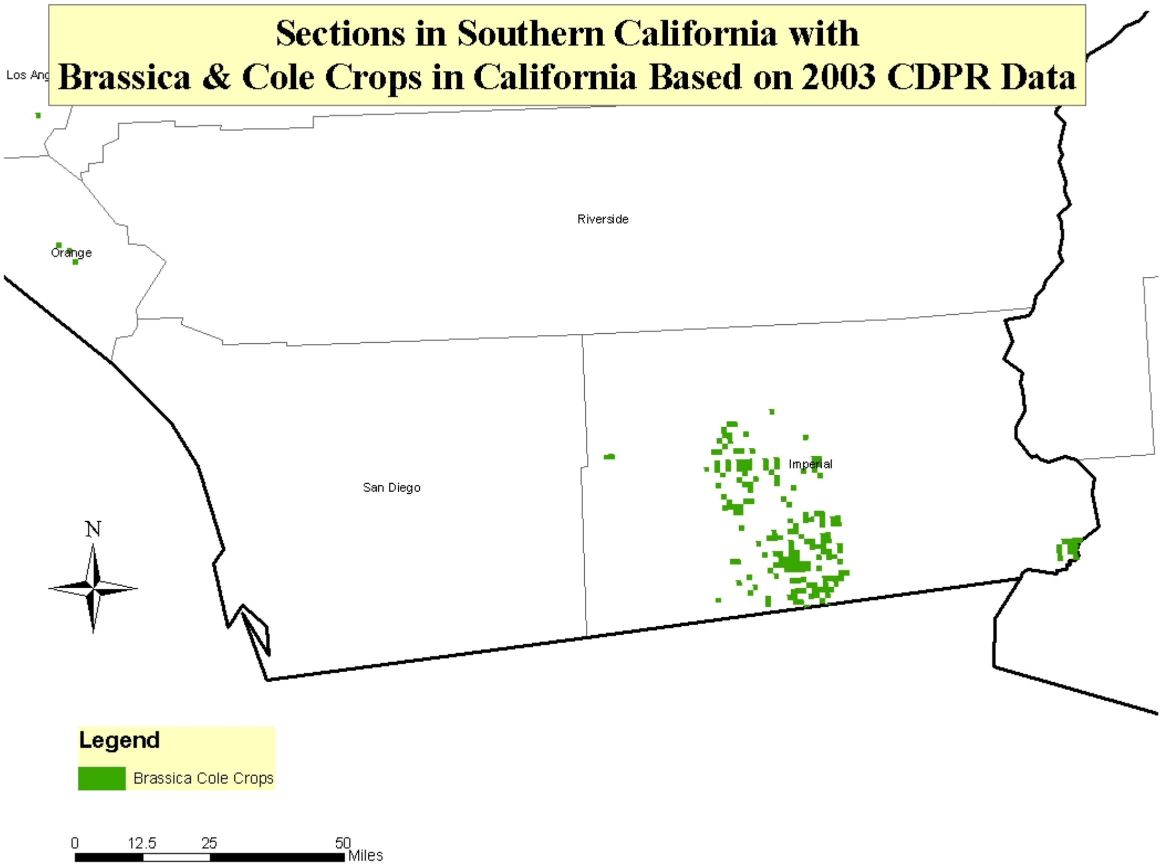


Figure 2.7 Location of One-Mile Square Sections within Southern California with Brassica & Cole Crops (CDPR, 2003)

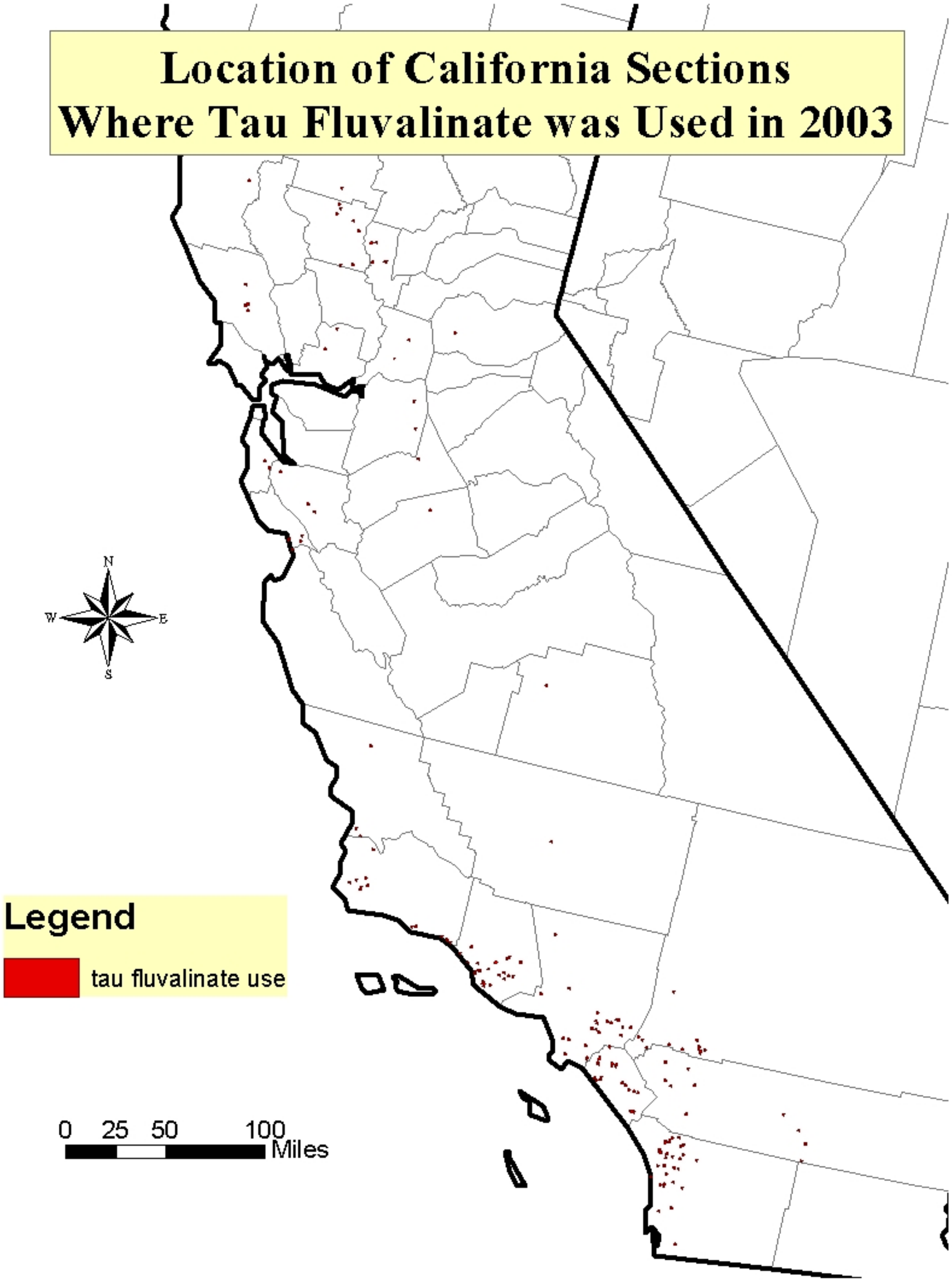


Figure 3.1 Location of Tau Fluvalinate Use in California (CDPR, 2003)

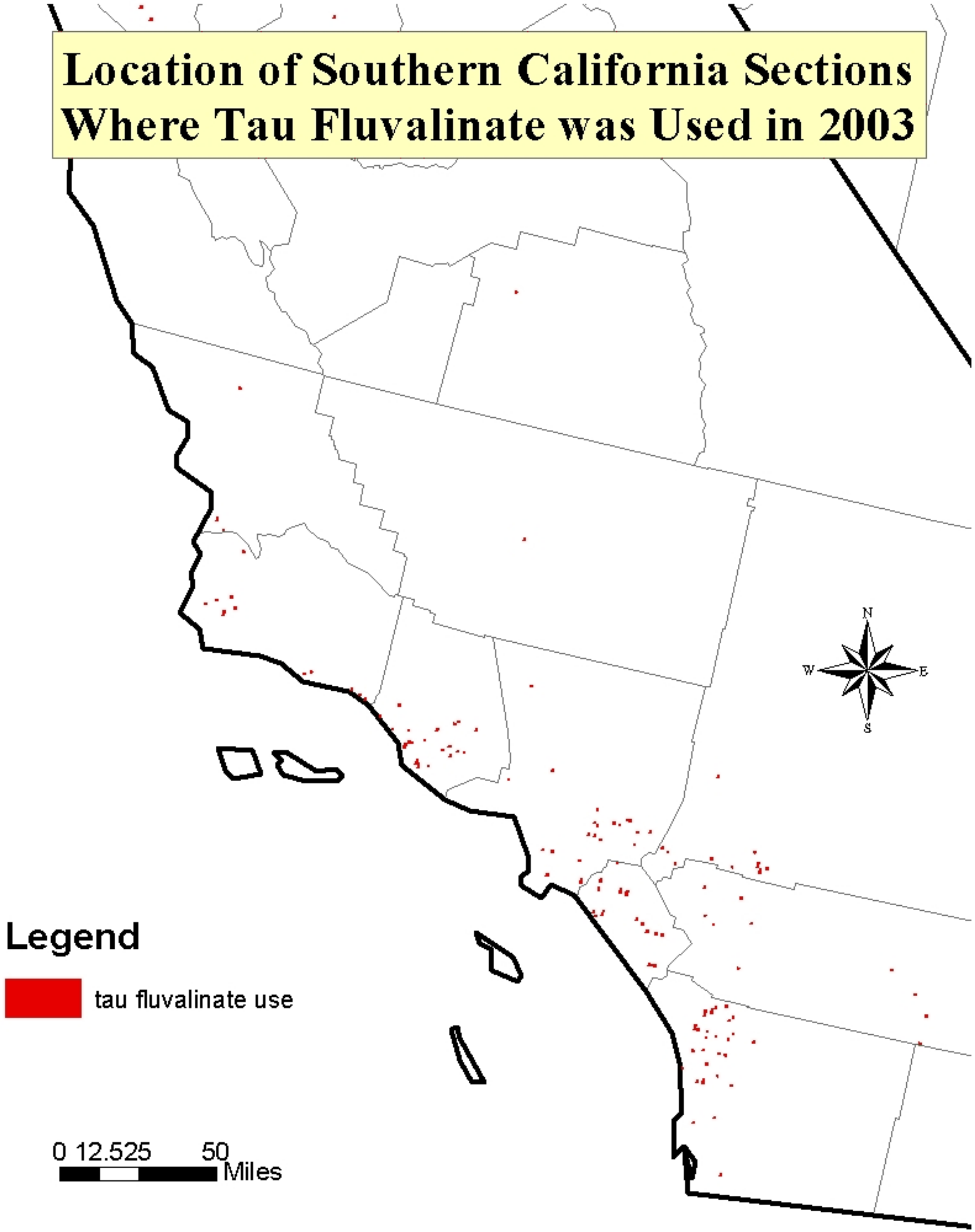


Figure 3.2 Location of One-Mile Square Sections in Southern California with Tau Fluvalinate Use (CDPR, 2003)

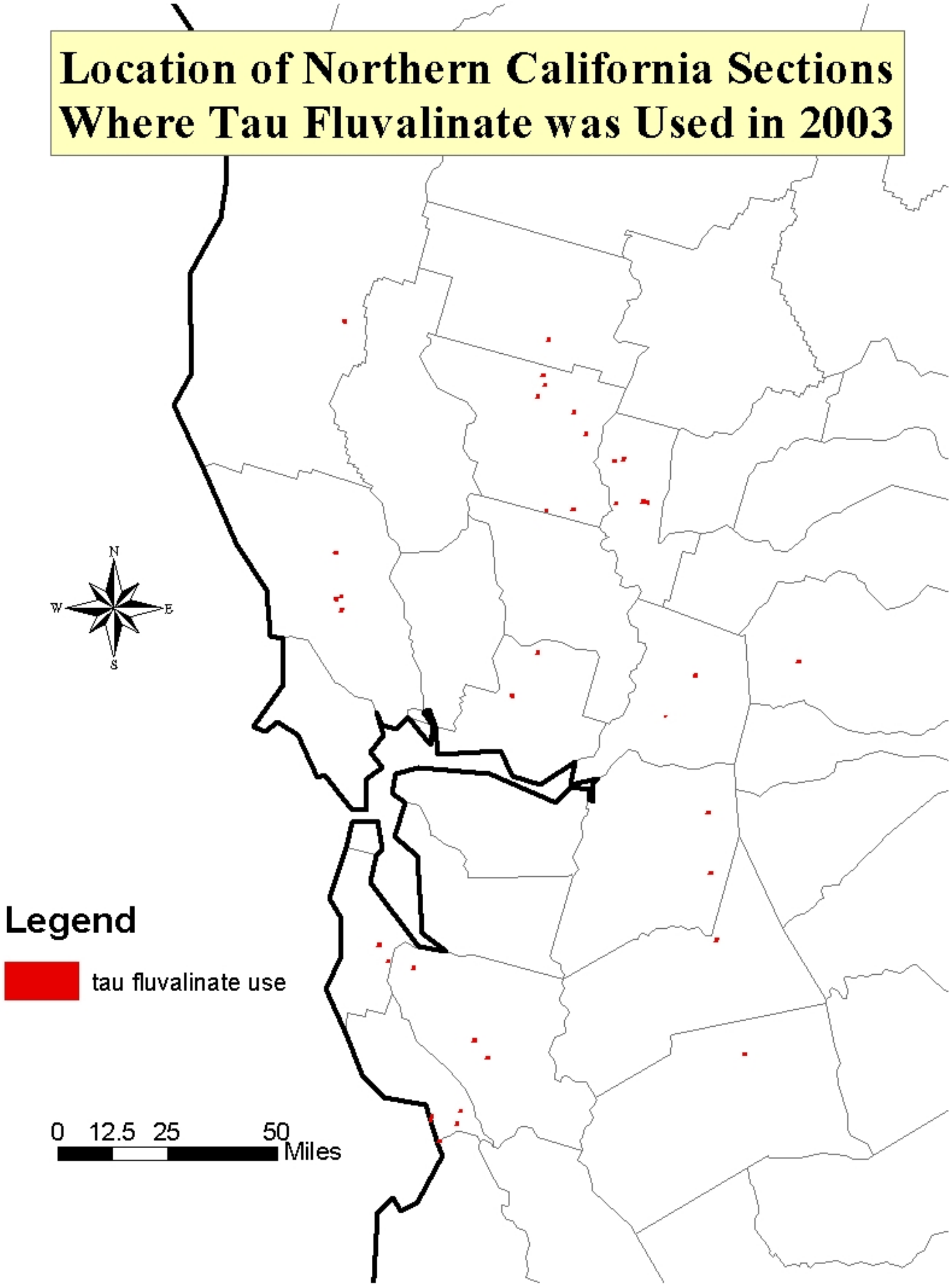


Figure 3.3 Location of One-Mile Square Sections in Central California with Tau Fluvalinate Use (CDPR, 2003)

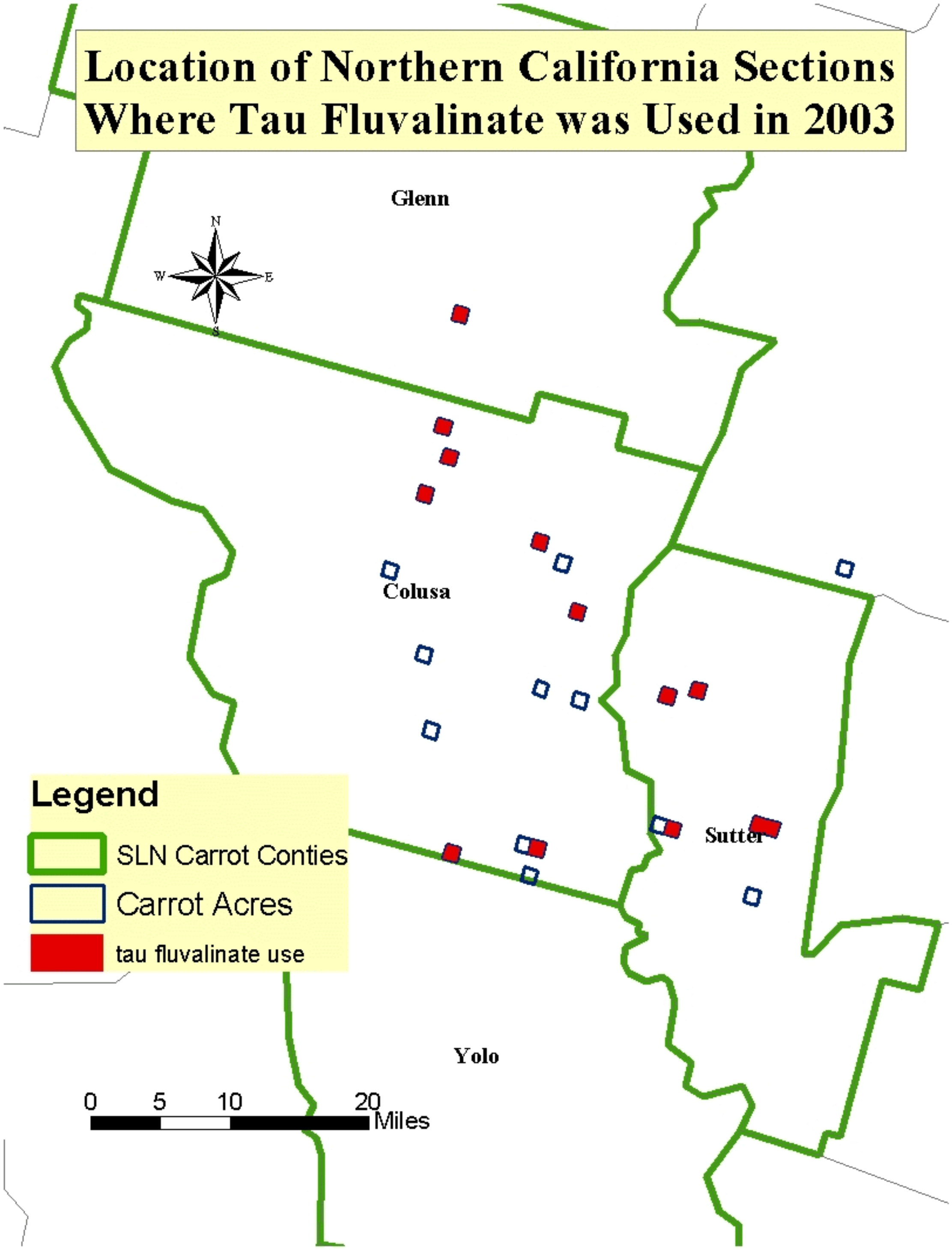


Figure 3.4 Location of One-Mile Square Sections with Carrot Acreage where Tau Fluvalinate was used in 2003 (CDPR, 2003)

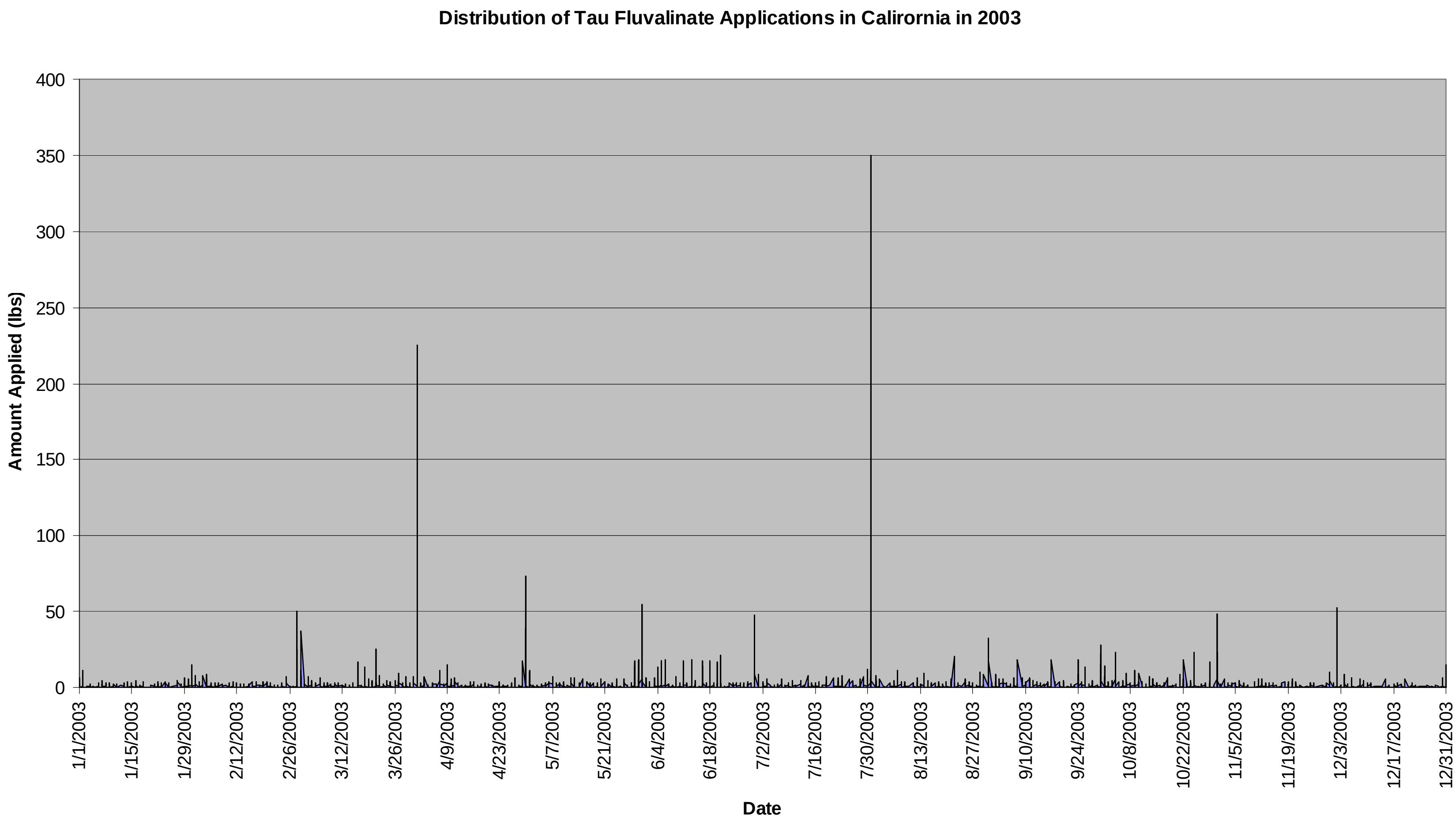


Figure 3.5 Time Series of 2003 Tau Fluvalinate Applications in California (CDPR, 2003)

Appendices

A. Environmental Fate Studies

There are three versions of fluvalinate which have been tested or proposed for testing since the late 1970's. These forms are racemic fluvalinate consisting of four diastereoisomers (designated as R-2R, R-2S, S-2R and S-2S), half resolved fluvalinate consisting of two diastereoisomers (R-2R and S-2R), and fully resolved fluvalinate consisting of a single diastereoisomer (S-2R). Initial testing conducted up until the mid-1980's was conducted using racemic fluvalinate. Beginning in the mid-1980's and until recently, environmental fate tests were conducted using the half resolved fluvalinate, also known as tau-fluvalinate. For environmental fate data, initial testing was conducted using the racemic form of fluvalinate. However, in 1989 the registrant proposed a bridging strategy for relying on racemic fluvalinate data to support the registration of tau-fluvalinate. The Agency agreed in a memorandum dated January 31, 1990 that racemic fluvalinate data for the abiotic processes could be used to support tau-fluvalinate. However, additional data would need to be submitted for tau-fluvalinate for biotic processes (aerobic soil metabolism, anaerobic soil metabolism, and terrestrial field dissipation).

Based on all acceptable and supplemental data (both bridged racemic data and data for tau-fluvalinate) the major routes of degradation for tau-fluvalinate in laboratory studies are by abiotic processes (photodegradation in water and soil, and pH dependent hydrolysis) and biotic processes under aerobic conditions. Tau-fluvalinate is expected to be rapidly degraded in both soil and aquatic environments under aerobic conditions but is expected to be stable under anaerobic conditions. Tau-fluvalinate is stable to hydrolysis under acidic conditions but is rapidly hydrolyzed under alkaline conditions with a half life at pH 9 of 1.13 days. Tau-fluvalinate degraded rapidly by aqueous photolysis with a half life of 1 day but was slightly more stable to soil photolysis with a half life of 18 days. Tau-fluvalinate degraded in an aerobic soil metabolism study with half lives of 8 and 15 days, and had half lives of 63 days in a supplemental terrestrial field dissipation study. In an anaerobic aquatic metabolism study tau-fluvalinate degraded with half lives of 255 and 413 days in the whole system. Tau-fluvalinate is highly immobile, with K_d values between 853 and 1,708 and corresponding K_{oc} values between 110,000 and 370,000, respectively. Finally, tau-fluvalinate is of low solubility in sterile water at 12 micrograms per liter (ug/l) and has a low potential for bioaccumulation with a reported Kow of 18,000 (MRID 41889711) and bioconcentration factors (BCF) of 120, 660, and 360 for the edible, non-edible and whole fish tissues, respectively.

The following is a summary of individual studies grouped by Subdivision N guideline numbers.

161-1 Hydrolysis (Acc. No. 76691, MRID 41597303, 45769201, 45769202)

Overall, **Accession No. 76691** was classified by EFED as unacceptable. However, the registrant noted that a more recent study (**MRID 41597303**) was submitted. EFED concluded that this study provided acceptable hydrolysis data for pH’s 5 and 9 but that the data at pH 7 was unacceptable. Wellmark has submitted an addendum to this study (**MRID 45769202**) which provides **supplemental** information on hydrolysis of tau-fluvalinate at pH 7. The study could not be classified as acceptable at this time because no information was provided on the sterility of the test system. A separate Data Evaluation Record (DER) has been prepared for this additional information.

In an partially acceptable study (**MRID 41597303**), the hydrolysis of tau fluvalinate was studied at pH 5 and pH 9, however, data was lacking at pH 7. In this study, fluvalinate hydrolyzed with registrant calculated half lives of 48 days at pH 5 and 1.13 days at pH 9 in sterile buffered aqueous solutions that were incubated in the dark at 25^0 C. The degradates 3-PB Aldehyde, anilino acid, and diacid were identified in both solutions. 3-PB acid was identified only in the pH 5 solution. The portions of the study conducted at pH 5 and pH 9 were classified as acceptable, however the portion conducted at pH 7 was deemed unacceptable because the study was terminated before a half was established.

In a supplemental study (**MRID 45769202**), the hydrolysis tau fluvalinate, at 9 μg a.i./L, was studied in the dark at 25°C in pH 7 aqueous buffered solution for up to 26 days. The test system consisted of foil-wrapped amber bottles (1 ounce) containing 20 mL of the treated test solution. The samples were shaken throughout the incubation. Duplicate samples were collected at 0, 1, 7, 14, 19, and 26 days posttreatment. Test solutions were extracted with ethyl acetate. The organic extracts and the extracted aqueous solutions were analyzed using LSC. The sample bottles were rinsed with methanol, and the rinse was analyzed using LSC. The organic extracts were analyzed via one-dimensional TLC. Areas of radioactivity on the plates were identified by cochromatography with unlabeled reference standards. Identifications were confirmed using GC. The following reference compounds for possible transformation products were included in the study: 3-PB Aldehyd, 3-PB Acid, Anilino acid, Diacid, Haloaniline, Oxamic acid, Cyanohydrin, 3-PB Cyanide, Amide, and Formanillide.

The overall [^{14}C]residue recovery was 101.13 ± 1.56% (range 99.42-103.93%). There was no significant loss of material with time. In the pH 7 buffer solution at 25°C, [^{14}C]fluvalinate declined from an average 95.10% at 0 days posttreatment to an average 51.89% at 14 days and to a final average 40.99% at 26 days (study termination). Three major transformation products were isolated: 3-phenoxybenzaldehyde [3-PB Aldehyde], 2-(2-chloro-4-carboxyl)anilino-3-methylbutanoic acid [Diacid], and 2-(2-chloro-4-trifluoromethyl)anilino-3-methylbutanoic acid [Anilino acid]. 3-PB Aldehyde and Diacid increased to average maximums of 20.23% and 20.36% of the applied, respectively, at 26 days posttreatment (study termination). Anilino acid averaged a maximum of 17.88% at 19 days posttreatment and decreased to 8.64% at 26 days. The only minor transformation product was 3-phenoxybenzoic acid [3-PB Acid], which averaged a maximum of 7.45% of the applied at 19 days posttreatment. Unidentified [^{14}C]residues in the extracted aqueous solution totaled a maximum of 5.64% of the applied at 26 days posttreatment Volatiles were not measured.

Based on first-order linear regression analysis (Excel 2000), fluvalinate degraded with a half-life of 22.5 days. A transformation pathway was provided by the study author. Fluvalinate degraded into 3-PB Aldehyde and Anilino acid via a ester hydrolysis. 3-PB Aldehyde degraded to 3-PB Acid via oxidation of the aldehyde to a carboxylic acid. Anilino acid degraded to Diacid via the hydrolysis of the trifluoromethyl group to a carboxylic acid.

161-2 Aqueous Photolysis (Acc. No. 072938, MRID 41597305, 45769201, 45769203)

The guideline was originally classified by EFED as potentially acceptable due to the fact that the study was only conducted at pH 5. The status also noted several other deficiencies with the results for pH 5. The registrant correctly noted that current guidance only requires that the study be conducted at pH 5. In addition, the registrant argued that the earlier study (Acc 072938) provides acceptable information on the rate of photo degradation of tau-fluvalinate while a more recent submission (MRID 41597305) provides acceptable information on the identity of the degradation products likely to occur as a result of aqueous photolysis of tau-fluvalinate. Wellmark has provided additional information for the pH 5 portion of the study which addresses the additional concerns of the original reviewer. This data is submitted in MRID 45769203 (an addendum to MRID 41597305) and a separate DER will be prepared for this submission. However, although the weight of evidence of the data from the studies reviewed provides useful information on the degradation products expected under natural sunlight (MRID's 45769203 & 41597305), and all study results suggest rapid photo degradation with half lives between 10 minutes and one day, overall, there is sufficient uncertainty in the comparability of results from the earlier study with a half life of 1 day (Acc 072938) and the subsequent studies with half lives of 10 minutes (MRID's 45769203 & 41597305) that the guideline is not fulfilled and all data is considered **supplemental**. Wellmark should consider conducting a single study which addresses all of the reviewers concerns, provides an accurate estimate of the photo degradation rate, and identifies all photo degradation products in a single study.

In an acceptable study (**Accession No. 072938**) fluvalinate was exposed to natural sunlight and photodegraded in a dilute aqueous solution with a half life of 0.6 to 1.0 day. Fluvalinate degraded by hydrolysis of the ester bond yielding haloaniline and anilino acid from the acid moeity and 3-PB acid from the alcohol moeity. The original review of the study classifed it as unaccpetable and asked for clarification of why material balances were low and whether glassware used was transparent to light between 290 and 800 nm. The registrant responded with explanation of the material balance issues based on the adherence of parent material to glass surfaces and confirmed the transparency of the test vessels to light between 290 and 800 nm.

In **supplemental** studies (**MRID 41597305 & 45769203**) the aqueous phototransformation of fluvalinate was studied at a nominal concentration of 10 μg a.i./L in an aqueous pH 5 buffer solution (0.1 M; phthalate) for 10 minutes under continuous irradiation. The light source was a filtered medium pressure mercury vapor lamp that was 2.6 times more intense than natural sunlight on a clear day in Cincinnati, OH; the light intensity averaged 2.26 x 10^4 μW/cm^2 between 222.4 and 1367.3 nm. The irradiated test system consisted of a single photochemical reaction vessel (1,000 mL volume; containing 950 mL of treated solution) constructed with a borosilicate immersion well that was cooled with circulating water; the temperature of the irradiated solution was not reported. The reaction vessel was attached to a volatile trapping system. Air was passed through the vessel, then through silica gel, ethylene glycol, and a NaOH solution. The corresponding dark control was placed in an amber bottle wrapped in aluminum foil and maintained at room temperatures (23°C); volatiles were not trapped. Subsamples of the test solution were collected immediately after treatment and mixing. The treated solution was sampled immediately posttreatment. Subsamples of the irradiated bulk solution were collected at 1, 2, 4, 6, 7, 8 and 10 minutes posttreatment. The dark control was sampled only at 10 minutes posttreatment. Aliquots of the subsamples were analyzed for total radioactivity using LSC. Additional aliquots were partitions with ethyl acetate. Aliquots of the resulting organic and aqueous fraction were analyzed for total radioactivity using LSC and for specific compounds using TLC. [^{14}C]Residues on the TLC plate were identified by comparison to the reference standards of fluvalinate, 3-phenoxybenzaldehyde, haloaniline, cyanohydrin, 3-phenoxybenzoyl acid, 3-phenoxybenzoic cyanide, oxamic acid, formanilide, amide, anilino acid, and diacid. Identifications were confirmed using GC and GC/MS.

The overall recovery of radiolabeled material immediately posttreatment was 100.0% of the applied. In the dark control at 10 days (only sampling interval), recovery was 95.74% of the applied. In the irradiated solution, recoveries were variable over time, averaging 98.64 ± 6.90% of the applied (range 91.24-98.86% at 1-8 minutes posttreatment, 113.94% at 10 minutes).

In the **dark control**, [^{14}C]fluvalinate was 94.60% of the applied at 0 days posttreatment and 90.21% at 10 minutes (study termination). In the **irradiated solutions**, [^{14}C]fluvalinate decreased from 94.60% of the applied at 0 days posttreatment to 55.74% at 7 minutes, 49.84% at 8 minutes, and 49.68% at 10 minutes.

In the **dark control**, no major transformation products were isolated. One minor transformation product, 3-phenoxybenzoic acid, was identified at 2.58% of the applied. Volatilization was not measured. In the **irradiated sample**, two major transformation products were isolated. Cyanohydrin of 3-phenoxybenzaldehyde (cyanohydrin) was a maximum 10.71% of the applied at 10 minutes. 3-Phenoxybenzoic acid (3-PB acid) was a maximum 9.73% at 7 minutes and was 8.12% at 10 minutes. Four minor transformation products were identified. 2-(2-Chloro-4-trifluoromethyl)anilino-3-methylbutanoic acid (anilino acid) was a maximum 8.99% at 10 minutes; 3-phenoxybenzaldehyde (3-PB aldehyde) was a maximum 5.27% at 8 minutes; 2-chloro-4-trifluoromethylaniline (haloaniline) was a maximum 5.14% at 6 minutes; and 2-(2-chloro-4-carboxyl)anilino-3-methylbutanoic acid (diacid) was a maximum 4.16% at 8 minutes. One unidentified transformation product was isolated at a maximum 7.97% at 8 minutes. In addition, aqueous-soluble [^{14}C]residues were a maximum of 6.21% of the applied and uncharacterized [^{14}C]residues in the container wash (10 days only) totaled 12.45%. At 10 minutes posttreatment (only interval measured), $^{14}CO_2$ totaled 1.97% of the applied and volatile organics totaled 0.43%.

Based on first-order linear regression analysis (Excel 2000) using all data points, fluvalinate degraded with a half-life of 10.00 minutes in the irradiated sample and 144.4 minutes in the dark control. The accuracy of the half-life calculated for the dark control is highly uncertain since it is based on only two sampling intervals. The **phototransformation half-life** of fluvalinate is 10.74 minutes. Since the intensity of the artificial light was 2.6 times the intensity of natural sunlight, the predicted **environmental phototransformation half-life** of fluvalinate is approximately 28 minutes. However, since the wavelength distribution of light from the mercury arc lamp is not similar to sunlight, the validity of this comparison is suspect.

A transformation pathway was proposed by the study author. Fluvalinate degraded via hydrolysis at the ester linkage to cyanohydrin which degraded to anilino acid and 3-phenoxybenzaldehyde (3-PBA). 3-PBA further degraded oxidation to 3-phenoxybenzoic acid. Anilino acid further degraded via oxidation to diacid or was hydrolyzed to haloaniline.

161-3 Soil Photolysis (Acc. No. 83757, MRID 41597307, & 45769201)

The original study submitted in support of fluvalinate (**Acc. No. 83757**) was classified by EFED as acceptable. However, this was based on a study submitted in 1981 and reviewed in 1985. The study deternined that photolysis appeared to have little effect on the degradation of fluvalinate in soil. Fluvalinate degraded on soil almost as fast and formed the same degradation products on soil not exposed to sunlight as when the soil was exposed to natural sunlight. The half life when exposed to sunlight was 4 days but the fact that the same half life (not summarized in the available description) was reported for the dark control suggests that in this study fluvalinate was stable to soil photolysis.

Subsequently, the registrant submitted a new soil photolysis study (MRID **41597307**) which was initially classified as unacceptable. In this study, fluvalinate photodegraded with a registrant calculated half life of 12.8 days on sandy loam soil continuously irradiated with a super metal halide lamp at 25 C. The major degradates detected were amide, 3-PB aldehyde, cyanohydrin, 3-PB acid, anilino acid, and diacid. This original classification was based on the fact that the wavelength of the artificial light source was not clear and was not compared with natural sunlight. The registrant correctly notes (**MRID 45769201**) that the study was classified as unacceptable due to the fact that the study was only conducted at pH 5 and that the Agency review of this study indicated that the study could be classified as acceptable if additional data were submitted on the light source used. The registrant provided additional information in a response document (**MRID 45769201**) and the study is upgraded to **acceptable**.

162-1 Aerobic Soil Metabolism (Acc. No. 126102, MRID 41889715, 45769201, & 45769204)

In **Accession No. 126102**, CF_3 labeled fluvalinate degraded in sandy loam, sandy clay, and clay soils with a half life of 6 to 8 days. The principal degradates in soil were anilino acid and haloaniline. The majority of the volatilized material was haloaniline. CO_2 accounted for 3.1% to 9% of the applied after 8 weeks. Benzyl labeled fluvalinate degraded with a half life of 4 days in a clay soil. The major degradate, 3-PB acid, appeared to degrade slowly in soil. Finally, fluvalinate degraded with a half life of 15 days in a sandy loam soil maintained under anaerobic conditions with similar degradates as those found under aerobic conditions. Also, this study was conducted using racemic fluvalinate and is not used in the assessment of tau (half resolved) fluvalinate

The study with **Accession No. 126102** was originally submitted to fulfill data needs for aerobic soil metabolism, anaerobic soil metabolism, and leaching/adsorption/desorption. The study was classified by EFED as unacceptable. This paper is a summary of several studies proposed for publication. The data presented are largely summaries of the experiments conducted. The submission does not provide adequate detail to evaluate the quality of the experiments conducted or review the conclusions.

Specific weaknesses are:

- Raw data is not supplied.
- The specific ratio of enantiomers of the radiolabeled substance and cold standard is not specified.
- Application rate is specified only as mass per unit area. Mass per unit weight is not available.
- Soils were exposed to light and dark period, not held in the dark the entire experiment.
- Some soils were not sampled with adequate frequency (e.g. not sampled within the first half-life).
- Extraction methods varied and the identity of the extraction solvent was not specified for individual results.
- The properties and temperature of the water used in soil partitioning experiment was not defined.
- Material balance in the soil partitioning experiments is not adequately defined.
- Three, not four, soils were used in partitioning experiments.
- Partition coefficients were not calculated.
- Soil incubation/equilibration times were not justified.

A subsequent study with **MRID 41889715** was submitted to fulfill the need for information on the aerobic soil metabolism of tau-fluvalinate which was also classified by EFED as unacceptable. This study (comprised of two studies conducted using different radiolabels) is not valid and does not meet guideline requirements for aerobic soil metabolism for the following reasons:

1) The experimental method was inadequate. Separate samples were used to determine soil residues and volatiles. Both soil residue data and volatile data must be obtained from the same samples.

2) The analytical method was questionable. The use of methanol to extract samples (polyurethane plugs and, initially, soil samples) was associated with additional degradation of the parent compound to a metabolite. It was not clear which of the reported data were obtained following extractions with acetonitrile or whether the volatiles data and time 0 soil data were determined using methanol as an extractant. All samples should be processed using an appropriate, validated analytical method. The text of the study report should clearly identify the analytical method used to process the samples and obtain the data for the metabolite characterization, the half-life calculation and the material balance determination.

3) The material balances were not adequately determined. Material balances were reported on a wet-weight basis with regard to soil residue data. All residues in soil should be reported on a dry-weight basis to preclude dilution or concentration effects caused by unequal drying of samples over time. Additionally, material balances were determined using estimated values (referred to as "calculated values" based on data obtained from the study using the other radiolabel) for volatiles in one of the studies (aniline ring label). Accurate values were not available due to analytical method problems resulting from the use of a methanol extractant.

4) The half-lives were questionable, as the two different radiolabeled parent compounds generated two different half-lives (approximately 8 and 15 days) in the same soil type and under the same conditions.

The registrant has submitted additional information in an adsorption/desorption study (**MRID 45769204**) to address the concerns identified in the review of MRID 41889715. EFED finds the arguments in the response document (**MRID 45769201**) sufficient to upgrade MRID 41889715 to **acceptable**. The additional aerobic soil metabolism data provided in the adsorption/desorption study (MRID 45769204) provides useful information aerobic soil metabolism for tau-fluvalinate but cannot by itself and is therefore classified as **supplemental**.

163-1 Adsorption/Desorption (Acc. No. 76691, MRID 41597303, 45769201, 45769202, Acceptable)

Accession # 126102 & MRID 41597309

The study with **Accession No.126102** was originally submitted to fulfill data needs for aerobic soil metabolism, anaerobic soil metabolism, and leaching/adsorption/desorption. The study was classified by EFED as unacceptable. Also, this study was conducted using racemic fluvalinate and is not used in the assessment of tau (half resolved) fluvalinate

A subsequent study with **MRID 41597309** was submitted to fulfill the need for information on the adsorption/desorption of tau-fluvalinate which was also classified by EFED as unacceptable due to improperly sieved soil. In response to these comments the registrant indicated (**MRID 45769201**) that an additional study would be submitted.

The registrant has submitted a new study that provides additional data on the adsorption/desorption of tau-fluvalinate. In this **supplemental** study (**MRID 45769204**) the adsorption/desorption characteristics of fluvalinate were studied in four U.S. soils and one U.S. sediment: a clay loam soil from Gilroy, California; a sandy loam soil from Hughson, California; a silt loam sediment from Washington County, Mississippi; a silt loam soil from Washington County, Mississippi; and a sand soil from Moss Landing, California, in three batch equilibrium experiments. In each batch equilibrium experiment, the four soils and one sediment were treated with unaged fluvalinate or aged fluvalinate. The aged [aniline-U-^{14}C]-labeled and [benzyl-U-^{14}C]-labeled fluvalinate were isolated from the 30-day soil extracts of aerobic Hanford Sandy loam soil which was maintained at 75% of 0.33 bar moisture and 25 ± 1°C in the dark (volatiles were collected during aging).

For the unaged [^{14}C]fluvalinate batch equilibrium experiment, the adsorption phase of the study was carried out by equilibrating air-dried soil (1-2% water) with [aniline-U-^{14}C]fluvalinate at nominal concentrations of 0.00175, 0.00315, 0.01025, and 0.0335 mg a.i./kg soil for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil at 24°C in the dark for 4 hours. The equilibrating solution used was 0.01M $CaCl_2$, with soil/solution ratios of 1:5 (w:v) for all test soils. The desorption phase of the study was carried out by replacing the adsorption solution with an equivalent volume of pesticide-free 0.01M $CaCl_2$ solution and equilibrating in the dark for 16 hours at 24°C. The desorption cycle was conducted once for all soils.

For the aged [^{14}C]fluvalinate batch equilibrium experiments, the adsorption phase of the study was carried out by equilibrating air-dried soil (1-2% water) with either aged [aniline-U-^{14}C]fluvalinate at nominal concentrations of 0.0027, 0.005, 0.012, and 0.0285 mg a.i/kg soil or aged [benzyl-U-^{14}C]fluvalinate at nominal concentrations of 0.00245, 0.00475, 0.012, and 0.029 mg a.i/kg soil for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil at 24°C in the dark for 20 hours. The equilibrating solution used was 0.01M $CaCl_2$, with soil/solution ratios of 1:5 (w:v) for all test soils. The desorption phase of the study was carried out by replacing the adsorption solution with an equivalent volume of pesticide-free 0.01M $CaCl_2$ solution and equilibrating in the dark for 24 hours at 24°C. The desorption cycle was conducted once for all soils.

The <u>unaged</u> [aniline-U-^{14}C]fluvalinate was stable throughout the study, representing 99% of total radiocarbon at the start and end of the adsorption-desorption study. The <u>aged</u> [aniline-U-^{14}C]fluvalinate changed slightly throughout the study, representing 85% of total radiocarbon at the start and 83% at end of the adsorption-desorption study. The <u>aged</u> [benzyl-U-^{14}C]fluvalinate changed slightly throughout the study, representing 87% of total radiocarbon at the start and 86% at end of the adsorption-desorption study. The mass balance at the end of the adsorption phase was not reported. Material balances at the end of the desorption phase for all soil and sediment samples treated with <u>unaged</u> [aniline-U-^{14}C]fluvalinate were 94-100%, 92-101%, 100-105%, 98-102%, and 92-96% of the applied radioactivity for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively. Material balances at the end of the desorption phase for all soil and sediment samples treated with <u>aged</u> [aniline-U-^{14}C]fluvalinate were 91-96%, 92-96%, 92-95%, 94-95%, and 91-93% of the applied radioactivity for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively. Material balances at the end of the desorption phase for all soil and sediment samples treated with <u>aged</u> [benzyl-U-^{14}C]fluvalinate were 93-101%, 97-103%, 98-104%, 97-105%, and 96-98% of the applied radioactivity for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively.

For the four soils and one sediment treated with unaged [aniline-U-^{14}C]fluvalinate: After 4 hours of equilibration, 99.5-100.0%, 98.4-99.7%, 99.4-101.3%, 99.1-100.0%, and 98.7-99.7% of the applied [^{14}C]fluvalinate was adsorbed to the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively (reviewer-calculated). Reviewer-calculated adsorption K_d values were 1708.0, 979.2, 853.1, 1123.4, and 1107.4 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively. Registrant-calculated adsorption K_d values were 1200, 1300, 1000, 1100, and 1300 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding adsorption K_{oc} values were 110000, 280000, 190000, 270000, and 370000. Freundlich K_{ads} values (registrant-calculated) were 340, 1600, 820, 340, and 630 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding Freundlich K_{oc} values were not determined.

At the end of the desorption phase (one cycle), 0.3-1.4%, 0.1-0.8%, 0.3-1.0%, 0.1-0.7%, and 0.1-0.8% of the adsorbed ^{14}C was desorbed from the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively (reviewer-calculated). Registrant-calculated desorption K_d values were 430, 680, 550, 1100, and 930 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding desorption K_{oc} values were 39000, 140000, 100000, 270000, and 270000. Freundlich K_{des} values (registrant-calculated) were 150, 93, 170, 130, and 110 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding desorption Freundlich K_{oc} values were not determined.

The reviewer-calculated r^2 value for the relationship of Kd vs. % organic carbon is 0.7243, for Kd vs. pH is 0.2795, and for Kd vs. % clay is 0.6408.

For the four soils and one sediment treated with aged [aniline-U-^{14}C]fluvalinate: After 4 hours of equilibration, 94.1-96.7%, 93.7-95.8%, 93.7-95.0%, 94.1-96.7%, and 92.6-95.0% of the applied [^{14}C]fluvalinate was adsorbed to the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively (reviewer-calculated). Reviewer-calculated adsorption K_d values were 92.3, 80.9, 80.5, 91.8, and 70.1 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively. Registrant-calculated adsorption K_d values were 94, 80, 78, 92, and 72 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding adsorption K_{oc} values were 8500, 17000, 15000, 22000, and 21000. Freundlich K_{ads} values (registrant-calculated) were 100, 81, 74, 98, and 76 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi

Silt loam soil, and Moss Landing Sand soil, respectively; corresponding Freundlich K_{oc} values were not determined.

At the end of the desorption phase (one cycle), 1.6-2.8%, 1.7-2.5%, 1.9-2.8%, 1.5-2.0%, and 1.3-1.8% of the adsorbed ^{14}C was desorbed from the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively (reviewer-calculated). Registrant-calculated desorption K_d values were 210, 230, 200, 270, and 330 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding desorption K_{oc} values were 19000, 49000, 38000, 66000, and 94000. Freundlich K_{des} values (registrant-calculated) were 140, 160, 140, 190, and 240 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding desorption Freundlich K_{oc} values were not determined.

The reviewer-calculated r^2 value for the relationship of Kd vs. % organic carbon is 0.3558, for Kd vs. pH is 0.0892, and for Kd vs. % clay is 0.5916.

For the four soils and one sediment treated with aged [benzyl-U-^{14}C]fluvalinate: After 4 hours of equilibration, 97.5-98.3%, 96.7-97.9%, 97.5-99.0%, 98.3-99.0%, and 95.8-97.7% of the applied [^{14}C]fluvalinate was adsorbed to the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively (reviewer-calculated). Reviewer-calculated adsorption K_d values were 285.9, 239.8, 407.5, 555.4, and 189.5 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively. Registrant-calculated adsorption K_d values were 220, 200, 290, 470, and 160 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding adsorption K_{oc} values were 20000, 43000, 55000, 110000, and 46000. Freundlich K_{ads} values (registrant-calculated) were 130, 120, 150, 240, and 110 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding Freundlich K_{oc} values were not determined.

At the end of the desorption phase (one cycle), 0.7-1.4%, 1.0-1.9%, 0.7-1.5%, 0.4-1.3%, and 1.0-1.4% of the adsorbed ^{14}C was desorbed from the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively (reviewer-calculated). The registrant-calculated desorption K_d values were 380, 310, 450, 690, and 370 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding desorption K_{oc} values were 35000, 66000, 85000, 170000, and 110000. Freundlich K_{des} values (registrant-calculated) were 210, 270, 410, 520, and 320 for the Gilroy Clay loam soil, Hanford Sandy loam soil, Mississippi Silt loam sediment, Mississippi Silt loam soil, and Moss Landing Sand soil, respectively; corresponding desorption Freundlich K_{oc} values were not determined.

The reviewer-calculated r^2 value for the relationship of Kd vs. % organic carbon is 0.0162, for Kd vs. pH is 0.3272, and for Kd vs. % clay is 0.0292.

Identification of [^{14}C]fluvalinate residues: In order to identify [^{14}C]residues of fluvalinate which was aged in aerobic Hanford Sandy loam soil (75% of 0.33 bar moisture and 25 ± 1°C in the dark), soil samples were analyzed after 7, 14, and 30 days of treatment (one sample per radiolabel). One [benzyl-U-^{14}C]fluvalinate soil sample was also sampled at 0 days posttreatment. At sampling intervals, the soil sample was extracted sequentially with methanol, chloroform, and water. The volatiles in the foam plug were extracted with diethyl ether. Aliquots of the combined soil extracts, diethyl ether extracts of the foam plug, and KOH trap solutions were quantified by LSC analysis. For all extracted soils except the 30-day aged extracted soils, the extracted soil was combusted prior to LSC analysis; only half of the 30-day aged extracted soils was combusted prior to LSC analysis (the other half was used for a supplemental desorption study). [^{14}C]Residues in the soil extracts were identified and quantified by HPLC without further manipulation.

In Hanford Sandy loam soil treated with [aniline-U-^{14}C]fluvalinate, fluvalinate accounted for 91% of the applied radioactivity at 7 days posttreatment (the first sampling interval), then decreased to 76% at 14 days and 51% at 30 days. No major transformation products were detected. Minor transformation products 4'-OH-fluvalinate {α-cyano-3-[(4-hydroxyphenoxy)benzyl] 2-[2-chloro-4-(trifluoromethyl)anilino]-3-methylbutanoate}, amide {α-carboxylamide-3-phenoxylbenzyl 2-[2-chloro-4-(trifluoromethyl)anilino]-3-methylbutanoate}, and anilino acid {2-[2-chloro-4-(trifluoromethyl)anilino]-3-methylbutanoic acid} were observed at maximum values of 4% (14 DAT), 1% (14-30 DAT), and 6% (14 DAT). Unidentified volatiles were a maximum of 16% at 30 days; carbon dioxide was measured at 2% from 14-30 days. Unextracted [^{14}C]residues were a maximum of 12% at 30 days. Overall [^{14}C]recovery decreased from 101% at 0 days to 90% at 30 days.

In Hanford Sandy loam soil treated with [benzyl-U-^{14}C]fluvalinate, fluvalinate accounted for 98% of the applied radioactivity at 0 days posttreatment, then decreased to 85% at 7 days to 70% at 14 days to 51% at 30 days. The only major transformation product was carbon dioxide. [^{14}C]Carbon dioxide was measured at 17% at 30 days. Minor transformation products 4'-OH-fluvalinate, amide, and 3-PBA {3-phenoxybenzoic acid} were observed at maximum values of 2% (14 DAT), 3% (30 DAT), and 1% (7-30 DAT). Unidentified volatiles were a maximum of 2% at 14 days. Unextracted [^{14}C]residues were a maximum of 14% at 30 days. Overall [^{14}C]recovery decreased from 100% at 0-7 days to 87-90% at 14-30 days.

Anaerobic Aquatic Metabolism Study (162-3) - MRID's 41996201, 42742501, 41889715, and 45769201 (amendment)

This study (comprised of two MRID's) is not valid and does not meet guideline requirements for anaerobic aquatic metabolism for the following reasons:

1) The analytical method was questionable. Based on information stated about the method in **MRID 41889715** (162-1 study; see deficiency list above), as well as statements made in the text of the current study (p. 21), the use of methanol to extract samples (Soxhlet extraction; second extraction) may have led to additional degradation of the parent compound to a metabolite. All samples should be processed using an appropriate, validated analytical method. Additionally, it was unclear which samples were analyzed by which methods of analysis (i.e., HPLC or TLC). The text of the study report should clearly identify the analytical method used to process the samples and obtain the data for the metabolite characterization, the half-life calculation and the material balance determination. Additionally, the source of the data were not clear for all samples and it could not be determined whether data obtained from both extractants used (i.e., acetonitrile and methanol) were added or whether only selected data were utilized. Concise tabular data with clearly marked sources were not included in the study report. Also, separate data were not included for the water and sediment phases of the test system.

2) The experimental method was inadequate to capture and allow for an accurate quantification of volatiles produced in the anaerobic aquatic systems. Consequently, the material balances were excessively low for samples representing the later sampling intervals ($\geq$179 days).

3) The experimental method was questionable in some aspects. The text of the study report indicated that a nutrient solution was utilized to flood the soil (under a nitrogen atmosphere) for four days and was then “withdrawn.” It is unclear from the description what was actually done to the samples and whether the procedure changed the chemical characteristics of the test systems (i.e., by removing highly soluble compounds from the soil).

4) The data reported for the sterile controls is not valid. The soils were sterilized by autoclaving, which can change the physico-chemical properties of the soils and, therefore, is not an acceptable method of sterilization. Additionally, there was a large discrepancy between the half-lives of the two radiolabeled parent compounds determined in the sterile soils (413 and 255 days), as well as between the time 0 values and subsequent patterns of degradation between the two radiolabeled compounds. Neither of the reported values represent valid half-lives, as they were determined from data obtained at only three sampling intervals and were estimated by extrapolation beyond the scope of the data. Additionally, a review of the data, which exhibit temporal and inter-replicate variability, do not indicate that degradation actually occurred in the sterile soils.

These studies were included in the April 3, 2002 EFED memorandum, however Wellmark did not respond to these deficiencies. These studies were originally classified in the status memorandum as unacceptable. However, the fact that a number of the deficiencies are similar to those discussed above (analytical method, volatiles, differences in half lives) and have been addressed above, and the fact that tau-fluvalinate is persistent in these studies EFED believes this study provides useful **supplemental** information on the anaerobic aquatic degradation of tau-fluvalinate. Submission of additional data may result in upgrading this study to acceptable.

165-1 Bioconcentration in Fish (MRID 92069044)

In an acceptable Bioconcentration in Fish study (**MRID 92069044**), fluvalinate residues were accumulated in edible, nonedible, and whole fish tissues of bluefill sunfish exposed to fluvalinate at 0.11 ppb for 30 days in a flow through aquarium. The maximum bioconcentration factors were 120x for edible tissues (body muscle, skin, and skeleton), 660x for nonedible tissues (fins, head, and internal organs), and 360x for whole fish. Dupuration was relatively slow with only 46% to 51% of the accumulated residues eliminated from the fish tissues by day 14 of the depuration period.

This study was conducted using fluvalinate. EFED determined in a memorandum dated January 31, 1990 that no additional data were required for tau-fluvalinate based on similarities in the compounds, the low bioconcentrations factors for fluvalinate, and the fact that it was not expected that repeating the study for tau fluvalinate would significantly alter the conclusions from this study.

164-1 Terrestrial Field Dissipation (MRID 42351601, 41889716l, & 41996202)

These studies were included in the April 3, 2002 EFED memorandum, however Wellmark did not respond to these deficiencies. Wellmark has submitted a waiver request. EFED notes that with the submission of limited information, the most recent study (MRID 42351601) could be upgraded to acceptable. EFED has determined that the terrestrial field dissipation data are not needed at this time given the limited use pattern. However, EFED recommended that the requirement be reserved, as opposed to waived, in case the use pattern changes. A summary of the previously submitted data is presented below. In general, this information suggests that the dissipation of tau fluvalinate under actual use conditions will not be appreciably different than that predicted from laboratory fate data.

MRID 42351601

This study is not valid *at this time* and does not meet guideline requirements *at this time* for terrestrial field dissipation for the following reasons:

1) The half-life was calculated using a data set with an incorrect value. The summary table in the abstract, Tables 14 & 15, and Figure 2 all indicate that the parent was present at a mean of 0.022 ppm at the 2-month sampling interval. However, the replicate data in Table 12 (p. 53) indicate that the actual mean value for the uncorrected data is 0.035 ppm; for recovery-corrected data, the value is 0.048 ppm (Table 13, p. 69). It is necessary that the half-life be calculated using the appropriate value. Additionally, it is unclear why the registrant did not utilize the available recovery-corrected data (reported in Table 13) to determine the half-life. Either the recovery-corrected data should be utilized to determine the half-life, or the registrant should explain the reasons why uncorrected data were used instead. Also, the accurate determination of the half-life should be done using replicate rather than mean data. It is also noted that the data for the 2-month sampling interval are highly variable between replicates, with individual recovery-corrected

values of 0.052, 0.074 and 0.018 ppm; a discussion of the possible reasons for this would be helpful to the reviewer.

2) The soil samples were stored for up to 379 days, but storage stability data were not reported. It is necessary that the registrant provide storage stability data for the parent and major degradates *in the test site soils* for up to the maximum period of storage so that the reviewer may determine whether the use of the data to determine the parent half-life and patterns of formation and decline for the degradates is valid.

3) The study was conducted on a bareground plot at the reported maximum label rate (at the time the study was conducted) for a turf use pattern. The registrant should confirm that the application rate used in the study is representative of the *current* maximum label rate. It is noted that in this MRID (42351601) it is stated that the maximum label rate for turf use is 0.15 lb a.i./A x 7 applications. However, in MRID 41889716 (see below), a terrestrial field dissipation study conducted on a cropped plot (turf), it is stated that the maximum label rate for turf use is 0.33 lb a.i./A x 7 applications. It is necessary that the registrant address and clarify this issue. It is noted, however, that because the two field studies conducted for the turf use pattern were done at different application rates, the half-lives determined from the cropped and bareground plots may not be validly compared. For this study to be upgraded to “Acceptable,” the application rate utilized in the study must be equivalent to the current use rate; otherwise, the study may only be upgraded to “Supplemental.”

4) If upgraded to “Acceptable,” the study would still only partially fulfill guideline data requirements. Only bareground plot data were submitted; data were not submitted for a cropped (turf) plot at a similar application rate (see Comment #3 above), and data were only submitted for a single representative use site.

MRID 41889716

This study is not valid and does not meet guideline requirements for terrestrial field dissipation for the following reasons:

1) The degradate 3-phenoxybenzoic acid, which was present in other terrestrial field dissipation studies as a major degradate (see MRID 42351601), was not monitored in the current study.

2) The study was not conducted using GLP’s. The registrant stated that the study was conducted prior to the implementation of the then-current guidelines (at the time of the submission in 1991).

3) The study was conducted on a turf plot at the reported maximum label rate for a turf use pattern of 0.33 lb a.i./A x 7 applications. It is unclear to the reviewer whether the application rate used in the study is representative of the *current* maximum label rate. It is also noted that in MRID 42351601, a terrestrial field dissipation study conducted on a bareground plot (turf use pattern), it is stated that the maximum label rate for turf use is 0.15 lb a.i./A x 7 applications.

4) Data for a bareground plot (turf use pattern) were not reported in this study. It is noted, the separately submitted field study conducted for the turf use pattern on a bareground plot was done at a different application rate.

5) A half-life in turf was not reported. The upper thatch was removed from the plot on a weekly basis, but samples were not analyzed for the parent compound or for total residues.

6) The half-life calculation was questionable. The study author stated that the time 0 data were discarded because the value was lower than subsequent values. Although this statement was apparently made with regard to total residues, the dissipation curve for the parent compound is also plotted without the use of the time 0 value. Additionally, the sampling intervals were inadequate, as a greater than 50% decrease in the parent compound concentration was observed between 30 and 90 days posttreatment (the period in which the half-life occurred).

7) Replicate data were not reported. Such data are necessary to allow for valid statistical analysis and to allow for a determination of data variability.

8) The number of samples collected may have been insufficient. From the information presented in the text, it was unclear how many samples were collected. Based on the text on page 12 of the study report, only single samples were collected from each of three treated subplots (randomly selected from a larger number of subplots) at each sampling interval.

9) The study was not conducted for a duration of time sufficient to determine the patterns of formation and decline of the metabolite haloaniline. The lack of replicate data was a confounding factor in the attempt to determine such patterns.

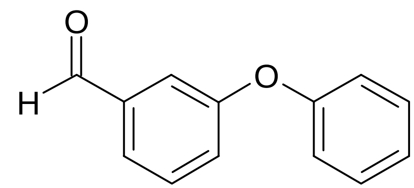
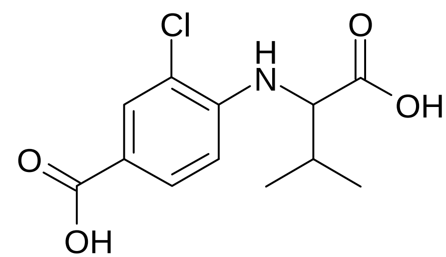
MRID 41996202

This study is not valid and does not meet guideline requirements for terrestrial field dissipation for the following reasons:

1) The MRID consists of an interim report for a terrestrial field dissipation study which is more fully documented in MRID 42351601. Thus, it cannot serve as a stand-alone study for the fulfillment of guideline requirements.

2) The half-life calculation was questionable and was based only on data obtained through 7 days posttreatment (see Comment #1). It is noted that a half-life of 5 days was reported in the current MRID (i.e., the interim report), while a half-life of 63 days was reported in the final report (MRID 42351601).

Table A-3. Environmental Degradates of Fluvalinate

Confirmed Degradate	**Lab Results Max %AR[5] (Study)**	**Chemical Structure**
3-Phenoxy-benzaldehyde **(3-PB Aldehyde)** CAS # 39515-51-0	20.2% (Hydrolysis - day 26) 8.2% (Aqueous Photolysis - day 20) 1.1% (aerobic soil - day 7) 2.2% (Anaerobic Aquatic - 7 days)	
2-(2-Chloro-4-carboxyl)anilino-3-methylbutanoic acid, 2-[4-Carboxyl-2-(chloro)anilino]-3-methylbutanoic acid **(Diacid)** CAS # 85236-41-5	20.3% (Hydrolysis @ pH 7 - day 21) 15.4% (Hydrolysis @ pH 9 - day 1) 1.2% (Hydrolysis @ pH 5 - day 2119) 4.1% (Aqueous Photolysis) 10.4% (soil Photolysis) 2.8% (aerobic soil - day 30) 19.8% (Anaerobic Aquatic - 120 days) 0.5% (Aerobic Aquatic - 90 days)	

[5] %AR =% of applied radioactivity.

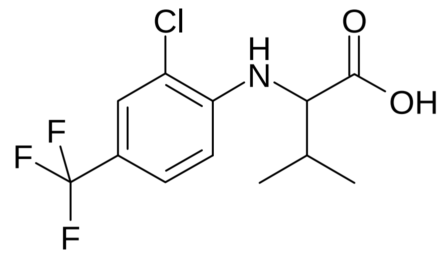
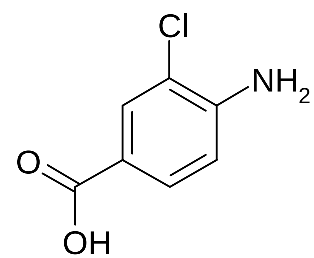
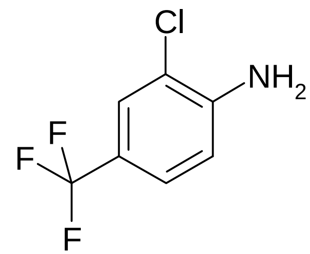
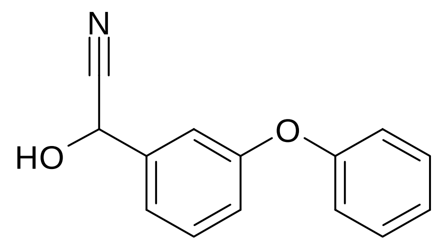
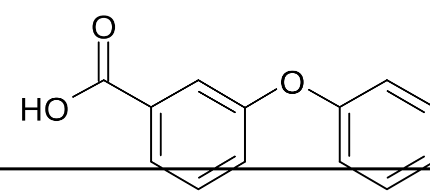
Table A-3. Environmental Degradates of Fluvalinate		
2-(2-Chloro-4-trifluoromethyl)-anilino-3-methylbutanoic acid, 2-[2-Chloro-4-(trifluoromethyl)-anilino]-3-methylbutanoic acid **(Anilino acid)** CAS # 76338-73-3	17.9% (Hydrolysis @ pH 7 - day 19) 23.7% (Hydrolysis @ pH 5 - day 14) 58.0% (Hydrolysis @ pH 9 - day 2.3) 9.0% (Aqueous Photolysis) 3.4% (soil Photolysis) 9.3% (aerobic soil - day 14) 42% (Anaerobic Aquatic - day 120) 5.3% (Aerobic Aquatic - day 54)	
4-amino-3-chlorobenzoic acid. CAS # 2486-71-7	4.5% (Anaerobic Aquatic - day 54) 0.4% (Aerobic Aquatic - day 90)	

Table A-3. Environmental Degradates of Fluvalinate		
2-Chloro-4-trifluoromethylaniline **(Haloaniline)** CAS # 39885-50-2	5.1% (Aqueous Photolysis - 6 minutes) 10% (Anaerobic Aquatic - day 28) 10% (Aerobic Aquatic - day 28) 6.1% (aerobic soil - day 30)	
Cyanohydrin	10.7% (Aq Photolysis - 10 minutes) 23.4% (soil photolysis)	
3-Phenoxybenzoic acid **(3-PB acid)** CAS # 3739-38-6	12.5% (Hydrolysis @ pH 5 - day 21) 9.7% (Aq Photolysis - day 0.005) 1.6% (soil photolysis) 1.6% (aerobic soil - day 7) 67.0% (Anaerobic Aquatic - 120 days)	

B. Aquatic Exposure Model and Results

```
FL Carrots (General Root and Tuber Vegetable Scenario); 1/21/2003
"Western Palm Beach County; MLRA: 156B; Metfile: W12844.dvf (old:
Met156B.met),  "
*** Record 3:
    0.78       0       0      33       1       1
*** Record 6 -- ERFLAG
       4
*** Record 7:
    0.03     0.2       1      10               4       1     354
*** Record 8
       1
*** Record 9
       1    0.25     100      30       3  91  87  88       0     100
*** Record 9a-d
       1      27
0101 1601 0102 1602 0103 1603 0104 1604 0105 1505 1605 2505 0106 1606 0107
1607
.813 .830 .846 .859 .870 .878 .881 .881 .880 .836 .849 .938 .840 .572 .285
.177
.011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011
.011
0108 1008 1608 0109 1609 0110 1610 0111 1611 0112 1612
.162 .210 .291 .422 .547 .636 .683 .715 .743 .768 .793
.011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011
*** Record 10 -- NCPDS, the number of cropping periods
      30
*** Record 11
  151060  150161  220161       1
  151061  150162  220162       1
  151062  150163  220163       1
  151063  150164  220164       1
  151064  150165  220165       1
  151065  150166  220166       1
  151066  150167  220167       1
  151067  150168  220168       1
  151068  150169  220169       1
  151069  150170  220170       1
  151070  150171  220171       1
  151071  150172  220172       1
  151072  150173  220173       1
  151073  150174  220174       1
  151074  150175  220175       1
  151075  150176  220176       1
  151076  150177  220177       1
  151077  150178  220178       1
  151078  150179  220179       1
  151079  150180  220180       1
  151080  150181  220181       1
  151081  150182  220182       1
  151082  150183  220183       1
  151083  150184  220184       1
  151084  150185  220185       1
  151085  150186  220186       1
  151086  150187  220187       1
  151087  150188  220188       1
  151088  150189  220189       1
  151089  150190  220190       1
```

```
*** Record 12 -- PTITLE
Fluvalinate - 2 applications @ 0.168 kg/ha
*** Record 13
      60        1        0        0
*** Record 15 -- PSTNAM
Fluvalinate
*** Record 16
  010561  0 2  0.0 0.168 0.95 0.05
  060561  0 2  0.0 0.168 0.95 0.05
  010562  0 2  0.0 0.168 0.95 0.05
  060562  0 2  0.0 0.168 0.95 0.05
  010563  0 2  0.0 0.168 0.95 0.05
  060563  0 2  0.0 0.168 0.95 0.05
  010564  0 2  0.0 0.168 0.95 0.05
  060564  0 2  0.0 0.168 0.95 0.05
  010565  0 2  0.0 0.168 0.95 0.05
  060565  0 2  0.0 0.168 0.95 0.05
  010566  0 2  0.0 0.168 0.95 0.05
  060566  0 2  0.0 0.168 0.95 0.05
  010567  0 2  0.0 0.168 0.95 0.05
  060567  0 2  0.0 0.168 0.95 0.05
  010568  0 2  0.0 0.168 0.95 0.05
  060568  0 2  0.0 0.168 0.95 0.05
  010569  0 2  0.0 0.168 0.95 0.05
  060569  0 2  0.0 0.168 0.95 0.05
  010570  0 2  0.0 0.168 0.95 0.05
  060570  0 2  0.0 0.168 0.95 0.05
  010571  0 2  0.0 0.168 0.95 0.05
  060571  0 2  0.0 0.168 0.95 0.05
  010572  0 2  0.0 0.168 0.95 0.05
  060572  0 2  0.0 0.168 0.95 0.05
  010573  0 2  0.0 0.168 0.95 0.05
  060573  0 2  0.0 0.168 0.95 0.05
  010574  0 2  0.0 0.168 0.95 0.05
  060574  0 2  0.0 0.168 0.95 0.05
  010575  0 2  0.0 0.168 0.95 0.05
  060575  0 2  0.0 0.168 0.95 0.05
  010576  0 2  0.0 0.168 0.95 0.05
  060576  0 2  0.0 0.168 0.95 0.05
  010577  0 2  0.0 0.168 0.95 0.05
  060577  0 2  0.0 0.168 0.95 0.05
  010578  0 2  0.0 0.168 0.95 0.05
  060578  0 2  0.0 0.168 0.95 0.05
  010579  0 2  0.0 0.168 0.95 0.05
  060579  0 2  0.0 0.168 0.95 0.05
  010580  0 2  0.0 0.168 0.95 0.05
  060580  0 2  0.0 0.168 0.95 0.05
  010581  0 2  0.0 0.168 0.95 0.05
  060581  0 2  0.0 0.168 0.95 0.05
  010582  0 2  0.0 0.168 0.95 0.05
  060582  0 2  0.0 0.168 0.95 0.05
  010583  0 2  0.0 0.168 0.95 0.05
  060583  0 2  0.0 0.168 0.95 0.05
  010584  0 2  0.0 0.168 0.95 0.05
  060584  0 2  0.0 0.168 0.95 0.05
  010585  0 2  0.0 0.168 0.95 0.05
  060585  0 2  0.0 0.168 0.95 0.05
```

```
  010586  0 2  0.0 0.168 0.95 0.05
  060586  0 2  0.0 0.168 0.95 0.05
  010587  0 2  0.0 0.168 0.95 0.05
  060587  0 2  0.0 0.168 0.95 0.05
  010588  0 2  0.0 0.168 0.95 0.05
  060588  0 2  0.0 0.168 0.95 0.05
  010589  0 2  0.0 0.168 0.95 0.05
  060589  0 2  0.0 0.168 0.95 0.05
  010590  0 2  0.0 0.168 0.95 0.05
  060590  0 2  0.0 0.168 0.95 0.05
*** Record 17
       0       1       0
*** Record 18
       0       0     0.5
*** Record 19 -- STITLE
Riviera Sand; HYDG: C
*** Record 20
     100           0   0   0   0   0   0   0   0   0
*** Record 26
       0       0       0
*** Record 33
       3
       1      10    1.65   0.073       0       0       0
        0.0312230.031223       0
             0.1   0.073   0.023    1.16    1154
       2      62    1.65   0.073       0       0       0
        0.0312230.031223       0
               2   0.073   0.023    1.16    1154
       3      28     1.7   0.211       0       0       0
        0.0312230.031223       0
               2   0.211   0.091   0.174    1154
***Record 40
       0
           YEAR      10             YEAR      10             YEAR      10   1
       1
       1  -----
       7    YEAR
     PRCP    TCUM   0   0
     RUNF    TCUM   0   0
     INFL    TCUM   1   1
     ESLS    TCUM   0   0  1.0E3
     RFLX    TCUM   0   0  1.0E5
     EFLX    TCUM   0   0  1.0E5
     RZFX    TCUM   0   0  1.0E5
```

stored as FLcarrotECO.out
Chemical: Fluvalinate
PRZM environment: FLcarrotC.txt modified Tueday, 28 January 2003 at 14:47:50
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 15:33:29
Metfile: w12844.dvf modified Wedday, 3 July 2002 at 08:04:30
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4463	0.3249	0.1755	0.08791	0.06695	0.02115
1962	0.4902	0.3579	0.194	0.09522	0.07515	0.02561
1963	0.533	0.3913	0.2216	0.1092	0.08353	0.02824
1964	0.4537	0.3311	0.2032	0.1204	0.09551	0.03366
1965	0.4541	0.3312	0.1816	0.09671	0.07644	0.02759
1966	0.4539	0.3313	0.181	0.1047	0.08703	0.03169
1967	0.4543	0.3314	0.1812	0.09361	0.07347	0.02658
1968	0.4551	0.3335	0.1975	0.1468	0.1195	0.04334
1969	0.502	0.3683	0.2112	0.1162	0.09272	0.03464
1970	0.4546	0.3319	0.1816	0.1075	0.08469	0.03036
1971	0.4593	0.3352	0.2129	0.1137	0.08953	0.03123
1972	0.4538	0.3312	0.2253	0.136	0.1087	0.0379
1973	0.4546	0.3463	0.1989	0.1062	0.08309	0.02956
1974	0.4534	0.3307	0.1813	0.08798	0.06798	0.02352
1975	0.4529	0.3302	0.1817	0.09856	0.07727	0.02675
1976	0.457	0.3431	0.2004	0.1296	0.1027	0.03648
1977	0.5932	0.4352	0.2595	0.1564	0.1234	0.044
1978	0.4671	0.3415	0.1871	0.1029	0.08198	0.03022
1979	0.4539	0.3311	0.192	0.1031	0.08051	0.02838
1980	0.4538	0.3339	0.1866	0.1139	0.08913	0.03106
1981	0.4539	0.3356	0.1846	0.09925	0.07648	0.02686
1982	0.4666	0.3407	0.1879	0.1106	0.08787	0.03081
1983	0.4539	0.3311	0.181	0.1063	0.08363	0.02955
1984	0.454	0.3313	0.181	0.1145	0.09092	0.03236
1985	0.4682	0.3418	0.1875	0.09558	0.07492	0.02649
1986	0.4533	0.3306	0.1809	0.09068	0.07083	0.02437
1987	0.4526	0.3551	0.2155	0.1098	0.08601	0.0291
1988	0.4539	0.3312	0.1837	0.116	0.09419	0.03363
1989	0.4539	0.3309	0.1809	0.08698	0.06651	0.02306
1990	0.4524	0.3297	0.181	0.1046	0.08343	0.02868

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	0.5932	0.4352	0.2595	0.1564	0.1234	0.044

0.0645161290322581	0.533	0.3913	0.2253	0.1468	0.1195	0.04334
0.0967741935483871	0.502	0.3683	0.2216	0.136	0.1087	0.0379
0.129032258064516	0.4902	0.3579	0.2155	0.1296	0.1027	0.03648
0.161290322580645	0.4682	0.3551	0.2129	0.1204	0.09551	0.03464
0.193548387096774	0.4671	0.3463	0.2112	0.1162	0.09419	0.03366
0.225806451612903	0.4666	0.3431	0.2032	0.116	0.09272	0.03363
0.258064516129032	0.4593	0.3418	0.2004	0.1145	0.09092	0.03236
0.290322580645161	0.457	0.3415	0.1989	0.1139	0.08953	0.03169
0.32258064516129	0.4551	0.3407	0.1975	0.1137	0.08913	0.03123
0.354838709677419	0.4546	0.3356	0.194	0.1106	0.08787	0.03106
0.387096774193548	0.4546	0.3352	0.192	0.1098	0.08703	0.03081
0.419354838709677	0.4543	0.3339	0.1879	0.1092	0.08601	0.03036
0.451612903225806	0.4541	0.3335	0.1875	0.1075	0.08469	0.03022
0.483870967741936	0.454	0.3319	0.1871	0.1063	0.08363	0.02956
0.516129032258065	0.4539	0.3314	0.1866	0.1062	0.08353	0.02955
0.548387096774194	0.4539	0.3313	0.1846	0.1047	0.08343	0.0291
0.580645161290323	0.4539	0.3313	0.1837	0.1046	0.08309	0.02868
0.612903225806452	0.4539	0.3312	0.1817	0.1031	0.08198	0.02838
0.645161290322581	0.4539	0.3312	0.1816	0.1029	0.08051	0.02824
0.67741935483871	0.4539	0.3312	0.1816	0.09925	0.07727	0.02759
0.709677419354839	0.4538	0.3311	0.1813	0.09856	0.07648	0.02686
0.741935483870968	0.4538	0.3311	0.1812	0.09671	0.07644	0.02675

0.774193548387097	0.4537	0.3311	0.181	0.09558	0.07515	0.02658
0.806451612903226	0.4534	0.3309	0.181	0.09522	0.07492	0.02649
0.838709677419355	0.4533	0.3307	0.181	0.09361	0.07347	0.02561
0.870967741935484	0.4529	0.3306	0.181	0.09068	0.07083	0.02437
0.903225806451613	0.4526	0.3302	0.1809	0.08798	0.06798	0.02352
0.935483870967742	0.4524	0.3297	0.1809	0.08791	0.06695	0.02306
0.967741935483871	0.4463	0.3249	0.1755	0.08698	0.06651	0.02115

0.1	0.50082	0.36726	0.22099	0.13536	0.1081	0.037758
			Average of yearly averages:	0.030229		

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: FLcarrotECO
Metfile: w12844.dvf
PRZM scenario: FLcarrotC.txt
EXAMS environment file: pond298.exv
Chemical Name: Fluvalinate

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	502.91	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	1.0E-7	torr	
Solubility	sol	0.12	mg/L	
Kd	Kd	1154	mg/L	
Koc	Koc	244000	mg/L	
Photolysis half-life	kdp	1	days	Half-life
Aerobic Aquatic Metabolism	kbacw	0	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	92.6	days	Halfife
Aerobic Soil Metabolism	asm	22.2	days	Halfife
Hydrolysis:	pH 5	48	days	Half-life
Hydrolysis:	pH 7	22.5	days	Half-life
Hydrolysis:	pH 9	1.13	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI	0	cm	
Application Rate:	TAPP	0.168	kg/ha	

Application Efficiency:		APPEFF	0.95	fraction
Spray Drift	DRFT	0.05	fraction of application rate applied to pond	
Application Date	Date	1-5	dd/mm or dd/mmm or dd-mm or dd-mmm	
Interval 1	interval	5	days	Set to 0 or delete line for single app.
Record 17:	FILTRA			
	IPSCND	1		
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			
	FEXTRC	0.5		
Flag for Index Res. Run		IR	Pond	
Flag for runoff calc.	RUNOFF		none	none, monthly or total(average of entire run)

```
"CaLettuceC, August 12, 2004"
Monterey County; MLRA C-14, CA Coastal Valley; Metfile: W23273.dvf
*** Record 3:
    0.79     0.3       0      17       1       1
*** Record 6 -- ERFLAG
       4
*** Record 7:
    0.37    0.88     0.5      10               1       9     354
*** Record 8
       1
*** Record 9
       1    0.25      12      80       3  94  89  94       0      20
*** Record 9a-d
       1      26
0101 1601 0102 1602 0103 1603 0104 1604 0105 1605 0106 1606 0107 1007 1607
0108
.632 .318 .186 .188 .190 .191 .527 .558 .569 .572 .574 .575 .634 .796 .750
.602
.011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 .011
.011
1608 0109 1609 0110 1610 0111 1611 0112 1012 1612
.302 .176 .176 .177 .178 .505 .560 .634 .803 .767
.011 .011 .011 .011 .011 .011 .011 .011 .011 .011
*** Record 10 -- NCPDS, the number of cropping periods
      30
*** Record 11
  100261  050561  120561       1
  100262  050562  120562       1
  100263  050563  120563       1
  100264  050564  120564       1
  100265  050565  120565       1
  100266  050566  120566       1
  100267  050567  120567       1
  100268  050568  120568       1
  100269  050569  120569       1
  100270  050570  120570       1
  100271  050571  120571       1
  100272  050572  120572       1
  100273  050573  120573       1
  100274  050574  120574       1
  100275  050575  120575       1
  100276  050576  120576       1
  100277  050577  120577       1
  100278  050578  120578       1
  100279  050579  120579       1
  100280  050580  120580       1
  100281  050581  120581       1
  100282  050582  120582       1
  100283  050583  120583       1
  100284  050584  120584       1
  100285  050585  120585       1
  100286  050586  120586       1
  100287  050587  120587       1
  100288  050588  120588       1
  100289  050589  120589       1
  100290  050590  120590       1
*** Record 12 -- PTITLE
```

```
Fluvalinate - 2 applications @ 0.168 kg/ha
*** Record 13
      60       1       0       0
*** Record 15 -- PSTNAM
Fluvalinate
*** Record 16
  010561  0 1  0.0 0.168 0.95 0.05
  060561  0 1  0.0 0.168 0.95 0.05
  010562  0 1  0.0 0.168 0.95 0.05
  060562  0 1  0.0 0.168 0.95 0.05
  010563  0 1  0.0 0.168 0.95 0.05
  060563  0 1  0.0 0.168 0.95 0.05
  010564  0 1  0.0 0.168 0.95 0.05
  060564  0 1  0.0 0.168 0.95 0.05
  010565  0 1  0.0 0.168 0.95 0.05
  060565  0 1  0.0 0.168 0.95 0.05
  010566  0 1  0.0 0.168 0.95 0.05
  060566  0 1  0.0 0.168 0.95 0.05
  010567  0 1  0.0 0.168 0.95 0.05
  060567  0 1  0.0 0.168 0.95 0.05
  010568  0 1  0.0 0.168 0.95 0.05
  060568  0 1  0.0 0.168 0.95 0.05
  010569  0 1  0.0 0.168 0.95 0.05
  060569  0 1  0.0 0.168 0.95 0.05
  010570  0 1  0.0 0.168 0.95 0.05
  060570  0 1  0.0 0.168 0.95 0.05
  010571  0 1  0.0 0.168 0.95 0.05
  060571  0 1  0.0 0.168 0.95 0.05
  010572  0 1  0.0 0.168 0.95 0.05
  060572  0 1  0.0 0.168 0.95 0.05
  010573  0 1  0.0 0.168 0.95 0.05
  060573  0 1  0.0 0.168 0.95 0.05
  010574  0 1  0.0 0.168 0.95 0.05
  060574  0 1  0.0 0.168 0.95 0.05
  010575  0 1  0.0 0.168 0.95 0.05
  060575  0 1  0.0 0.168 0.95 0.05
  010576  0 1  0.0 0.168 0.95 0.05
  060576  0 1  0.0 0.168 0.95 0.05
  010577  0 1  0.0 0.168 0.95 0.05
  060577  0 1  0.0 0.168 0.95 0.05
  010578  0 1  0.0 0.168 0.95 0.05
  060578  0 1  0.0 0.168 0.95 0.05
  010579  0 1  0.0 0.168 0.95 0.05
  060579  0 1  0.0 0.168 0.95 0.05
  010580  0 1  0.0 0.168 0.95 0.05
  060580  0 1  0.0 0.168 0.95 0.05
  010581  0 1  0.0 0.168 0.95 0.05
  060581  0 1  0.0 0.168 0.95 0.05
  010582  0 1  0.0 0.168 0.95 0.05
  060582  0 1  0.0 0.168 0.95 0.05
  010583  0 1  0.0 0.168 0.95 0.05
  060583  0 1  0.0 0.168 0.95 0.05
  010584  0 1  0.0 0.168 0.95 0.05
  060584  0 1  0.0 0.168 0.95 0.05
  010585  0 1  0.0 0.168 0.95 0.05
  060585  0 1  0.0 0.168 0.95 0.05
  010586  0 1  0.0 0.168 0.95 0.05
```

```
  060586  0 1  0.0 0.168 0.95 0.05
  010587  0 1  0.0 0.168 0.95 0.05
  060587  0 1  0.0 0.168 0.95 0.05
  010588  0 1  0.0 0.168 0.95 0.05
  060588  0 1  0.0 0.168 0.95 0.05
  010589  0 1  0.0 0.168 0.95 0.05
  060589  0 1  0.0 0.168 0.95 0.05
  010590  0 1  0.0 0.168 0.95 0.05
  060590  0 1  0.0 0.168 0.95 0.05
*** Record 17
       0       1       0
*** Record 19 -- STITLE
Placentia sandy loam; Hydrologic Group D  Placentia sandy loam; Hydrologic
Group D
*** Record 20
     171           0   0   0   0   0   0   0   0   0
*** Record 26
       0       0       0
*** Record 33
       5
       1      10   1.575   0.295       0       0       0
        0.0312230.031223       0
            0.1   0.295    0.17   0.725    1154
       2      22   1.575   0.295       0       0       0
        0.0312230.031223       0
              2   0.295    0.17   0.725    1154
       3      40   1.475   0.347       0       0       0
        0.0312230.031223       0
              5   0.347   0.242   0.058    1154
       4      77   1.725   0.224       0       0       0
        0.0312230.031223       0
            5.5   0.224   0.139   0.058    1154
       5      22    1.75   0.214       0       0       0
        0.0312230.031223       0
            5.5   0.214   0.089   0.058    1154
***Record 40
       0
            YEAR      10             YEAR      10             YEAR      10   1
       1
       1  -----
       7    YEAR
    PRCP    TCUM   0   0
    RUNF    TCUM   0   0
    INFL    TCUM   1   1
    ESLS    TCUM   0   0  1.0E3
    RFLX    TCUM   0   0  1.0E5
    EFLX    TCUM   0   0  1.0E5
    RZFX    TCUM   0   0  1.0E5
```

stored as CAcarrotECO.out
Chemical: Fluvalinate
PRZM environment: calettuceC.txt modified Thuday, 12 August 2004 at 10:03:24
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 15:33:29
Metfile: w23273.dvf modified Tueday, 12 March 2002 at 15:44:06
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4488	0.3266	0.177	0.08594	0.06673	0.02377
1962	0.457	0.3343	0.1844	0.0921	0.07247	0.02951
1963	0.4586	0.3362	0.1861	0.09334	0.07345	0.03023
1964	0.4583	0.3357	0.1857	0.09336	0.07364	0.03059
1965	0.4584	0.3357	0.1857	0.09329	0.07356	0.03067
1966	0.4585	0.336	0.1859	0.09316	0.07329	0.03041
1967	0.4581	0.3354	0.1854	0.09303	0.07331	0.03036
1968	0.4577	0.3349	0.185	0.09242	0.0726	0.02979
1969	0.4578	0.3351	0.1852	0.09268	0.07293	0.03005
1970	0.4575	0.3348	0.1848	0.09235	0.07265	0.03009
1971	0.4583	0.3356	0.1857	0.09912	0.07888	0.03309
1972	0.4592	0.3364	0.1864	0.09383	0.07397	0.03121
1973	0.4586	0.336	0.186	0.09318	0.07322	0.03043
1974	0.4581	0.3355	0.1855	0.09307	0.07329	0.03048
1975	0.4583	0.3357	0.1857	0.09324	0.07349	0.03063
1976	0.4581	0.3354	0.1854	0.09283	0.07295	0.03041
1977	0.4972	0.408	0.2359	0.1248	0.09995	0.04107
1978	0.4608	0.3378	0.1879	0.09505	0.0751	0.03293
1979	0.4588	0.3362	0.1862	0.09346	0.07358	0.03071
1980	0.458	0.3355	0.1855	0.09292	0.07311	0.03004
1981	0.4579	0.3353	0.1853	0.0926	0.07259	0.02968
1982	0.4581	0.3357	0.1856	0.09294	0.07309	0.02992
1983	0.4576	0.3348	0.1849	0.09232	0.07237	0.02908
1984	0.4564	0.3335	0.1836	0.09119	0.07139	0.02825
1985	0.4574	0.3348	0.1848	0.09214	0.07212	0.02891
1986	0.457	0.3342	0.1843	0.09197	0.07222	0.02945
1987	0.4581	0.3355	0.1854	0.09276	0.07291	0.02996
1988	0.457	0.3339	0.1841	0.09198	0.07225	0.02952
1989	0.4574	0.3344	0.1846	0.09221	0.07239	0.02969
1990	0.4575	0.3347	0.1848	0.09237	0.07253	0.02952

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	0.4972	0.408	0.2359	0.1248	0.09995	0.04107

0.0645161290322581	0.4608	0.3378	0.1879	0.09912	0.07888	0.03309
0.0967741935483871	0.4592	0.3364	0.1864	0.09505	0.0751	0.03293
0.129032258064516	0.4588	0.3362	0.1862	0.09383	0.07397	0.03121
0.161290322580645	0.4586	0.3362	0.1861	0.09346	0.07364	0.03071
0.193548387096774	0.4586	0.336	0.186	0.09336	0.07358	0.03067
0.225806451612903	0.4585	0.336	0.1859	0.09334	0.07356	0.03063
0.258064516129032	0.4584	0.3357	0.1857	0.09329	0.07349	0.03059
0.290322580645161	0.4583	0.3357	0.1857	0.09324	0.07345	0.03048
0.32258064516129	0.4583	0.3357	0.1857	0.09318	0.07331	0.03043
0.354838709677419	0.4583	0.3357	0.1857	0.09316	0.07329	0.03041
0.387096774193548	0.4581	0.3356	0.1856	0.09307	0.07329	0.03041
0.419354838709677	0.4581	0.3355	0.1855	0.09303	0.07322	0.03036
0.451612903225806	0.4581	0.3355	0.1855	0.09294	0.07311	0.03023
0.483870967741936	0.4581	0.3355	0.1854	0.09292	0.07309	0.03009
0.516129032258065	0.4581	0.3354	0.1854	0.09283	0.07295	0.03005
0.548387096774194	0.458	0.3354	0.1854	0.09276	0.07293	0.03004
0.580645161290323	0.4579	0.3353	0.1853	0.09268	0.07291	0.02996
0.612903225806452	0.4578	0.3351	0.1852	0.0926	0.07265	0.02992
0.645161290322581	0.4577	0.3349	0.185	0.09242	0.0726	0.02979
0.67741935483871	0.4576	0.3348	0.1849	0.09237	0.07259	0.02969
0.709677419354839	0.4575	0.3348	0.1848	0.09235	0.07253	0.02968
0.741935483870968	0.4575	0.3348	0.1848	0.09232	0.07247	0.02952

0.774193548387097 0.4574 0.3347 0.1848 0.09221 0.07239
0.02952
0.806451612903226 0.4574 0.3344 0.1846 0.09214 0.07237
0.02951
0.838709677419355 0.457 0.3343 0.1844 0.0921 0.07225
0.02945
0.870967741935484 0.457 0.3342 0.1843 0.09198 0.07222
0.02908
0.903225806451613 0.457 0.3339 0.1841 0.09197 0.07212
0.02891
0.935483870967742 0.4564 0.3335 0.1836 0.09119 0.07139
0.02825
0.967741935483871 0.4488 0.3266 0.177 0.08594 0.06673
0.02377

0.1 0.45916 0.33638 0.18638 0.094928 0.074987 0.032758
Average of yearly averages: 0.0303483333333333

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: CAcarrotECO
Metfile: w23273.dvf
PRZM scenario: calettuceC.txt
EXAMS environment file: pond298.exv
Chemical Name: Fluvalinate
Description Variable Name Value Units Comments
Molecular weight mwt 502.91 g/mol
Henry's Law Const. henry atm-m^3/mol
Vapor Pressure vapr 1.0E-7 torr
Solubility sol 0.12 mg/L
Kd Kd 1154 mg/L
Koc Koc 244000 mg/L
Photolysis half-life kdp 1 days Half-life
Aerobic Aquatic Metabolism kbacw 0 days Halfife
Anaerobic Aquatic Metabolism kbacs 92.6 days Halfife
Aerobic Soil Metabolism asm 22.2 days Halfife
Hydrolysis: pH 5 48 days Half-life
Hydrolysis: pH 7 22.5 days Half-life
Hydrolysis: pH 9 1.13 days Half-life
Method: CAM 1 integer See PRZM manual
Incorporation Depth: DEPI 0 cm
Application Rate: TAPP 0.168 kg/ha

Application Efficiency: APPEFF 0.95 fraction
Spray Drift DRFT 0.05 fraction of application rate applied to pond
Application Date Date 1-5 dd/mm or dd/mmm or dd-mm or dd-mmm
Interval 1 interval 5 days Set to 0 or delete line for single app.
Record 17: FILTRA
IPSCND 1
UPTKF
Record 18: PLVKRT
PLDKRT
FEXTRC 0.5
Flag for Index Res. Run IR Pond
Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

```
ORXmastree; 11/8/2001
"Benton Co. OR MLRA A2; Metfile: W24232.dvf (old: Met2.met),"
*** Record 3:
    0.73    0.16        0       17        1       2
*** Record 6 -- ERFLAG
       4
*** Record 7:
    0.37    0.69        1       10                2       4     354
*** Record 8
       1
*** Record 9
       1    0.25     120       40        2  80  72  77       0     250
*** Record 9a-d
       1      24
0101 1601 0102 1602 0103 1603 0104 1604 0105 1605 0106 1606 0107 1607 0108
1608
.009 .010 .015 .016 .023 .029 .034 .038 .041 .039 .038 .034 .029 .024 .021
.021
.040 .040 .040 .040 .040 .040 .040 .040 .040 .040 .040 .040 .040 .040 .040
.040
0109 1609 0110 1610 0111 1611 0112 1612
.023 .024 .027 .029 .006 .007 .007 .008
.040 .040 .040 .040 .040 .040 .040 .040
*** Record 10 -- NCPDS, the number of cropping periods
      30
*** Record 11
  150461  150861  301061       1
  150462  150862  301062       1
  150463  150863  301063       1
  150464  150864  301064       1
  150465  150865  301065       1
  150466  150866  301066       1
  150467  150867  301067       1
  150468  150868  301068       1
  150469  150869  301069       1
  150470  150870  301070       1
  150471  150871  301071       1
  150472  150872  301072       1
  150473  150873  301073       1
  150474  150874  301074       1
  150475  150875  301075       1
  150476  150876  301076       1
  150477  150877  301077       1
  150478  150878  301078       1
  150479  150879  301079       1
  150480  150880  301080       1
  150481  150881  301081       1
  150482  150882  301082       1
  150483  150883  301083       1
  150484  150884  301084       1
  150485  150885  301085       1
  150486  150886  301086       1
  150487  150887  301087       1
  150488  150888  301088       1
  150489  150889  301089       1
  150490  150890  301090       1
*** Record 12 -- PTITLE
```

```
Fluvalinate - 12 applications @ 0.381 kg/ha
*** Record 13
     360       1       0       0
*** Record 15 -- PSTNAM
Fluvalinate
*** Record 16
  010561  0 2  0.0 0.381 0.99 0.01
  150561  0 2  0.0 0.381 0.99 0.01
  290561  0 2  0.0 0.381 0.99 0.01
  120661  0 2  0.0 0.381 0.99 0.01
  260661  0 2  0.0 0.381 0.99 0.01
  100761  0 2  0.0 0.381 0.99 0.01
  240761  0 2  0.0 0.381 0.99 0.01
  070861  0 2  0.0 0.381 0.99 0.01
  210861  0 2  0.0 0.381 0.99 0.01
  040961  0 2  0.0 0.381 0.99 0.01
  180961  0 2  0.0 0.381 0.99 0.01
  021061  0 2  0.0 0.381 0.99 0.01
  010562  0 2  0.0 0.381 0.99 0.01
  150562  0 2  0.0 0.381 0.99 0.01
  290562  0 2  0.0 0.381 0.99 0.01
  120662  0 2  0.0 0.381 0.99 0.01
  260662  0 2  0.0 0.381 0.99 0.01
  100762  0 2  0.0 0.381 0.99 0.01
  240762  0 2  0.0 0.381 0.99 0.01
  070862  0 2  0.0 0.381 0.99 0.01
  210862  0 2  0.0 0.381 0.99 0.01
  040962  0 2  0.0 0.381 0.99 0.01
  180962  0 2  0.0 0.381 0.99 0.01
  021062  0 2  0.0 0.381 0.99 0.01
  010563  0 2  0.0 0.381 0.99 0.01
  150563  0 2  0.0 0.381 0.99 0.01
  290563  0 2  0.0 0.381 0.99 0.01
  120663  0 2  0.0 0.381 0.99 0.01
  260663  0 2  0.0 0.381 0.99 0.01
  100763  0 2  0.0 0.381 0.99 0.01
  240763  0 2  0.0 0.381 0.99 0.01
  070863  0 2  0.0 0.381 0.99 0.01
  210863  0 2  0.0 0.381 0.99 0.01
  040963  0 2  0.0 0.381 0.99 0.01
  180963  0 2  0.0 0.381 0.99 0.01
  021063  0 2  0.0 0.381 0.99 0.01
  010564  0 2  0.0 0.381 0.99 0.01
  150564  0 2  0.0 0.381 0.99 0.01
  290564  0 2  0.0 0.381 0.99 0.01
  120664  0 2  0.0 0.381 0.99 0.01
  260664  0 2  0.0 0.381 0.99 0.01
  100764  0 2  0.0 0.381 0.99 0.01
  240764  0 2  0.0 0.381 0.99 0.01
  070864  0 2  0.0 0.381 0.99 0.01
  210864  0 2  0.0 0.381 0.99 0.01
  040964  0 2  0.0 0.381 0.99 0.01
  180964  0 2  0.0 0.381 0.99 0.01
  021064  0 2  0.0 0.381 0.99 0.01
  010565  0 2  0.0 0.381 0.99 0.01
  150565  0 2  0.0 0.381 0.99 0.01
  290565  0 2  0.0 0.381 0.99 0.01
```

120665	0	2	0.0	0.381	0.99	0.01
260665	0	2	0.0	0.381	0.99	0.01
100765	0	2	0.0	0.381	0.99	0.01
240765	0	2	0.0	0.381	0.99	0.01
070865	0	2	0.0	0.381	0.99	0.01
210865	0	2	0.0	0.381	0.99	0.01
040965	0	2	0.0	0.381	0.99	0.01
180965	0	2	0.0	0.381	0.99	0.01
021065	0	2	0.0	0.381	0.99	0.01
010566	0	2	0.0	0.381	0.99	0.01
150566	0	2	0.0	0.381	0.99	0.01
290566	0	2	0.0	0.381	0.99	0.01
120666	0	2	0.0	0.381	0.99	0.01
260666	0	2	0.0	0.381	0.99	0.01
100766	0	2	0.0	0.381	0.99	0.01
240766	0	2	0.0	0.381	0.99	0.01
070866	0	2	0.0	0.381	0.99	0.01
210866	0	2	0.0	0.381	0.99	0.01
040966	0	2	0.0	0.381	0.99	0.01
180966	0	2	0.0	0.381	0.99	0.01
021066	0	2	0.0	0.381	0.99	0.01
010567	0	2	0.0	0.381	0.99	0.01
150567	0	2	0.0	0.381	0.99	0.01
290567	0	2	0.0	0.381	0.99	0.01
120667	0	2	0.0	0.381	0.99	0.01
260667	0	2	0.0	0.381	0.99	0.01
100767	0	2	0.0	0.381	0.99	0.01
240767	0	2	0.0	0.381	0.99	0.01
070867	0	2	0.0	0.381	0.99	0.01
210867	0	2	0.0	0.381	0.99	0.01
040967	0	2	0.0	0.381	0.99	0.01
180967	0	2	0.0	0.381	0.99	0.01
021067	0	2	0.0	0.381	0.99	0.01
010568	0	2	0.0	0.381	0.99	0.01
150568	0	2	0.0	0.381	0.99	0.01
290568	0	2	0.0	0.381	0.99	0.01
120668	0	2	0.0	0.381	0.99	0.01
260668	0	2	0.0	0.381	0.99	0.01
100768	0	2	0.0	0.381	0.99	0.01
240768	0	2	0.0	0.381	0.99	0.01
070868	0	2	0.0	0.381	0.99	0.01
210868	0	2	0.0	0.381	0.99	0.01
040968	0	2	0.0	0.381	0.99	0.01
180968	0	2	0.0	0.381	0.99	0.01
021068	0	2	0.0	0.381	0.99	0.01
010569	0	2	0.0	0.381	0.99	0.01
150569	0	2	0.0	0.381	0.99	0.01
290569	0	2	0.0	0.381	0.99	0.01
120669	0	2	0.0	0.381	0.99	0.01
260669	0	2	0.0	0.381	0.99	0.01
100769	0	2	0.0	0.381	0.99	0.01
240769	0	2	0.0	0.381	0.99	0.01
070869	0	2	0.0	0.381	0.99	0.01
210869	0	2	0.0	0.381	0.99	0.01
040969	0	2	0.0	0.381	0.99	0.01
180969	0	2	0.0	0.381	0.99	0.01
021069	0	2	0.0	0.381	0.99	0.01

010570	0	2	0.0	0.381	0.99	0.01
150570	0	2	0.0	0.381	0.99	0.01
290570	0	2	0.0	0.381	0.99	0.01
120670	0	2	0.0	0.381	0.99	0.01
260670	0	2	0.0	0.381	0.99	0.01
100770	0	2	0.0	0.381	0.99	0.01
240770	0	2	0.0	0.381	0.99	0.01
070870	0	2	0.0	0.381	0.99	0.01
210870	0	2	0.0	0.381	0.99	0.01
040970	0	2	0.0	0.381	0.99	0.01
180970	0	2	0.0	0.381	0.99	0.01
021070	0	2	0.0	0.381	0.99	0.01
010571	0	2	0.0	0.381	0.99	0.01
150571	0	2	0.0	0.381	0.99	0.01
290571	0	2	0.0	0.381	0.99	0.01
120671	0	2	0.0	0.381	0.99	0.01
260671	0	2	0.0	0.381	0.99	0.01
100771	0	2	0.0	0.381	0.99	0.01
240771	0	2	0.0	0.381	0.99	0.01
070871	0	2	0.0	0.381	0.99	0.01
210871	0	2	0.0	0.381	0.99	0.01
040971	0	2	0.0	0.381	0.99	0.01
180971	0	2	0.0	0.381	0.99	0.01
021071	0	2	0.0	0.381	0.99	0.01
010572	0	2	0.0	0.381	0.99	0.01
150572	0	2	0.0	0.381	0.99	0.01
290572	0	2	0.0	0.381	0.99	0.01
120672	0	2	0.0	0.381	0.99	0.01
260672	0	2	0.0	0.381	0.99	0.01
100772	0	2	0.0	0.381	0.99	0.01
240772	0	2	0.0	0.381	0.99	0.01
070872	0	2	0.0	0.381	0.99	0.01
210872	0	2	0.0	0.381	0.99	0.01
040972	0	2	0.0	0.381	0.99	0.01
180972	0	2	0.0	0.381	0.99	0.01
021072	0	2	0.0	0.381	0.99	0.01
010573	0	2	0.0	0.381	0.99	0.01
150573	0	2	0.0	0.381	0.99	0.01
290573	0	2	0.0	0.381	0.99	0.01
120673	0	2	0.0	0.381	0.99	0.01
260673	0	2	0.0	0.381	0.99	0.01
100773	0	2	0.0	0.381	0.99	0.01
240773	0	2	0.0	0.381	0.99	0.01
070873	0	2	0.0	0.381	0.99	0.01
210873	0	2	0.0	0.381	0.99	0.01
040973	0	2	0.0	0.381	0.99	0.01
180973	0	2	0.0	0.381	0.99	0.01
021073	0	2	0.0	0.381	0.99	0.01
010574	0	2	0.0	0.381	0.99	0.01
150574	0	2	0.0	0.381	0.99	0.01
290574	0	2	0.0	0.381	0.99	0.01
120674	0	2	0.0	0.381	0.99	0.01
260674	0	2	0.0	0.381	0.99	0.01
100774	0	2	0.0	0.381	0.99	0.01
240774	0	2	0.0	0.381	0.99	0.01
070874	0	2	0.0	0.381	0.99	0.01
210874	0	2	0.0	0.381	0.99	0.01

040974	0	2	0.0	0.381	0.99	0.01
180974	0	2	0.0	0.381	0.99	0.01
021074	0	2	0.0	0.381	0.99	0.01
010575	0	2	0.0	0.381	0.99	0.01
150575	0	2	0.0	0.381	0.99	0.01
290575	0	2	0.0	0.381	0.99	0.01
120675	0	2	0.0	0.381	0.99	0.01
260675	0	2	0.0	0.381	0.99	0.01
100775	0	2	0.0	0.381	0.99	0.01
240775	0	2	0.0	0.381	0.99	0.01
070875	0	2	0.0	0.381	0.99	0.01
210875	0	2	0.0	0.381	0.99	0.01
040975	0	2	0.0	0.381	0.99	0.01
180975	0	2	0.0	0.381	0.99	0.01
021075	0	2	0.0	0.381	0.99	0.01
010576	0	2	0.0	0.381	0.99	0.01
150576	0	2	0.0	0.381	0.99	0.01
290576	0	2	0.0	0.381	0.99	0.01
120676	0	2	0.0	0.381	0.99	0.01
260676	0	2	0.0	0.381	0.99	0.01
100776	0	2	0.0	0.381	0.99	0.01
240776	0	2	0.0	0.381	0.99	0.01
070876	0	2	0.0	0.381	0.99	0.01
210876	0	2	0.0	0.381	0.99	0.01
040976	0	2	0.0	0.381	0.99	0.01
180976	0	2	0.0	0.381	0.99	0.01
021076	0	2	0.0	0.381	0.99	0.01
010577	0	2	0.0	0.381	0.99	0.01
150577	0	2	0.0	0.381	0.99	0.01
290577	0	2	0.0	0.381	0.99	0.01
120677	0	2	0.0	0.381	0.99	0.01
260677	0	2	0.0	0.381	0.99	0.01
100777	0	2	0.0	0.381	0.99	0.01
240777	0	2	0.0	0.381	0.99	0.01
070877	0	2	0.0	0.381	0.99	0.01
210877	0	2	0.0	0.381	0.99	0.01
040977	0	2	0.0	0.381	0.99	0.01
180977	0	2	0.0	0.381	0.99	0.01
021077	0	2	0.0	0.381	0.99	0.01
010578	0	2	0.0	0.381	0.99	0.01
150578	0	2	0.0	0.381	0.99	0.01
290578	0	2	0.0	0.381	0.99	0.01
120678	0	2	0.0	0.381	0.99	0.01
260678	0	2	0.0	0.381	0.99	0.01
100778	0	2	0.0	0.381	0.99	0.01
240778	0	2	0.0	0.381	0.99	0.01
070878	0	2	0.0	0.381	0.99	0.01
210878	0	2	0.0	0.381	0.99	0.01
040978	0	2	0.0	0.381	0.99	0.01
180978	0	2	0.0	0.381	0.99	0.01
021078	0	2	0.0	0.381	0.99	0.01
010579	0	2	0.0	0.381	0.99	0.01
150579	0	2	0.0	0.381	0.99	0.01
290579	0	2	0.0	0.381	0.99	0.01
120679	0	2	0.0	0.381	0.99	0.01
260679	0	2	0.0	0.381	0.99	0.01
100779	0	2	0.0	0.381	0.99	0.01

240779	0	2	0.0	0.381	0.99	0.01
070879	0	2	0.0	0.381	0.99	0.01
210879	0	2	0.0	0.381	0.99	0.01
040979	0	2	0.0	0.381	0.99	0.01
180979	0	2	0.0	0.381	0.99	0.01
021079	0	2	0.0	0.381	0.99	0.01
010580	0	2	0.0	0.381	0.99	0.01
150580	0	2	0.0	0.381	0.99	0.01
290580	0	2	0.0	0.381	0.99	0.01
120680	0	2	0.0	0.381	0.99	0.01
260680	0	2	0.0	0.381	0.99	0.01
100780	0	2	0.0	0.381	0.99	0.01
240780	0	2	0.0	0.381	0.99	0.01
070880	0	2	0.0	0.381	0.99	0.01
210880	0	2	0.0	0.381	0.99	0.01
040980	0	2	0.0	0.381	0.99	0.01
180980	0	2	0.0	0.381	0.99	0.01
021080	0	2	0.0	0.381	0.99	0.01
010581	0	2	0.0	0.381	0.99	0.01
150581	0	2	0.0	0.381	0.99	0.01
290581	0	2	0.0	0.381	0.99	0.01
120681	0	2	0.0	0.381	0.99	0.01
260681	0	2	0.0	0.381	0.99	0.01
100781	0	2	0.0	0.381	0.99	0.01
240781	0	2	0.0	0.381	0.99	0.01
070881	0	2	0.0	0.381	0.99	0.01
210881	0	2	0.0	0.381	0.99	0.01
040981	0	2	0.0	0.381	0.99	0.01
180981	0	2	0.0	0.381	0.99	0.01
021081	0	2	0.0	0.381	0.99	0.01
010582	0	2	0.0	0.381	0.99	0.01
150582	0	2	0.0	0.381	0.99	0.01
290582	0	2	0.0	0.381	0.99	0.01
120682	0	2	0.0	0.381	0.99	0.01
260682	0	2	0.0	0.381	0.99	0.01
100782	0	2	0.0	0.381	0.99	0.01
240782	0	2	0.0	0.381	0.99	0.01
070882	0	2	0.0	0.381	0.99	0.01
210882	0	2	0.0	0.381	0.99	0.01
040982	0	2	0.0	0.381	0.99	0.01
180982	0	2	0.0	0.381	0.99	0.01
021082	0	2	0.0	0.381	0.99	0.01
010583	0	2	0.0	0.381	0.99	0.01
150583	0	2	0.0	0.381	0.99	0.01
290583	0	2	0.0	0.381	0.99	0.01
120683	0	2	0.0	0.381	0.99	0.01
260683	0	2	0.0	0.381	0.99	0.01
100783	0	2	0.0	0.381	0.99	0.01
240783	0	2	0.0	0.381	0.99	0.01
070883	0	2	0.0	0.381	0.99	0.01
210883	0	2	0.0	0.381	0.99	0.01
040983	0	2	0.0	0.381	0.99	0.01
180983	0	2	0.0	0.381	0.99	0.01
021083	0	2	0.0	0.381	0.99	0.01
010584	0	2	0.0	0.381	0.99	0.01
150584	0	2	0.0	0.381	0.99	0.01
290584	0	2	0.0	0.381	0.99	0.01

120684	0	2	0.0	0.381	0.99	0.01
260684	0	2	0.0	0.381	0.99	0.01
100784	0	2	0.0	0.381	0.99	0.01
240784	0	2	0.0	0.381	0.99	0.01
070884	0	2	0.0	0.381	0.99	0.01
210884	0	2	0.0	0.381	0.99	0.01
040984	0	2	0.0	0.381	0.99	0.01
180984	0	2	0.0	0.381	0.99	0.01
021084	0	2	0.0	0.381	0.99	0.01
010585	0	2	0.0	0.381	0.99	0.01
150585	0	2	0.0	0.381	0.99	0.01
290585	0	2	0.0	0.381	0.99	0.01
120685	0	2	0.0	0.381	0.99	0.01
260685	0	2	0.0	0.381	0.99	0.01
100785	0	2	0.0	0.381	0.99	0.01
240785	0	2	0.0	0.381	0.99	0.01
070885	0	2	0.0	0.381	0.99	0.01
210885	0	2	0.0	0.381	0.99	0.01
040985	0	2	0.0	0.381	0.99	0.01
180985	0	2	0.0	0.381	0.99	0.01
021085	0	2	0.0	0.381	0.99	0.01
010586	0	2	0.0	0.381	0.99	0.01
150586	0	2	0.0	0.381	0.99	0.01
290586	0	2	0.0	0.381	0.99	0.01
120686	0	2	0.0	0.381	0.99	0.01
260686	0	2	0.0	0.381	0.99	0.01
100786	0	2	0.0	0.381	0.99	0.01
240786	0	2	0.0	0.381	0.99	0.01
070886	0	2	0.0	0.381	0.99	0.01
210886	0	2	0.0	0.381	0.99	0.01
040986	0	2	0.0	0.381	0.99	0.01
180986	0	2	0.0	0.381	0.99	0.01
021086	0	2	0.0	0.381	0.99	0.01
010587	0	2	0.0	0.381	0.99	0.01
150587	0	2	0.0	0.381	0.99	0.01
290587	0	2	0.0	0.381	0.99	0.01
120687	0	2	0.0	0.381	0.99	0.01
260687	0	2	0.0	0.381	0.99	0.01
100787	0	2	0.0	0.381	0.99	0.01
240787	0	2	0.0	0.381	0.99	0.01
070887	0	2	0.0	0.381	0.99	0.01
210887	0	2	0.0	0.381	0.99	0.01
040987	0	2	0.0	0.381	0.99	0.01
180987	0	2	0.0	0.381	0.99	0.01
021087	0	2	0.0	0.381	0.99	0.01
010588	0	2	0.0	0.381	0.99	0.01
150588	0	2	0.0	0.381	0.99	0.01
290588	0	2	0.0	0.381	0.99	0.01
120688	0	2	0.0	0.381	0.99	0.01
260688	0	2	0.0	0.381	0.99	0.01
100788	0	2	0.0	0.381	0.99	0.01
240788	0	2	0.0	0.381	0.99	0.01
070888	0	2	0.0	0.381	0.99	0.01
210888	0	2	0.0	0.381	0.99	0.01
040988	0	2	0.0	0.381	0.99	0.01
180988	0	2	0.0	0.381	0.99	0.01
021088	0	2	0.0	0.381	0.99	0.01

```
  010589  0 2  0.0 0.381 0.99 0.01
  150589  0 2  0.0 0.381 0.99 0.01
  290589  0 2  0.0 0.381 0.99 0.01
  120689  0 2  0.0 0.381 0.99 0.01
  260689  0 2  0.0 0.381 0.99 0.01
  100789  0 2  0.0 0.381 0.99 0.01
  240789  0 2  0.0 0.381 0.99 0.01
  070889  0 2  0.0 0.381 0.99 0.01
  210889  0 2  0.0 0.381 0.99 0.01
  040989  0 2  0.0 0.381 0.99 0.01
  180989  0 2  0.0 0.381 0.99 0.01
  021089  0 2  0.0 0.381 0.99 0.01
  010590  0 2  0.0 0.381 0.99 0.01
  150590  0 2  0.0 0.381 0.99 0.01
  290590  0 2  0.0 0.381 0.99 0.01
  120690  0 2  0.0 0.381 0.99 0.01
  260690  0 2  0.0 0.381 0.99 0.01
  100790  0 2  0.0 0.381 0.99 0.01
  240790  0 2  0.0 0.381 0.99 0.01
  070890  0 2  0.0 0.381 0.99 0.01
  210890  0 2  0.0 0.381 0.99 0.01
  040990  0 2  0.0 0.381 0.99 0.01
  180990  0 2  0.0 0.381 0.99 0.01
  021090  0 2  0.0 0.381 0.99 0.01
*** Record 17
       0       1       0
*** Record 18
       0       0     0.5
*** Record 19 -- STITLE
Pilchuck
*** Record 20
     150           0   0   0   0   0   0   0   0   0
*** Record 26
       0       0       0
*** Record 33
       4
       1      10    1.55   0.123       0       0       0
        0.0312230.031223       0
             0.1   0.123   0.033    1.16    1154
       2      40     1.7   0.123       0       0       0
        0.0312230.031223       0
               2   0.123   0.033    1.16    1154
       3      50     1.8   0.069       0       0       0
        0.0312230.031223       0
               5   0.069   0.019   0.174    1154
       4      50     1.8   0.046       0       0       0
        0.0312230.031223       0
               5   0.046   0.016   0.116    1154
***Record 40
       0
            YEAR      10            YEAR      10            YEAR      10   1
       1
       1  -----
       7    YEAR
    PRCP    TCUM   0   0
    RUNF    TCUM   0   0
    INFL    TCUM   1   1
```

```
ESLS    TCUM   0   0  1.0E3
RFLX    TCUM   0   0  1.0E5
EFLX    TCUM   0   0  1.0E5
RZFX    TCUM   0   0  1.0E5
```

stored as ORornECO.out
Chemical: Fluvalinate
PRZM environment: ORXmasTreeC.txt modified Satday, 12 October 2002 at 16:23:10
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 15:33:29
Metfile: w24232.dvf modified Wedday, 3 July 2002 at 08:06:10
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.2192	0.1757	0.1304	0.1162	0.111	0.05704
1962	0.2353	0.1913	0.1471	0.1341	0.1302	0.08589
1963	0.2388	0.195	0.1507	0.1403	0.1369	0.09415
1964	0.2387	0.1949	0.1502	0.1386	0.1351	0.09335
1965	0.2386	0.1949	0.1502	0.1391	0.1359	0.09526
1966	0.2363	0.1925	0.148	0.1371	0.1338	0.09225
1967	0.2329	0.1891	0.1443	0.1338	0.131	0.0898
1968	0.2465	0.2002	0.1545	0.1459	0.1391	0.09375
1969	0.2449	0.2103	0.1605	0.1434	0.1391	0.09795
1970	0.2382	0.1945	0.1498	0.138	0.1347	0.09403
1971	0.2614	0.2102	0.1571	0.1444	0.1393	0.09483
1972	0.2392	0.1953	0.1514	0.138	0.1346	0.09265
1973	0.2375	0.1937	0.1493	0.1373	0.1336	0.09351
1974	0.2374	0.1936	0.1492	0.1392	0.1362	0.09584
1975	0.2375	0.1939	0.1492	0.1383	0.1348	0.09213
1976	0.2381	0.1943	0.1498	0.1387	0.1351	0.09071
1977	0.2361	0.1923	0.148	0.136	0.1325	0.08975
1978	0.2358	0.1918	0.1474	0.1359	0.1324	0.09026
1979	0.262	0.21	0.1555	0.1415	0.1359	0.09137
1980	0.2373	0.1935	0.149	0.1379	0.1343	0.09239
1981	0.2544	0.2072	0.1681	0.1458	0.1403	0.09918
1982	0.2391	0.1953	0.1507	0.14	0.1369	0.09655
1983	0.2374	0.1938	0.1491	0.1386	0.1346	0.09166
1984	0.2365	0.1929	0.1482	0.137	0.1336	0.09326
1985	0.2386	0.1949	0.1502	0.1385	0.1353	0.09461
1986	0.2359	0.1921	0.1474	0.1358	0.1326	0.09006
1987	0.2366	0.1928	0.1483	0.1375	0.1358	0.09255
1988	0.2388	0.1951	0.1505	0.1399	0.137	0.09742
1989	0.2361	0.1925	0.1479	0.137	0.1335	0.09241
1990	0.2342	0.1905	0.146	0.1354	0.1324	0.09184

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	0.262	0.2103	0.1681	0.1459	0.1403	0.09918

0.0645161290322581	0.2614	0.2102	0.1605	0.1458	0.1393	0.09795
0.0967741935483871	0.2544	0.21	0.1571	0.1444	0.1391	0.09742
0.129032258064516	0.2465	0.2072	0.1555	0.1434	0.1391	0.09655
0.161290322580645	0.2449	0.2002	0.1545	0.1415	0.137	0.09584
0.193548387096774	0.2392	0.1953	0.1514	0.1403	0.1369	0.09526
0.225806451612903	0.2391	0.1953	0.1507	0.14	0.1369	0.09483
0.258064516129032	0.2388	0.1951	0.1507	0.1399	0.1362	0.09461
0.290322580645161	0.2388	0.195	0.1505	0.1392	0.1359	0.09415
0.32258064516129	0.2387	0.1949	0.1502	0.1391	0.1359	0.09403
0.354838709677419	0.2386	0.1949	0.1502	0.1387	0.1358	0.09375
0.387096774193548	0.2386	0.1949	0.1502	0.1386	0.1353	0.09351
0.419354838709677	0.2382	0.1945	0.1498	0.1386	0.1351	0.09335
0.451612903225806	0.2381	0.1943	0.1498	0.1385	0.1351	0.09326
0.483870967741936	0.2375	0.1939	0.1493	0.1383	0.1348	0.09265
0.516129032258065	0.2375	0.1938	0.1492	0.138	0.1347	0.09255
0.548387096774194	0.2374	0.1937	0.1492	0.138	0.1346	0.09241
0.580645161290323	0.2374	0.1936	0.1491	0.1379	0.1346	0.09239
0.612903225806452	0.2373	0.1935	0.149	0.1375	0.1343	0.09225
0.645161290322581	0.2366	0.1929	0.1483	0.1373	0.1338	0.09213
0.67741935483871	0.2365	0.1928	0.1482	0.1371	0.1336	0.09184
0.709677419354839	0.2363	0.1925	0.148	0.137	0.1336	0.09166
0.741935483870968	0.2361	0.1925	0.148	0.137	0.1335	0.09137

0.774193548387097	0.2361	0.1923	0.1479	0.136	0.1326	0.09071
0.806451612903226	0.2359	0.1921	0.1474	0.1359	0.1325	0.09026
0.838709677419355	0.2358	0.1918	0.1474	0.1358	0.1324	0.09006
0.870967741935484	0.2353	0.1913	0.1471	0.1354	0.1324	0.0898
0.903225806451613	0.2342	0.1905	0.146	0.1341	0.131	0.08975
0.935483870967742	0.2329	0.1891	0.1443	0.1338	0.1302	0.08589
0.967741935483871	0.2192	0.1757	0.1304	0.1162	0.111	0.05704

0.1	0.25361	0.20972	0.15694	0.1443	0.1391	0.097333
			Average of yearly averages:	0.0918816666666666		

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: ORornECO
Metfile: w24232.dvf
PRZM scenario: ORXmasTreeC.txt
EXAMS environment file: pond298.exv
Chemical Name: Fluvalinate

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	502.91	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	1.0E-7	torr	
Solubility	sol	0.12	mg/L	
Kd	Kd	1154	mg/L	
Koc	Koc	244000	mg/L	
Photolysis half-life	kdp	1	days	Half-life
Aerobic Aquatic Metabolism	kbacw	0	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	92.6	days	Halfife
Aerobic Soil Metabolism	asm	22.2	days	Halfife
Hydrolysis:	pH 5	48	days	Half-life
Hydrolysis:	pH 7	22.5	days	Half-life
Hydrolysis:	pH 9	1.13	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI	0	cm	
Application Rate:	TAPP	0.381	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	

Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	1-5	dd/mm or dd/mmm or dd-mm or dd-mmm	
Interval 1	interval	14	days	Set to 0 or delete line for single app.
Interval 2	interval	14	days	Set to 0 or delete line for single app.
Interval 3	interval	14	days	Set to 0 or delete line for single app.
Interval 4	interval	14	days	Set to 0 or delete line for single app.
Interval 5	interval	14	days	Set to 0 or delete line for single app.
Interval 6	interval	14	days	Set to 0 or delete line for single app.
Interval 7	interval	14	days	Set to 0 or delete line for single app.
Interval 8	interval	14	days	Set to 0 or delete line for single app.
Interval 9	interval	14	days	Set to 0 or delete line for single app.
Interval 10	interval	14	days	Set to 0 or delete line for single app.
Interval 11	interval	14	days	Set to 0 or delete line for single app.
Record 17:	FILTRA			
IPSCND	1			
UPTKF				
Record 18:	PLVKRT			
PLDKRT				
FEXTRC	0.5			
Flag for Index Res. Run		IR	Pond	
Flag for runoff calc.	RUNOFF		none	none, monthly or total(average of entire run)

C. Ecological Effects Data

Birds

Acceptable guideline studies are available to assess acute and chronic toxicity to birds. These studies are sufficient to estimate risk to birds from acute and chronic exposure to *tau*-fluvalinate. Tables C-1 - C-3 summarize the acute and chronic toxicity studies with birds. More detailed summaries of the studies follow the tables. No studies were found in the ECOTOX database.

Table C-1 Avian Acute Oral Toxicity (§71-1)

Test Organism	Test Substance	Purity	NOAEL (mg/kg)	LOAEL (mg/kg)	LD_{50} (mg/kg)	Toxicity[1]	Classification	MRID/Author
N. Bobwhite Quail *Colinus virginianus*	Half-resolved	93.2%	1000	1590[2]	> 2510	Practically non-toxic	Acceptable	00085444/ Wildlife Int'l 1979
	Half-resolved	93.1%	Not estab.	398[2]	> 2510	Practically non-toxic	Acceptable	00104671/ Wildlife Int'l 1981

[1] Based on LD_{50} (mg/kg) <10 very highly toxic; 10-50 highly toxic; 51-500 moderately toxic; 501-2000 slightly toxic; >2000 practically nontoxic
[2] Based on sublethal effects

Table C-2 Avian Subacute Dietary Toxicity (§71-2)

Test Organism	Test Substance	Purity	NOAEC (ppm)	LOAEC (ppm)	LC_{50} (ppm)	Toxicity[1]	Classification	MRID/Author
N. Bobwhite Quail *Colinus virginianus*	Half-resolved	93.1%	3160[2]	5620[2]	> 5620	Practically non-toxic	Acceptable	00094601/ Wildlife Int'l 1981
	Half-resolved	93.2%	1000	1780	5627	Practically non-toxic	Acceptable	00079964/ Wildlife Int'l 1979
Mallard Duck *Anas platyrhynchos*	Half-resolved	93.1%	1780[2]	3160[2]	> 5620	Practically non-toxic	Acceptable	00104672/Wildlife Int'l 1981
	Half-resolved	93.2%	3160[2]	5620[2]	> 5620	Practically non-toxic	Acceptable	00079965/ Wildlife Int'l 1979

[1] Based on LC_{50} (mg/kg) <50 very highly toxic; 50-500 highly toxic; 501-1000 moderately toxic; 1001-5000 slightly toxic; >5000 practically nontoxic
[2] Based on sublethal effects

Table C-3 Avian Reproduction (§71-4)

Test Organism	Test Substance	Purity	NOAEC (ppm)	LOAEC (ppm)	Classification	MRID/Author
N. Bobwhite Quail *Colinus virginianus*	Half-resolved	93%	900	> 900	Acceptable	00149824/ Wildlife Int'l 1981
Mallard Duck *Anas platyrhynchos*	Half-resolved	93%	900	> 900	Acceptable	00149825/ Wildlife Int'l 1981

MRID 00085444. (Guideline §71-1) Acute oral LD_{50} on bobwhite quail. 1979.

To evaluate the acute oral toxicity of half-resolved fluvalinate technical, 22-week-old Bobwhite quail (*Colinus virginianus*) were dosed (via oral intubation) with concentrations of 0 (control), 398, 631, 1000, 1590, or 2510 mg/kg and observed for 14 days. Mortality was 10% at the 2510 mg/kg dose level; there were no mortalities observed at any other dose level. The LD_{50} was determined to be greater than the highest tested concentration, 2510 mg/kg, which classifies half-resolved fluvalinate as practically non-toxic to bobwhite quail on an acute oral basis. Some lethargy was observed in some birds dosed with 1590 mg/kg on day 3, and one bird at this dose level remained lethargic on day 4. At all other times during the test period, all birds at the 398-1590 mg/kg dose levels were normal in both appearance and behavior. At the 2510 mg/kg dose level, several birds were lethargic with lower limb weakness on day 3. Lethargy continued to be observed at this dose level through day 5, after which all birds were asymptomatic until study termination. The NOAEL is 1000 and the LOAEL is 1590 based on lethargy. The study is classified as *acceptable* because it is scientifically sound and meets guideline requirements for an avian acute oral study.

MRID 00104671. (Guideline §71-1) Acute oral LD_{50} on bobwhite quail. 1981.

To determine the acute toxicity of half-resolved fluvalinate technical, five-month-old Bobwhite quail (*Colinus virginianus*) were dosed (via oral intubation) with concentrations of 0 (control), 398, 631, 1000, 1590, or 2510 mg/kg and observed for 14 days. There were no mortalities in either the control or the 398 mg/kg treatment group. Mortality rates were 10, 20, 10, and 20% for the 631, 1000, 1590, and 2510 mg/kg treatment groups, respectively. The LD_{50} is greater than the highest tested concentration, 2510 mg/kg, which classifies half-resolved fluvalinate as practically non-toxic to bobwhite quail on an acute oral basis. All control birds appeared normal and exhibited normal behavior throughout the study. At the 398 mg/kg dose level, three birds were lethargic on days 2-3. All other birds appeared normal throughout the study. The LOAEL is 398 mg/kg based on lethargy. A NOAEL is not established. The NOAEL for mortality is 398 mg/kg and the LOAEL is 631 mg/kg. The study is classified as *acceptable* because it is scientifically sound and meets guideline requirements for an avian acute oral study.

MRID 00094601. (Guideline §71-2) Eight-day dietary LC_{50} with bobwhite quail. 1981.

Bobwhite quail (*Colinus virginianus*) were exposed to half-resolved fluvalinate technical at concentrations of 0 (control), 562, 1000, 1780, 3160, or 5620 ppm. The birds were exposed to appropriate dietary concentrations for 5 days and then maintained on the basal diet for 3 days until test termination (day 8). No treatment-related mortalities were observed in any treatment group. All birds were normal in appearance and exhibited normal behavior throughout the duration of the study. Birds exposed to 5620 ppm fluvalinate had a slightly lower weight gain and slightly reduced feed consumption. The LC_{50} was determined to be greater than the highest tested concentration, 5620 ppm, which classifies half-resolved fluvalinate as practically non-toxic to bobwhite quail on a subacute dietary basis. The NOAEL is 3160 ppm and the LOAEL is 5620 ppm based on lower body weight gain and reduced feed consumption. The study is classified as *acceptable* because it is scientifically sound and meets guideline requirements for an avian subacute dietary study.

MRID 00079964. (Guideline §71-2) Eight-day dietary LC_{50} with bobwhite quail. 1979.

Bobwhite quail (*Colinus virginianus*) were exposed to half-resolved fluvalinate technical at concentrations of 0 (control), 562, 1000, 1780, 3160, or 5620 ppm. The birds were exposed to appropriate dietary concentrations for 5 days and then maintained on the basal diet for 3 days until test termination (day 8). Mortality rates were 10%, 20%, and 50% for the 1780, 3160, and 5620 ppm treatments, respectively. All birds appeared normal and exhibited normal behavior in the 562 and 1000 ppm treatments. Symptoms of toxicity, including lethargy, depression, and reduced reaction to external stimuli (sound and movement), were noted at the 3160 and 5620 ppm treatment levels. Nostril- and toe-picking were also observed in fluvalinate treatments $\geq$1780 ppm. Based on mortality and sublethal effects, the NOAEC is 1000 ppm, and the LOAEC is 1780 ppm. The acute dietary LC_{50} for bobwhite quail was determined to be 5627 ppm (95% CI: 3318-9554 ppm), which classifies half-resolved fluvalinate as practically non-toxic to bobwhite quail on a subacute dietary basis. The study is classified as *acceptable* because it is scientifically sound and meets guideline requirements for an avian subacute dietary study.

MRID 00104672. (Guideline §71-2) Eight-day dietary LC_{50} with mallard duck. 1981.

Mallard ducks (*Anas platyrhynchos*) were exposed to half-resolved fluvalinate technical at concentrations of 0 (control), 562, 1000, 1780, 3160, or 5620 ppm. The birds were exposed to appropriate dietary concentrations for 5 days and then maintained on the basal diet for 3 days until test termination (day 8). Mortality was 10% for the 3160 ppm treatment group and 20% for the highest concentration tested, 5620 ppm. The acute dietary LC_{50} for mallard ducks was determined to be > 5627 ppm, which classifies half-resolved fluvalinate as practically non-toxic to the mallard duck on a subacute dietary basis. All control birds appeared normal and exhibited normal behavior throughout the test period. One bird in the 562 ppm treatment group was lethargic and had reduced reactions to external stimuli. All the birds in the 1000 ppm group appeared normal. There were concentration-related reductions in body weight gain for birds in the 3160 and 5620 ppm treatments; the NOAEC is 1780 ppm, and the LOAEC is 3160 ppm. The study is classified as *acceptable* because it is scientifically sound and meets guideline requirements for an avian subacute dietary study.

MRID 00079965. (Guideline §71-2) Eight-day dietary LC_{50} with mallard duck. 1979.

Mallard ducks (*Anas platyrhynchos*) were exposed to half-resolved fluvalinate technical at concentrations of 0 (control), 562, 1000, 1780, 3160, or 5620 ppm. The birds were exposed to appropriate dietary concentrations for 5 days and then maintained on the basal diet for 3 days until test termination (day 8). No mortalities or overt symptoms of toxicity were observed at any test level over the course of the study. According to the study author, there was a dose-related reduction in body weight gain and feed consumption for birds in the 5620 ppm treatment; thus, the sublethal effect NOAEC is 3160 ppm and the LOAEC is 5620 ppm. The acute dietary LC_{50} for mallard ducks was determined to be > 5627 ppm, which classifies half-resolved fluvalinate as practically non-toxic to the mallard duck on a subacute dietary basis. The study is classified as *acceptable* because it is scientifically sound and meets guideline requirements for an avian subacute dietary study.

MRID 00149824. (Guideline §71-4) One-generation reproduction study with bobwhite quail. 1981.

Bobwhite quail (*Colinus virginianus*) were fed dietary levels of half-resolved fluvalinate technical at 100, 300, or 900 ppm a.i. for 18 weeks. There were no treatment-related mortalities. There were no significant effects on any of the following reproductive parameters: eggs laid, eggs cracked, viable embryos, live 3-week embryos, normal hatchlings, or 14-day old survivors. There was a statistically significant difference in hatchling body weight for the 100 and 300 ppm a.i. levels; however, the observed differences were not considered to be biologically significant because the actual difference was < 0.4 grams, and no effect was observed at the 900 ppm a.i. treatment level. Consequently, the NOAEC was 900 ppm a.i., and the LOAEC was greater than 900 ppm a.i. The study is classified as *acceptable* because it is scientifically sound and meets guideline requirements for an avian reproduction study.

MRID 00149825. (Guideline §71-4) One-generation reproduction study with mallard duck. 1981.

Mallard ducks (*Anas platyrhynchos*) were fed dietary levels of half-resolved fluvalinate technical at 100, 300, or 900 ppm a.i. for 18 weeks. No mortalities occurred in any treatment group over the course of the study. There were no significant effects on adult body weight or feed consumption at any treatment level. There were no significant effects on any of the following reproductive parameters: eggs laid, eggs cracked, viable embryos, live 3-week embryos, normal hatchlings, or 14-day old survivors. Consequently, the NOAEC was 900 ppm a.i., and the LOAEC was greater than 900 ppm a.i. The study is classified as *acceptable* because it is scientifically sound and meets guideline requirements for an avian reproduction study.

Beneficial Insects and Other Terrestrial Invertebrates

Acceptable guideline studies are available to assess acute toxicity to honey bees. Tables **C-4** and **C-5** summarize the acute toxicity studies with honey bees. More detailed summaries of the studies follow the tables. Other studies on honey bees have previously been submitted to the Agency. Most of these studies were conducted in the 1980's. In a memorandum from A. Maciorowski to B. Briscoe dated 04/04/1996, the following statement was provided:

"The record on fluvalinate through 1990 showed this chemical to be no more than moderately toxic to bees. In fact, several studies placed fluvalinate in the "practically nontoxic" range. In addition, a fluvalinate product (Apistan) was being used extensively within beehives, and is still in use, without apparent adverse effects on bees.

The need for further study came in 1991 with the submission of an acute study showing fluvalinate to be highly toxic to bees. Because this was in conflict with all studies reviewed to that point, the Agency asked Sandoz to reconduct the study. Sandoz agreed to the request, and conducted a foliar residue study, as well..."

Since the Agency has used the newer studies for labeling purposes, the older, conflicting studies are not summarized here.

A search of the open literature (e.g. ECOTOX) provided another toxicity study to honey bees following 24 hour exposure to *tau*-fluvalinate in petri dish cages (Ref. 58586). The acute LC_{50} from that study is >200μg/cage. This study indicates lower toxicity to honey bees; however, the method of exposure is so different that it cannot be compared to the submitted honey bee study. Mortality data are available for *Varroa jacobsoni* (mite in bee hives). The data on *Varroa jacobsoni* indicate that toxicity is likely to be high, in the low μg/vial or ng/cm^2 (petri dish). Other toxicity data are available; however, they were not reported in a way that may be compared to the bee studies. The German cockroach study LD_{50} values are in the 0.05 - 0.21 μg/insect range, which appear to be more susceptible than the bee; however, the bee studies and the cockroach studies need to be reported on a μg/g insect basis in order for them to be compared. Those studies that were reported in any type of quantitative basis are summarized in the following tables. Data on additional species identified in ECOTOX but not sufficiently characterized to use in a qualitative description were not summarized. Population density data are available on *Tetranychus urticae* (two-spotted spider mite), *Ctenarytaina eucalypti* (Blu gum psyllid), *Liriomyza trifilii* (serpentine leafminer) and *NR Lumbricidae* (oligochaete family). Relevant data are summarized in Table **C-6**.

Table C-4 Beneficial Insects Acute Contact (§141-1)

Test Organism	Test Substance	Purity	NOAEL (μg/bee)	LOAEL (μg/bee)	LD_{50} (μg/bee)	Toxicity[1]	Classification	MRID
Honey Bee *Apis mellifera*	?	88.4%			0.2	Highly toxic	Acceptable	41783901/ Wildlife Int'l 1991
	rs-fluvalinate	88%	0.156	0.313	1.8	Highly toxic	Acceptable	41996203/ Washington State University 1991
	rs-fluvalinate	91%	0.156	0.313	1.2	Highly toxic		
	half-resolved	82.2%	< 0.156	0.156	0.8	Highly toxic		

[1] Based on LC_{50} (μg/bee) <2 highly toxic; 2-10.99 moderately toxic; 11 and greater = practically nontoxic

Table C-5 Beneficial Insects Foliar Residue

Test Organism	Test Substance	Purity	Residual Toxicity (RT_{25})	Classification	MRID/Author
Honey Bee *Apis mellifera*	rs-fluvalinate half-resolved	22.3% 22.3%	3 hours	Acceptable	41996204/ Washington State University 1991

Table C-6. Summary of Studies from the Open Literature for Terrestrial Invertebrates

Genus	Species	Common name	Major Group Effect	Measurement	Endpoint	Duration (Hours)	Conc mean	Conc Units	Exposure Type	Ref#
Terrestrial Invertebrates										
Varroa	*jacobsoni*	Mite	Mortality	Mortality	LD_{50}	24	0.56	μg	Vial	63848
Varroa	*jacobsoni*	Mite	Mortality	Mortality	LD_{90}	24	2.4	μg/vial	Vial	63849
Varroa	*jacobsoni*	Mite	Mortality	Mortality	LC_{50}	24	0.73-131.54	ng/cm^2	Petri	63656
Varroa	*jacobsoni*	Mite	Mortality	Mortality	LC_{50}	24	41.5	mg/ml	Petri	67175
Varroa	*jacobsoni*	Mite	Mortality	Mortality	LC_{50}	24	7.46	μg/ cage	Petri	58586
Hymenoptera	*apidae*	Honey bee	Mortality	Mortality	LC_{50}	24	>200	μg/ cage	Petri	58586
Dietyoptera	*blattellidae*	German cockroach	Mortality	Mortality	LD_{50}	24	0.05 - 0.21	μg/ insect	Topical	69972
Dietyoptera	*blattellidae*	German cockroach	Mortality	Mortality	LD_{50}	24	2.65	ng/mg bw	Topical	69961

Table C-6. Summary of Studies from the Open Literature for Terrestrial Invertebrates										
Genus	Species	Common name	Major Group Effect	Measurement	Endpoint	Duration (Hours)	Conc mean	Conc Units	Exposure Type	Ref#
Terrestrial Invertebrates										
Aphytis	*melinus*	Parasitic wasp	Mortality	Mortality	LC_{50}	48	6.5	g a.i./100 L	Dipped leaves	59334
Rhizobius	*lophanthae*	Coccinellid predator of diaspidid scales	Mortality	Mortality	LC_{50}	48	5.6	g a.i./100 L	Dipped leaves	59334
Spodoptera	*frugiperda*	Fall armyworm	Reproduction	Reproduction	LOAEL	48	0.09 a.i.	ppm	diet	63584
Spodoptera	*frugiperda*	Fall armyworm	Mortality	Mortality	LD_{50}	48	7.13 & 0.033	μg/g insect	Topical	73599
Siphonaptera	*pulicidae*	Cat flea	Mortality	Mortality	LC_{50}	24	116.26	mg/925 cm^2	Filter paper in test tubes	69973
Amblyseius	*womersleyi*	Mite	Mortality	Mortality	47.6%	48	10 a.i.	ppm	Leaf 20% formulation	62893
Tetranychus	*urticae*	Two-spotted spider mite	Mortality	Mortality	LC_{50}	24	156	ppm	Slide dip	71035
Tetranychus	*urticae*	Two-spotted spider mite	POP	Population Abundance	LOAEL	21 days	0.09	a.i. g/ha	Field	73705
Lumbricidae	*NR*	Oligochaete family	POP	Population Abundance and Biomass	NOAEL	1 treatment[a]	0.18	kg a.i./ha	Field	39542

NR = Not reported

Vial = Pesticide-treated vial

Petri = petri dish sprayed with pesticide

[a]Population density evaluated at 7 and 21 days

MRID 41996204. (Guideline §141-2) Non-target residual toxicity test for honey bees.1991.

Worker bees (*Apis mellifera*) were exposed to field residues of rs- or s-fluvalinate at the maximum labeled application rate (0.15 lbs a.i./A for rs-fluvalinate and 0.075 lbs a.i./A for s-fluvalinate) on Vernal alfalfa. Alfalfa leaves were sampled at 3, 8, and 24 hours after spraying. The number of dead and alive bees were counted after a 24-hour exposure period to the alfalfa residues for each of the collection time periods. Average mortality of honey bees was low, even within three hours of fluvalinate application. The RT_{25} for half-resolved fluvalinate was determined to be 3 hours. Thus, rs- and s-fluvalinate applications at the tested levels pose minimal hazard to honey bees when they are not actively foraging. The study is classified as *acceptable,* is scientifically sound and fulfills the requirements for a residual toxicity study with the honey bee.

MRID 41996203. (Guideline §141-1) Honey bee acute contact LD50. 1991.

Three replicate groups of 10 worker bees/dose level (*Apis mellifera L.*) were dosed with either rs- (88% and 91%) or s-fluvalinate (82%) at nominal doses of 0, 0 (acetone), 0.15625, 0.3125, 0.625, 1.25, 2.5, 5 or 10 μg a.i./bee. Dosages were corrected for % a.i.. Observations were recorded once on days 1 and 2. The 48-hour LD_{50}s were estimated as follows: 88% rs-fluvalinate = 1.78 (1.32-2.39) μg a.i./bee; 91% rs-fluvalinate = 1.16 (0.86-1.57) μg a.i./bee; and 82% s-fluvalinate = 0.78 (0.61 - 1.01) μg a.i./bee. The slopes of the dose-response curves are 1.53, 1.56 and 1.94 for the 88% and 91% rs-fluvalinate and the 82% s-fluvalinate, respectively. The toxicity category is highly toxic. The NOAEL for mortality is 0.156 μg a.i.bee for both rs-fluvalinate and < 0.156 μg/bee for s-fluvalinate. The moving average and probit methods were used for statistical analyses. The study is classified as *acceptable,* is scientifically sound and fulfills the requirements for an acute contact LD_{50} study with the honey bee.

MRID 41783901. (Guideline §141-1) Honey bee acute contact LD50. 1991.

Two replicates of 25 bees/dose were dosed with nominal doses of 0, 0 (acetone), 0.00625, 0.0125, 0.025, 0.05, 0.1, 0.2, 0.4 or 0.6 μg fluvalinate/bee. Observations were recorded twice on the day of initiation and once on days 1 and 2. The binomial probability method was used for the statistical analysis. The 48-hour LD_{50} was estimated to be 0.2 μg/bee (classified as highly toxic). All surviving bees were normal in appearance and behavior throughout the test. Immobile bees were observed at the 0.05 μg/bee dose level and above. Treatment-related mortality was observed, starting at 0.05 μg/bee. The NOAEL was 0.025 μg/bee based on mortality and immobility. The study is classified as *acceptable*, is scientifically sound and fulfills the requirements for an acute contact LD_{50} study with the honey bee.

Mammals

Acute toxicity

Acceptable acute oral toxicity studies were conducted on rats with the technical material, formulations, impurities and degradates/metabolites. The formulation, Mavrik 2E (25 % a.i.) and the two degradates, cyanohydrin and chloranilino acid may be more acutely toxic than the parent.

Since the LD_{50}s for the other degradates/impurities were all greater than 500 mg/kg, their toxicity in relation to the parent cannot be estimated. Acceptable chronic toxicity studies are available for mammals. Studies on mammals are summarized in Tables C-7 - C-8. More detailed summaries are provided after the tables. Summaries of studies from the open literature (ECOTOX studies) are provided in Table C-9 following the detailed summaries. The studies identified by ECOTOX are either acute or subacute studies. Four of the 7 studies were conducted using intraperitoneal injection. This route of exposure has little bearing on environmental exposure and the studies will not be used or compared with the oral studies. The 3 remaining studies consist of 2 single dose gavage studies and one 21-day gavage study with rats. One of the single dose studies reports an acute LD_{50} of 280 - 293 (70 a.i.) mg/kg, which is lower than the submitted LD_{50} value for a formulation with a similar percentage a.i. (1109 mg/kg or 277 mg/kg a.i.). It is not clear whether or not these are the same formulation. The other single dose study on the technical material reports a LOAEL of 25 mg/kg for sublethal neurological effects and the 21-day study reports a NOAEL of 4.4 mg/kg/day with clinical signs of neurotoxicity and enzymatic changes relevant to kidney and liver toxicity observed at the LOAEL.

Table C-7 Acute Oral Mammalian Toxicity (§81-1)

Test Organism	Test Substance	Purity	LD_{50} (mg/kg bw)	Toxicity[2]	Classification	MRID/Author
Rat *Rattus norvegicus*	Half-resolved	87.7%	LD_{50}: 1402 (♂) 3162 - 5000 (♀)	Slightly toxic to practically nontoxic	Not yet classified	46521901/WIL Research Labs 1992
	Half-resolved	88.4%	> 3000 mg/kg (♂+♀)	Practically nontoxic	Not yet classified	46521902/Food and Drug Res. Lab 1989
	Mavrik 2E	25%	LD_{50} = 277a.i. (♂) 263 a.i. (♀)	Slightly toxic	Acceptable	00094119/WIL Research Laboratories, 1981
	Cyanohydrin (I, D)	97.7%	519 (♂+♀)	Slightly toxic	Acceptable	00150115/Elars Bioresearch Laboratories 1981
	Chloranilino acid (I, D)	98.6%	424 (♂), 346 (♀)	Moderately toxic	Acceptable	00150113/SRI International 1982
	Formanilide (D)	99.5%	>500 (♂+♀)	Slightly toxic	Supplemental (only 2 dose levels)	00149686/Biosearch, Inc. 1984
	Fluvalamide (D)	99.9%	>500 (♂+♀)	Slightly toxic	Supplemental (only 2 dose levels)	00149685/Biosearch, Inc. 1984
	m-Phenoxybenzaldehyde (D)	99.0%	>500 (♂+♀)	Slightly toxic	Supplemental (only 2 dose levels)	00149681/Biosearch, Inc. 1984
	3-Chloro-4-aminobenzotrifluoride	99.7%	>500 (♂+♀)	Slightly toxic	Supplemental (only 2 dose levels)	00149684/Biosearch, Inc. 1984

[1] Newly submitted study from Registrant. RD is reviewing it.
[2] Based on LD_{50} (mg/kg) <10 very highly toxic; 10-50 highly toxic; 51-500 moderately toxic; 501-2000 slightly toxic; >2000 practically nontoxic
I = impurity, D = degradate

Table C-8 Mammalian Developmental (§83-3) and Reproductive Toxicity (§83-4)

Study	Test Organism	Test Substance	Purity	NOAEC/LOAEC (ppm) NOAEL/LOAEL (mg/kg bw/day)	Classification	MRID/Author
Developmental toxicity	**Rat** *Rattus norvegicus*	Half-resolved	88.4%	Maternal NOAEL: 5[1] Maternal LOAEL: 10	Acceptable Guideline	44743301/Argus Research Laboratories, 1998
				Developmental NOAEL 15 (HDT)[1] Developmental LOAEL >15		
Developmental toxicity	**Rabbit** *Oryctolagus*	Half-resolved	93.1%	Maternal NOAEL: 25[1] Maternal LOAEL: 125	Acceptable Guideline	00094112/Hazleton Laboratories, 1981
				Developmental NOAEL: 25[1] Developmental LOAEL: 125		
Reproductive toxicity	**Rat** *Rattus norvegicus*	Half-resolved	93.1%	Parental systemic NOAEC: 25[1] Parental systemic LOAEC: 125	Acceptable Guideline	44596601/Huntingdon Research Centre, 1986
				Offspring systemic NOAEC: 25[1] Offspring systemic LOAEC: 125		
				Reproductive NOAEC: 125[1] Reproductive LOAEC: >125		
90-day dietary study	**Mouse** *Mus musculus*	Half-resolved		NOAEL< 1.0 mg/kg bw/day: "pyrethroid reaction" - skin lesions, with their sequella	Supplementary	00094113/1981
2-year chronic toxicity study	**Rat** *Rattus norvegicus*	Half-resolved	92.1%	NOAEL: 0.5 mg/kg/day LOAEL: 1.0 mg/kg/day	Acceptable Guideline	92069048/1984

[1] The test material in the developmental toxicity studies was administered by gavage as a mg/kg body weight/day dose. The test material was mixed into the diet in the reproduction study. For comparison purposes, the concentration levels expressed as ppm in the diet are equivalent to the following dose levels expressed as mg/kg body weight/day: 0, 10, 25 or 125 ppm are equivalent to (males/females) 0/0, 0.76/0.84, 1.90/2.08, and 9.53/10.51 mg/kg bw/day, respectively.

MRID 46521901. (Guideline §81-1) Acute oral toxicity. 1992

In an acute oral toxicity study, single doses of *tau*-fluvalinate was administered by gavage to groups five Crl:CD.BR albino rats/sex/dose. Males were administered 700, 1183 or 2000 mg/kg and females were administered 2000, 3162 or 5000 mg/kg in a corn oil vehicle. No controls were included in the study. The majority of deaths (9/12) occurred within the first 2 days of dosing. Mortality in males was recorded as follows: 0/5, 2/5 and 4/5 for 700, 1183 and 2000 mg/kg dose groups, respectively. For females, mortality was recorded as 1/5, 0/5 and 5/5 for 2000, 3162 and 5000 mg/kg dose groups, respectively. Clinical signs of toxicity were observed at all dose levels, mostly during the first week of the study. These included hypoactivity, evidence of salivation, ataxia, urogenital staining, labored respiration and rales, decreased and soft or mucoid feces, red material around the nose, yellow or red material around the mouth, ocular discharge (clear or red), hypothermia, prostration, scabbing, swollen prepuce and alopecia. Approximately two-thirds of the animals had gastro-intestinal abnormalities. Additional findings included reddened kidneys, liver, lungs and adrenal glands and a hemorrhagic thymus gland. The LD_{50} values were calculated by the method of Litchfield and Wilcoxon. The acute LD_{50}s are 1402 (95% C.I. 1021 - 1924) for males and between 3162 and 5000 mg/kg for females. This study has not yet been classified by the Agency.

MRID 46521902. (Guideline §81-1) Acute oral toxicity. 1989

In an acute oral toxicity study, single doses of *tau*-fluvalinate was administered by gavage to groups five Sprague-Dawley rats/sex/dose at the following dose levels: 500, 1000, 2000 and 3000 mg/kg. No control group was included in the study and no vehicle was used. No mortality occurred up to 2000 mg/kg. At 3000 mg/kg, one female died on day 7. Clinical signs were observed at all dose levels, but particularly the 3 higher dose levels. The following clinical signs were observed: ataxia, dark material around the eyes, decreased activity, diarrhea, increased activity, labored breathing, rigidity of the limbs, salivation and apparent urinary incontinence. Hair loss was noted on the chin, on the abdomen and underneath the forearm. Sores were also noted. Group mean body weight was decreased from study days 1-4 in males at 2000 and 3000 mg/kg and in females at 2000 mg/kg. The acute LD_{50}s are greater than 3000 mg/kg. This study has not yet been classified by the Agency.

MRID 00094119. (Guideline §81-1) Acute oral toxicity. 1981.

In an acute oral toxicity study, single doses of Mavrik 2E (25% formulation) was administered by gavage to groups five Sprague-Dawley rats/sex/dose at the following dose levels: 100, 500, 1000, 2500 and 5000 mg/kg formulation in 0.5 - 5.0 ml/kg distilled water. No control group was included in the study and no vehicle was used at the higher dose levels. Mortality was observed as follows: 0/10, 1/10, 3/10, 9/9 and 10/10 in the 100, 500, 1000, 2500 and 5000 mg/kg groups, respectively. Animals which died had significant body weight decreases. Clinical signs of toxicity were observed in all groups. These included: inactivity, salivation, dried red material around mouth, nose and eyes, loose feces, excreta stains, ataxia, labored and slow respiration, lacrimation, intermittent scratching/digging at the cage, a white precipitate in the mouth at the time of dosing, mastication, reddened extremities, violent jumping with the head hitting the top of the cage, lowered temperature, vocalization, glazed eyes and prostration. Some of the latter clinical signs were only observed at higher dose levels. The acute LD_{50} is 1109.0 mg/kg (277 mg/kg a.i.) for males and 1052 mg/kg (263 mg/kg a.i.) for females. The NOAEL for mortality is 100 mg/kg and the LOAEL is 500 mg/kg. The NOAEL for clinical signs cannot be established. The LOAEL is 100 mg/kg based on clinical signs of toxicity. This study is classified as Acceptable Guideline for a formulation.

MRID 000150115. (Guideline §81-1) Acute oral toxicity. 1981.

In an acute oral toxicity study, single doses of m-phenoxymandelonitrile (cyanohydrin, a degradate) was administered by gavage to groups five albino rats/sex/dose at the following dose levels: 0, 200, 300, 350, 400 and 500 mg/kg in 10 ml/kg corn oil. Mortality was observed as follows: 0/10, 0/10, 5/10, 1/10, 1/10 and 6/10 in the 0, 200, 300, 350, 400 and 500 mg/kg groups, respectively. Animals died from anoxia 2-4 hours post dosing. Survivors recovered within 1-4 days. Clinical signs included salivation, labored respiration and diarrhea. There was a lack of a consistent dose-mortality relationship. In addition, it is possible that one of the deaths at 300 mg/kg may have been due to corn oil dilution backing up into the mouth and lungs, thus causing the death. The stomach was filled with food. The animals might not have been fasted prior to dosing. Therefore, although an LD_{50} value could be calculated, meaningful confidence limits could not be estimated. The acute LD_{50} is 519 mg/kg. The NOAEL for mortality is 200 mg/kg and the LOAEL is 300 mg/kg. This study is classified as Acceptable Guideline for a degradate.

MRID 000150113. (Guideline §81-1) Acute oral toxicity. 1982.

In an acute oral toxicity study, single doses of (R)-N-(2-chloro-4-trifluoro-methylphenyl)-valine (chloranilino acid, a degradate) was administered by gavage to groups ten Sprague-Dawley rats/sex/dose at the following dose levels: 300, 378, 476 or 600 mg/kg (males) and 250, 315, 397 or 500 mg/kg for females in 1 ml/100 g bw corn oil. No control group was included in the study. Mortality was observed as follows: 0/10, 3/10, 7/10 and 10/10 in the 300, 378, 476 and 600 mg/kg group males, respectively and 0/10, 4/10, 7/10 and 10/10 in the 250, 315, 397 and 500 mg/kg group females, respectively. Clinical signs of toxicity included ataxia and depression preceding death and hemorrhage of the lungs in all animals that died. Depression was observed at all dose levels, even at levels where there was no mortality. In surviving animals, dyspnea, humped back, chromodacryorrhea, prostration and ataxia were observed (the latter two were at higher dose levels). The acute LD_{50} is 424 (382-471) mg/kg for males and 346 (310-385) mg/kg for females. The NOAEL for mortality is 250 mg/kg (combined sexes) and the LOAEL is 315 mg/kg (combined sexes). The NOAEL for clinical signs cannot be established. The LOAEL is 250 mg/kg based on signs of depression. This study is classified as Acceptable Guideline for a degradate.

MRID 44743301. (Guideline §83-3a) Developmental toxicity study in rats. 1998.

In a developmental toxicity study (1998, MRID 44743301), *Tau*-Fluvalinate (88.4% a.i., Lot #56613870/96026) was administered by gavage at 0, 5, 10, or 15 mg/kg/day to pregnant Crl:CD®BR VAF/Plus® rats (25/dose) on gestation days (GDs) 6-19. Dams were sacrificed on GD 20. No animals died during the study.

Decreases ($p \leq 0.05$ or 0.01) in body weights and body weight gains were observed in the 10 mg/kg animals as follows: decreased mean body weights (↓5%, GD 20); reduced body weights corrected for gravid uterine weight (↓6%); decreased body weight gains (↓17%, GDs 15-17); reduced body weight gains for the overall treatment interval (↓17%, GDs 6-20) and for the overall study interval (↓13%, GDs 0-20); decreased body weight gains corrected for gravid uterine weight for the overall treatment interval (↓45%, GDs 6-20) and for the overall study interval (↓26%, GDs 0-20). Decreases ($p \leq 0.05$ or 0.01) in absolute (g/day) and relative (g/kg/day) food consumption were noted in the 10 mg/kg animals at GDs 6-9 (↓10-11%), GDs 15-19 (↓11-13%), for the overall treatment interval (↓9-10%, GDs 6-20), and for the overall study interval (↓6-7%, GDs 0-20). At 15 mg/kg, clinical observations were limited to increased incidences of chromorhinorrhea (14/375 possible observations in 8/25 animals, $p \leq 0.01$) and urine-stained abdominal fur (7/375 possible observations in 3/25 animals). When compared to concurrent controls, decreases ($p \leq 0.05$ or 0.01) in body weights and body weight gains were 18-20); reduced body weights corrected for gravid uterine weight (↓8%); decreased gravid uterine weights (↓12%, not statistically significant); decreased body weight gains (↓33%, GDs 15-17); reduced body weight gains for the overall treatment interval (↓27%, GDs 6-20) and for the overall study interval (↓22%, GDs 0-20); decreased body weight gains corrected for gravid uterine weight for the overall treatment interval (↓54%, GDs 6-20) and for the overall study interval (↓34%, GDs 0-20). Decreases ($p \leq 0.05$ or 0.01) in absolute (g/day) and relative (g/kg/day) food consumption were noted in the 15 mg/kg animals beginning at GDs 6-9 and continuing throughout treatment (↓8-17%), for the overall treatment interval (↓12-15%, GDs 6-20), and for the overall study interval (↓7-10%, GDs 0-20). No treatment-related gross pathologic findings were noted. The number of corpora lutea, implantations, resorptions, percent males, and pre- and postimplantation losses were similar between control and treated groups. **The maternal LOAEL is 10 mg/kg/day based on decreased body weights, body weight gains, and food consumption. The maternal NOAEL is 5 mg/kg/day.**

There were no treatment-related developmental effects noted at any dose level. **The developmental LOAEL was not observed. The developmental NOAEL is ≥15 mg/kg/day.**

This developmental toxicity study is classified **acceptable (§83-3[a])** and does satisfy the guideline requirement for a developmental toxicity study in the rat.

MRID 00094112 and 92069054. (Guideline §83-3b) Developmental toxicity study in rabbits. 1981 and 1990.

In a developmental toxicity study (1981, MRID No. 00094112, and 1990, MRID No.: 92069054) Fluvalinate technical (93.1%, Run 23-R, Batch # 0281028) was administered in a corn oil vehicle by gavage at 0, 5, 25, or 125 mg/kg/day to pregnant New Zealand White rabbits (17 females/dose) on gestation days (GDs) 6 through 18. Dams were sacrificed on GD 29. One high-dose female died on Day 16 following signs of labored respiration, cyanosis and depression. The cause of death of this female is not readily apparent but was not considered treatment related. One control animal and one high-dose female were both sacrificed near the end of "term" after discovery of signs indicating abortion. No unusual gross pathology was observed in either animal.

Maternal survival was comparable between the control and treated groups. No treatment-related findings were noted in the low- or mid-dose groups. In the high dose group (125 mg/kg/day), general depression (17/17) was observed at a greater incidence relative to controls (2/14). A transient (statistically significant) mean body weight loss (13-14%) was noted for high-dose females between Days 6-18. The greater incidences of depression and body weight loss in high-dose females are considered compound-related. The number of corpora lutea, implantations, resorptions, percent males, and pre- and post-implantation losses were similar between control and treated groups. **The maternal LOAEL is 125 mg/kg bw/day, based on general depression and a decrease in body weight. The maternal NOAEL is 25 mg/kg bw/day.**

No treatment-related differences in fetal weights and lengths were observed. Accompanying the maternal toxicity in the high dose group were embryo or fetotoxic effects, higher incidence of resorption (40.2% vs. 22.6% in controls), and concurrent lower fetal viability (59.8% vs. 76.7% in controls). These effects were not statistically significant, but were large and consistent, and are considered to be related to the administration of compound and a secondary effect of maternal toxicity. The number and incidence of visceral anomalies and variants were not statistically different between groups. The incidence of skeletal anomalies were increased in the high dose group as a result of fetuses in one litter having short and spatulate ribs (5 rabbits), short and curved femurs (5 rabbits), and a curved tibia and fibula (4 rabbits). A total of 10 litters and 55 fetuses were examined at the high dose. **The developmental LOAEL is 125 mg/kg/day, based on higher incidence of resorption and concurrent lower fetal viability and evidence of skeletal variants. The developmental NOAEL is 25 mg/kg/day.**

The developmental toxicity study in the rabbit is classified **acceptable/guideline** (83-3[b]) and **satisfies** the guideline requirement for a developmental toxicity study (OPPTS 870.3700; OECD 414) in rabbits.

MRID 44596601. (Guideline §84-4) Reproduction study in rats. 1986.

In a 2-generation reproduction study (1986, MRID 44596601), fluvalinate (93.1% a.i.) was continuously administered in the diet to Sprague-Dawley rats (P generation - 28/sex/dose, 32/sex/dose at the high-dose; F_1 generation - 24/sex/dose) at dose levels of 0, 10, 25 or 125 ppm (equivalent to [M/F]0/0, 0.76/0.84, 1.90/2.08, and 9.53/10.51 mg/kg/day, respectively). Exposure to P animals began at 6 weeks of age and lasted for 10 weeks prior to mating and throughout mating, gestation, and lactation. F_1 pups selected to produce the F_2 generation were exposed to the same dosage as their parents at post-natal day (PND) 21 and continuously throughout the rest of the study. After approximately 12 weeks of treatment, F_1 offspring were paired to produce the F_2 litters that were necropsied at weaning. Mating to produce a second F_{2b} generation was not performed.

Systemic toxicity. There were no differences of toxicological concern in body weight, body weight gain, food consumption, female sexual development, reproductive performance, gross pathologic findings, absolute and body weight-adjusted organ weights, and histological findings. At 125 ppm, treatment-related clinical signs were limited to skin ulceration in P males (3/32 treated vs 0/28 controls), P females (1/32 treated vs 0/28 controls), and F_1 males (2/24 treated vs 0/24 controls). The P female and her litter were severely ulcerated and, therefore, were sacrificed. F_1 dams did not exhibit any treatment-related clinical signs. No observations of toxicological significance were made at the mid- (25 ppm) and low-dose (10 ppm). **The systemic toxicity LOAEL is 125 ppm (9.53/10.51 [M/F] mg/kg/day) based on clinical signs (skin ulceration). The systemic toxicity NOAEL is 25 ppm (1.90/2.08 [M/F] mg/kg/day).**

Offspring toxicity. There were no differences of toxicological concern in litter size, viability, developmental landmarks, gross pathologic findings, absolute and body weight-adjusted organ weights, and histological findings. At 125 ppm, tremors were observed during the lactation period (~LD 14) in the F_1 litters (15/28 treated litters vs 0/28 controls) and F_2 litters (6/20 treated litters vs 1/24 controls). There was a toxicologically significant decrease in F_2 pup weight at PND 21 (↓12%, p<0.05). This decrease in pup weight, combined with a slightly lower litter size, caused a significant decrease (↓16%, p<0.05) in mean litter weight when compared to controls (286.9 g treated vs 342.1 g controls). No observations of toxicological significance were made in the 10 or 25 ppm groups. **The offspring toxicity LOAEL is 125 ppm (9.53/10.51 [M/F] mg/kg/day) based on decreased pup body weights and increased incidence of clinical signs (tremors). The offspring toxicity NOAEL is 25 ppm (1.90/2.08 [M/F] mg/kg/day**).

Since no effects on reproductive parameters were observed, **the reproductive LOAEL is > 125 ppm (9.53/10.51 [M/F] mg/kg/day. The reproductive NOAEL is 125 ppm (9.53/10.51 [M/F] mg/kg/day.**

The reproductive study is determined to be **acceptable/guideline (§83-4)** and <u>does</u> satisfy the guideline requirement for a multi-generational reproductive toxicity study in rats.

MRID 44596601. (Guideline §84-5) Chronic/oncogenicity study in rats. 1984.
In a combined chronic / carcinogenicity study, fluvalinate (92.1% a.i, Run 23R, Batch No. 0281028) was administered to Charles Rivers CD rats (85/sex/dose) by gavage at dose levels of 0, 0.25, 0.50, 1.0, or 2.5 mg/kg bw/day for 24 months.

In males and females from groups receiving 1.0 and 2.5 mg/kg/day, transient clinical signs of toxicity included excessive salivation and lacrimation, pawing of the bottom and sides of the cage, abnormal stance, ruffling, and transient hyperactivity followed by hypoactivity. These signs were observed during the first 3 hours after dosing and subsided within 6 hours. No treatment-related effects on hematology, urinalysis, ophthalmology, clinical chemistry or organ weights were observed in male or female rats at any dose. Mean body weights were significantly decreased (13-15%) in females receiving 2.5 mg/kg/day. There were no effects of dosing on food consumption. There was an increase in plantar ulcers in females receiving 2.5 mg/kg/day when compared to controls. No other treatment-related effects on gross or histopathology were observed at any dose. At the doses tested, there were no treatment-related increases in tumor incidences in treated animals when compared with controls. **The LOAEL is 1.0 mg/kg/day, based on**

abnormal stance, ruffling, and transient hyperactivity followed by hypoactivity in males and females. The NOAEL is 0.50 mg/kg/day .

This chronic/carcinogenicity study in the rat is classified as **acceptable/guideline** and **satisfies** the guideline requirement for a chronic/carcinogenicity study [OPPTS 870.4300); OECD 453] in the rat.

Table C-9. Summary of Studies from the Open Literature for Terrestrial Mammals										
Genus	Species	Common name	Major Group Effect	Measurement	Endpoint	Duration (Days)	Conc mean	Conc Units	Exposure Type	Ref#
Terrestrial Invertebrates										
Mus	*musculus*	House mouse	Growth Cellular Neurological Kidney, liver Spleen	Body weight Leucocyte reduction Clinical signs, locomotor Nephro-, hepatotoxicity Possible immunosuppressive	LOAEL	15 days	15	mg/kg i.p	Lab	76876
Rattus	*norvegicus*	Norway rat	Neurological	Motor activity, startle response	LOAEL	1 dose	25	mg/kg p.o.	Lab	76654
Rattus	*norvegicus*	Norway rat	Mortality, neuro Clinical signs Biochemical changes	Clinical signs of neurotoxicity Enzymatic changes: liver & kidney toxicity; decrease in estrogen levels	LD_{50} NOAEL	1 dose 21 days	280 - 293 (70 a.i.) 17.5 (4.4 a.i.)	mg/kg po po mg/kg	Lab	76875
Mus	*musculus*	House mouse	Neurotoxicity	Clinical signs	LD_{50}	1 dose	105 (26.2 a.i.) ip	mg/kg ip	Lab	77066
				Enhanced pentobarb sleeping time	LOAEL	7 days	10.5	mg/kg ip		
Rattus	*norvegicus*	Norway rat	Neurotoxicity	Learning, memory	LOAEL	1 dose	10.5 (2.6 a.i.)	mg/kg ip	Lab	77065

Terrestrial Plants

No acceptable Guideline toxicity studies are available for terrestrial plants. From the open literature (ECOTOX), efficacy studies provide limited information. In a study on the response of the two-spotted spider mite (*Tetranychus urticae*) to various pesticides on strawberries, fluvalinate 2F was found not to have an effect on fruit yield when compared to untreated fruit when applied once a week for 3 weeks at a rate of 0.09 kg a.i./ha (0.00008 lb a.i./acre) (ref. 73705).

In a second field study on the bioefficacy of various insecticides on serpentine leafminer (*Liriomyza trifolii*), infesting pea (*Pisum sativum*), Mavrik 25 EC (0.005%) was applied on leaves at the appearance of the leafminer damage (ref. 75351). Fluvalinate provided an 80% reduction in leaf damage when compared to untreated control 2 weeks after application. A increased green-pod yield was observed when compared to the control group (1.812 kg/ha compared to 1.102 kg/ha, respectively).

Freshwater Fish

Acute Toxicity Studies

Submitted acute toxicity studies conducted with *tau*-fluvalinate on freshwater fish indicate that it is very highly toxic to fish with 96-hour acute LC_{50}s ranging from 0.35 to 2.9 μg/L. Most of the studies were static bioassays and the protocols did not call for analytically measuring the concentration of the test material. The data from two static fish studies (carp) in which concentrations were analytically measured indicate that the concentration of the *tau*-fluvalinate rapidly declined in the test solution. The half-life was approximately 24 hours. Therefore, there is significant uncertainty over the concentration of the test material and all of the static studies are classified as supplemental, including the carp bioassays.

Chronic Toxicity Studies

No acceptable studies are available for an estimation of potential chronic toxicity to freshwater fish. One flow-through early life stage study with fathead minnows was submitted; however, due to analytical variability and insufficient reporting such that the results could not be statistically verified, this study is classified as supplemental. No toxicity studies with freshwater fish were found in the ECOTOX database. Tables C-10 - C-13 summarize the results of the toxicity studies for freshwater fish.

Table C-10 Freshwater Fish Acute (§72-1)								
Test Organism	**Test Substance**	**Purity**	**NOAEC (μg/L)**	**96-h LC_{50} (μg/L)**	**Toxicity[1]**	**Classification**	**Comments**	**MRID/Author**
Bluegill Sunfish *Lepomis macrochirus*	Half-resolved	93.1%	0.33	0.90	Very highly toxic	Supplemental	Footnote 2 S, G, N	00094599/ Analytical Biochemistry Lab. 1981
	Mavrik 2E	24.9%		2.1 EUP (0.5 a.i.)	Very highly toxic	Supplemental	Footnote 2 S, G, N	00094605/ Analytical Biochemistry Lab. 1981
	Mavrik 2F	23.5%	5.2	11 (2.6 a.i.)	Very highly toxic	Supplemental	Footnote 2 S, G, N	00154543/ EG&G Bionomics 1983
	Half-resolved	93.2%		2.7	Very highly toxic	Supplemental	[DO] too low, Footnote 3 S, G, N	00079962/ EG&G Bionomics 1979
Carp *Cyprinus carpio*	Half-resolved	93.1%	<0.35	0.35[3]	Very highly toxic	Supplemental	Footnote 2 S, G, M, A	00150125/ Sandoz Ltd 1984
	Mavrik 2F	24.1%	<1.5 (<0.36 a.i.)	11.2 (2.7 a.i.)	Very highly toxic	Supplemental	Footnote 2 S, G, M, A	00154545/ Sandoz Ltd 1984
Rainbow Trout *Salmo gairdneri*	Half-resolved	93.2%		14	Very highly toxic	Supplemental	Footnote 2, 3; S, G, N	00079961/ EG&G Bionomics 1979
	Half-resolved	93.1%	< 1.8	2.9	Very highly toxic	Supplemental	Footnote 2 S, G, N	00094598/ Analytical Biochemistry Lab. 1981
	Mavrik 2E	24.9%		2.2 a.i. 8.8 as product	Very highly toxic	Supplemental	Footnote 2 S, G, N	00094604/ Analytical Biochemistry Lab. 1981
	Mavrik 2F	23.5%		4.2 as product 1.0 (a.i.)	Very highly toxic	Supplemental	Footnote 2 S, G, N	00154544/EG&G Bionomics 1983

[1]Based on LC_{50} (mg/L): < 0.1 very highly toxic; 0.1-1 highly toxic; >1-10 moderately toxic; >10-100 slightly toxic; >100 practically nontoxic

[2] Probable adsorption of chemical to glass test chamber, photolysis or hydrolysis.

[3] Buffered to pH 6.5

F = Flow-through, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration, A = continuous aeration

Table C-11 Freshwater Fish Study With Soil Substrate (§72-1)							
Test Organism	**Test Substance**	**Purity**	**96-h LC_{50} (μg/L)**	**Toxicity[1]**	**Classification**	**Comments**	**MRID/Author**
Bluegill Sunfish *Lepomis macrochirus*	Half-resolved	93.1%	2.6	Very highly toxic	Supplemental	Low DO Footnote 2 S, G, N	00094600/ Analytical Biochemistry Lab. 1981

[1] Based on LC_{50} (mg/L): < 0.1 very highly toxic; 0.1-1 highly toxic; >1-10 moderately toxic; >10-100 slightly toxic; >100 practically nontoxic

[2] Probable adsorption of chemical to glass test chamber, photolysis or hydrolysis.

F = Flow-through, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration

Table C-12 14-day Acute Flow-Through Study							
Test Organism	**Test Substance**	**Purity**	**NOAEC (μg/L)**	**EC_{50} (μg/L)**	**Endpoints Affected**	**Classification/ Comments**	**MRID/Author**
Bluegill Sunfish *Lepomis macrochirus*	Half-resolved	93.1%	0.26	0.66	Behavioral: negative sensitivity to exterior movement, quiescence, partial loss of equilibrium	Supplemental F, G, N, A	00094596/ Analytical Biochemistry Lab. 1981

F = Flow-through, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration, A = aeration prior to entering chamber

Table C-13 Freshwater Early Life-Stage Study (§72-4)							
Test Organism	**Test Substance**	**Purity**	**NOAEC (μg/L)**	**LOAEC (μg/L)**	**Endpoints Affected**	**Classification/ Comments**	**MRID/Author**
Fathead Minnow *Pimephales promelas*	Half-resolved	93.1%	0.064	0.152	Growth	Supplemental F, G, M, A	00127996/ Analytical Biochemistry Lab. 1982

F = Flow-through, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration, A = aeration prior to going into chamber

Acute Studies

MRID 00094599. In a 96-hour acute toxicity study, Bluegill Sunfish (*Lepomis macrochirus*) were exposed to Half-Resolved Fluvalinate Technical (Tau-Fluvalinate) at nominal treatment concentrations of 0 (solvent control), 0.18, 0.33, 0.57, 1.00, 1.80, and 3.30 ppb a.i. under static conditions. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96 hours, mortality was 0% in the control and nominal 0.18 and 0.33 ppb a.i. treatment groups and 10, 60, 100 and 100% in the nominal 0.57, 1.00, 1.80 and 3.30 ppb a.i. treatment groups, respectively. Sub-lethal effects were not reported. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00094599. In a 96-hour acute toxicity study, Bluegill Sunfish (*Lepomis macrochirus*) were exposed to Half-Resolved Fluvalinate Technical (Tau-Fluvalinate) at nominal treatment concentrations of 0 (solvent control), 0.18, 0.33, 0.57, 1.00, 1.80, and 3.30 ppb a.i. under static conditions. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96 hours, mortality was 0% in the control and nominal 0.18 and 0.33 ppb a.i. treatment groups and 10, 60, 100 and 100% in the nominal 0.57, 1.00, 1.80 and 3.30 ppb a.i. treatment groups, respectively. Sub-lethal effects were not reported. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00094600. In a 96-hour acute toxicity study, Bluegill Sunfish (*Lepomis macrochirus*) were exposed to Half-Resolved Fluvalinate Technical (Tau-Fluvalinate) at nominal treatment concentrations of 0 (solvent control), 0.32, 0.56, 1.00, 1.80, and 3.20 ppb a.i. under static conditions. A one inch layer of sandy loam soil was included in each test chamber. Analytical verification of the test material in the different strata (over-lying water, pore water, sediment) was not conducted at any point during the definitive test. By 96 hours, mortality was 0% in the solvent control and nominal 0.56 ppb a.i. treatment levels and 10, 10, 20 and 70% in the nominal 0.32, 1.00, 1.80 and 3.20 ppb a.i. treatment levels, respectively. Sub-lethal effects were not reported. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00094596. In a 14-day acute toxicity study, Bluegill Sunfish (*Lepomis macrochirus*) were exposed to Fluvalinate (Tau-Fluvalinate) at nominal treatment concentrations of 0 (solvent control), 0.12, 0.26, 0.47, 0.93, and 1.9 ppb a.i. under flow-through conditions. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 14 days, mortality was 0% in the solvent control and nominal 0.12-0.93 ppb a.i. treatment groups and 25% in the nominal 1.9 ppb a.i. treatment group. Negative response to exterior movement and a violent coughing ventilation in response to noise stimuli were observed in the nominal 0.47, 0.93 and 1.9 ppb a.i. treatment groups, however the actual number of fish affected by each sub-lethal effect could not be determined due to illegible data. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00094598. In a 96-hour acute toxicity study, Rainbow trout (*Salmo gairdneri*) were exposed to Half Resolved Fluvalinate Technical (Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative control), 1.8, 3.3, 5.7, 10, and 18 ppb a.i. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96-hours, mortality was 0% in the control and 10, 60, 100, 100, and 100% in the 1.8, 3.3, 5.7, 10, and 18 ppb a.i. treatment groups, respectively. No sub-lethal effects were reported. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00079961. In a 96-hour acute toxicity study, Rainbow trout (*Salmo gairdneri*) were exposed to ZR-3210 Technical (Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative and solvent controls), 2.5, 4.1, 6.8, 11, 19, and 32 ppb a.i. under static conditions. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96-hours, no mortalities were observed in the controls or the nominal 2.5, 4.1, and 6.8 ppb a.i. treatment groups. The percent mortality was 10, 100, and 100% in the 11, 19, and 32 ppb a.i. treatment groups, respectively. Lethargy was observed in the nominal 2.5-11 ppb a.i. treatment groups,, however the actual number of fish that were affected in each treatment level was not reported. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00079962. In a 96-hour acute toxicity study, Bluegill Sunfish (*Lepomis macrochirus*) were exposed to ZR-3210 Technical (Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative and solvent controls), 0.84, 1.4, 2.3, 3.6, 6.0, and 10 ppb a.i. under static conditions. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96-hours, mortality was 0% in the controls and nominal 0.84 ppb a.i. treatment groups and 10, 20, 80, 100 and 100% in the nominal 1.4, 2.3, 3.6, 6.0 and 10 ppb a.i. treatment groups, respectively. The sub-lethal effects observed during testing in the solvent control and all treatment groups included loss of equilibrium, surfacing, rapid respiration, and lethargy. The test solutions in the nominal 3.6, 6.0 and 10 ppb a.i. treatment groups were cloudy from 72- to 96-hours. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00094605. In a 96-hour acute toxicity study, Bluegill Sunfish (*Lepomis macrochirus*) were exposed to Mavrik 2E Half-Resolved (Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative control), 0.18, 0.32, 0.57, 1.00 and 1.80 ppb a.i. under static conditions. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96 hours, mortality was 10, 20, 30, 30, 80 and 100% in the control and nominal 0.18, 0.32, 0.57, 1.00 and 1.80 ppb a.i. treatment levels, respectively. The sub-lethal effects included surfacing and was observed in one fish in the nominal 0.18 ppb a.i. treatment level. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00154543. In a 96-hour acute toxicity study, Bluegill Sunfish (*Lepomis macrochirus*) were exposed to Mavrik 2F (Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative and solvent controls), 5.2, 8.5, 14, 24, and 40 ppb form. under static conditions. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96-hours, mortality was 0% in the negative and solvent control and in the nominal 5.2 ppb form treatment level and 30, 80, 100 and 100% in the nominal 8.5, 14, 24 and 40 ppb form. treatment levels, respectively. After 96-hours, all of the surviving fish in the nominal 14 ppb form. treatment level were lethargic. After 24-hours, one fish in the solvent control was exhibiting a complete loss of equilibrium, however the fish appeared normal by 48-hours. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions

MRID 00150125. In a 96-hour acute toxicity study, Carp (*Cyprinus carpio*) were exposed to Half-Resolved Fluvalinate (Tau-Fluvalinate) at nominal treatment concentrations of 0 (solvent control), 1.8, 3.2, 5.8, 10.0, 18.0, 32.0, 58.0, 100, and 180 ppb test material under static conditions. The mean measured treatment concentrations were 1.9, 2.3, 2.1, 4.1, 6.3, 17, 27, 34, and 74 ppb test material, respectively. By 96-hours, mortality was 0% in the control and 10, 40, 50, 80, 100, 100, 100, 100 and 100% in the mean-measured 1.9, 2.3, 2.1, 4.1, 6.3, 17, 27, 34, and 74 ppb test material treatment levels, respectively. The NOEC based on mortality was 1.9 ppb test material. The sub-lethal effects observed during testing in the control and treatment groups included dazed/flaccid, slight cramps, swimming on side, hyperexitability, dark colored, dorsal fin slack, and nystagmus.

MRID 00154545. In a 96-hour acute toxicity study, Carp (*Cyprinus carpio*) were exposed to Mavrik Aquaflow 2F (Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative control), 5.8, 10, 18, 32, 58, 100, 180, 320, and 570 ppb (equivalent to 1.5, 2.5, 4.5, 8.0, 14.5, 25, 45, 80, and 142.5 ppb a.i. fluvalinate) under static conditions. The mean measured treatment concentrations were 1.5, 2.1, 2.4, 4.5, 6.6, 8.0, 21.6, 24.6, and 70.8 ppb a.i., respectively, resulting in recoveries of 30.7-96.7% on nominal active ingredient concentrations. By 96-hours, the percent mortality was 10, 60, 70, 90, 100, 90, 100, 100, and 100% in the 1.5, 2.1, 2.4, 4.5, 6.6, 8.0, 21.6, 24.6, and 70.8 ppb a.i. treatment groups, respectively. No mortalities were observed in the control. The sub-lethal effects observed during testing in the control and treatment groups included dazed/flaccid, slight cramps, swimming on side, hyperexitability, dark colored, dorsal fin slack, and nystagmus.

MRID 00094604. In a 96-hour acute toxicity study, Rainbow trout (*Salmo gairdneri*) were exposed to Mavrik 2E Half-Resolved (Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative control), 0.25, 0.43, 0.77, 1.4, and 2.5 ppb a.i.. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96-hours, no mortalities were observed in the control or the nominal 0.25, 0.43, 0.77, and 1.4 ppb a.i. treatment groups. Mortality was 70% in the 2.5 ppb a.i. treatment group. The sub-lethal effects included loss of equilibrium and surfacing in the nominal 0.77, 1.4, and 2.5 ppb a.i. treatment groups. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00154544. In a 96-hour acute toxicity study, Rainbow Trout (*Salmo gairdneri*) were exposed to Mavrik 2F (formulation containing Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative and solvent controls), 2.6, 4.3, 7.5, 12 and 20 ppb Mavrik 2F under static conditions. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96-hours, mortality was 0% in the negative and solvent controls and 20, 40, 100, 100 and 100% in the nominal 2.6, 4.3, 7.5, 12 and 20 ppb Mavrik 2F treatment levels, respectively. Several of the surviving fish in the nominal 2.6 and 4.3 ppb Mavrik 2F treatment levels were surfacing, however, the actual number of fish affected was not reported. Test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

Chronic Studies

MRID 00127996. The chronic toxicity of Fluvalinate HR Technical (fluvalinate) to the early life-stage of fathead minnow (*Pimephales promelas)* was studied under flow-through conditions for 35 days (5-day hatching period and 30-day post-hatch period). Fertilized eggs/embryos (120 embryos/treatment), <48 hours old, were exposed to Fluvalinate HR Technical at nominal concentrations of 0 (negative and solvent controls), 8, 16, 33, 65, and 130 ppt a.i. (parts per trillion active ingredient.; ng a.i./L). Mean-measured concentrations were <7 (<LOQ, negative control), 17, 35, 64, 152, and 480 ppt a.i., respectively. However, fluvalinate concentrations were not stable in the test systems based upon weekly analysis of test solutions from each treatment level, with reviewer-calculated high-low ratios of 2.0-3.1. Nominal concentrations were therefore used in reporting results. No treatment-related effect on the time to hatch was apparent (not statistically assessed). All embryos hatched between Days 3 and 5. No statistically-significant differences in hatching success were observed. Percent hatch averaged 98% for both control groups and the nominal ≤65 ppt a.i. treatment groups, and 88% for the 130 ppt a.i. treatment group. Although not statistically-significant, the 10% reduction in percent hatch observed at the nominal 130 ppt a.i. may have been a result of exposure. The time to swim-up was not monitored. A statistically-significant reduction in pre-thinning (on study Day 12; 7 days post-hatch) larval survival was observed at the nominal 130 ppt a.i. level compared to the negative control. Prior to thinning, larval survival averaged 72 and 86% for the negative and solvent controls, respectively, and 76, 98, 83, 65, and 6.7% for the nominal 8, 16, 33, 65, and 130 ppt a.i. levels, respectively. No treatment-related effect on survival was observed in fry following thinning, with mean percent survival ranging from 88 to 98% for all control and treatment levels. Statistically-significant reductions in terminal length and wet weights were observed at the nominal 65 and 130 ppt a.i. levels compared to the corresponding negative controls. Terminal lengths averaged 18 mm for both control groups and the nominal ≤33 ppt a.i. levels, and 17 mm for the 65 and 130 ppt a.i. levels. Terminal wet weights averaged 0.11-0.12 mg for both control groups and the nominal ≤33 ppt a.i. levels, and 0.096 and 0.084 mg for the 65 and 130 ppt a.i. levels, respectively. No significant toxicant-related behavioral effects were noted during the post-thinning period. There was significant analytical variability, and the reported toxicity values could not be statistically verified by the reviewer since replicate mean data were not reported.

Marine/Estuarine Fish

No acceptable acute toxicity studies on the technical material are available for marine/estuarine fish. The submitted study on sheepshead minnows indicates that *tau*-fluvalinate is very highly toxic to marine/estuarine fish with 96-hour acute LC_{50} of 10.8 μg/L. As with the freshwater fish studies, the study was a static bioassay using nominal concentrations. Therefore, due to the likelihood of significant degradation of the test material during the exposure period of the study, there is uncertainty over the concentration of the test material. The study is classified as supplemental.

One acceptable acute flow-through study conducted on sheepshead minnows with Mavrik 2F, a 22.3% formulation is available (MRID 42284602). Measured concentrations in this study indicate that the concentration of the active ingredient was maintained to within 99 to 110% of the nominal concentrations. No toxicity studies with marine/estuarine fish were found in the ECOTOX database. Table C-14 summarizes the results of the acute toxicity studies conducted with marine/estuarine fish.

An acceptable guideline study is available for marine/estuarine fish. In marine/estuarine fish, reproductive capacity and growth are diminished at concentration levels 0.07 μg/L and above. At higher levels (e.g. 0.14 μg/L), lethargy was observed. Table C-15 summarizes the results from the chronic study in marine/estuarine fish. A search of the open literature (e.g. ECOTOX) provided no additional data on toxicity to marine/estuarine fish following chronic exposure to *tau*-fluvalinate.

Table C-14 Estuarine/Marine Fish Acute Toxicity (§72-3)								
Test Organism	**Test Substance**	**Purity**	**NOAEC (μg/L)**	**LOAEC (μg/L)**	**96-h LC_{50} (μg/L)**	**Toxicity[1]**	**Classification/ Comments**	**MRID/Author**
Sheepshead Minnow *Cyprinodon variegatus*	Half-resolved	93.1%			10.8	Very highly toxic	Supplemental Footnote 2 S, M at 0 hour, G. DO <40% after 24 hrs	00155450, 00160766/ Springborn Bionomics 1985
	Mavrik 2F	22.3%	< 22.5	22.5	27.4 (a.i.)	Very highly toxic	Acceptable for formulation F, G, M, A	42284602/ Toxikon Environmental Sciences 1992

[1] Based on LC_{50} (mg/L): < 0.1 very highly toxic; 0.1-1 highly toxic; >1-10 moderately toxic; >10-100 slightly toxic; >100 practically nontoxic
[2] Probable adsorption of chemical to glass test chamber, photolysis or hydrolysis.
F = Flow-through, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration, A = aeration prior to use

Table C-15 Life-cycle (§72-5)

Test Organism	**Test Substance**	**Purity**	**NOAEC (μg/L)**	**LOAEC (μg/L)**	**Endpoints Affected**	**Classification/ Comments**	**MRID/Author**
Sheepshead Minnow *Cyprinodon variegatus*	Half-resolved	87.7%	0.036	0.070	Percent spawning frequency; no. eggs produced/female; length, weight, survival of F_0	Acceptable F, M, G, A	43753501/ Wildlife Int'l 1995

F = Flow-through, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration, A = aeration prior to use

MRID 00155450, 00160766. In a 96-hour acute toxicity study, Sheepshead minnow (*Cyprinodon variegatus*) were exposed to Fluvalinate (Tau-Fluvalinate) at nominal treatment concentrations of 0 (negative and solvent controls) 1.2, 2.0, 3.3, 5.3, 9.0, 15, and 25 ppb a.i. under static conditions. The 0-hour measured treatment concentrations were 1.7, 1.2, 2.4, 4.0, 9.0, 13, and 33 ppb a.i., respectively. Analytical verification of the test material in the test solution was not conducted at any other time during the definitive test. By 96-hours, mortality was 0% in the measured 1.2, 2.4 and 9.0 ppb a.i. treatment levels, 10% in the negative and solvent controls and measured 1.7 and 4.0 ppb a.i. treatment levels, and 100% in the measured 13 and 22 ppb a.i. treatment levels. Anteriorly extended pectoral fins, partial to complete loss of equilibrium, rapid respiration and lethargy were observed throughout the study. At test termination, all surviving fish in the mean-measured 1.7, 1.2, 2.4, 4.0 and 9.0 ppb a.i. treatment levels had anteriorly extending pectoral fins and all of the surviving fish in the mean-measured 1.7 and 2.4 ppb a.i. treatment levels were respiring rapidly. The concentrations of the test material were only analytically verified from one sample at 0-hours and the resulting measured concentrations did not exhibit a similar shift in order, with the lowest concentration measuring a higher content of active ingredient than the second lowest concentration. Because the order of test concentrations is shifted, the test is rejected, because regression analysis cannot yield statistically sound median lethal concentrations and confidence limits (Supporting Documents to Pesticide Reregistration Rejection Rate Analysis, US EPA, OPPTS, December, 1994). The measured test concentrations were unacceptable and therefore a toxicity category could not be applied.

MRID 42284602. (Guideline §72-3) Acute toxicity test with Sheepshead Minnows (Mavrik 2F Formulation). 1992

Groups of 20 sheepshead minnows (*Cyprinodon variegatus*) were exposed to the following mean measured concentrations of Mavrik 2F, a 22.3% a.i. formulation under flow-through test conditions: 0, 22.5, 34.8, 64.1, 101 or 163 μg a.i./L. The 96-hour LC_{50} was 27.4 μg a.i./L (95% C.I.: 22.5 - 34.8 μg/L). Sublethal and lethal effects were observed at all concentrations. Mortality was as follows: 0, 4, 17, 19, 19 and 19 for the 0, 22.5, 34.8, 64.1, 101 or 163 μg a.i./L concentration levels, respectively. Lethargy, total and partial loss of equilibrium were listed as the sublethal effects. One fish was lethargic after 48 hours at the 22.5 μg/L concentration. A total of 4 fish died at the same concentration level. A higher percentage of fish exhibited sublethal effects at 34.8 μg/L and above. The statistical analysis included a binomial test, the moving average method and the probit method. The NOAEC could not be established. The study is scientifically sound, meets the guideline requirements for a flow-through acute estuarine/marine fish toxicity study and is classified as *acceptable* for a formulation.

MRID 43753501. (Guideline §72-5) Life-Cycle Toxicity Test with Sheepshead Minnows. 1995

Tau-fluvalinate was tested in a flow-through life-cycle toxicity test with sheepshead minnows (*Cyprinoden variegatus*) at mean measured concentrations of 0, 0 (acetone), 0.0087, 0.017, 0.036, 0.070 or 0.14 μg a.i./L. At 0.070 μg/L and above, a treatment-related decrease in the number of eggs produced/female/reproductive day, percent spawning frequency, number of fertile eggs/female/reproductive day and length of F_0 fish at 28 and 56 days posthatch was observed. Clinical signs included lethargy in several F_0 fish and in several F_1 larvae at the highest concentration. The statistical methods included contingency tables, ANOVA F-test, a means comparison test (Scheffe's test or Bonferroni's t-test) or Mann-Whitney U-Wilcoxon Rank Sum W test. The statistical analyses were verified with either the Williams' test or Tukey's studentized range test. The NOAEC is 0.036 μg a.i./L and the LOAEC is 0.070 μg a.i./L. The geometric-mean MATC was 0.050 μg a.i./L. The study is scientifically sound, meets the guideline requirements for a flow-through life-cycle estuarine/marine fish toxicity study and is classified as *acceptable.*

Freshwater Invertebrates

No acceptable acute toxicity studies on the technical material are available for freshwater invertebrates. The submitted studies on daphnia indicate that *tau*-fluvalinate is very highly toxic to freshwater invertebrates with 48-hour acute EC_{50}'s ranging from 0.4 - 74 μg/L.
As with the freshwater fish studies, with one exception, the studies were static bioassays using nominal concentrations. Therefore, due to the likelihood of significant degradation of the test material during the exposure periods of the studies, there is uncertainty over the concentration of the test material. The studies are classified as supplemental.

Table C-16 summarizes the results of the acute toxicity studies conducted with daphnids.

Acute toxicity studies with freshwater invertebrates were found in the ECOTOX database on *Procambarus clarkii* (red swamp crayfish) and *Culex pipiens* (mosquito) with endpoints based on mortality. These studies were also static studies conducted with nominal concentrations. The crayfish study was conducted in glass containers and the mosquito study was conducted in paper cups. The acute LC_{50} in crayfish following 96 hours exposure at 22°C is 0.31 μg/L and the LC_{50} in mosquito larvae following 24 hours exposure is 57.8 μg/L.

No acceptable chronic studies on freshwater invertebrates are available. One chronic study was submitted on daphnia; however, in that study, mean-measured concentrations were determined by two inadequate methods, and conflicting results were obtained. Nominal concentrations were therefore used in reporting results. This study is classified as supplemental. Table C-17 summarizes the results from this study.

Table C-16 Freshwater Invertebrate Acute Toxicity (§72-2)

Test Organism	Test Substance	Purity	NOAEC (μg/L)	48-h EC_{50} (μg/L)	Toxicity[1]	Classification/ Comments	MRID/Author
Waterflea *Daphnia magna*	Half-resolved	93.1%	< 18	74	Very highly toxic	Supplemental Footnote 2 S, G, N	00094597/ Analytical Biochemistry Lab. 1981
	Half-resolved	93.1%	<0.24	1.0	Very highly toxic	Supplemental F, G, N	00127995/ EG&G Bionomics1982
	Half-resolved	93.2%	0.06	0.4	Very highly toxic	Supplemental Footnote 2, 3 S, G, N	00079960/ EG&G Bionomics 1979
	Mavrik 2E	24.9%	<5.6	325 as product 81 as a.i.	Highly toxic	Supplemental Footnote 2 S, G, N	00094603/ Analytical Biochemistry Lab. 1981
	Mavrik 2F	23.5%	<1.6	11 as product 2.6 as a.i.	Very highly toxic	Supplemental Footnote 2, 3 S, G, N	00154546/EG&G Bionomics 1983

[1] Based on LC_{50} (mg/L): < 0.1 very highly toxic; 0.1-1 highly toxic; >1-10 moderately toxic; >10-100 slightly toxic; >100 practically nontoxic
[2] Probable adsorption of chemical to glass test chamber, photolysis or hydrolysis.
[3] Buffered to pH 6.5
F = Flow-through, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration

Table C-17 Freshwater Invertebrate Chronic Toxicity 21-day flow-through (§72-4)

Test Organism	Test Substance	Purity	NOAEC (μg/L)	LOAEC (μg/L)	Endpoints Affected	Classification/ Comments	MRID/Author
Waterflea *Daphnia magna*	Half-resolved	93.1%	0.044	0.089	Reproduction, growth	Supplemental F, G, M	00127997/ Analytical Biochemistry Lab. 1983

F = Flowthrough, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration

MRID 0094597. The 48-hour acute toxicity of Half-Resolved Fluvalinate Technical to the water flea, *Daphnia magna*, was studied under static conditions. Daphnids were exposed to the test material at nominal concentrations of 0 (negative and solvent controls), 18, 32, 56, 100, 180 and 320 ppb a.i. Analytical verification of the test material concentrations within the test solutions was not conducted at any point during the definitive test. After 48 hours, mortality/immobilization was 0, 0, 10, 25, 65, 100 and 100% in the nominal 0 (negative and solvent controls), 18, 32, 56, 100, 180 and 320 ppb a.i. treatment levels, respectively. Sub-lethal effects such as surfacing, partial immobilization or loss of equilibrium were observed in all exposure concentrations, however the actual number of daphnids that were affected in each treatment level could not be determined due to illegible raw data. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00127995. The 48-hour acute toxicity of Half-Resolved (αRS,2R)-Fluvalinate Technical to the water flea, *Daphnia magna*, was studied under flow-through conditions. Daphnids were exposed to the test material at nominal concentrations of 0 (negative and solvent controls), 0.24, 0.49, 0.95, 1.9 and 3.9 ppb a.i. Analytical verification of the test material in the test solutions was not conducted at any point during the definitive test. After 48 hours, mortality/immobilization was 0% in the negative and solvent controls and 13, 13, 28, 88 and 100% in the nominal 0.24, 0.49, 0.95, 1.9 and 3.9 ppb a.i. treatment groups, respectively. Lethargy was observed in all exposure concentrations, however, the actual number of daphnids that were affected in each treatment level was not reported. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00079960. The 48-hour acute toxicity of ZR-3210 Technical to the water flea, *Daphnia magna*, was studied under static conditions. Daphnids were exposed to the test material at nominal concentrations of 0 (negative and solvent controls), 0.06, 0.09, 0.14, 0.22, 0.36 and 0.60 ppb a.i. Analytical verification of the test material concentrations within the test solutions was not conducted at any point during the definitive test. After 48 hours, mortality/immobilization was 0% in the negative and solvent controls and the nominal 0.06 ppb a.i. treatment group, and 7, 7, 13, 47and 73% in the nominal 0.09, 0.14, 0.22, 0.36 and 0.60 ppb a.i. treatment groups, respectively. Sub-lethal effects such as surfacing, erratic swimming and lethargy were observed in all exposure concentrations, however the actual number of daphnids that were affected in each treatment level was not reported. Erratic swimming was observed in all treatment levels; surfacing was observed in the nominal 0.22 and 0.36 ppb a.i. treatment groups and lethargy was observed in the nominal 0.09-0.60 ppb a.i. treatment groups. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test material under these study conditions.

MRID 00094603. The 48-hour acute toxicity of Mavrik 2E (emulsifiable concentrate containing 24.9% half-resolved fluvalinate) to the water flea, *Daphnia magna*, was studied under static conditions. Daphnids were exposed to the test material at nominal concentrations of 0 (negative and solvent controls), 5.6, 10, 18, 32, 56 and 100 ppb a.i.. Analytical verification of the test material concentrations within the test solutions was not conducted at any point during the definitive test. after 48 hours, mortality/immobilization was 0% in the negative and solvent controls, and 5, 5, 10, 5, 25 and 65% in the nominal 5.6, 10, 18, 32, 56 and 100 ppb a.i. treatment groups, respectively. Sub-lethal effects such as surfacing or loss of equilibrium were observed in all exposure concentrations, however the actual number of daphnids that were affected in each treatment level could not be determined due to illegible raw data. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00154546. The 48-hour acute toxicity of Mavrik 2F (formulation containing 23.5% a.i., fluvalinate) to the water flea, *Daphnia magna*, was studied under static conditions. Daphnids were exposed to the test material at nominal concentrations of 0 (negative and solvent controls), 1.6, 2.6, 4.4, 7.2, 12 and 20 ppb Mavrik 2F. Analytical verification of the test material concentrations within the test solutions was not conducted at any point during the definitive test. After 48 hours, mortality/immobilization was 0% in the negative and solvent controls and 13, 20, 27, 13, 60 and 87% in the 1.6, 2.6, 4.4, 7.2, 12 and 20 ppb Mavrik 2F treatment groups, respectively. At test termination, all surviving daphnids in each exposure group were lethargic and on the bottom of the test vessel. No sub-lethal effects were observed in the negative or solvent control. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 00127997. The 21-day-chronic toxicity of Half Resolved (αRS,2R) Fluvalinate Technical (fluvalinate) to *Daphnia magna* was studied under flow-through conditions. Nominal concentrations were 0 (negative and solvent controls), 9, 18, 37, 75, and 150 ppt a.i. (parts per trillion a.i.; ng a.i./L). Mean-measured concentrations were determined by two inadequate methods, and conflicting results were obtained. Nominal concentrations were therefore used in reporting results. After 21 days of exposure, survival averaged 95 and 100% for the negative and solvent control groups, respectively, 100% for the 9, 18, and 37 ppt a.i. groups, and 90% for the 75 and 150 ppt a.i. groups. Survival was significantly reduced on a biological basis compared to the control groups at the 75 and 150 ppt a.i. level. This conclusion was based on the lack of replicate variation in the solvent control and lower treatment levels and random mortality observed in the negative control group. A statistically-significant effect (William's, $p<0.05$) on reproduction (no. of offspring/adult/reproductive day) was observed at the nominal 75 and 150 ppt a.i. test levels compared to the pooled control. The number of young/adult/- reproductive day averaged 12 for both control and the ≤37 ppt a.i. groups, 11 for the 75 ppt a.i. group, and 9.3 for the 150 ppt a.i. group. A biologically-significant effect on terminal lengths of surviving adult daphnia was observed at the nominal 75 and 150 ppt a.i. test levels compared to the controls. Length averaged 4.4 mm for both control and the ≤18 ppt a.i. groups, and 4.3, 4.1, and 4.0 mm for the 37, 75, and 150 ppt a.i. groups, respectively.

Marine/Estuarine Invertebrates

No acceptable acute toxicity studies on the technical material are available for marine/estuarine invertebrates. The submitted studies on eastern oysters and mysid shrimp indicate that *tau*-fluvalinate is very highly toxic to marine/estuarine invertebrates with EC_{50}'s of 12 μg/L for eastern oysters and 0.018 μg/L for mysid shrimp. As with the freshwater fish studies, the studies were static bioassays. The measured concentrations in the eastern oyster study show significant degradation of the test chemical within the first 24 hours of the study. Therefore, the studies are classified as supplemental.

An acceptable study on eastern oysters is available on Mavrik 2F, a 22% formulation (MRID 42284601). Table C-18 summarizes the results of the acute toxicity studies conducted with marine/estuarine invertebrates.

No chronic toxicity studies are available on marine/estuarine invertebrates. No acceptable data on acute or chronic toxicity of *tau*-fluvalinate to marine/estuarine invertebrates were found in the open literature (i.e. ECOTOX).

Table C-18 Estuarine/Marine Invertebrate Acute Toxicity (§72-3)							
Test Organism	**Test Substance**	**Purity**	**NOAEC (μg/L)**	**EC_{50} (μg/L)**	**Toxicity[1]**	**Classification/ Comments**	**MRID/Author**
Eastern Oyster *Crassostrea virginica*	Half-resolved	93.1%	< 1.5	12	Very highly toxic	Supplemental, Footnote 2 S, M, G	00160767/ Springborn Bionomics 1986
	Mavrik 2F	22.3%	11500	> 102000 a.i.	Practically non-toxic	Acceptable for formulated product F, G, M	42284601/ Toxikon Environmental Sciences 1992
Mysid Shrimp *Mysidopsis bahia*	Half-resolved	93.1%		0.018	Very highly toxic	Supplemental Footnote 2 S, G, N, A	00127994/ EG&G Bionomics 1982
	Mavrik Aquaflow	22.0%		0.094 (0.011 a.i.)	Very highly toxic	Supplemental F, M, G, A	44106501/ Wildlife Int'l 1996

[1]Based on EC_{50} (mg/L): < 0.1 very highly toxic; 0.1-1 highly toxic; >1-10 moderately toxic; >10-100 slightly toxic; >100 practically nontoxic

[2] Probable adsorption of chemical to glass test chamber, photolysis or hydrolysis

F = Flow-through, S = Static, G = Glass test vessel, N = Nominal concentration, M = measured concentration, A = aeration prior to use

MRID 00160767. In a 48-hour mollusk EC_{50} study, groups of Eastern Oyster (*Crassostrea virginica*) embryos were exposed to nominal concentrations of 3.3, 5.3, 9.0, 15 or 25 μg/L *tau*-fluvalinate for 48 hours. Based on the mean of measured concentrations at 0 and 48 hours, these nominal concentrations corresponded to 17, 11, 5.0, 2.4 and 1.5, 2.4, 5.0, 11 and 17 μg/L. At mean measured concentrations of $\geq$5.0 μg/L, the number of normal larvae was substantially reduced when compared to the control larval group. The calculated 48-hour EC_{50} and 95% confidence interval (based on mean-measured concentrations) for embryos-larvae were 12 (3.6-87) μg/L. The measured concentrations showed that concentrations of *tau*-fluvalinate rapidly disappeared over the exposure period. By 48-hours, the concentrations decreased by approximately 50% or more. A NOAEC for reduction of larvae was not established.

MRID 00127994. The 96-hour acute toxicity of Half-Resolved Fluvalinate Technical (Tau-Fluvalinate) to the saltwater mysid, *Mysidopsis bahia*, was studied under static conditions. Mysids were exposed to the test material at nominal concentrations of 0 (negative and solvent controls), 3.2, 5.6, 10.0, 18.0, 32.0, and 56.0 pptr a.i. Analytical verification of the test material in the test solution was not conducted at any point during the definitive test. By 96 hours, mortality was 10% in both the negative and solvent controls, and 10, 25, 25, 25, 75 and 100% in the nominal 3.2, 5.6, 10.0, 18.0, 32.0 and 56.0 pptr a.i., respectively. Lethargy was observed in the 18.0, 32.0, and 56.0 pptr a.i. treatment groups during testing. The test solutions were not analytically verified in this study, so the actual concentrations that test organisms were exposed to are unknown. Toxicity values and categorization derived using nominal test concentrations may not be indicative of exposure to the test substance under these study conditions.

MRID 42284601. (Guideline §72-3) Mollusc 96-Hour Shell Deposition Study (Formulation). 1992.

Replicate groups of 20 Eastern Oysters (*Crassostrea virginica*) were exposed to the following mean-measured concentrations of Mavrik 2F formulation (22.3% a.i.) under flow-through test conditions: 0 (dilution water), 1.36, 2.44, 6.79, 11.5, 22.4, 43.5 or 102 mg a.i./L. Mean new shell growth in the control was 2.32 mm. The percent reduction in new shell growth ranged from 8% at 2.44 and 11.5 mg a.i./L to 47% at 43.5 and 102 mg a.i./L. No oysters died during the study. The NOAEC was 22.3 mg a.i./L, the highest concentration with shell growth not significantly different from the control group. Based on shell growth data, the 96-hour EC_{50} value was >102 mg a.i./L. Less than 50% growth inhibition in shell growth was observed at the selected exposure concentrations. The NOAEC was determined using Williams' test. Mavrik 2F is classified as practically nontoxic to eastern oysters. The study is scientifically sound and meets the guideline requirements for an oyster shell deposition study with a formulation. The study is classified as *acceptable.*

MRID 44106501. The 96-hour acute toxicity of Tau-Fluvalinate to the saltwater mysid, *Mysidopsis bahia*, was studied under flow-through conditions. Mysids were exposed to the test material at nominal concentrations of 0 (negative and blank controls), 0.0094, 0.019, 0.038, 0.075, and 0.15 ppb form.. The study author reported that the actual test solutions could not be analyzed because the tested concentrations were lower than the levels of detection and quantification for the analytical methodology. To demonstrate treatment concentration stability, the study author determined the initial and final recoveries from the individual treatment level stock solutions. Mean-measured stock concentrations were <0.0090 (<LOQ, controls), 0.0130, 0.0261, 0.0533, 0.1030, and 0.223 ppb form., respectively (110-119% of nominal). The reviewer used the average % recoveries from the stock solutions to extrapolate the measured test concentrations (0 (negative and blank controls), 0.010, 0.0210, 0.0430, 0.0830 and 0.180 ppb form). At 96 hours, mortality was 0% in the negative and blank controls and in the mean-measured (extrapolated from measured stock concentrations) 0.010 and 0.0430 ppb form. treatment levels and 5, 35 and 80% in the mean-measured 0.0210, 0.0830 and 0.180 ppb form. treatment levels, respectively. The **96-hour LC_{50} (with 95% C.I.) was determined to be 0.011 (0.090-0.14) ppb a.i.** Erratic swimming was observed in surviving mysids from the ≥0.0430 ppb a.i. treatment groups during the study. Based on sublethal effects, the **NOEC and LOEC values were 0.0210 and 0.0430 ppm a.i.**, respectively.

MRID 43093001 (Guideline §72-7) Aquatic Ecosystem Study. 1993.

A minicosm study was conducted on *tau*-fluvalinate. The study authors defined the term minicosm as a small artificially controlled ecosystem that is larger than a laboratory microcosm (glass aquaria) and smaller than a mesocosm (< 0.1 acre). The study used 3 x 8 x 2 ft. ponds (21.6 ft^2 water surface area and 740 L over 10 cm of sediment per pond). Water and biologically active sediment spikes (hydrosoil) used for the study were collected from an on-site reservoir pond. Actual sediment (5-cm of clay and 5-cm of topsoil) used to line the bottoms of each minicosm were collected from the same source on the research site to assure similarity. Minicosms were established and allowed to acclimate and be naturally colonized for 60 days prior to the test start date. Sampling was conducted to assess for contamination. Treatment was conducted every 14 days (3 treatments total for all treatment groups except for the nominal 0.30 lb a.i./A formulation A group, which was applied only once). Pre and post-treatment biological samples were collected at a varied intervals until test termination (56 days following the first application). Ponds were only stocked with sixteen Bluegill sunfish (*Lepomis macrochirus*) per pond. All other biota were allowed to succeed from the area surrounding the ponds and the natural reservoir pond water and biologically active hydrosoil spikes. Fish were stocked at the smallest practical size (<5 cm) so that more fish could be sustained in each minicosm pond thereby reducing the potential effects of variability between individual fish and incidental (unrelated to treatment) fish loss.

The minicosm ponds were fertilized with liquid ammonium polyphosphate. For analysis of the phytoplankton community, samples were collected on Days, -15, -1 (prior to first treatment on Day 0), and on Days 13, 27, and 41 following the first application of the test materials. For analysis of the zooplankton community, samples were collected on Days, -15, -1, and on Days 6, 13, 20, 27, 34, and 41. For analysis of the macroinvertebrate community (e.g., aquatic insects, molluscs, crustaceans, and worms visible to the unaided eye and retained in 0.24 mm (No. 60) sieve), samples were collected on Days -15, and -1 (prior to first treatment on Day 0), and on

Days 13, 27, and 41 following the first application of the test materials. Physical, analytical and chemical measurements were conducted in each pond at various times through the study.

This minicosm study was intended to evaluate the effects of different dose levels and three formulations containing the active ingredient fluvalinate on aquatic ecosystems, especially on finfish and on the organisms that serve as a food source for finfish. The three formulations of fluvalinate designated as A, B, and C, consisted of: Mavrik Aquaflow (23.0% half-resolved fluvalinate), a formulation containing 22.2% fully resolved fluvalinate and a formulation containing 22.2% microencapsulated half-resolved fluvalinate, respectively. The study design included simulated contamination via aerial spray drift and runoff from agricultural fields with thirty-five minicosm ponds divided into six treatment groups and a negative control group. Four of the six treatment groups received applications of Formulation A at rates simulating environmental concentrations that would be expected from off target loading due to field application rates of 0.05, 0.10, 0.15, and 0.30 lb a.i./A (equivalent to 0.056, 0.112, 0.168, and 0.336 kg a.i./ha). The ponds treated to simulate 0.30 lb a.i./A (0.336 kg a.i./ha) loading were treated only once with simulated spray drift and once with simulated runoff (a soil slurry containing fluvalinate). The other ponds receiving Formulation A were treated three times, at two week intervals, with simulated spray drift and runoff. One treatment group was dosed with Formulation B at a rate simulating environmental concentrations that would be expected from field application rates of 0.15 lb a.i./A (0.168 kg a.i./ha). The last treatment group was dosed with Formulation C at a rate simulating environmental concentrations that would be expected from field application rates of 0.15 lb a.i./A. Formulations B and C also were applied as simulated spray drift and runoff three times at two week intervals. On each date when simulated runoff application was performed, soil-slurry (not containing fluvalinate) was added to each control pond to match the sediment input received by the treatment groups.

Mean-measured fluvalinate concentrations in the minicosm **water** were 0.15, 0.21, and 0.13 ppb a.i in the 0.15 lb a.i./A formulation A, B, and C treatment groups, respectively, and 0.31 ppb in the 0.30 lb a.i. formulation/A treatment group. Fluvalinate did not appear to accumulate in the water column during the study period. Fluvalinate half-lives for the nominal 0.15 lb a.i./A formulations ranged from 10.4 to 27.8 hours for A, 9.8 to 13.3 hours for B, and 21.0 to 47.0 hour for C, and was 11.7 hours for the nominal 0.30 lb a.i./A formulation A treatment group. Mean-measured fluvalinate concentrations in the minicosm **sediment** were 1.48, 1.11, and 3.68 ppb a.i in the 0.15 lb a.i./A formulation A, B, and C treatment groups, respectively, and 1.81 ppb in the 0.30 lb a.i. formulation A treatment group. Fluvalinate residues were not detectable in the top 5-cm of the minicosm sediment within 192 hours of the simulated spray drift and runoff regime for the nominal 0.15 lb a.i./A formulations A and B treatment groups. Formulation C persisted in the sediment, presumably due to the microencapsulation of the test material. Only formulation C (0.15 lb a.i./A treatment group) accumulated in the sediment during the study period.

All water quality parameters generally appeared to be within normal ranges over the course of the study and did not appear to be adversely affected by the application of the test materials. Water quality during the study also did not appear to have any adverse effects on any of the phytoplankton, zooplankton, and fish populations assessed in this study.

In general, the majority of the biological communities assessed in this study showed no fluvalinate treatment-related effects following simulated spray drift and runoff exposure to the various formulations and application rates. Phytoplankton were not negatively affected by treatment and the NOEC for phytoplankton was determined to be greater than all nominal application rates tested for the three fluvalinate formulations (A, B, and C). Zooplankton abundance, specifically of Cladocerans, Rotifers, and Ostracods was not biologically or statistically reduced, compared to the control groups, by exposure to any of the three formulations; although, only the Rotifera were truly abundant enough for meaningful analysis. There were statistically significant treatment-related reductions observed at various sampling intervals for adult and immature Copepod abundance. Abundance of both life-stages of Copepods was significantly reduced at all application rates and all formulations 13 days following the first simulated spray drift and runoff application. Consequently, the NOEC values for zooplankton were concluded to be nominal 0.05 lb a.i./A for formulation A (three applications; excluding the 0.30 lb a.i./A treatment group, which was only applied once during the study period), nominal <0.15 lb a.i./A for formulations B and C (three applications), and <0.30 lb a.i./A for formulation A (1 application). Benthic macroinvertebrates from the families Chironomidae, Chironominae, and Tanypodinae (from the order Diptera) were not biologically or statistically reduced, compared to the control group, by exposure to any of the three formulations. There were, however, statistically significant treatment-related reductions at various sampling intervals for Caenidae nymph (Mayflies) abundance at all application rates, for all formulations 13 days following the first simulated spray drift and runoff application. While it was concluded that there were treatment-related reductions in macroinvertebrate abundance as the result of treatment with fluvalinate, these effects were difficult to interpret because of the confounding effect of seasonal fluctuations in abundance. Based on the significant reductions in Caenidae abundance, (a dominant group in the benthic macroinvertebrate community) the NOEC values for benthic macroinvertebrates were concluded to be nominal 0.05 lb a.i./A for formulation A (three applications; excluding the 0.30 lb a.i./A treatment group, which was only applied once during the study period), nominal <0.15 lb a.i./A for formulations B and C (three applications), and <0.30 lb a.i./A for formulation A (1 application). There were no apparent treatment-related effects on mortality, length, and weight for the stocked Bluegills *(Lepomis macrochirus*). The NOEC values for Bluegills (*Lepomis macrochirus*) in the study minicosms were determined to be greater than all nominal application rates tested for the three fluvalinate formulations (A, B, and C).

Aquatic Plants

No acceptable studies are available for aquatic plants. A search of the open literature (ECOTOX) did not provide any data for aquatic plants.

Aquatic Degradates

No submitted acute or chronic studies on either fish or aquatic invertebrates are available for these degradates. A quick online search of ECOTOX provided an acute toxicity study on daphnia with 3-phenoxy-benzaldehyde. The 48-hour EC_{50} for daphnia (immobility) was reported as >50 μg/L, which is greater than the endpoint of 1.0 μg/L for the parent used in this risk assessment. Therefore, this degradate is likely to be less toxic to freshwater invertebrates than the parent. Acute toxicity studies conducted with the degradate, cyanohydrin on carp, bluegill sunfish, inland silversides, coho and chinook salmon and northern squawfish were also found in the online version of ECOTOX. The 96-hour LC_{50}s were 570 and 500 μg/L, respectively for bluegill sunfish and inland silverside. LC_{50}s at other timepoints were reported in the low mg/L range. Mortality was observed in other species in the mg/L range.

Studies with the degradates, 3-phenoxy-benzaldehyde and cyanohydrin on green and blue-green algae were found in the public literature (i.e. ECOTOX). The endpoints examined in the algae studies include general growth, photosynthesis, nitrogen fixation, population biomass and assimilation efficiency. For 3-phenoxybenzaldehyde, the most sensitive endpoint relevant to assessment of risk to aquatic plants is an EC_{50} of 2300 μg/L based on population biomass of *Anabaena variabilis* (blue-green algae; Ref. 15991)). The study was a 12-14 day static study. No further details are available at this time. one study is available for the degradate, cyanohydrin (Ref. 56359). This study examined assimilation efficiency of *Chlorococcales*, a green algae order following exposure to cyanohydrin in a static study. The 24-hour EC_{50} for assimilation efficiency is less than 3 mg/L.

Tables C-19 and C-20 summarize these studies.

Table C-19 Summary of Aquatic Studies from the Open Literature for Degradates										
Genus	Species	Common name	Major Group Effect	Measurement	Endpoint	Duration (Hours)	Conc mean	Conc Units	Exposure Type	Ref#
				3-phenoxy-benzaldehyde						
Daphnia	*magna*	waterflea	Immobility	Immobility	EC_{50}	48	>50	µg/L		7357
				Cyanohydrin						
Leuciscus	*idus melanotus*	carp	Mortality	Mortality	LC_{50}	48	1700; 900	µg/L		547
Lepomis	*macrochirus*	bluegill sunfish	Mortality	Mortality	LC_{50}	96	570	µg/L		863
Menidia	*beryllina*	inland silverside	Mortality	Mortality	LC_{50}	96	500	µg/L		863
Oncorhynchus	*kisutch*	coho salmon	Mortality	Mortality		24	10000	µg/L		15148
Oncorhynchus	*tshawytscha*	chinook salmon	Mortality	Mortality		24	10000	µg/L		15148
Ptychocheilus	*oregonensis*	northern squawfish	Mortality	Mortality		24	10000	µg/L		15148

Table C-20 Summary of Aquatic Plant Studies from the Open Literature for Degradates						
Scientific name Common name	**Endpoint**	**Effect Measurement**	**Media Type**	**Duration -------------- Exp Typ**	**Conc (ug/L)**	**Ref #**
CAS #/Chemical: 39515510, 3-Phenoxybenzaldehyde						
Anabaena cylindrica Blue-green algae	EC50	General Growth	FW	12 - 14 d ---------- S	A 7600	15991
Anabaena cylindrica Blue-green algae	EC50	Photosynthesis	FW	3 h ---------- S	A 50000	15991
Anabaena cylindrica Blue-green algae	EC50	Nitrogen fixation	FW	5 h ---------- S	A 46000	15991
Anabaena cylindrica Blue-green algae	EC50	Population Biomass	FW	12 - 14 d ---------- S	A 2400	15991
Anabaena inaequalis Blue-green algae	EC50	General Growth	FW	12 - 14 d ---------- S	A >10000	15991
Anabaena inaequalis Blue-green algae	EC50	Photosynthesis	FW	3 h ---------- S	A 2000	15991

Table C-20 Summary of Aquatic Plant Studies from the Open Literature for Degradates						
Scientific name Common name	**Endpoint**	**Effect Measurement**	**Media Type**	**Duration -------------- Exp Typ**	**Conc (ug/L)**	**Ref #**
Anabaena inaequalis Blue-green algae	EC50	Nitrogen fixation	FW	5 h ---------- S	A 12000	15991
Anabaena inaequalis Blue-green algae	EC50	Population Biomass	FW	12 - 14 d ---------- S	A >10000	15991
Anabaena variabilis Blue-green algae	EC50	General Growth	FW	12 - 14 d ---------- S	A 5500	15991
Anabaena variabilis Blue-green algae	EC50	Photosynthesis	FW	3 h ---------- S	A 50000	15991
Anabaena variabilis Blue-green algae	EC50	Population Biomass	FW	12 - 14 d ---------- S	A 2300	15991
Chlorella pyrenoidosa Green algae	EC50	General Growth	FW	12 - 14 d ---------- S	A 10000	15991
Chlorella pyrenoidosa Green algae	EC50	Photosynthesis	FW	3 h ---------- S	A 70000	15991

Table C-20 Summary of Aquatic Plant Studies from the Open Literature for Degradates						
Scientific name Common name	**Endpoint**	**Effect Measurement**	**Media Type**	**Duration -------------- Exp Typ**	**Conc (ug/L)**	**Ref #**
Chlorella pyrenoidosa Green algae	EC50	Population Biomass	FW	12 - 14 d ---------- S	A >10000	15991
Scenedesmus quadricauda Green algae	EC50	General Growth	FW	12 - 14 d ----------	A 5800	15991
Scenedesmus quadricauda Green algae	EC50	Photosynthesis	FW	12 - 14 d ---------- S	A 35000	15991
Scenedesmus quadricauda Green algae	EC50	Population Biomass	FW	12 - 14 d ---------- S	A 6600	15991
CAS #/Chemical: 75865, Acetone cyanohydrin						
Chlorococcales Green algae order	EC50	Assimilation Efficiency	FW	24 h ---------- S	F <3 mg/L	56359

Table C-21 COMPARATIVE AQUATIC TOXICITY STUDY RESULTS WITH 5 PYRETHROIDS

Tau-Fluvalinate: Freshwater Fish Acute (§72-1)

Test Organism	Purity	96-h LC_{50} (μg/L)	Toxicity[1]
Bluegill Sunfish *Lepomis macrochirus*	93.1%	0.90	Very highly toxic
	93.2%	2.7	Very highly toxic
Carp *Cyprinus carpio*	93.1%	0.35	Very highly toxic
Rainbow Trout *Salmo gairdneri*	93.2%	14	Very highly toxic
	93.1%	2.9	Very highly toxic

Pyrethroid 1: Freshwater Fish Acute Toxicity

Species	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Rainbow trout *(Oncorhynchus mykiss)*	88.3	0.15	Highly toxic
Bluegill sunfish *(Lepomis macrochirus)*	88.3	0.35	Highly toxic

Pyrethroid 2: Freshwater Fish Acute Toxicity

Species	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Bluegill sunfish *(Lepomis macrochirus)*	91.5	1.78	Very highly toxic

Pyrethroid 2: Freshwater Fish Acute Toxicity

Species	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Bluegill sunfish *(Lepomis macrochirus)*	92.9	2.2	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	91.5	0.92	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	92.9	0.82	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	88.2	0.69	Very highly toxic

Pyrethroid 3: Freshwater Fish Acute Toxicity

Species	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Bluegill sunfish *(Lepomis macrochirus)*	99.3	1.4	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	99.3	0.91	Very highly toxic

Pyrethroid 4: Freshwater Fish Acute Toxicity

Species	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Bluegill sunfish *(Lepomis macrochirus)*	98.8	0.26	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	92.1	1.2	Very highly toxic
Channel catfish (*Ictalurus punctatus*)	90.0	2.4	Very highly toxic
Fathead minnow (*Pimephales promelas*)	96.0	1.13	Very highly toxic
Fathead minnow (*Pimephales promelas*)	93.5	0.33	Very highly toxic

Pyrethroid 5: Freshwater fish acute toxicity

Species	% a.i.	96-Hour LC_{50} (ppb)	Toxicity category
Bluegill sunfish *(Lepomis macrochirus)*	95.7	2.52	Very highly toxic
Bluegill sunfish *(Lepomis macrochirus)*	100	6.1	Very highly toxic
Bluegill sunfish *(Lepomis macrochirus)*	95.7	6.8	Very highly toxic
Bluegill sunfish *(Lepomis macrochirus)*	Tech	0.79	Very highly toxic

Pyrethroid 5: Freshwater fish acute toxicity

Species	% a.i.	96-Hour LC_{50} (ppb)	Toxicity category
Bluegill sunfish *(Lepomis macrochirus)*	94.4	13.3	Very highly toxic
Bluegill sunfish *(Lepomis macrochirus)*	91.4	13.5	Very highly toxic
Bluegill sunfish *(Lepomis macrochirus)*	91	5	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	95	9.8	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	94	5.3	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	Tech	2.1	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss)*	91	2.9	Very highly toxic
Coho Salmon *(Oncorhynchus kisutch)*	Tech	17	Very highly toxic
Atlantic salmon *(Salmo salar*)	Tech	1.5	Very highly toxic
Brook trout (*Salvelinus fontinalis*)	92.5	3.2	Very highly toxic
Brook trout (*Salvelinus fontinalis*)	Tech	3.9	Very highly toxic
Rainbow trout *(Oncorhynchus mykiss*)	91	2.9	Very highly toxic

Pyrethroid 5: Freshwater fish acute toxicity

Species	% a.i.	96-Hour LC_{50} (ppb)	Toxicity category
Fathead minnow (*Pimephales promelas*)	91	5.7	Very highly toxic
Fathead minnow (*Pimephales promelas*)	Tech	3	Very highly toxic
Channel catfish (*Ictalurus punctatus*)	91	7.2	Very highly toxic
Channel catfish (*Ictalurus punctatus*)	Tech	5.4	Very highly toxic

Tau-Fluvalinate: Estuarine/Marine Fish Acute Toxicity (§72-3)

Test Organism	Purity	96-h LC_{50} (μg/L)	Toxicity
Sheepshead Minnow *Cyprinodon variegatus*	93.1%	10.8	Very highly toxic

Pyrethroid 1: Estuarine/Marine Fish Acute Toxicity

Species	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Sheepshead minnow *(Cyprinodon variegatus)*	88.3	17.5	Very highly toxic

Pyrethroid 2: Estuarine/Marine Fish Acute Toxicity

Species/Static	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Sheepshead minnow *(Cyprinodon variegatus)*	91.5	0.73	Very highly toxic
Sheepshead minnow *(Cyprinodon variegatus)*	91.5	3.42	Very highly toxic
Sheepshead minnow *(Cyprinodon variegatus)*	88.2	2.39	Very highly toxic

Pyrethroid 3: Estuarine/Marine Fish Acute Toxicity

Species/Static	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Sheepshead minnow *(Cyprinodon variegatus)*	91.5	0.73	Very highly toxic
Sheepshead minnow *(Cyprinodon variegatus)*	91.5	0.73	Very highly toxic

Pyrethroid 4: Estuarine/Marine Fish Acute Toxicity

Species/Static	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Sheepshead minnow *(Cyprinodon variegatus)*	100	4.4	Very highly toxic
California grunion *(Leuresthes tenis*) larvae	100	0.29	Very highly toxic
California grunion *(Leuresthes tenis*) Juvenile	100	0.60	Very highly toxic
Atlantic silverside (*Menidia menidia*)	100	0.31	Very highly toxic

Pyrethroid 4: Estuarine/Marine Fish Acute Toxicity

Species/Static	% ai	96-hour LC50 (ppb) (nominal)	Toxicity Category
Inland silverside (*Menidia beryllina*)	100	1.0	Very highly toxic
Stripped mullet (*Mugil cephalus*)	100	0.58	Very highly toxic
Gulf toadfish (*Opsanus beta*)	100	2.4	Very highly toxic
Mosquitofish (Gambusia affinis)	92.1	2.6	Very highly toxic

Pyrethroid 5: Estuarine/marine fish acute toxicity.

Species	% a.i.	96-Hour LC_{50} (ppb)	Toxicity category
Inland silversides (*Menidia beryllina*)	Tech	6.2	Very highly toxic
Inland silversides (*Menidia beryllina*)	94.6	6.6	Very highly toxic
Sheepshead minnow *(Cyprinodon variegatus)*	93	7.8	Very highly toxic
Sheepshead minnow *(Cyprinodon variegatus)*	93	88	Very highly toxic
Atlantic Silverside *(Menidia menidia*)	93	2.2	Very highly toxic

Pyrethroid 5: Estuarine/marine fish acute toxicity.

Species	% a.i.	96-Hour LC_{50} (ppb)	Toxicity category
Stripped mullet (*Mugil cephalus*)	93	5.5	Very highly toxic

Tau-Fluvalinate: Freshwater Invertebrate Acute Toxicity (§72-2)

Test Organism	Purity	48-h LC_{50} (μg/L)	Toxicity[1]
Waterflea	93.1%	74	Very highly toxic
Daphnia magna	93.1%	1.0	Very highly toxic
	93.2%	0.4	Very highly toxic

Pyrethroid 1: Freshwater Invertebrate Acute Toxicity

Species	% ai	48-hour EC_{50} (ppb)	Toxicity category
Waterflea (*Daphnia magna*)	88.3	1.6	Very highly toxic

Pyrethroid 2: Freshwater Invertebrate Acute Toxicity

Species	% ai	48-hour EC_{50} (ppb)	Toxicity category
Waterflea (*Daphnia magna*)	91.5	1.0	Very highly toxic
Waterflea (*Daphnia magna*)	84.6	2.0	Very highly toxic
Waterflea (*Daphnia magna*)	99	89.0	Very highly toxic

Species	% ai	48-hour EC_{50} (ppb)	Toxicity category
Amphopod (*Hyallella azteca*)	92.3	0.0053	Very highly toxic
Phantom midge (*Chaoborus sp.*)	84.6	0.03	Very highly toxic
Midge 1st instar (*Chironomus tentans*)	92.3	0.0069	Very highly toxic
Midge 4 th instar (*Chironomus tentans*)	92.3	4.6	Very highly toxic
Midge (*Chironomus thummi*)	84.6	0.2	Very highly toxic
Mayfly (*Cloeon dipterum*)	98.1	0.03	Very highly toxic
Mayfly (*Cloeon dipterum*)	84.6	0.07	Very highly toxic
Water boatman (*Corixa punctata*)	84.6	0.7	Very highly toxic
Aquatic beetle (*Gyrinus natator*)	84.6	0.07	Very highly toxic
Backswimmer (*Notonecta sp.)*	84.6	0.3	Very highly toxic
Water mite (*Pinna carnea*)	84.6	0.02	Very highly toxic
Crayfish (*Orconectes nais*)	91.7	0.069	Very highly toxic

Pyrethroid 3: Freshwater Invertebrate Acute Toxicity

Species	% ai	48-hour EC_{50} (ppb)	Toxicity category
Waterflea (*Daphnia magna*)	99.3	3.5	Very highly toxic

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Pyrethroid 4: Freshwater Invertebrate Acute Toxicity

Species	% ai	48-hour EC_{50} (ppb)	Toxicity category
Waterflea (*Daphnia magna*)	91.4	0.53	Very highly toxic
Waterflea (*Daphnia magna*)	30.0	2.9	Very highly toxic
Midge (*Chironomus plumosus*)	90.0	0.43	Very highly toxic
Scud (*Gammarus pseudolimnaeu*)	90.0	0.032	Very highly toxic

Pyrethroid 5 Freshwater invertebrate acute toxicity.

Species	% a.i.	48-Hour LC_{50} (ppb)	Toxicity category
Waterflea (*Daphnia magna*)	95.7	0.039	Very highly toxic
Mayfly (*Hexagenia bilineuta*)	97	0.100	Very highly toxic
Waterflea *(Daphnia magna)*	Tech	0.32	Very highly toxic
Waterflea (*Daphnia magna*)	Tech	0.58	Very highly toxic
Waterflea *(Daphnia magna)*	94.4	0.7	Very highly toxic

Pyrethroid 5 Freshwater invertebrate acute toxicity.

Species	**% a.i.**	**48-Hour LC_{50} (ppb)**	**Toxicity category**
Waterflea (*Daphnia magna*)	91	1.26	Very highly toxic
Waterflea (*Daphnia magna*)	95.7	7.2	Very highly toxic
Crayfish (*Procambarus blandingii*)	89.1	210	Very highly toxic
Scud (*Gammarus pseudolimnaeus*)	91	0.17	Very highly toxic

Tau-Fluvalinate: Estuarine/Marine Invertebrate Acute Toxicity (§72-3)

Test Organism	Purity	EC_{50} (μg/L)	Toxicity
Eastern Oyster *Crassostrea virginica*	93.1%	12	Very highly toxic
Mysid Shrimp *Mysidopsis bahia*	93.1%	0.018	Very highly toxic

Pyrethroid 1: Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	48-hour LC50 (ppb)	Toxicity Category
Eastern oyster (*Crassostrea virginica*)	88.3	285 (embryos) > 2.15 (spat)	Very highly toxic
Mysid *(Americamysis bahia)*	88.3	0.0040	Very highly toxic

Pyrethroid 2: Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50 (ppb)	Toxicity Category
Pacific oyster (*Crassostrea gigas*)	91.5	2.27 (ppm)	Very highly toxic
Eastern oyster (*Crassostrea virginica*)	91.5	370 spat	Very highly toxic

Pyrethroid 2: Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50 (ppb)	Toxicity Category
Mysid *(Americamysis bahia)*	98.1	0.002	Very highly toxic
Mysid *(Americamysis bahia)*	95.9	0.005	Very highly toxic
Mysid *(Americamysis bahia)*	97	0.0047 (6 d old)	Very highly toxic

Pyrethroid 3: Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50 (ppb)	Toxicity Category
Eastern oyster (*Crassostrea virginica*)	92.5	18.2	Very highly toxic
Mysid *(Americamysis bahia)*	95	0.0037	Very highly toxic

Pyrethroid 4: Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50 (ppb)	Toxicity Category
Mysid *(Americamysis bahia)*	100	0.008	Very highly toxic

Pyrethroid 4: Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50 (ppb)	Toxicity Category
Eastern oyster (*Crassostrea virginica*)	90	> 1000 embryo larvae	Moderately toxic
Fiddler crab (*Uca pugilator*)	Tech	39	Very highly toxic
Pink shrimp (*Penaeus duorarum*)	100	0.84	Very highly toxic
Pink shrimp (*Penaeus duorarum*)	Tech	1.4	Very highly toxic

Pyrethroid 5: Estuarine/marine invertebrate acute toxicity

Species	% a.i.	96-hour LC_{50}/EC_{50} (ppb)	Toxicity category
Mysid *(Mysidopsis bahia)*	93	0.019	Very highly toxic
Mysid *(Mysidopsis bahia)*	93	0.046	Very highly toxic
Mysid *(Mysidopsis bahia)*	93	0.02	Very highly toxic
Mysid *(Mysidopsis bahia)*	90.8	0.075	Very highly toxic
Brown Shrimp (*Penaeus aztecus*)	89	0.34	Very highly toxic

Pyrethroid 5: Estuarine/marine invertebrate acute toxicity

Species	% a.i.	96-hour LC_{50}/EC_{50} (ppb)	Toxicity category
Pink Shrimp (*Penaeus duorarum*)	93	0.22	Very highly toxic
Pink Shrimp (*Penaeus duorarum*)	95.7	0.35	Very highly toxic
Fiddler Crab (*Uca pugilator*)	95.7	2.39	Very highly toxic
Fiddler Crab (*Uca pugilator*)	89	2.65	Very highly toxic
Stone Crab (*Menippe mercenaria*)	93	0.018	Very highly toxic
Pacific Oyster (*Crassostrea gigas*)	Tech	>1050	Highly toxic
Eastern Oyster (*Crassostrea virginica*)	95.7	>536	Highly toxic
Eastern Oyster (*Crassostrea virginica*)	95.7	>407	Very highly toxic
Eastern Oyster (*Crassostrea virginica*)	93	>1000	Highly toxic

D. The Risk Quotient Method and Levels of Concern

The Risk Quotient Method is the means used by EFED to integrate the results of exposure and ecotoxicity data. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values (i.e., RQ = EXPOSURE/TOXICITY), both acute and chronic. These RQs are then compared to OPP's levels of concern (LOCs). These LOCs are criteria used by OPP to indicate potential risk to non-target organisms and the need to consider regulatory action. EFED has defined LOCs for acute risk, potential restricted use classification, and for endangered species.

The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories:

(1) acute - there is a potential for acute risk; regulatory action may be warranted in addition to restricted use classification;

(2) acute restricted use - the potential for acute risk is high, but this may be mitigated through restricted use classification

(3) acute endangered species - the potential for acute risk to endangered species is high, regulatory action may be warranted, and

(4) chronic risk - the potential for chronic risk is high, regulatory action may be warranted.

Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to non-target insects, or chronic risk from granular/bait formulations to mammalian or avian species.

The ecotoxicity test values (i.e., measurement endpoints) used in the acute and chronic risk quotients are derived from required studies. Examples of ecotoxicity values derived from short-term laboratory studies that assess acute effects are: (1) LC_{50} (fish and birds), (2) LD_{50} (birds and mammals), (3) EC_{50} (aquatic plants and aquatic invertebrates), and (4) EC_{25} (terrestrial plants). Examples of toxicity test effect levels derived from the results of long-term laboratory studies that assess chronic effects are: (1) LOEL (birds, fish, and aquatic invertebrates), and (2) NOEL (birds, fish and aquatic invertebrates). The NOEL is generally used as the ecotoxicity test value in assessing chronic effects.

Risk presumptions, along with the corresponding RQs and LOCs are summarized in Table D1.

Table D-1: Risk Presumptions and LOCs		
Risk Presumption	**RQ**	**LOC**
Birds[1]		
Acute Risk	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOEC	1
Wild Mammals[1]		
Acute Risk	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOEC	1
Aquatic Animals[2]		
Acute Risk	EEC/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOEC	1
Terrestrial and Semi-Aquatic Plants		
Acute Risk	EEC/EC_{25}	1
Acute Endangered Species	EEC/EC_{05} or NOEC	1
Aquatic Plants[2]		
Acute Risk	EEC/EC_{50}	1
Acute Endangered Species	EEC/EC_{05} or NOEC	1

[1] LD_{50}/sqft = (mg/sqft) / (LD_{50} * wt. of animal)
LD_{50}/day = (mg of toxicant consumed/day) / (LD_{50} * wt. of animal)

[2] EEC = (ppm or ppb) in water

E. Summary of Endangered/Threatened Species

Unique Taxa Count by State for Selected Crops

Reporting for > 1 Acres

Broccoli (22), Brussels sprouts (24), Canola (edible) (27), Cauliflower (31), Chinese cabbage (36), Collards (39), Head cabbage (85), Kale (95), Mustard cabbage (115), Mustard greens (116), Turnip greens (203), Watercress (208), Cabbage, all (303)

CA

Broccoli

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	20	19	16	17	15	17		14	20	1	
Affected States:	1	1	1	1	1	1	0	1	1	1	0
Affected Species:	13	14	19	6	7	7		13	124	1	

Brussels sprouts

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	3	3	3	3	1	3		2	3		
Affected States:	1	1	1	1	1	1	0	1	1	0	0
Affected Species:	9	5	8	4	1	3		7	39		

Cabbage, all

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	28	27	23	24	21	23		21	28	1	
Affected States:	1	1	1	1	1	1	0	1	1	1	0
Affected Species:	15	14	21	6	7	8		19	155	1	

Cauliflower

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	14	14	11	12	11	13		7	14	1	
Affected States:	1	1	1	1	1	1	0	1	1	1	0
Affected Species:	13	14	14	6	6	7		8	100	1	

Chinese cabbage

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	13	13	11	13	11	12		10	13	1	
Affected States:	1	1	1	1	1	1	0	1	1	1	0
Affected Species:	14	13	18	6	5	6		7	107	1	

Collards

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	3	3	3	3	2	3		3	3		
Affected States:	1	1	1	1	1	1	0	1	1	0	0
Affected Species:	11	11	7	5	3	4		3	43		

Head cabbage

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	17	16	13	14	14	15		11	17	1	
Affected States:	1	1	1	1	1	1	0	1	1	1	0
Affected Species:	13	13	18	6	6	8		12	116	1	

Kale

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	9	9	9	9	8	7		7	9		
Affected States:	1	1	1	1	1	1	0	1	1	0	0
Affected Species:	13	13	13	6	7	7		11	100		

Mustard greens

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	9	9	8	8	9	8		6	9		
Affected States:	1	1	1	1	1	1	0	1	1	0	0
Affected Species:	13	9	12	5	5	5		5	76		

Turnip greens

	Bird	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids	Insects	Plant	Snails	Clam
Affected Counties:	2	2	2	2	2	1		1	2		
Affected States:	1	1	1	1	1	1	0	1	1	0	0
Affected Species:	8	5	4	2	3	2		1	21		

Grand Summary

	Bird	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids	Insects	Plant	Snails	Clam
Total Counties:	28	27	23	24	21	23		21	28	1	
Total States:	1	1	1	1	1	1		1	1	1	
Unique Species Totals:	15	14	21	6	7	8		19	155	1	

Species Affected:

SALAMANDER, DESERT SLENDER	Batrachoseps aridus	Amphibian
FROG, MOUNTAIN YELLOW-LEGGED	Rana muscosa	Amphibian
FROG, CALIFORNIA RED-LEGGED	Rana aurora draytonii	Amphibian
SALAMANDER, CALIFORNIA TIGER	Ambystoma californiense	Amphibian
SALAMANDER, SANTA CRUZ LONG-TOED	Ambystoma macrodactylum croceum	Amphibian
TOAD, ARROYO SOUTHWESTERN	Bufo californicus (=microscaphus)	Amphibian
RAIL, CALIFORNIA CLAPPER	Rallus longirostris obsoletus	Bird
TERN, CALIFORNIA LEAST	Sterna antillarum browni	Bird
SHRIKE, SAN CLEMENTE LOGGERHEAD	Lanius ludovicianus mearnsi	Bird
GNATCATCHER, COASTAL CALIFORNIA	Polioptila californica californica	Bird
SPARROW, SAN CLEMENTE SAGE	Amphispiza belli clementeae	Bird
RAIL, LIGHT-FOOTED CLAPPER	Rallus longirostris levipes	Bird
PLOVER, WESTERN SNOWY	Charadrius alexandrinus nivosus	Bird
PELICAN, BROWN	Pelecanus occidentalis	Bird
CONDOR, CALIFORNIA	Gymnogyps californianus	Bird
VIREO, LEAST BELL'S	Vireo bellii pusillus	Bird
FLYCATCHER, SOUTHWESTERN WILLOW	Empidonax traillii extimus	Bird
OWL, NORTHERN SPOTTED	Strix occidentalis caurina	Bird
EAGLE, BALD	Haliaeetus leucocephalus	Bird
MURRELET, MARBLED	Brachyramphus marmoratus marmoratus	Bird
RAIL, YUMA CLAPPER	Rallus longirostris yumanensis	Bird
SHRIMP, RIVERSIDE FAIRY	Streptocephalus woottoni	Crustacean

SHRIMP, CALIFORNIA FRESHWATER	Syncaris pacifica	Crustacean
SHRIMP, LONGHORN FAIRY	Branchinecta longiantenna	Crustacean
SHRIMP, SAN DIEGO FAIRY	Branchinecta sandiegonensis	Crustacean
SHRIMP, VERNAL POOL FAIRY	Branchinecta lynchi	Crustacean
SHRIMP, VERNAL POOL TADPOLE	Lepidurus packardi	Crustacean

SHRIMP, CONSERVANCY FAIRY	Branchinecta conservatio	Crustacean
GOBY, TIDEWATER	Eucyclogobius newberryi	Fish
TROUT, PAIUTE CUTTHROAT	Oncorhynchus clarki seleniris	Fish
CHUB, MOHAVE TUI	Gila bicolor mohavensis	Fish
PUPFISH, DESERT	Cyprinodon macularius	Fish
CHUB, BONYTAIL	Gila elegans	Fish
TROUT, LITTLE KERN GOLDEN	Oncorhynchus aguabonita whitei	Fish
SALMON, CHINOOK (CALIFORNIA COASTAL ESU)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, CHINOOK (CENTRAL VALLEY SPRING RUN)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, CHINOOK (SACRAMENTO RIVER WINTER RUN)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, COHO (CENTRAL CALIFORNIA COAST POP)	Oncorhynchus (=Salmo) kisutch	Fish
SALMON, COHO (SOUTHERN OR/NORTHERN CA COAST)	Oncorhynchus (=Salmo) kisutch	Fish
SMELT, DELTA	Hypomesus transpacificus	Fish
STEELHEAD, CALIFORNIA CENTRAL VALLEY POP	Oncorhynchus (=Salmo) mykiss	Fish
SUCKER, SANTA ANA	Catostomus santaanae	Fish
STICKLEBACK, UNARMORED THREESPINE	Gasterosteus aculeatus williamsoni	Fish
STEELHEAD, SOUTHERN CALIFORNIA POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
STEELHEAD, SOUTH-CENTRAL CALIFORNIA POP	Oncorhynchus (=Salmo) mykiss	Fish
STEELHEAD, NORTHERN CALIFORNIA POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
STEELHEAD, CENTRAL CALIFORNIA POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
SQUAWFISH, COLORADO	Ptychocheilus lucius	Fish
SUCKER, RAZORBACK	Xyrauchen texanus	Fish
BEETLE, OHLONE TIGER	Cicindela ohlone	Insect
BEETLE, MOUNT HERMON JUNE	Polyphylla barbata	Insect
GRASSHOPPER, ZAYANTE BAND-WINGED	Trimerotropis infantilis	Insect
BEETLE, VALLEY ELDERBERRY LONGHORN	Desmocerus californicus dimorphus	Insect
MOTH, KERN PRIMROSE SPHINX	Euproserpinus euterpe	Insect
FLY, DELHI SANDS FLOWER-LOVING	Rhaphiomidas terminatus abdominalis	Insect
BUTTERFLY, SMITH'S BLUE	Euphilotes enoptes smithi	Insect
BUTTERFLY, MYRTLE'S SILVERSPOT	Speyeria zerene myrtleae	Insect

BUTTERFLY, BAY CHECKERSPOT	Euphydryas editha bayensis	Insect

BUTTERFLY, BEHREN'S SILVERSPOT	Speyeria zerene behrensii	Insect
BUTTERFLY, CALLIPPE SILVERSPOT	Speyeria callippe callippe	Insect
SKIPPER, LAGUNA MOUNTAIN	Pyrgus ruralis lagunae	Insect
BUTTERFLY, SAN BRUNO ELFIN	Callophrys mossii bayensis	Insect
BUTTERFLY, QUINO CHECKERSPOT	Euphydryas editha quino (=E. e. wrighti)	Insect
BUTTERFLY, EL SEGUNDO BLUE	Euphilotes battoides allyni	Insect
BUTTERFLY, PALOS VERDES BLUE	Glaucopsyche lygdamus palosverdesensis	Insect
BUTTERFLY, LANGE'S METALMARK	Apodemia mormo langei	Insect
BUTTERFLY, LOTIS BLUE	Lycaeides argyrognomon lotis	Insect
BUTTERFLY, MISSION BLUE	Icaricia icarioides missionensis	Insect
VOLE, AMARGOSA	Microtus californicus scirpensis	Mammal
FOX, SANTA ROSA ISLAND	Urocyon littoralis santarosae	Mammal
FOX, SANTA CATALINA ISLAND	Urocyon littoralis catalinae	Mammal
FOX, SAN JOAQUIN KIT	Vulpes macrotis mutica	Mammal
RABBIT, RIPARIAN BRUSH	Sylvilagus bachmani riparius	Mammal
KANGAROO RAT, SAN BERNARDINO	Dipodomys merriami parvus	Mammal
FOX, SANTA CRUZ ISLAND	Urocyon littoralis santacruzae	Mammal
SEAL, GUADALUPE FUR	Arctocephalus townsendi	Mammal
KANGAROO RAT, GIANT	Dipodomys ingens	Mammal
SHEEP, PENINSULAR BIGHORN	Ovis canadensis	Mammal
MOUSE, SALT MARSH HARVEST	Reithrodontomys raviventris	Mammal
KANGAROO RAT, STEPHENS'	Dipodomys stephensi (incl. D. cascus)	Mammal
MOUNTAIN BEAVER, POINT ARENA	Aplodontia rufa nigra	Mammal
MOUSE, PACIFIC POCKET	Perognathus longimembris pacificus	Mammal
KANGAROO RAT, TIPTON	Dipodomys nitratoides nitratoides	Mammal
KANGAROO RAT, MORRO BAY	Dipodomys heermanni morroensis	Mammal
SHREW, BUENA VISTA	Sorex ornatus relictus	Mammal
KANGAROO RAT, FRESNO	Dipodomys nitratoides exilis	Mammal
WOODRAT, RIPARIAN	Neotoma fuscipes riparia	Mammal
OTTER, SOUTHERN SEA	Enhydra lutris nereis	Mammal
FOX, SAN MIGUEL ISLAND	Urocyon littoralis littoralis	Mammal
EVENING-PRIMROSE, SAN BENITO	Camissonia benitensis	Plant
DWARF-FLAX, MARIN	Hesperolinon congestum	Plant
FLANNELBUSH, MEXICAN	Fremontodendron mexicanum	Plant
FIDDLENECK, LARGE-FLOWERED	Amsinckia grandiflora	Plant
EVENING-PRIMROSE, ANTIOCH DUNES	Oenothera deltoides ssp. howellii	Plant
GRASS, HAIRY ORCUTT	Orcuttia pilosa	Plant
GRASS, SACRAMENTO ORCUTT	Orcuttia viscida	Plant

GRASS, SAN JOAQUIN VALLEY ORCUTT	Orcuttia inaequalis	Plant
GRASS, SLENDER ORCUTT	Orcuttia tenuis	Plant
GRASS, SOLANO	Tuctoria mucronata	Plant
CHECKER-MALLOW, KECK'S	Sidalcea keckii	Plant
JEWELFLOWER, CALIFORNIA	Caulanthus californicus	Plant
GILIA, HOFFMANN'S SLENDER-FLOWERED	Gilia tenuiflora ssp. hoffmannii	Plant
GOLDEN SUNBURST, HARTWEG'S	Pseudobahia bahiifolia	Plant
GRASS, COLUSA	Neostapfia colusana	Plant
GOLDFIELDS, BURKE'S	Lasthenia burkei	Plant
GILIA, MONTEREY	Gilia tenuiflora ssp. arenaria	Plant
ALOPECURUS, SONOMA	Alopecurus aequalis var. sonomensis	Plant
AMBROSIA, SAN DIEGO	Ambrosia pumila	Plant
FRINGEPOD, SANTA CRUZ ISLAND	Thysanocarpus conchuliferus	Plant
GOLDFIELDS, CONTRA COSTA	Lasthenia conjugens	Plant
GRASS, CALIFORNIA ORCUTT	Orcuttia californica	Plant
JEWELFLOWER, TIBURON	Streptanthus niger	Plant
BLADDERPOD, SAN BERNARDINO MOUNTAINS	Lesquerella kingii ssp. bernardina	Plant
CHECKER-MALLOW, PEDATE	Sidalcea pedata	Plant
BUTTON-CELERY, SAN DIEGO	Eryngium aristulatum var. parishii	Plant
BUSHMALLOW, SANTA CRUZ	Malacothamnus fasciculatus var.	Plant
BUSH-MALLOW, SAN CLEMENTE ISLAND	Malacothamnus clementinus	Plant
BUCKWHEAT, SOUTHERN MOUNTAIN WILD	Eriogonum kennedyi var.	Plant
BUCKWHEAT, CUSHENBURY	Eriogonum ovalifolium var. vineum	Plant
BROOM, SAN CLEMENTE ISLAND	Lotus dendroideus ssp. traskiae	Plant
BRODIAEA, THREAD-LEAVED	Brodiaea filifolia	Plant
CEANOTHUS, COYOTE	Ceanothus ferrisae	Plant
BLUECURLS, HIDDEN LAKE	Trichostema austromontanum ssp. compactum	Plant
Amole, Camatta Canyon	Chlorogalum purpureum var. reductum	Plant
BIRD'S-BEAK, SOFT	Cordylanthus mollis ssp. mollis	Plant
BIRD'S-BEAK, SALT MARSH	Cordylanthus maritimus ssp. maritimus	Plant
BIRD'S-BEAK, PENNELL'S	Cordylanthus tenuis ssp. capillaris	Plant
BIRD'S-BEAK, PALMATE-BRACTED	Cordylanthus palmatus	Plant
AMOLE, PURPLE	Chlorogalum purpureum var. purpureum	Plant
BEDSTRAW, ISLAND	Galium buxifolium	Plant
BARBERRY, NEVIN'S	Berberis nevinii	Plant
BARBERRY, ISLAND	Berberis pinnata ssp. insularis	Plant

BLUEGRASS, SAN BERNARDINO	Poa atropurpurea	Plant
CLOVER, SHOWY INDIAN	Trifolium amoenum	Plant
DUDLEYA, SANTA MONICA MOUNTAINS	Dudleya cymosa ssp. ovatifolia	Plant
DUDLEYA, SANTA CRUZ ISLAND	Dudleya nesiotica	Plant
DUDLEYA, SANTA CLARA VALLEY	Dudleya setchellii	Plant
DUDLEYA, MARCESCENT	Dudleya cymosa ssp. marcescens	Plant
DUDLEYA, CONEJO	Dudleya abramsii ssp. parva	Plant
DAISY, PARISH'S	Erigeron parishii	Plant
CYPRESS, SANTA CRUZ	Cupressus abramsiana	Plant
CYPRESS, GOWEN	Cupressus goveniana ssp. goveniana	Plant
CACTUS, BAKERSFIELD	Opuntia treleasei	Plant
CROWN-BEARD, BIG-LEAVED	Verbesina dissita	Plant
DUDLEYA, VERITY'S	Dudleya verityi	Plant
CLOVER, MONTEREY	Trifolium trichocalyx	Plant
CLARKIA, VINE HILL	Clarkia imbricata	Plant
CLARKIA, SPRINGVILLE	Clarkia springvillensis	Plant
CLARKIA, PISMO	Clarkia speciosa ssp. immaculata	Plant
CEANOTHUS, VAIL LAKE	Ceanothus ophiochilus	Plant
CHECKER-MALLOW, KENWOOD MARSH	Sidalcea oregana ssp. valida	Plant
BACCHARIS, ENCINITAS	Baccharis vanessae	Plant
MILK-VETCH, COACHELLA VALLEY	Astragalus lentiginosus var. coachellae	Plant
CROWNSCALE, SAN JACINTO	Atriplex coronata var. notatior	Plant
ROCK-CRESS, SANTA CRUZ ISLAND	Sibara filifolia	Plant
PAINTBRUSH, TIBURON	Castilleja affinis ssp. neglecta	Plant
SPINEFLOWER, ROBUST	Chorizanthe robusta (incl. vars. robusta and hartwegii)	Plant
SPINEFLOWER, ORCUTT'S	Chorizanthe orcuttiana	Plant
SPINEFLOWER, MONTEREY	Chorizanthe pungens var. pungens	Plant
SPINEFLOWER, HOWELL'S	Chorizanthe howellii	Plant
SPINEFLOWER, BEN LOMOND	Chorizanthe pungens var. hartwegiana	Plant
SEDGE, WHITE	Carex albida	Plant
SEA-BLITE, CALIFORNIA	Suaeda californica	Plant
SANDWORT, MARSH	Arenaria paludicola	Plant
SPINEFLOWER, SLENDER-HORNED	Dodecahema leptoceras	Plant
RUSH-ROSE, ISLAND	Helianthemum greenei	Plant
SPINEFLOWER, SONOMA	Chorizanthe valida	Plant
ROCK-CRESS, MCDONALD'S	Arabis mcdonaldiana	Plant
ROCK-CRESS, HOFFMANN'S	Arabis hoffmannii	Plant

PUSSYPAWS, MARIPOSA	Calyptridium pulchellum	Plant
POTENTILLA, HICKMAN'S	Potentilla hickmanii	Plant
POLYGONUM, SCOTT'S VALLEY	Polygonum hickmanii	Plant
PIPERIA, YADON'S	Piperia yadonii	Plant
MILK-VETCH, BRAUNTON'S	Astragalus brauntonii	Plant
PENTACHAETA, WHITE-RAYED	Pentachaeta bellidiflora	Plant
LARKSPUR, BAKER'S	Delphinium bakeri	Plant
SANDWORT, BEAR VALLEY	Arenaria ursina	Plant
THISTLE, FOUNTAIN	Cirsium fontinale var. fontinale	Plant
WOOLLY-THREADS, SAN JOAQUIN	Monolopia (=Lembertia) congdonii	Plant
WOOLLY-STAR, SANTA ANA RIVER	Eriastrum densifolium ssp. sanctorum	Plant
WOODLAND-STAR, SAN CLEMENTE ISLAND	Lithophragma maximum	Plant
WATERCRESS, GAMBEL'S	Rorippa gambellii	Plant
WALLFLOWER, MENZIE'S	Erysimum menziesii	Plant
WALLFLOWER, CONTRA COSTA	Erysimum capitatum var. angustatum	Plant
WALLFLOWER, BEN LOMOND	Erysimum teretifolium	Plant
TUCTORIA, GREEN'S	Tuctoria greenei	Plant
THORNMINT, SAN MATEO	Acanthomintha obovata ssp. duttonii	Plant
SPINEFLOWER, SCOTTS VALLEY	Chorizanthe robusta var. hartwegii	Plant
THISTLE, LA GRACIOSA	Cirsium loncholepis	Plant
PENNY-CRESS, KNEELAND PRAIRIE	Thlaspi californicum	Plant
THISTLE, CHORRO CREEK BOG	Cirsium fontinale var. obispoense	Plant
TARPLANT, SANTA CRUZ	Holocarpha macradenia	Plant
TARPLANT, OTAY	Deinandra (=Hemizonia) conjugens	Plant
TARPLANT, GAVIOTA	Deinandra increscens ssp. villosa	Plant
TARAXACUM, CALIFORNIA	Taraxacum californicum	Plant
SUNFLOWER, SAN MATEO WOOLLY	Eriophyllum latilobum	Plant
STONECROP, LAKE COUNTY	Parvisedum leiocarpum	Plant
STICKYSEED, BAKER'S	Blennosperma bakeri	Plant
SPURGE, HOOVER'S	Chamaesyce hooveri	Plant
THORNMINT, SAN DIEGO	Acanthomintha ilicifolia	Plant
LUPINE, NIPOMO MESA	Lupinus nipomensis	Plant
PAINTBRUSH, SOFT-LEAVED	Castilleja mollis	Plant
ADOBE SUNBURST, SAN JOAQUIN	Pseudobahia peirsonii	Plant
PHACELIA, ISLAND	Phacelia insularis ssp. insularis	Plant
MEADOWFOAM, BUTTE COUNTY	Limnanthes floccosa ssp. californica	Plant
MANZANITA, SANTA ROSA ISLAND	Arctostaphylos confertiflora	Plant
MANZANITA, PALLID	Arctostaphylos pallida	Plant
MANZANITA, MORRO	Arctostaphylos morroensis	Plant

MANZANITA, DEL MAR	Arctostaphylos glandulosa ssp. crassifolia	Plant
MALLOW, KERN	Eremalche kernensis	Plant
YERBA SANTA, LOMPOC	Eriodictyon capitatum	Plant
MALACOTHRIX, ISLAND	Malacothrix squalida	Plant
MILK-VETCH, CLARA HUNT'S	Astragalus clarianus	Plant
LUPINE, CLOVER	Lupinus tidestromii	Plant
LIVEFOREVER, SANTA BARBARA ISLAND	Dudleya traskiae	Plant
LIVEFOREVER, LAGUNA BEACH	Dudleya stolonifera	Plant
LILY, WESTERN	Lilium occidentale	Plant
LILY, PITKIN MARSH	Lilium pardalinum ssp. pitkinense	Plant
LESSINGIA, SAN FRANCISCO	Lessingia germanorum (=L.g. var. germanorum)	Plant
LAYIA, BEACH	Layia carnosa	Plant
LARKSPUR, YELLOW	Delphinium luteum	Plant
LARKSPUR, SAN CLEMENTE ISLAND	Delphinium variegatum ssp. kinkiense	Plant
MALACOTHRIX, SANTA CRUZ	Malacothrix indecora	Plant
MINT, SAN DIEGO MESA	Pogogyne abramsii	Plant
NAVARRETIA, SPREADING	Navarretia fossalis	Plant
NAVARRETIA, FEW-FLOWERED	Navarretia leucocephala ssp. pauciflora (=N. pauciflora)	Plant
ONION, MUNZ'S	Allium munzii	Plant
OWL'S-CLOVER, FLESHY	Castilleja campestris ssp. succulenta	Plant
MEADOWFOAM, SEBASTOPOL	Limnanthes vinculans	Plant
MILK-VETCH, COASTAL DUNES	Astragalus tener var. titi	Plant
MOUNTAIN-MAHOGANY, CATALINA ISLAND	Cercocarpus traskiae	Plant
NAVARRETIA, MANY-FLOWERED	Navarretia leucocephala ssp. plieantha	Plant
MONARDELLA, WILLOWY	Monardella linoides ssp. viminea	Plant
MUSTARD, SLENDER-PETALED	Thelypodium stenopetalum	Plant
MINT, OTAY MESA	Pogogyne nudiuscula	Plant
MILK-VETCH, VENTURA MARSH	Astragalus pycnostachyus var.	Plant
MILK-VETCH, TRIPLE-RIBBED	Astragalus tricarinatus	Plant
OXYTHECA, CUSHENBURY	Oxytheca parishii var. goodmaniana	Plant
PAINTBRUSH, ASH-GREY INDIAN	Castilleja cinerea	Plant
PAINTBRUSH, SAN CLEMENTE ISLAND INDIAN	Castilleja grisea	Plant
MILK-VETCH, PIERSON'S	Astragalus magdalenae var. peirsonii	Plant
MILK-VETCH, LANE MOUNTAIN	Astragalus jaegerianus	Plant
MILK-VETCH, CUSHENBURY	Astragalus albens	Plant
MOUNTAINBALM, INDIAN KNOB	Eriodictyon altissimum	Plant

CA

WHIPSNAKE (=striped racer),	Masticophis lateralis euryxanthus	Reptile
TURTLE, OLIVE (PACIFIC) RIDLEY	Lepidochelys olivacea	Reptile
TORTOISE, DESERT	Gopherus agassizii	Reptile
LIZARD, BLUNT-NOSED LEOPARD	Gambelia silus	Reptile
LIZARD, ISLAND NIGHT	Xantusia riversiana	Reptile
SNAKE, GIANT GARTER	Thamnophis gigas	Reptile
SNAKE, SAN FRANCISCO GARTER	Thamnophis sirtalis tetrataenia	Reptile
LIZARD, COACHELLA VALLEY FRINGE-TOED	Uma inornata	Reptile
SNAIL, MORRO SHOULDERBAND	Helminthoglypta walkeriana	Snail

No species were excluded.

Unique Taxa Count by State for Selected Crops

Reporting for > 1 Acres

Bedding & garden plants (14), Floriculture crops (69), Foliage plants (nursery) (70), Nursery and greenhouse crops (120), Nursery crops (in the open) (121), Nursery and greenhouse crops, other (131)

Bedding & garden plants

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	287	139	233	30	25	56		60	206	6	60
Affected States:	42	29	40	7	7	13	2	19	37	3	23
Affected Species:	53	48	47	14	12	24	11	37	408	8	37

Floriculture crops

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	352	179	270	37	31	93		60	244	9	58
Affected States:	43	30	43	7	6	14	3	20	40	7	20
Affected Species:	55	47	49	12	12	26	12	36	427	10	42

Foliage plants (nursery)

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	49	28	47	10	7	36		8	36	1	4
Affected States:	12	7	16	3	2	5	2	4	10	1	4
Affected Species:	45	21	27	4	6	17	2	9	267	1	6

Nursery and greenhouse crops

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	1030	424	880	70	52	197		134	638	26	255
Affected States:	49	39	47	10	10	18	4	25	47	13	27
Affected Species:	56	84	58	17	17	28	12	43	497	24	67

Nursery and greenhouse crops, other

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	402	166	385	22	20	52		77	277	8	90
Affected States:	45	33	42	7	4	14	1	19	42	6	22
Affected Species:	48	47	44	10	9	23	1	27	307	8	39

Nursery crops (in the open)

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Affected Counties:	507	250	419	50	41	124		87	339	13	105
Affected States:	48	36	43	8	9	13	3	21	43	8	23
Affected Species:	56	66	51	16	16	25	6	37	452	18	57

Grand Summary

	Bird Clam	Fish	Mammal	Amphibian	Crustacean	Reptile	Arachnids		Insects	Plant	Snails
Total Counties:	106	442	897	71	53	202	8	139	655	29	265
Total States:	49	39	47	10	10	18	4	25	47	13	27
Unique Species Totals:	56	85	58	18	17	28	12	43	502	26	67

Species Affected:

TREEFROG, PINE BARRENS	Hyla andersonii	Amphibian
SALAMANDER, SAN MARCOS	Eurycea nana	Amphibian
FROG, CHIRICAHUA LEOPARD	Rana chiricahuensis	Amphibian
FROG, CALIFORNIA RED-LEGGED	Rana aurora draytonii	Amphibian
FROG, MOUNTAIN YELLOW-LEGGED	Rana muscosa	Amphibian
SALAMANDER, RED HILLS	Phaeognathus hubrichti	Amphibian
SALAMANDER, FLATWOODS	Ambystoma cingulatum	Amphibian
SALAMANDER, DESERT SLENDER	Batrachoseps aridus	Amphibian
FROG, DUSKY GOPHER (MISSISSIPPI DPS)	Rana capito sevosa	Amphibian
SALAMANDER, CALIFORNIA TIGER	Ambystoma californiense	Amphibian
SALAMANDER, SANTA CRUZ LONG-TOED	Ambystoma macrodactylum croceum	Amphibian
SALAMANDER, BARTON SPRINGS	Eurycea sosorum	Amphibian
SALAMANDER, SHENANDOAH	Plethodon shenandoah	Amphibian
SALAMANDER, SONORA TIGER	Ambystoma tigrinum stebbinsi	Amphibian
SALAMANDER, TEXAS BLIND	Typhlomolge rathbuni	Amphibian
TOAD, HOUSTON	Bufo houstonensis	Amphibian

TOAD, ARROYO SOUTHWESTERN	Bufo californicus (=microscaphus)	Amphibian
SALAMANDER, CHEAT MOUNTAIN	Plethodon nettingi	Amphibian
SPIDER, MADLA'S CAVE	Cicurina madla	Arachnid
SPIDER, GOVERNMENT CANYON CAVE	Neoleptoneta microps	Arachnid
SPIDER, KAUAI CAVE WOLF	Adelocosa anops	Arachnid
SPIDER, SPRUCE-FIR MOSS	Microhexura montivaga	Arachnid
SPIDER, TOOTH CAVE	Neoleptoneta myopica	Arachnid
SPIDER, VESPER CAVE	Cicurina vespera	Arachnid
CICURINA VENII (NCN)	Cicurina venii	Arachnid
PSEUDOSCORPION, TOOTH CAVE	Tartarocreagris texana	Arachnid
HARVESTMAN, BONE CAVE	Texella reyesi	Arachnid

HARVESTMAN, BEE CREEK CAVE	Texella reddelli	Arachnid
SPIDER, ROBBER BARON CAVE	Cicurina baronia	Arachnid
HARVESTMAN, ROBBER BARON	Texella cokendolpheri	Arachnid
PLOVER, PIPING	Charadrius melodus	Bird
TERN, INTERIOR (POPULATION)	Sterna antillarum	Bird
TERN, ROSEATE	Sterna dougallii dougallii	Bird
'O'O, KAUAI (='A'A)	Moho braccatus	Bird
NUKU PU'U	Hemignathus lucidus	Bird
THRUSH, LARGE KAUAI	Myadestes myadestinus	Bird
WARBLER (WOOD), KIRTLAND'S	Dendroica kirtlandii	Bird
OWL, MEXICAN SPOTTED	Strix occidentalis lucida	Bird
PLOVER, WESTERN SNOWY	Charadrius alexandrinus nivosus	Bird
KITE, EVERGLADE SNAIL	Rostrhamus sociabilis plumbeus	Bird
WOODPECKER, RED-COCKADED	Picoides borealis	Bird
SHRIKE, SAN CLEMENTE LOGGERHEAD	Lanius ludovicianus mearnsi	Bird
HAWK, HAWAIIAN (IO)	Buteo solitarius	Bird
SHEARWATER, NEWELL'S TOWNSEND'S	Puffinus auricularis newelli	Bird
CONDOR, CALIFORNIA	Gymnogyps californianus	Bird
RAIL, YUMA CLAPPER	Rallus longirostris yumanensis	Bird
STILT, HAWAIIAN (=AE'O)	Himantopus mexicanus knudseni	Bird
STORK, WOOD	Mycteria americana	Bird
PELICAN, BROWN	Pelecanus occidentalis	Bird
CRANE, WHOOPING	Grus americana	Bird
CRANE, MISSISSIPPI SANDHILL	Grus canadensis pulla	Bird
TERN, CALIFORNIA LEAST	Sterna antillarum browni	Bird
PETREL, HAWAIIAN DARK-RUMPED	Pterodroma phaeopygia sandwichensis	Bird
'O'U (HONEYCREEPER)	Psittirostra psittacea	Bird
CREEPER, HAWAII	Oreomystis mana	Bird
CROW, HAWAIIAN ('ALALA)	Corvus hawaiiensis	Bird
PALILA	Loxioides bailleui	Bird
CURLEW, ESKIMO	Numenius borealis	Bird

OWL, NORTHERN SPOTTED	Strix occidentalis caurina	Bird
JAY, FLORIDA SCRUB	Aphelocoma coerulescens	Bird
COOT, HAWAIIAN (=ALAE KEO	Fulica americana alai	Bird
GNATCATCHER, COASTAL CALIFORNIA	Polioptila californica californica	Bird
CAHOW	Pterodroma cahow	Bird
CARACARA, AUDUBON'S CRESTED	Polyborus plancus audubonii	Bird

RAIL, LIGHT-FOOTED CLAPPER	Rallus longirostris levipes	Bird
FALCON, NORTHERN APLOMADO	Falco femoralis septentrionalis	Bird
RAIL, CALIFORNIA CLAPPER	Rallus longirostris obsoletus	Bird
THRUSH, SMALL KAUAI (PUAIOHI)	Myadestes palmeri	Bird
EAGLE, BALD	Haliaeetus leucocephalus	Bird
PYGMY-OWL, CACTUS	Glaucidium brasilianum cactorum	Bird
DUCK, HAWAIIAN (KOLOA)	Anas wyvilliana	Bird
VIREO, BLACK-CAPPED	Vireo atricapilla	Bird
VIREO, LEAST BELL'S	Vireo bellii pusillus	Bird
FLYCATCHER, SOUTHWESTERN WILLOW	Empidonax traillii extimus	Bird
GOOSE, HAWAIIAN (NENE)	Branta (=Nesochen) sandvicensis	Bird
'AKIA LOA, KAUAI (HEMIGNATHUS PROCERUS)	Hemignathus procerus	Bird
SPARROW, FLORIDA GRASSHOPPER	Ammodramus savannarum floridanus	Bird
WARBLER (WOOD), GOLDEN-CHEEKED	Dendroica chrysoparia	Bird
'AKEPA, HAWAII	Loxops coccineus coccineus	Bird
SPARROW, SAN CLEMENTE SAGE	Amphispiza belli clementeae	Bird
'AKIA POLA'AU (HEMIGNATHUS MUNROI)	Hemignathus munroi	Bird
MURRELET, MARBLED	Brachyramphus marmoratus marmoratus	Bird
MOORHEN, HAWAIIAN COMMON	Gallinula chloropus sandvicensis	Bird
SPARROW, CAPE SABLE SEASIDE	Ammodramus maritimus mirabilis	Bird
BOBWHITE, MASKED	Colinus virginianus ridgwayi	Bird
PRAIRIE-CHICKEN, ATTWATER'S GREATER	Tympanuchus cupido attwateri	Bird
RIFFLESHELL, TAN	Epioblasma florentina walkeri (=E.	Clam
CLUBSHELL, SOUTHERN	Pleurobema decisum	Clam
COMBSHELL, SOUTHERN (=PENITENT MUSSEL)	Epioblasma penita	Clam
PEARLYMUSSEL, WHITE	Plethobasus cicatricosus	Clam
ROCK-POCKETBOOK, OUACHITA (=WHEELER'S PM)	Arkansia wheeleri	Clam
PEARLYMUSSEL, WHITE CAT'S PAW	Epioblasma obliquata perobliqua	Clam
RABBITSFOOT, ROUGH	Quadrula cylindrica strigillata	Clam
PEARLYMUSSEL, TURGID-BLOSSOM	Epioblasma turgidula	Clam
COMBSHELL, CUMBERLAND	Epioblasma brevidens	Clam
PEARLYMUSSEL, YELLOW-BLOSSOM	Epioblasma florentina florentina	Clam
COMBSHELL, UPLAND	Epioblasma metastriata	Clam
SPINYMUSSEL, TAR RIVER	Elliptio steinstansana	Clam

PEARLYMUSSEL, PALE LILLIPUT	Toxolasma cylindrellus	Clam

POCKETBOOK, SHINY-RAYED	Lampsilis subangulata	Clam
POCKETBOOK, FINE-LINED	Lampsilis altilis	Clam
POCKETBOOK, FAT	Potamilus capax	Clam
PIGTOE, SOUTHERN	Pleurobema georgianum	Clam
PIGTOE, SHINY	Fusconaia cor	Clam
PIGTOE, ROUGH	Pleurobema plenum	Clam
CLUBSHELL	Pleurobema clava	Clam
SPINYMUSSEL, JAMES RIVER	Pleurobema collina	Clam
CLUBSHELL, OVATE	Pleurobema perovatum	Clam
PIGTOE, HEAVY (=JUDGE TAIT'S MUSSEL)	Pleurobema taitianum	Clam
PIGTOE, FINE-RAYED	Fusconaia cuneolus	Clam
PIGTOE, DARK	Pleurobema furvum	Clam
PEARLYMUSSEL, TUBERCLED-BLOSSOM	Epioblasma torulosa torulosa	Clam
PIGTOE, CUMBERLAND (=CUMBERLAND PIGTOE MUSSEL	Pleurobema gibberum	Clam
SLABSHELL, CHIPOLA	Elliptio chipolaensis	Clam
RIFFLESHELL, NORTHERN	Epioblasma torulosa rangiana	Clam
PIGTOE, OVAL	Pleurobema pyriforme	Clam
KIDNEYSHELL, TRIANGULAR	Ptychobranchus greeni	Clam
THREERIDGE, FAT	Amblema neislerii	Clam
ACORNSHELL, SOUTHERN	Epioblasma othcaloogensis	Clam
BANKCLIMBER, PURPLE	Elliptoideus sloatianus	Clam
MOCCASINSHELL, ALABAMA	Medionidus acutissimus	Clam
MUSSEL, SCALESHELL	Leptodea leptodon	Clam
MUSSEL, RING PINK (=GOLF STICK PEARLY)	Obovaria retusa	Clam
MUSSEL, OYSTER	Epioblasma capsaeformis	Clam
MUSSEL, DWARF WEDGE	Alasmidonta heterodon	Clam
BEAN, PURPLE	Villosa perpurpurea	Clam
MOCCASINSHELL, OCHLOCKONEE	Medionidus simpsonianus	Clam
MUSSEL, WINGED MAPLELEAF	Quadrula fragosa	Clam
HEELSPLITTER, INFLATED	Potamilus inflatus	Clam
HEELSPLITTER, CAROLINA	Lasmigona decorata	Clam
MOCCASINSHELL, GULF	Medionidus penicillatus	Clam
MOCCASINSHELL, COOSA	Medionidus parvulus	Clam
PEARLYMUSSEL, PURPLE CAT'S	Epioblasma obliquata obliquata	Clam
ELKTOE, APPALACHIAN	Alasmidonta raveneliana	Clam
ELKTOE, CUMBERLAND	Alasmidonta atropurpurea	Clam
FANSHELL	Cyprogenia stegaria	Clam

FATMUCKET, ARKANSAS	Lampsilis powelli	Clam
MUCKET, ORANGE-NACRE	Lampsilis perovalis	Clam
PEARLYMUSSEL, CUMBERLAND MONKEYFACE	Quadrula intermedia	Clam
PEARLYMUSSEL, PINK MUCKET	Lampsilis abrupta	Clam
PEARLYMUSSEL, ORANGE-FOOTED	Plethobasus cooperianus	Clam
PEARLYMUSSEL, LITTLE-WING	Pegias fabula	Clam
STIRRUP SHELL	Quadrula stapes	Clam
PEARLYMUSSEL, HIGGINS' EYE	Lampsilis higginsii	Clam
PEARLYMUSSEL, GREEN-BLOSSOM	Epioblasma torulosa gubernaculum	Clam
PEARLYMUSSEL, CURTIS'	Epioblasma florentina curtisii	Clam
PEARLYMUSSEL, CUMBERLAND BEAN	Villosa trabalis	Clam
PEARLYMUSSEL, CRACKING	Hemistena lata	Clam
PEARLYMUSSEL, BIRDWING	Conradilla caelata	Clam
PEARLYMUSSEL, APPALACHIAN MONKEYFACE	Quadrula sparsa	Clam
PEARLYMUSSEL, ALABAMA LAMP	Lampsilis virescens	Clam
PEARLSHELL, LOUISIANA	Margaritifera hembeli	Clam
PEARLYMUSSEL, DROMEDARY	Dromus dromas	Clam
CRAYFISH, NASHVILLE	Orconectes shoupi	Crustacean
AMPHIPOD, ILLINOIS CAVE	Gammarus acherondytes	Crustacean
AMPHIPOD, KAUAI CAVE	Spelaeorchestia koloana	Crustacean
SHRIMP, VERNAL POOL TADPOLE	Lepidurus packardi	Crustacean
AMPHIPOD, PECK'S CAVE	Stygobromus (=Stygonectes) pecki	Crustacean
SHRIMP, VERNAL POOL FAIRY	Branchinecta lynchi	Crustacean
SHRIMP, SQUIRREL CHIMNEY CAVE	Palaemonetes cummingi	Crustacean
SHRIMP, SAN DIEGO FAIRY	Branchinecta sandiegonensis	Crustacean
SHRIMP, RIVERSIDE FAIRY	Streptocephalus woottoni	Crustacean
SHRIMP, KENTUCKY CAVE	Palaemonias ganteri	Crustacean
SHRIMP, CONSERVANCY FAIRY	Branchinecta conservatio	Crustacean
SHRIMP, CALIFORNIA FRESHWATER	Syncaris pacifica	Crustacean
SHRIMP, ALABAMA CAVE	Palaemonias alabamae	Crustacean
ISOPOD, LEE COUNTY CAVE	Lirceus usdagalun	Crustacean
ISOPOD, MADISON CAVE	Antrolana lira	Crustacean
CRAYFISH, SHASTA	Pacifastacus fortis	Crustacean
SHRIMP, LONGHORN FAIRY	Branchinecta longiantenna	Crustacean
SALMON, CHINOOK (PUGET SOUND)	Oncorhynchus (=Salmo) tshawytscha	Fish
MADTOM, SCIOTO	Noturus trautmani	Fish
MADTOM, PYGMY	Noturus stanauli	Fish

MADTOM, NEOSHO	Noturus placidus	Fish
SALMON, CHUM (HOOD CANAL SUMMER POPULATION)	Oncorhynchus (=Salmo) keta	Fish
SALMON, COHO (OREGON COAST POPULATION)	Oncorhynchus (=Salmo) kisutch	Fish
SALMON, SOCKEYE (SNAKE RIVER POPULATION)	Oncorhynchus (=Salmo) nerka	Fish
LOGPERCH, ROANOKE	Percina rex	Fish
MADTOM, SMOKY	Noturus baileyi	Fish
SALMON, CHINOOK (LOWER COLUMBIA RIVER)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, CHINOOK (UPPER WILLAMETTE RIVER)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, CHINOOK (CALIFORNIA COASTAL ESU)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, ATLANTIC	Salmo salar	Fish
SALMON, CHINOOK (SACRAMENTO RIVER WINTER RUN)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, CHINOOK (SNAKE RIVER FALL RUN)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, CHINOOK (UPPER COLUMBIA RIVER SPRING)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, SOCKEYE (OZETTE LAKE POPULATION)	Oncorhynchus (=Salmo) nerka	Fish
SALMON, CHINOOK (CENTRAL VALLEY SPRING RUN)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, COHO (CENTRAL CALIFORNIA COAST POP)	Oncorhynchus (=Salmo) kisutch	Fish
SALMON, COHO (SOUTHERN OR/NORTHERN CA COAST)	Oncorhynchus (=Salmo) kisutch	Fish
SALMON, CHINOOK (SNAKE RIVER SPRING/SUMMER)	Oncorhynchus (=Salmo) tshawytscha	Fish
SALMON, CHUM (COLUMBIA RIVER POPULATION)	Oncorhynchus (=Salmo) keta	Fish
DARTER, FOUNTAIN	Etheostoma fonticola	Fish
DARTER, WATERCRESS	Etheostoma nuchale	Fish
DARTER, VERMILION	Etheostoma chermocki	Fish
DARTER, SNAIL	Percina tanasi	Fish
DARTER, SLACKWATER	Etheostoma boschungi	Fish
DARTER, OKALOOSA	Etheostoma okaloosae	Fish
DARTER, NIANGUA	Etheostoma nianguae	Fish
DARTER, MARYLAND	Etheostoma sellare	Fish
PUPFISH, DEVILS HOLE	Cyprinodon diabolis	Fish
DARTER, GOLDLINE	Percina aurolineata	Fish
CHUB, SLENDER	Erimystax cahni	Fish

DARTER, ETOWAH	Etheostoma etowahae	Fish
DARTER, DUSKYTAIL	Etheostoma percnurum	Fish
DARTER, CHEROKEE	Etheostoma scotti	Fish
DARTER, BOULDER	Etheostoma wapiti	Fish
DARTER, AMBER	Percina antesella	Fish
DACE, MOAPA	Moapa coriacea	Fish
DACE, BLACKSIDE	Phoxinus cumberlandensis	Fish
DARTER, LEOPARD	Percina pantherina	Fish
PUPFISH, DESERT	Cyprinodon macularius	Fish
GOBY, TIDEWATER	Eucyclogobius newberryi	Fish
GAMBUSIA, SAN MARCOS	Gambusia georgei	Fish
GAMBUSIA, PECOS	Gambusia nobilis	Fish
MINNOW, RIO GRANDE SILVERY	Hybognathus amarus	Fish
CATFISH, YAQUI	Ictalurus pricei	Fish
CAVEFISH, ALABAMA	Speoplatyrhinus poulsoni	Fish
CAVEFISH, OZARK	Amblyopsis rosae	Fish
CHUB, YAQUI	Gila purpurea	Fish
PUPFISH, OWENS	Cyprinodon radiosus	Fish
CHUB, SPOTFIN	Cyprinella monacha	Fish
SAWFISH, SMALLTOOTH	Pristis pectinata	Fish
CHUB, BONYTAIL	Gila elegans	Fish
CHUB, HUMPBACK	Gila cypha	Fish
POOLFISH, PAHRUMP (= PAHRUMP KILLIFISH)	Empetrichthys latos	Fish
CHUB, MOHAVE TUI	Gila bicolor mohavensis	Fish
CHUB, OREGON	Oregonichthys crameri	Fish
CHUB, OWENS TUI	Gila bicolor snyderi	Fish
MADTOM, YELLOWFIN	Noturus flavipinnis	Fish
MINNOW, LOACH	Tiaroga cobitis	Fish
STURGEON, WHITE	Acipenser transmontanus	Fish
STICKLEBACK, UNARMORED THREESPINE	Gasterosteus aculeatus williamsoni	Fish
SHINER, TOPEKA	Notropis topeka (=tristis)	Fish
STEELHEAD, LOWER COLUMBIA RIVER POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
SILVERSIDE, WACCAMAW	Menidia extensa	Fish
STEELHEAD, MIDDLE COLUMBIA RIVER POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
STEELHEAD, NORTHERN CALIFORNIA POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
STEELHEAD, SNAKE RIVER BASIN POPULATION	Oncorhynchus (=Salmo) mykiss	Fish

WOUNDFIN	Plagopterus argentissimus	Fish
SUCKER, RAZORBACK	Xyrauchen texanus	Fish
SUCKER, MODOC	Catostomus microps	Fish
SHINER, PALEZONE	Notropis albizonatus	Fish
SUCKER, JUNE	Chasmistes liorus	Fish
SHINER, PECOS BLUNTNOSE	Notropis simus pecosensis	Fish
STURGEON, SHORTNOSE	Acipenser brevirostrum	Fish
STURGEON, PALLID	Scaphirhynchus albus	Fish
STEELHEAD, SOUTH-CENTRAL CALIFORNIA POP	Oncorhynchus (=Salmo) mykiss	Fish
STURGEON, GULF	Acipenser oxyrinchus desotoi	Fish
STURGEON, ALABAMA	Scaphirhynchus suttkusi	Fish
STEELHEAD, SOUTHERN CALIFORNIA POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
STEELHEAD, UPPER COLUMBIA RIVER POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
STEELHEAD, UPPER WILLAMETTE RIVER POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
TOPMINNOW, GILA (YAQUI)	Poeciliopsis occidentalis	Fish
SMELT, DELTA	Hypomesus transpacificus	Fish
SUCKER, LOST RIVER	Deltistes luxatus	Fish
STEELHEAD, CENTRAL CALIFORNIA POPULATION	Oncorhynchus (=Salmo) mykiss	Fish
TROUT, PAIUTE CUTTHROAT	Oncorhynchus clarki seleniris	Fish
SUCKER, SANTA ANA	Catostomus santaanae	Fish
TROUT, LAHONTAN CUTTHROAT	Oncorhynchus clarki henshawi	Fish
SHINER, CAPE FEAR	Notropis mekistocholas	Fish
SQUAWFISH, COLORADO	Ptychocheilus lucius	Fish
TROUT, BULL	Salvelinus confluentus	Fish
TROUT, GREENBACK CUTTHROAT	Oncorhynchus clarki stomias	Fish
TROUT, LITTLE KERN GOLDEN	Oncorhynchus aguabonita whitei	Fish
SPIKEDACE	Meda fulgida	Fish
STEELHEAD, CALIFORNIA CENTRAL VALLEY POP	Oncorhynchus (=Salmo) mykiss	Fish
SPINEDACE, LITTLE COLORADO	Lepidomeda vittata	Fish
SUCKER, SHORTNOSE	Chasmistes brevirostris	Fish
TROUT, APACHE	Oncorhynchus apache	Fish
SHINER, ARKANSAS RIVER	Notropis girardi	Fish
TROUT, GILA	Oncorhynchus gilae	Fish
SHINER, BEAUTIFUL	Cyprinella formosa	Fish
SHINER, BLUE	Cyprinella caerulea	Fish
SHINER, CAHABA	Notropis cahabae	Fish

SCULPIN, PYGMY	Cottus paulus (=pygmaeus)	Fish
GRASSHOPPER, ZAYANTE BAND-WINGED	Trimerotropis infantilis	Insect
BUTTERFLY, BAY CHECKERSPOT	Euphydryas editha bayensis	Insect
BEETLE, TOOTH CAVE GROUND	Rhadine persephone	Insect
DRAGONFLY, HINES EMERALD	Somatochlora hineana	Insect
BEETLE, VALLEY ELDERBERRY LONGHORN	Desmocerus californicus dimorphus	Insect
BEETLE, AMERICAN BURYING	Nicrophorus americanus	Insect
BEETLE, COFFIN CAVE MOLD	Batrisodes texanus	Insect
FLY, DELHI SANDS FLOWER-LOVING	Rhaphiomidas terminatus abdominalis	Insect
MOTH, BLACKBURN'S SPHINX	Manduca blackburni	Insect
MOTH, KERN PRIMROSE SPHINX	Euproserpinus euterpe	Insect
RHADINE EXILIS (NCN)	Rhadine exilis	Insect
BUTTERFLY, SCHAUS	Heraclides aristodemus ponceanus	Insect
BUTTERFLY, PALOS VERDES BLUE	Glaucopsyche lygdamus palosverdesensis	Insect
BEETLE, COMAL SPRINGS RIFFLE	Heterelmis comalensis	Insect
BEETLE, HUNGERFORD'S CRAWLING WATER	Brychius hungerfordi	Insect
BUTTERFLY, SMITH'S BLUE	Euphilotes enoptes smithi	Insect
RHADINE INFERNALIS (NCN)	Rhadine infernalis	Insect
BUTTERFLY, UNCOMPAHGRE FRITILLARY	Boloria acrocnema	Insect
BUTTERFLY, MYRTLE'S SILVERSPOT	Speyeria zerene myrtleae	Insect
BUTTERFLY, OREGON SILVERSPOT	Speyeria zerene hippolyta	Insect
BUTTERFLY, MITCHELL'S SATYR	Neonympha mitchellii mitchellii	Insect
BUTTERFLY, SAN BRUNO ELFIN	Callophrys mossii bayensis	Insect
BEETLE, DELTA GREEN GROUND	Elaphrus viridis	Insect
BUTTERFLY, QUINO CHECKERSPOT	Euphydryas editha quino (=E. e. wrighti)	Insect
BUTTERFLY, SAINT FRANCIS' SATYR	Neonympha mitchellii francisci	Insect
BEETLE, HELOTES MOLD	Batrisodes venyivi	Insect
BEETLE, COMAL SPRINGS DRYOPID	Stygoparnus comalensis	Insect
SKIPPER, LAGUNA MOUNTAIN	Pyrgus ruralis lagunae	Insect
BUTTERFLY, CALLIPPE SILVERSPOT	Speyeria callippe callippe	Insect
BUTTERFLY, BEHREN'S SILVERSPOT	Speyeria zerene behrensii	Insect
SKIPPER, PAWNEE MONTANE	Hesperia leonardus montana	Insect
BEETLE, PURITAN TIGER	Cicindela puritana	Insect
BEETLE, OHLONE TIGER	Cicindela ohlone	Insect
BEETLE, NORTHEASTERN BEACH TIGER	Cicindela dorsalis dorsalis	Insect
SKIPPER, CARSON WANDERING	Pseudocopaeodes eunus obscurus	Insect

BUTTERFLY, MISSION BLUE	Icaricia icarioides missionensis	Insect
BUTTERFLY, EL SEGUNDO BLUE	Euphilotes battoides allyni	Insect
BUTTERFLY, FENDER'S BLUE	Icaricia icarioides fenderi	Insect
BUTTERFLY, KARNER BLUE	Lycaeides melissa samuelis	Insect
BUTTERFLY, LANGE'S METALMARK	Apodemia mormo langei	Insect
BUTTERFLY, LOTIS BLUE	Lycaeides argyrognomon lotis	Insect
BEETLE, KRETSCHMARR CAVE	Texamaurops reddelli	Insect
BEETLE, MOUNT HERMON JUNE	Polyphylla barbata	Insect
BAT, OZARK BIG-EARED	Corynorhinus (=Plecotus) townsendii	Mammal
MANATEE, WEST INDIAN	Trichechus manatus	Mammal
BAT, VIRGINIA BIG-EARED	Corynorhinus (=Plecotus) townsendii virginianus	Mammal
OCELOT	Leopardus (=Felis) pardalis	Mammal
BAT, LESSER (=SANBORN'S) LONG-NOSED	Leptonycteris curasoae yerbabuenae	Mammal
SQUIRREL, MOUNT GRAHAM RED	Tamiasciurus hudsonicus grahamensis	Mammal
BEAR, GRIZZLY	Ursus arctos horribilis	Mammal
BEAR, LOUISIANA BLACK	Ursus americanus luteolus	Mammal
LYNX, CANADA	Lynx canadensis	Mammal
VOLE, FLORIDA SALT MARSH	Microtus pennsylvanicus dukecampbelli	Mammal
VOLE, HUALAPAI MEXICAN	Microtus mexicanus hualpaiensis	Mammal
SQUIRREL, DELMARVA PENINSULA FOX	Sciurus niger cinereus	Mammal
SQUIRREL, NORTHERN IDAHO GROUND	Spermophilus brunneus brunneus	Mammal
OTTER, SOUTHERN SEA	Enhydra lutris nereis	Mammal
SQUIRREL, VIRGINIA NORTHERN FLYING	Glaucomys sabrinus fuscus	Mammal
MOUSE, SALT MARSH HARVEST	Reithrodontomys raviventris	Mammal
PANTHER, FLORIDA	Puma (=Felis) concolor coryi	Mammal
KANGAROO RAT, SAN BERNARDINO	Dipodomys merriami parvus	Mammal
MOUSE, ALABAMA BEACH	Peromyscus polionotus ammobates	Mammal
WOLF, RED	Canis rufus	Mammal
MOUNTAIN BEAVER, POINT ARENA	Aplodontia rufa nigra	Mammal
BAT, INDIANA	Myotis sodalis	Mammal
RABBIT, RIPARIAN BRUSH	Sylvilagus bachmani riparius	Mammal
MOUSE, SOUTHEASTERN BEACH	Peromyscus polionotus niveiventris	Mammal
JAGUAR	Panthera onca	Mammal
CARIBOU, WOODLAND	Rangifer tarandus caribou	Mammal
FERRET, BLACK-FOOTED	Mustela nigripes	Mammal
MOUSE, ANASTASIA ISLAND BEACH	Peromyscus polionotus phasma	Mammal

KANGAROO RAT, STEPHENS'	Dipodomys stephensi (incl. D. cascus)	Mammal
RABBIT, PYGMY	Brachylagus idahoensis	Mammal
KANGAROO RAT, MORRO BAY	Dipodomys heermanni morroensis	Mammal
KANGAROO RAT, GIANT	Dipodomys ingens	Mammal
KANGAROO RAT, FRESNO	Dipodomys nitratoides exilis	Mammal
SHREW, BUENA VISTA	Sorex ornatus relictus	Mammal
SHEEP, SIERRA NEVADA BIGHORN	Ovis canadensis californiana	Mammal
SHEEP, PENINSULAR BIGHORN	Ovis canadensis	Mammal
SEAL, HAWAIIAN MONK	Monachus schauinslandi	Mammal
SEAL, GUADALUPE FUR	Arctocephalus townsendi	Mammal
Jaguarundi, Sinaloan	Herpailurus (=Felis) yagouaroundi tolteca	Mammal
JAGUARUNDI, Gulf Coast	Herpailurus (=Felis) yagouaroundi	Mammal
KANGAROO RAT, TIPTON	Dipodomys nitratoides nitratoides	Mammal
PRAIRIE DOG, UTAH	Cynomys parvidens	Mammal
WOODRAT, RIPARIAN	Neotoma fuscipes riparia	Mammal
WOLF, GRAY	Canis lupus	Mammal
DEER, COLUMBIAN WHITE-TAILED	Odocoileus virginianus leucurus	Mammal
FOX, SAN MIGUEL ISLAND	Urocyon littoralis littoralis	Mammal
FOX, SANTA CATALINA ISLAND	Urocyon littoralis catalinae	Mammal
FOX, SAN JOAQUIN KIT	Vulpes macrotis mutica	Mammal
FOX, SANTA CRUZ ISLAND	Urocyon littoralis santacruzae	Mammal
VOLE, AMARGOSA	Microtus californicus scirpensis	Mammal
FOX, SANTA ROSA ISLAND	Urocyon littoralis santarosae	Mammal
WHALE, NORTHERN RIGHT	Eubalaena glacialis	Mammal
MOUSE, PREBLE'S MEADOW	Zapus hudsonius preblei	Mammal
MOUSE, PERDIDO KEY BEACH	Peromyscus polionotus trissyllepsis	Mammal
BAT, HAWAIIAN HOARY	Lasiurus cinereus semotus	Mammal
MOUSE, PACIFIC POCKET	Perognathus longimembris pacificus	Mammal
PRONGHORN, SONORAN	Antilocapra americana sonoriensis	Mammal
MOUSE, CHOCTAWHATCHEE BEACH	Peromyscus polionotus allophrys	Mammal
DWARF-FLAX, MARIN	Hesperolinon congestum	Plant
ASTER, DECURRENT FALSE	Boltonia decurrens	Plant
FRINGE TREE, PYGMY	Chionanthus pygmaeus	Plant
ARROWHEAD, BUNCHED	Sagittaria fasciculata	Plant
EVENING-PRIMROSE, ANTIOCH DUNES	Oenothera deltoides ssp. howellii	Plant
EVENING-PRIMROSE, SAN BENITO	Camissonia benitensis	Plant
ASPLENIUM FRAGILE VAR. INSULARE (NCN)	Asplenium fragile var. insulare	Plant
FRINGEPOD, SANTA CRUZ ISLAND	Thysanocarpus conchuliferus	Plant

FRITILLARY, GENTNER'S	Fritillaria gentneri	Plant
FOUR-O'CLOCK, MACFARLANE'S	Mirabilis macfarlanei	Plant
'ANUNU (SICYOS ALBA)	Sicyos alba	Plant
AMPHIANTHUS, LITTLE	Amphianthus pusillus	Plant
AMOLE, PURPLE	Chlorogalum purpureum var. purpureum	Plant
FERN, AMERICAN HART'S-TONGUE	Asplenium scolopendrium var.	Plant
FERN, PENDANT KIHI (ADENOPHORUS PERIENS)	Adenophorus periens	Plant
Amole, Camatta Canyon	Chlorogalum purpureum var. reductum	Plant
AMBROSIA, SOUTH TEXAS	Ambrosia cheiranthifolia	Plant
FIDDLENECK, LARGE-FLOWERED	Amsinckia grandiflora	Plant
FLANNELBUSH, MEXICAN	Fremontodendron mexicanum	Plant
AMBROSIA, SAN DIEGO	Ambrosia pumila	Plant
FLANNELBUSH, PINE HILL	Fremontodendron californicum ssp. decumbens	Plant
AMARANTH, SEABEACH	Amaranthus pumilus	Plant
HAREBELLS, AVON PARK	Crotalaria avonensis	Plant
ALANI (MELICOPE PALLIDA)	Melicope pallida	Plant
HEATHER, MOUNTAIN GOLDEN	Hudsonia montana	Plant
HEARTLEAF, DWARF-FLOWERED	Hexastylis naniflora	Plant
HAU KUAHIWI (HIBISCADELPHUS DISTANS)	Hibiscadelphus distans	Plant
HAU KAUHIWI (HIBISCADELPHUS WOODI)	Hibiscadelphus woodii	Plant
'AIEA (NOTHOCESTRUM	Nothocestrum peltatum	Plant
HEDYOTIS ST.-JOHNII (NCN)	Hedyotis st.-johnii	Plant
HARPERELLA	Ptilimnium nodosum	Plant
'AIEA (NOTHOCESTRUM BREVIFLORUM)	Nothocestrum breviflorum	Plant
HAPLOSTACHYS HAPLOSTACHYA (NCN)	Haplostachys haplostachya	Plant
HALA PEPE (PLEOMELE	Pleomele hawaiiensis	Plant
HA'IWALE (CYRTANDRA LIMAHULIENSIS)	Cyrtandra limahuliensis	Plant
HA'IWALE (CYRTANDRA GIFFARDII)	Cyrtandra giffardii	Plant
HAHA (CYANEA STICTOPHYLLA)	Cyanea stictophylla	Plant
HAHA (CYANEA SHIPMANII)	Cyanea shipmannii	Plant
'AKOKO (EUPHORBIA	Euphorbia haeleeleana	Plant
A'E (ZANTHOXYLUM HAWAIIENSE)	Zanthoxylum hawaiiense	Plant
ADOBE SUNBURST, SAN JOAQUIN	Pseudobahia peirsonii	Plant
JACQUEMONTIA, BEACH	Jacquemontia reclinata	Plant

A'E (ZANTHOXYLUM DIPETALUM VAR. TOMENTOSUM)	Zanthoxylum dipetalum var. tomentosum	Plant
IRISETTE, WHITE	Sisyrinchium dichotomum	Plant
IRIS, DWARF LAKE	Iris lacustris	Plant
IPOMOPSIS, HOLY GHOST	Ipomopsis sancti-spiritus	Plant
HEAU (EXOCARPOS LUTEOLUS)	Exocarpos luteolus	Plant
HYPERICUM, HIGHLANDS SCRUB	Hypericum cumulicola	Plant
HAHA (CYANEA PLATYPHYLLA)	Cyanea platyphylla	Plant
HOWELLIA, WATER	Howellia aquatilis	Plant
HOLEI (OCHROSIA KILAUEAENSIS)	Ochrosia kilaueaensis	Plant
AGAVE, ARIZONA	Agave arizonica	Plant
HILO ISCHAEMUM (ISCHAEMUM BYRONE)	Ischaemum byrone	Plant
HIBISCUS, CLAY'S	Hibiscus clayi	Plant
HESPEROMANNIA LYDGATEI (NCN)	Hesperomannia lydgatei	Plant
ILIAU (WILKESIA HOBDYI)	Wilkesia hobdyi	Plant
ALLOCARYA, CALISTOGA	Plagiobothrys strictus	Plant
GOLDFIELDS, CONTRA COSTA	Lasthenia conjugens	Plant
GOLDFIELDS, BURKE'S	Lasthenia burkei	Plant
GOLDENROD, HOUGHTON'S	Solidago houghtonii	Plant
BEDSTRAW, EL DORADO	Galium californicum ssp. sierrae	Plant
GOLDENROD, BLUE RIDGE	Solidago spithamaea	Plant
DUDLEYA, VERITY'S	Dudleya verityi	Plant
HAHA (CYANEA REMYI)	Cyanea remyi	Plant
ALANI (MELICOPE	Melicope zahlbruckneri	Plant
GOUANIA MEYENII (NCN)	Gouania meyenii	Plant
GOLDEN SUNBURST, HARTWEG'S	Pseudobahia bahiifolia	Plant
ALOPECURUS, SONOMA	Alopecurus aequalis var. sonomensis	Plant
ALSINIDENDRON VISCOSUM (NCN)	Alsinidendron viscosum	Plant
GILIA, MONTEREY	Gilia tenuiflora ssp. arenaria	Plant
GILIA, HOFFMANN'S SLENDER-FLOWERED	Gilia tenuiflora ssp. hoffmannii	Plant
GERARDIA, SANDPLAIN	Agalinis acuta	Plant
ALANI (MELICOPE QUADRANGULARIS)	Melicope quadrangularis	Plant
GRASS, SAN JOAQUIN VALLEY ORCUTT	Orcuttia inaequalis	Plant
GEOCARPON MINIMUM	Geocarpon minimum	Plant
HAHA (CYANEA HAMATIFLORA SSP. CARLSONII)	Cyanea hamatiflora carlsonii	Plant
HAHA (CYANEA COPELANDII SSP. COPELANDII)	Cyanea copelandii ssp. copelandii	Plant

HAHA (CYANEA ASARIFOLIA)	Cyanea asarifolia	Plant
GROUND-PLUM, GUTHRIE'S	Astragalus bibullatus	Plant
GRASS, TENNESSEE YELLOW-EYED	Xyris tennesseensis	Plant
ALANI (MELICOPE KNUDSENII)	Melicope knudsenii	Plant
GRASS, SLENDER ORCUTT	Orcuttia tenuis	Plant
GOOSEBERRY, MICCOSUKEE (FLORIDA)	Ribes echinellum	Plant
ALANI (MELICOPE HAUPUENSIS)	Melicope haupuensis	Plant
GRASS, SACRAMENTO ORCUTT	Orcuttia viscida	Plant
GRASS, HAIRY ORCUTT	Orcuttia pilosa	Plant
GRASS, COLUSA	Neostapfia colusana	Plant
GRASS, CALIFORNIA ORCUTT	Orcuttia californica	Plant
GOURD, OKEECHOBEE	Cucurbita okeechobeensis ssp. okeechobeensis	Plant
HAHA (CYANEA RECTA)	Cyanea recta	Plant
GRASS, SOLANO	Tuctoria mucronata	Plant
BONAMIA MENZIESII (NCN)	Bonamia menziesii	Plant
CEANOTHUS, VAIL LAKE	Ceanothus ophiochilus	Plant
BUCKWHEAT, IONE (IRISH HILL)	Eriogonum apricum (incl. var prostratum)	Plant
BUCKWHEAT, CUSHENBURY	Eriogonum ovalifolium var. vineum	Plant
BROOM, SAN CLEMENTE ISLAND	Lotus dendroideus ssp. traskiae	Plant
BRODIAEA, THREAD-LEAVED	Brodiaea filifolia	Plant
CHAFFSEED, AMERICAN	Schwalbea americana	Plant
CHAMAESYCE HALEMANUI	Chamaesyce halemanui	Plant
CHECKER-MALLOW, KECK'S	Sidalcea keckii	Plant
BRODIAEA, CHINESE CAMP	Brodiaea pallida	Plant
CHECKER-MALLOW, KENWOOD MARSH	Sidalcea oregana ssp. valida	Plant
CHECKER-MALLOW, NELSON'S	Sidalcea nelsoniana	Plant
CHECKER-MALLOW, PEDATE	Sidalcea pedata	Plant
CLARKIA, PISMO	Clarkia speciosa ssp. immaculata	Plant
BONAMIA, FLORIDA	Bonamia grandiflora	Plant
CEANOTHUS, COYOTE	Ceanothus ferrisae	Plant
BLUET, ROAN MOUNTAIN	Hedyotis purpurea var. montana	Plant
BLUE-STAR, KEARNEY'S	Amsonia kearneyana	Plant
BLUEGRASS, SAN BERNARDINO	Poa atropurpurea	Plant
BLUEGRASS, NAPA	Poa napensis	Plant
BLUEGRASS, MANN'S (POA MANNII)	Poa mannii	Plant
BLUEGRASS, HAWAIIAN	Poa sandvicensis	Plant
BLUECURLS, HIDDEN LAKE	Trichostema austromontanum ssp. compactum	Plant

BLAZING STAR, SCRUB	Liatris ohlingerae	Plant
BLAZING STAR, HELLER'S	Liatris helleri	Plant
CLADONIA, FLORIDA PERFORATE	Cladonia perforata	Plant
BLADDERPOD, SPRING CREEK	Lesquerella perforata	Plant
DAISY, MAGUIRE	Erigeron maguirei	Plant
CHECKER-MALLOW, WENATCHEE MOUNTAINS	Sidalcea oregana var. calva	Plant
CACTUS, SILER PINCUSHION	Pediocactus (=Echinocactus,=Utahia)	Plant
BUTTERWEED, LAYNE'S	Senecio layneae	Plant
BUTTERWORT, GODFREY'S	Pinguicula ionantha	Plant
BUTTON-CELERY, SAN DIEGO	Eryngium aristulatum var. parishii	Plant
CACTUS, ARIZONA HEDGEHOG	Echinocereus triglochidiatus var.	Plant
CACTUS, BAKERSFIELD	Opuntia treleasei	Plant
CACTUS, COCHISE PINCUSHION	Coryphantha robbinsorum	Plant
CACTUS, KNOWLTON	Pediocactus knowltonii	Plant
CACTUS, KUENZLER HEDGEHOG	Echinocereus fendleri var. kuenzleri	Plant
CACTUS, LEE PINCUSHION	Coryphantha sneedii var. leei	Plant
CACTUS, MESA VERDE	Sclerocactus mesae-verdae	Plant
CACTUS, NICHOL'S TURK'S HEAD	Echinocactus horizonthalonius var.	Plant
CACTUS, PEEBLES NAVAJO	Pediocactus peeblesianus peeblesianus	Plant
CEANOTHUS, PINE HILL	Ceanothus roderickii	Plant
CACTUS, SAN RAFAEL	Pediocactus despainii	Plant
BUCKWHEAT, SCRUB	Eriogonum longifolium var.	Plant
CACTUS, SNEED PINCUSHION	Coryphantha sneedii var. sneedii	Plant
CACTUS, TOBUSCH FISHHOOK	Ancistrocactus tobuschii	Plant
CACTUS, UINTA BASIN HOOKLESS	Sclerocactus glaucus	Plant
CACTUS, WINKLER	Pediocactus winkleri	Plant
CACTUS, WRIGHT FISHHOOK	Sclerocactus wrightiae	Plant
CAMPION, FRINGED	Silene polypetala	Plant
BUTTERFLY PLANT, COLORADO	Gaura neomexicana var. coloradensis	Plant
BUSHMALLOW, SANTA CRUZ	Malacothamnus fasciculatus var.	Plant
BUSH-MALLOW, SAN CLEMENTE ISLAND	Malacothamnus clementinus	Plant
BUSH-CLOVER, PRAIRIE	Lespedeza leptostachya	Plant
BULRUSH, NORTHEASTERN (=BARBED BRISTLE)	Scirpus ancistrochaetus	Plant
BUCKWHEAT, SOUTHERN MOUNTAIN WILD	Eriogonum kennedyi var.	Plant
CLARKIA, PRESIDIO	Clarkia franciscana	Plant
CACTUS, PIMA PINEAPPLE	Coryphantha scheeri var. robustispina	Plant
DROPWORT, CANBY'S	Oxypolis canbyi	Plant

BEAR-POPPY, DWARF	Arctomecon humilis	Plant
BEARGRASS, BRITTON'S	Nolina brittoniana	Plant
BEAKED-RUSH, KNIESKERN'S	Rhynchospora knieskernii	Plant
BARBERRY, NEVIN'S	Berberis nevinii	Plant
BARBERRY, ISLAND	Berberis pinnata ssp. insularis	Plant
BARBARA'S BUTTONS, MOHR'S	Marshallia mohrii	Plant
DAWN-FLOWER, TEXAS PRAIRIE (=TEXAS BITTERWEED	Hymenoxys texana	Plant
BACCHARIS, ENCINITAS	Baccharis vanessae	Plant
DELISSEA RHYTODISPERMA (NCN)	Delissea rhytidosperma	Plant
AYENIA, TEXAS	Ayenia limitaris	Plant
DIELLIA ERECTA (NCN)	Diellia erecta	Plant
DIELLIA PALLIDA (NCN)	Diellia pallida	Plant
BLADDERPOD, SAN BERNARDINO MOUNTAINS	Lesquerella kingii ssp. bernardina	Plant
'AWIWI (HEDYOTIS COOKIANA)	Hedyotis cookiana	Plant
CATCHFLY, SPALDING'S	Silene spaldingii	Plant
DUBAUTIA LATIFOLIA	Dubautia latifolia	Plant
'AWIWI (CENTAURIUM	Centaurium sebaeoides	Plant
AVENS, SPREADING	Geum radiatum	Plant
AUPAKA (ISODENDRION LONGIFOLIUM)	Isodendrion longifolium	Plant
AUPAKA (ISODENDRION LAURIFOLIUM)	Isodendrion laurifolium	Plant
DUBAUTIA PAUCIFLORULA	Dubautia pauciflorula	Plant
AUPAKA (ISODENDRION HOSAKAE)	Isodendrion hosakae	Plant
DUDLEYA, CONEJO	Dudleya abramsii ssp. parva	Plant
DUDLEYA, MARCESCENT	Dudleya cymosa ssp. marcescens	Plant
DUDLEYA, SANTA CLARA VALLEY	Dudleya setchellii	Plant
DUDLEYA, SANTA CRUZ ISLAND	Dudleya nesiotica	Plant
DUDLEYA, SANTA MONICA MOUNTAINS	Dudleya cymosa ssp. ovatifolia	Plant
DOGWEED, ASHY	Thymophylla tephroleuca	Plant
BIRCH, VIRGINIA ROUND-LEAF	Betula uber	Plant
CLARKIA, SPRINGVILLE	Clarkia springvillensis	Plant
CLARKIA, VINE HILL	Clarkia imbricata	Plant
CLIFFROSE, ARIZONA	Purshia (=cowania) subintegra	Plant
CLOVER, MONTEREY	Trifolium trichocalyx	Plant
CLOVER, RUNNING BUFFALO	Trifolium stoloniferum	Plant
BLADDERPOD, MISSOURI	Lesquerella filiformis	Plant
BLADDERPOD, LYRATE	Lesquerella lyrata	Plant

BITTERCRESS, SMALL-ANTHERED	Cardamine micranthera	Plant
BIRDS-IN-A-NEST, WHITE	Macbridea alba	Plant
BIRD'S-BEAK, SOFT	Cordylanthus mollis ssp. mollis	Plant
BIRD'S-BEAK, SALT MARSH	Cordylanthus maritimus ssp. maritimus	Plant
BIRD'S-BEAK, PENNELL'S	Cordylanthus tenuis ssp. capillaris	Plant
DAISY, WILLAMETTE	Erigeron decumbens var. decumbens	Plant
CLOVER, SHOWY INDIAN	Trifolium amoenum	Plant
DAISY, PARISH'S	Erigeron parishii	Plant
BELLFLOWER, BROOKSVILLE	Campanula robinsiae	Plant
CONEFLOWER, SMOOTH	Echinacea laevigata	Plant
CONEFLOWER, TENNESSEE PURPLE	Echinacea tennesseensis	Plant
COYOTE-THISTLE, LOCH LOMOND	Eryngium constancei	Plant
CROWN-BEARD, BIG-LEAVED	Verbesina dissita	Plant
CROWNSCALE, SAN JACINTO	Atriplex coronata var. notatior	Plant
CYANEA UNDULATA (NCN)	Cyanea undulata	Plant
CYCLADENIA, JONES	Cycladenia jonesii (=humilis)	Plant
CYPRESS, GOWEN	Cupressus goveniana ssp. goveniana	Plant
CYPRESS, SANTA CRUZ	Cupressus abramsiana	Plant
BEDSTRAW, ISLAND	Galium buxifolium	Plant
DAISY, LAKESIDE	Hymenoxys herbacea	Plant
ASTER, FLORIDA GOLDEN	Chrysopsis floridana	Plant
BIRD'S-BEAK, PALMATE-BRACTED	Cordylanthus palmatus	Plant
ROCK-CRESS, MCDONALD'S	Arabis mcdonaldiana	Plant
RUSH-ROSE, ISLAND	Helianthemum greenei	Plant
ROSEROOT, LEEDY'S	Sedum integrifolium ssp. leedyi	Plant
ROSEMARY, SHORT-LEAVED	Conradina brevifolia	Plant
ROSEMARY, ETONIA	Conradina etonia	Plant
ROSEMARY, CUMBERLAND	Conradina verticillata	Plant
ROCK-CRESS, SMALL	Arabis perstellata var perstellata	Plant
SILVERSWORD, MAUNA KEA ('AHINAHINA)	Argyroxiphium sandwicense ssp. sandwicense	Plant
ROCK-CRESS, SANTA CRUZ ISLAND	Sibara filifolia	Plant
SANDWORT, BEAR VALLEY	Arenaria ursina	Plant
ROCK-CRESS, LARGE (=BRAUN'S)	Arabis perstellata	Plant
ROCK-CRESS, HOFFMANN'S	Arabis hoffmannii	Plant
RHODODENDRON, CHAPMAN	Rhododendron chapmanii	Plant
REMYA MONTGOMERYI (NCN)	Remya montgomeryi	Plant
REMYA KAUAIENSIS (NCN)	Remya kauaiensis	Plant
REED-MUSTARD, BARNEBY	Schoenocrambe barnebyi	Plant
RATTLEWEED, HAIRY	Baptisia arachnifera	Plant

ROCK-CRESS, SHALE BARREN	Arabis serotina	Plant
SCHIEDEA SPERGULINA VAR. LEIOPODA (NCN)	Schiedea spergulina var. leiopoda	Plant
PHACELIA, CLAY	Phacelia argillacea	Plant
SILENE LANCEOLATA (NCN)	Silene lanceolata	Plant
SILENE HAWAIIENSIS (NCN)	Silene hawaiiensis	Plant
SEDGE, WHITE	Carex albida	Plant
SEDGE, NAVAJO	Carex specuicola	Plant
SEDGE, GOLDEN	Carex lutea	Plant
SEAGRASS, JOHNSON'S	Halophila johnsonii	Plant
SANDLACE	Polygonella myriophylla	Plant
SCHIEDEA SPERGULINA VAR. SPERGULINA (NCN)	Schiedea spergulina var. spergulina	Plant
SAND-VERBENA, LARGE-FRUITED	Abronia macrocarpa	Plant
SCHIEDEA NUTTALLII (NCN)	Schiedea nuttallii	Plant
SCHIEDEA MEMBRANACEA (NCN)	Schiedea membranacea	Plant
SCHIEDEA KAUAIENSIS (NCN)	Schiedea kauaiensis	Plant
SCHIEDEA HELLERI (NCN)	Schiedea helleri	Plant
SANDWORT, MARSH	Arenaria paludicola	Plant
SANDWORT, CUMBERLAND	Arenaria cumberlandensis	Plant
QUILLWORT, BLACK-SPORED	Isoetes melanospora	Plant
SEA-BLITE, CALIFORNIA	Suaeda californica	Plant
PHYLLOSTEGIA WARSHAUERI (NCN)	Phyllostegia warshaueri	Plant
QUILLWORT, MAT-FORMING	Isoetes tegetiformans	Plant
PLATANTHERA HOLOCHILA (NCN)	Platanthera holochila	Plant
PITCHER-PLANT, MOUNTAIN	Sarracenia rubra ssp. jonesii	Plant
PITCHER-PLANT, GREEN	Sarracenia oreophila	Plant
PITCHER-PLANT, ALABAMA CANEBRAKE	Sarracenia rubra alabamensis	Plant
PIPERIA, YADON'S	Piperia yadonii	Plant
PINKROOT, GENTIAN	Spigelia gentianoides	Plant
POA SIPHONOGLOSSA (NCN)	Poa siphonoglossa	Plant
PHYLLOSTEGIA WAWRANA (NCN)	Phyllostegia wawrana	Plant
PO'E (PORTULACA SCLEROCARPA)	Portulaca sclerocarpa	Plant
PHYLLOSTEGIA WAIMEAE (NCN)	Phyllostegia waimeae	Plant
PHYLLOSTEGIA VELUTINA (NCN)	Phyllostegia velutina	Plant
PHYLLOSTEGIA KNUDSENII (NCN)	Phyllostegia knudsenii	Plant
PHLOX, YREKA	Phlox hirsuta	Plant
PHLOX, TEXAS TRAILING	Phlox nivalis ssp. texensis	Plant
PHACELIA, NORTH PARK	Phacelia formosula	Plant

PHACELIA, ISLAND	Phacelia insularis ssp. insularis	Plant
PINK, SWAMP	Helonias bullata	Plant
POPOLO KU MAI (SOLANUM INCOMPLETUM)	Solanum incompletum	Plant
SKULLCAP, LARGE-FLOWERED	Scutellaria montana	Plant
PU'UKA'A (CYPERUS TRACHYSANTHOS)	Cyperus trachysanthos	Plant
PUSSYPAWS, MARIPOSA	Calyptridium pulchellum	Plant
PRIMROSE, MAGUIRE	Primula maguirei	Plant
PRICKLY-APPLE, FRAGRANT	Cereus eriophorus var. fragrans	Plant
PRAIRIE-CLOVER, LEAFY	Dalea foliosa	Plant
POTENTILLA, HICKMAN'S	Potentilla hickmanii	Plant
PLUM, SCRUB	Prunus geniculata	Plant
POPPY, SACRAMENTO PRICKLY	Argemone pleiacantha ssp. pinnatisecta	Plant
QUILLWORT, LOUISIANA	Isoetes louisianensis	Plant
POPOLO 'AIAKEAKUA (SOLANUM SANDWICENSE)	Solanum sandwicense	Plant
POPCORNFLOWER, ROUGH	Plagiobothrys hirtus	Plant
PONDBERRY	Lindera melissifolia	Plant
MINT, GARRETT'S	Dicerandra christmanii	Plant
POLYGALA, TINY	Polygala smallii	Plant
JEWELFLOWER, CALIFORNIA	Caulanthus californicus	Plant
POGONIA, SMALL WHORLED	Isotria medeoloides	Plant
POTATO-BEAN, PRICE'S	Apios priceana	Plant
UHIUHI (CAESALPINIA KAVAIENSIS)	Caesalpinia kavaiense	Plant
WALLFLOWER, CONTRA COSTA	Erysimum capitatum var. angustatum	Plant
WALLFLOWER, BEN LOMOND	Erysimum teretifolium	Plant
WAHINE NOHO KULA (ISODENDRION PYRIFOLIUM)	Isodendrion pyrifolium	Plant
VIOLA HELENAE (NCN)	Viola helenae	Plant
VIGNA O-WAHUENSIS (NCN)	Vigna o-wahuensis	Plant
VETCH, HAWAIIAN (VICIA	Vicia menziesii	Plant
SILVERSWORD, KA'U (ARGYROXIPHIUM KAUENSE)	Argyroxiphium kauense	Plant
UMBEL, HUACHUCA WATER	Lilaeopsis schaffneriana var. recurva	Plant
WATERCRESS, GAMBEL'S	Rorippa gambellii	Plant
TUCTORIA, GREEN'S	Tuctoria greenei	Plant
TRILLIUM, RELICT	Trillium reliquum	Plant
TRILLIUM, PERSISTENT	Trillium persistens	Plant
TOWNSENDIA, LAST CHANCE	Townsendia aprica	Plant
TORREYA, FLORIDA	Torreya taxifolia	Plant

THORNMINT, SAN MATEO	Acanthomintha obovata ssp. duttonii	Plant
THORNMINT, SAN DIEGO	Acanthomintha ilicifolia	Plant
VERVAIN, CALIFORNIA	Verbena californica	Plant
WILD-BUCKWHEAT, GYPSUM	Eriogonum gypsophilum	Plant
YERBA SANTA, LOMPOC	Eriodictyon capitatum	Plant
YELLOWHEAD, DESERT	Yermo xanthocephalus	Plant
XYLOSMA CRENATUM (NCN)	Xylosma crenatum	Plant
WOOLLY-THREADS, SAN JOAQUIN	Monolopia (=Lembertia) congdonii	Plant
WOOLLY-STAR, SANTA ANA RIVER	Eriastrum densifolium ssp. sanctorum	Plant
WOODLAND-STAR, SAN CLEMENTE ISLAND	Lithophragma maximum	Plant
WIREWEED	Polygonella basiramia	Plant
WALLFLOWER, MENZIE'S	Erysimum menziesii	Plant
WILD-RICE, TEXAS	Zizania texana	Plant
WAREA, WIDE-LEAF	Warea amplexifolia	Plant
WILD-BUCKWHEAT, CLAY-LOVING	Eriogonum pelinophilum	Plant
WHITLOW-WORT, PAPERY	Paronychia chartacea	Plant
WAWAE'IOLE (PHLEGMARIURUS (=LYCOPODIUM) NUTAN	Lycopodium (=Phlegmariurus) nutans	Plant
WAWAE'IOLE (PHLEGMARIURUS (=HUPERZIA) MANNII)	Huperzia mannii	Plant
WATER-WILLOW, COOLEY'S	Justicia cooleyi	Plant
WATER-PLANTAIN, KRAL'S	Sagittaria secundifolia	Plant
THISTLE, PITCHER'S	Cirsium pitcheri	Plant
WINGS, PIGEON	Clitoria fragrans	Plant
SPINEFLOWER, ROBUST	Chorizanthe robusta (incl. vars. robusta and hartwegii)	Plant
THISTLE, SUISUN	Cirsium hydrophilum var. hydrophilum	Plant
SPURGE, TELEPHUS	Euphorbia telephioides	Plant
SPURGE, HOOVER'S	Chamaesyce hooveri	Plant
SPURGE, GARBER'S	Chamaesyce garberi	Plant
SPURGE, DELTOID	Chamaesyce deltoidea ssp. deltoidea	Plant
SPIRAEA, VIRGINIA	Spiraea virginiana	Plant
SPINEFLOWER, SONOMA	Chorizanthe valida	Plant
STENOGYNE CAMPANULATA (NCN)	Stenogyne campanulata	Plant
SPINEFLOWER, SCOTTS VALLEY	Chorizanthe robusta var. hartwegii	Plant
STICKSEED, SHOWY	Hackelia venusta	Plant
SPINEFLOWER, ORCUTT'S	Chorizanthe orcuttiana	Plant
SPINEFLOWER, MONTEREY	Chorizanthe pungens var. pungens	Plant
SPINEFLOWER, HOWELL'S	Chorizanthe howellii	Plant
SPINEFLOWER, BEN LOMOND	Chorizanthe pungens var. hartwegiana	Plant

SPERMOLEPIS HAWAIIENSIS (NCN)	Spermolepis hawaiiensis	Plant
SNEEZEWEED, VIRGINIA	Helenium virginicum	Plant
SNAKEROOT	Eryngium cuneifolium	Plant
SPINEFLOWER, SLENDER-HORNED	Dodecahema leptoceras	Plant
TARAXACUM, CALIFORNIA	Taraxacum californicum	Plant
POLYGALA, LEWTON'S	Polygala lewtonii	Plant
THISTLE, LA GRACIOSA	Cirsium loncholepis	Plant
THISTLE, FOUNTAIN	Cirsium fontinale var. fontinale	Plant
THISTLE, CHORRO CREEK BOG	Cirsium fontinale var. obispoense	Plant
THELYPODY, HOWELL'S SPECTACULAR	Thelypodium howellii spectabilis	Plant
TETRAMOLOPIUM ARENARIUM	Tetramolopium arenarium	Plant
TARPLANT, SANTA CRUZ	Holocarpha macradenia	Plant
STENOGYNE ANGUSTIFOLIA (NCN)	Stenogyne angustifolia var. angustifolia	Plant
TARPLANT, GAVIOTA	Deinandra increscens ssp. villosa	Plant
THISTLE, SACRAMENTO	Cirsium vinaceum	Plant
SUNFLOWER, SCHWEINITZ'S	Helianthus schweinitzii	Plant
SUNFLOWER, SAN MATEO WOOLLY	Eriophyllum latilobum	Plant
SUNFLOWER, PECOS	Helianthus paradoxus	Plant
SUNFLOWER, EGGERT'S	Helianthus eggertii	Plant
SUMAC, MICHAUX'S	Rhus michauxii	Plant
STONECROP, LAKE COUNTY	Parvisedum leiocarpum	Plant
STICKYSEED, BAKER'S	Blennosperma bakeri	Plant
TARPLANT, OTAY	Deinandra (=Hemizonia) conjugens	Plant
MA'O HAU HELE (HIBISCUS BRACKENRIDGEI)	Hibiscus brackenridgei	Plant
LARKSPUR, YELLOW	Delphinium luteum	Plant
PENTACHAETA, WHITE-RAYED	Pentachaeta bellidiflora	Plant
LARKSPUR, SAN CLEMENTE ISLAND	Delphinium variegatum ssp. kinkiense	Plant
POLYGONUM, SCOTT'S VALLEY	Polygonum hickmanii	Plant
MARISCUS PENNATIFORMIS (NCN)	Mariscus pennatiformis	Plant
MARISCUS FAURIEI (NCN)	Mariscus fauriei	Plant
LADIES'-TRESSES, UTE	Spiranthes diluvialis	Plant
MA'OLI'OLI (SCHIEDEA	Schiedea apokremnos	Plant
LADIES'-TRESSES, NAVASOTA	Spiranthes parksii	Plant
MANZANITA, SANTA ROSA ISLAND	Arctostaphylos confertiflora	Plant
MANZANITA, PRESIDIO (=RAVEN'S)	Arctostaphylos hookeri var. ravenii	Plant
MANZANITA, PALLID	Arctostaphylos pallida	Plant
MANZANITA, MORRO	Arctostaphylos morroensis	Plant
MANZANITA, IONE	Arctostaphylos myrtifolia	Plant

MANZANITA, DEL MAR	Arctostaphylos glandulosa ssp. crassifolia	Plant
MILK-VETCH, CUSHENBURY	Astragalus albens	Plant
MAPELE (CYRTANDRA	Cyrtandra cyaneoides	Plant
MEADOWFOAM, LARGE-FLOWERED WOOLY	Limnanthes floccosa grandiflora	Plant
MILK-VETCH, COASTAL DUNES	Astragalus tener var. titi	Plant
MILK-VETCH, COACHELLA VALLEY	Astragalus lentiginosus var. coachellae	Plant
MILK-VETCH, CLARA HUNT'S	Astragalus clarianus	Plant
MILK-VETCH, BRAUNTON'S	Astragalus brauntonii	Plant
MILKPEA, SMALL'S	Galactia smallii	Plant
MEHAMEHAME (FLUEGGEA NEOWAWRAEA)	Flueggea neowawraea	Plant
LARKSPUR, BAKER'S	Delphinium bakeri	Plant
MEADOWFOAM, SEBASTOPOL	Limnanthes vinculans	Plant
MALLOW, KERN	Eremalche kernensis	Plant
KIPONAPONA (PHYLLOSTEGIA RACEMOSA)	Phyllostegia racemosa	Plant
LAUKAHI KUAHIWI (PLANTAGO PRINCEPS)	Plantago princeps	Plant
KOKI'O (KOKIA KAUAIENSIS)	Kokia kauaiensis	Plant
KOKI'O KE'OKE'O (HIBISCUS WAIMEAE SSP. HANNER	Hibiscus waimeae ssp. hannerae	Plant
KOLEA (MYRSINE LINEARIFOLIA)	Myrsine linearifolia	Plant
KO'OLOA'ULA (ABUTILON	Abutilon menziesii	Plant
KUAWAWAENOHU (ALSINIDENDRON LYCHNOIDES)	Alsinidendron lychnoides	Plant
MEADOWRUE, COOLEY'S	Thalictrum cooleyi	Plant
LILY, MINNESOTA TROUT	Erythronium propullans	Plant
MANIOC, WALKER'S	Manihot walkerae	Plant
LIVEFOREVER, LAGUNA BEACH	Dudleya stolonifera	Plant
LIPOCHAETA VENOSA (NCN)	Lipochaeta venosa	Plant
LAU'EHU (PANICUM NIIHAUENSE)	Panicum niihauense	Plant
LAUKAHI KUAHIWI (PLANTAGO HAWAIENSIS)	Plantago hawaiensis	Plant
LILY, WESTERN	Lilium occidentale	Plant
LOBELIA NIIHAUENSIS (NCN)	Lobelia niihauensis	Plant
LILY, PITKIN MARSH	Lilium pardalinum ssp. pitkinense	Plant
LOCOWEED, FASSETT'S	Oxytropis campestris var. chartacea	Plant
LICHEN, ROCK GNOME	Gymnoderma lineare	Plant
LESSINGIA, SAN FRANCISCO	Lessingia germanorum (=L.g. var. germanorum)	Plant
LEATHER-FLOWER, MOREFIELD'S	Clematis morefieldii	Plant

LEATHER-FLOWER, ALABAMA	Clematis socialis	Plant
LEAD-PLANT, CRENULATE	Amorpha crenulata	Plant
LAYIA, BEACH	Layia carnosa	Plant
LAULIHILIHI (SCHIEDEA STELLARIOIDES)	Schiedea stellarioides	Plant
LILY, TIBURON MARIPOSA	Calochortus tiburonensis	Plant
LOUSEWORT, FURBISH	Pedicularis furbishiae	Plant
MALACOTHRIX, SANTA CRUZ	Malacothrix indecora	Plant
MALACOTHRIX, ISLAND	Malacothrix squalida	Plant
MAKOU (PEUCEDANUM SANDWICENSE)	Peucedanum sandwicense	Plant
MAHOE (ALECTRYON MACROCOCCUS)	Alectryon macrococcus	Plant
LYSIMACHIA FILIFOLIA (NCN)	Lysimachia filifolia	Plant
LUPINE, SCRUB	Lupinus aridorum	Plant
LIVEFOREVER, SANTA BARBARA ISLAND	Dudleya traskiae	Plant
LUPINE, CLOVER	Lupinus tidestromii	Plant
MEADOWFOAM, BUTTE COUNTY	Limnanthes floccosa ssp. californica	Plant
LOULU (PRITCHARDIA VISCOSA)	Pritchardia viscosa	Plant
LOULU (PRITCHARDIA	Pritchardia schattaueri	Plant
LOULU (PRITCHARDIA	Pritchardia napaliensis	Plant
LOULU (PRITCHARDIA AFFINIS)	Pritchardia affinis	Plant
LOOSESTRIFE, ROUGH-LEAVED	Lysimachia asperulaefolia	Plant
LOMATIUM, COOK'S	Lomatium cookii	Plant
LOMATIUM, BRADSHAW'S	Lomatium bradshawii	Plant
LUPINE, NIPOMO MESA	Lupinus nipomensis	Plant
NEHE (LIPOCHAETA MICRANTHA)	Lipochaeta micrantha	Plant
MUNROIDENDRON RACEMOSUM (NCN)	Munroidendron racemosum	Plant
'OHA WAI (CLERMONTIA LINDSEYANA)	Clermontia lindseyana	Plant
'OHA WAI (CLERMONTIA DREPANOMORPHA)	Clermontia drepanomorpha	Plant
'OHA (DELISSEA UNDULATA)	Delissea undulata	Plant
'OHA (DELISSEA RIVULARIS)	Delissea rivularis	Plant
NOHOANU (GERANIUM MULTIFLORUM)	Geranium multiflorum	Plant
NERAUDIA SERICEA (NCN)	Neraudia sericea	Plant
'OHA WAI (CLERMONTIA	Clermontia pyrularia	Plant
NEHE (LIPOCHAETA WAIMEAENSIS)	Lipochaeta waimeaensis	Plant
'OHAI (SESBANIA TOMENTOSA)	Sesbania tomentosa	Plant

KOKI'O (KOKIA DRYNARIOIDES)	Kokia drynarioides	Plant
NAVARRETIA, SPREADING	Navarretia fossalis	Plant
MILK-VETCH, DESERET	Astragalus desereticus	Plant
NAVARRETIA, FEW-FLOWERED	Navarretia leucocephala ssp. pauciflora (=N. pauciflora)	Plant
NANI WAI'ALE'ALE (VIOLA KAUAENSIS VAR. WAHIAW	Viola kauaiensis var. wahiawaensis	Plant
MUSTARD, SLENDER-PETALED	Thelypodium stenopetalum	Plant
JEWELFLOWER, TIBURON	Streptanthus niger	Plant
MUSTARD, CARTER'S	Warea carteri	Plant
NERAUDIA OVATA (NCN)	Neraudia ovata	Plant
PAINTBRUSH, SAN CLEMENTE ISLAND INDIAN	Castilleja grisea	Plant
PENSTEMON, BLOWOUT	Penstemon haydenii	Plant
PENNYROYAL, TODSEN'S	Hedeoma todsenii	Plant
PENNY-CRESS, KNEELAND PRAIRIE	Thlaspi californicum	Plant
JEWELFLOWER, METCALF CANYON	Streptanthus albidus ssp. albidus	Plant
PAWPAW, RUGEL'S	Deeringothamnus rugelii	Plant
PAWPAW, FOUR-PETAL	Asimina tetramera	Plant
PAWPAW, BEAUTIFUL	Deeringothamnus pulchellus	Plant
'OHA WAI (CLERMONTIA PELEANA)	Clermontia peleana	Plant
PAINTBRUSH, SOFT-LEAVED	Castilleja mollis	Plant
NAVARRETIA, MANY-FLOWERED	Navarretia leucocephala ssp. plieantha	Plant
PAINTBRUSH, GOLDEN	Castilleja levisecta	Plant
PAINTBRUSH, ASH-GREY INDIAN	Castilleja cinerea	Plant
OXYTHECA, CUSHENBURY	Oxytheca parishii var. goodmaniana	Plant
OWL'S-CLOVER, FLESHY	Castilleja campestris ssp. succulenta	Plant
ORCHID, WESTERN PRAIRIE	Platanthera praeclara	Plant
ORCHID, EASTERN PRAIRIE	Platanthera leucophaea	Plant
ONION, MUNZ'S	Allium munzii	Plant
'OLULU (BRIGHAMIA INSIGNIS)	Brighamia insignis	Plant
PAINTBRUSH, TIBURON	Castilleja affinis ssp. neglecta	Plant
KIO'ELE (HEDYOTIS CORIACEA)	Hedyotis coriacea	Plant
KAMAKAHALA (LABORDIA TINIFOLIA VAR. WAHIAWAEN	Labordia tinifolia var. wahiawaensis	Plant
KAUILA (COLUBRINA	Colubrina oppositifolia	Plant
KAULU (PTERALYXIA KAUAIENSIS)	Pteralyxia kauaiensis	Plant
MINT, LAKELA'S	Dicerandra immaculata	Plant
ACHYRANTHES MUTICA (NCN)	Achyranthes mutica	Plant
MOUNTAIN-MAHOGANY, CATALINA ISLAND	Cercocarpus traskiae	Plant

MILK-VETCH, VENTURA MARSH	Astragalus pycnostachyus var.	Plant
ZIZIPHUS, FLORIDA	Ziziphus celata	Plant
MILK-VETCH, TRIPLE-RIBBED	Astragalus tricarinatus	Plant
MILKWEED, MEAD'S	Asclepias meadii	Plant
MILK-VETCH, SHIVWITS	Astragalus ampullarioides	Plant
MILK-VETCH, PIERSON'S	Astragalus magdalenae var. peirsonii	Plant
MILK-VETCH, MANCOS	Astragalus humillimus	Plant
MILK-VETCH, LANE MOUNTAIN	Astragalus jaegerianus	Plant
MILK-VETCH, JESUP'S	Astragalus robbinsii var. jesupi	Plant
MILK-VETCH, HOLMGREN	Astragalus holmgreniorum	Plant
MILK-VETCH, HELIOTROPE	Astragalus montii	Plant
MILK-VETCH, FISH SLOUGH	Astragalus lentiginosus var. piscinensis	Plant
NEHE (LIPOCHAETA FAURIEI)	Lipochaeta fauriei	Plant
KAMAKAHALA (LABORDIA LYDGATEI)	Labordia lydgatei	Plant
MOUNTAINBALM, INDIAN KNOB	Eriodictyon altissimum	Plant
MORNING-GLORY, STEBBINS	Calystegia stebbinsii	Plant
MONKSHOOD, NORTHERN WILD	Aconitum noveboracense	Plant
JOINT-VETCH, SENSITIVE	Aeschynomene virginica	Plant
MONKEY-FLOWER, MICHIGAN	Mimulus glabratus var. michiganensis	Plant
MINT, LONGSPURRED	Dicerandra cornutissima	Plant
MINT, OTAY MESA	Pogogyne nudiuscula	Plant
MINT, SAN DIEGO MESA	Pogogyne abramsii	Plant
MINT, SCRUB	Dicerandra frutescens	Plant
MONARDELLA, WILLOWY	Monardella linoides ssp. viminea	Plant
TURTLE, RINGED SAWBACK	Graptemys oculifera	Reptile
TURTLE, GREEN SEA	Chelonia mydas	Reptile
TURTLE, HAWKSBILL SEA	Eretmochelys imbricata	Reptile
TURTLE, KEMP'S (ATLANTIC) RIDLEY SEA	Lepidochelys kempii	Reptile
TURTLE, LEATHERBACK SEA	Dermochelys coriacea	Reptile
TURTLE, LOGGERHEAD SEA	Caretta caretta	Reptile
CROCODILE, AMERICAN	Crocodylus acutus	Reptile
TURTLE, PLYMOUTH RED-BELLIED	Pseudemys rubriventris bangsi	Reptile
TURTLE, ALABAMA RED-BELLIED	Pseudemys alabamensis	Reptile
TURTLE, YELLOW-BLOTCHED MAP	Graptemys flavimaculata	Reptile
WHIPSNAKE (=striped racer),	Masticophis lateralis euryxanthus	Reptile
RATTLESNAKE, NEW MEXICAN RIDGE-NOSED	Crotalus willardi obscurus	Reptile
TURTLE, OLIVE (PACIFIC) RIDLEY	Lepidochelys olivacea	Reptile

SNAKE, NORTHERN COPPERBELLY WATER	Nerodia erythrogaster neglecta	Reptile
LIZARD, COACHELLA VALLEY FRINGE-TOED	Uma inornata	Reptile
SNAKE, EASTERN INDIGO	Drymarchon corais couperi	Reptile
SNAKE, GIANT GARTER	Thamnophis gigas	Reptile
SNAKE, LAKE ERIE WATER	Nerodia sipedon insularum	Reptile
SNAKE, ATLANTIC SALT MARSH	Nerodia clarkii taeniata	Reptile
SKINK, BLUE-TAILED MOLE	Eumeces egregius lividus	Reptile
TURTLE, FLATTENED MUSK	Sternotherus depressus	Reptile
SNAKE, SAN FRANCISCO GARTER	Thamnophis sirtalis tetrataenia	Reptile
TORTOISE, DESERT	Gopherus agassizii	Reptile
TORTOISE, GOPHER	Gopherus polyphemus	Reptile
SNAKE, CONCHO WATER	Nerodia paucimaculata	Reptile
LIZARD, BLUNT-NOSED LEOPARD	Gambelia silus	Reptile
LIZARD, ISLAND NIGHT	Xantusia riversiana	Reptile
SKINK, SAND	Neoseps reynoldsi	Reptile
AMBERSNAIL, KANAB	Oxyloma haydeni kanabensis	Snail
SNAIL, IOWA PLEISTOCENE	Discus macclintocki	Snail
PEBBLESNAIL, FLAT	Lepyrium showalteri	Snail
CAVESNAIL, TUMBLING CREEK	Antrobia culveri	Snail
CAMPELOMA, SLENDER	Campeloma decampi	Snail
RIVERSNAIL, ANTHONY'S	Athearnia anthonyi	Snail
ROCKSNAIL, PAINTED	Leptoxis taeniata	Snail
ROCKSNAIL, PLICATE	Leptoxis plicata	Snail
ROCKSNAIL, ROUND	Leptoxis ampla	Snail
ELIMIA, LACY	Elimia crenatella	Snail
SNAIL, ARMORED	Pyrgulopsis (=Marstonia) pachyta	Snail
SNAIL, BLISS RAPIDS	Taylorconcha serpenticola	Snail
SNAIL, VIRGINIA FRINGED	Polygyriscus virginianus	Snail
SNAIL, FLAT-SPIRED	Triodopsis platysayoides	Snail
LIMPET, BANBURY SPRINGS	Lanx sp.	Snail
SNAIL, MORRO SHOULDERBAND	Helminthoglypta walkeriana	Snail
SNAIL, NEWCOMB'S	Erinna newcombi	Snail
SNAIL, NOONDAY	Mesodon clarki nantahala	Snail
SNAIL, PAINTED SNAKE COILED FOREST	Anguispira picta	Snail
SNAIL, SNAKE RIVER PHYSA	Physa natricina	Snail
SNAIL, TULOTOMA	Tulotoma magnifica	Snail
SNAIL, UTAH VALVATA	Valvata utahensis	Snail

SPRINGSNAIL, BRUNEAU HOT	Pyrgulopsis bruneauensis	Snail
SPRINGSNAIL, IDAHO	Fontelicella idahoensis	Snail
LIOPLAX, CYLINDRICAL	Lioplax cyclostomaformis	Snail
SNAIL, CHITTENANGO OVATE	Succinea chittenangoensis	Snail

No species were excluded.

Species Listing by State for Crop

Carrots (30)

Minimum of 1 Acre

California

County		Status	County presence
Butte (1073338 Acres)			
Bird			
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
Crustacean			
SHRIMP, CONSERVANCY FAIRY	*Branchinecta conservatio*	Endangered	known
SHRIMP, VERNAL POOL FAIRY	*Branchinecta lynchi*	Threatened	known
SHRIMP, VERNAL POOL TADPOLE	*Lepidurus packardi*	Endangered	known
Fish			
SALMON, CHINOOK (CENTRAL VALLEY SPRING RUN)	*Oncorhynchus (=Salmo) tshawytscha*	Threatened	known
SALMON, CHINOOK (SACRAMENTO RIVER WINTER RUN)	*Oncorhynchus (=Salmo) tshawytscha*	Endangered	known
STEELHEAD, CALIFORNIA CENTRAL VALLEY POP	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
Insect			
BEETLE, VALLEY ELDERBERRY LONGHORN	*Desmocerus californicus dimorphus*	Threatened	known
Plant			
GRASS, HAIRY ORCUTT	*Orcuttia pilosa*	Endangered	known
GRASS, SLENDER ORCUTT	*Orcuttia tenuis*	Threatened	known
MEADOWFOAM, BUTTE COUNTY	*Limnanthes floccosa ssp. californica*	Endangered	known
SPURGE, HOOVER'S	*Chamaesyce hooveri*	Threatened	known
TUCTORIA, GREEN'S	*Tuctoria greenei*	Endangered	known
Reptile			
SNAKE, GIANT GARTER	*Thamnophis gigas*	Threatened	known
Fresno (3851096 Acres)			
Amphibian			
SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	
Bird			
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
Crustacean			
SHRIMP, VERNAL POOL FAIRY	*Branchinecta lynchi*	Threatened	known

California

County		Status	County presence
Fresno (3851096 Acres)			
SHRIMP, VERNAL POOL TADPOLE	*Lepidurus packardi*	Endangered	known
Fish			
TROUT, LITTLE KERN GOLDEN	*Oncorhynchus aguabonita whitei*	Threatened	possible
TROUT, PAIUTE CUTTHROAT	*Oncorhynchus clarki seleniris*	Threatened	possible
Insect			
BEETLE, VALLEY ELDERBERRY LONGHORN	*Desmocerus californicus dimorphus*	Threatened	known
Mammal			
FOX, SAN JOAQUIN KIT	*Vulpes macrotis mutica*	Endangered	known
KANGAROO RAT, FRESNO	*Dipodomys nitratoides exilis*	Endangered	known
KANGAROO RAT, GIANT	*Dipodomys ingens*	Endangered	known
Plant			
ADOBE SUNBURST, SAN JOAQUIN	*Pseudobahia peirsonii*	Endangered	known
BIRD'S-BEAK, PALMATE-BRACTED	*Cordylanthus palmatus*	Endangered	known
CHECKER-MALLOW, KECK'S	*Sidalcea keckii*	Endangered	known
DUDLEYA, SANTA CLARA VALLEY	*Dudleya setchellii*	Endangered	possible
GOLDEN SUNBURST, HARTWEG'S	*Pseudobahia bahiifolia*	Endangered	known
GRASS, SAN JOAQUIN VALLEY ORCUTT	*Orcuttia inaequalis*	Threatened	known
JEWELFLOWER, CALIFORNIA	*Caulanthus californicus*	Endangered	known
OWL'S-CLOVER, FLESHY	*Castilleja campestris ssp. succulenta*	Endangered	known
PUSSYPAWS, MARIPOSA	*Calyptridium pulchellum*	Threatened	known
WOOLLY-THREADS, SAN JOAQUIN	*Monolopia (=Lembertia) congdonii*	Endangered	known
Reptile			
LIZARD, BLUNT-NOSED LEOPARD	*Gambelia silus*	Endangered	known
SNAKE, GIANT GARTER	*Thamnophis gigas*	Threatened	known
Humboldt (2293507 Acres)			
Bird			
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
MURRELET, MARBLED	*Brachyramphus marmoratus marmoratus*	Threatened	known
OWL, NORTHERN SPOTTED	*Strix occidentalis caurina*	Threatened	known
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
Fish			
GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known

California

County		Status	County presence

Humboldt (2293507 Acres)

SALMON, CHINOOK (CALIFORNIA COASTAL ESU)	*Oncorhynchus (=Salmo) tshawytscha*	Threatened	known
SALMON, COHO (SOUTHERN OR/NORTHERN CA COAST)	*Oncorhynchus (=Salmo) kisutch*	Threatened	known
STEELHEAD, NORTHERN CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Threatened	known

Plant

LAYIA, BEACH	*Layia carnosa*	Endangered	known
LILY, WESTERN	*Lilium occidentale*	Endangered	known
PENNY-CRESS, KNEELAND PRAIRIE	*Thlaspi californicum*	Endangered	known
WALLFLOWER, MENZIE'S	*Erysimum menziesii*	Endangered	known

Reptile

TURTLE, OLIVE (PACIFIC) RIDLEY SEA	*Lepidochelys olivacea*	Endangered	known

Imperial (2868255 Acres)

Amphibian

TOAD, ARROYO SOUTHWESTERN	*Bufo californicus (=microscaphus)*	Endangered	known

Bird

EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
RAIL, YUMA CLAPPER	*Rallus longirostris yumanensis*	Endangered	known

Fish

CHUB, BONYTAIL	*Gila elegans*	Endangered	possible
PUPFISH, DESERT	*Cyprinodon macularius*	Endangered	known
SQUAWFISH, COLORADO	*Ptychocheilus lucius*	Endangered	possible
SUCKER, RAZORBACK	*Xyrauchen texanus*	Endangered	known

Plant

MILK-VETCH, PIERSON'S	*Astragalus magdalenae var. peirsonii*	Threatened	known

Reptile

TORTOISE, DESERT	*Gopherus agassizii*	Threatened	known

Kern (5223304 Acres)

Amphibian

SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	

Bird

CONDOR, CALIFORNIA	*Gymnogyps californianus*	Endangered	possible

Kern (5223304 Acres)

		Status	County presence
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
FLYCATCHER, SOUTHWESTERN WILLOW	*Empidonax traillii extimus*	Endangered	known
VIREO, LEAST BELL'S	*Vireo bellii pusillus*	Endangered	known
Crustacean			
SHRIMP, LONGHORN FAIRY	*Branchinecta longiantenna*	Endangered	possible
Insect			
MOTH, KERN PRIMROSE SPHINX	*Euproserpinus euterpe*	Threatened	known
Mammal			
FOX, SAN JOAQUIN KIT	*Vulpes macrotis mutica*	Endangered	known
KANGAROO RAT, GIANT	*Dipodomys ingens*	Endangered	known
KANGAROO RAT, TIPTON	*Dipodomys nitratoides nitratoides*	Endangered	known
SHREW, BUENA VISTA	*Sorex ornatus relictus*	Endangered	known
Plant			
CACTUS, BAKERSFIELD	*Opuntia treleasei*	Endangered	known
JEWELFLOWER, CALIFORNIA	*Caulanthus californicus*	Endangered	known
MALLOW, KERN	*Eremalche kernensis*	Endangered	known
WOOLLY-THREADS, SAN JOAQUIN	*Monolopia (=Lembertia) congdonii*	Endangered	known
Reptile			
LIZARD, BLUNT-NOSED LEOPARD	*Gambelia silus*	Endangered	known
TORTOISE, DESERT	*Gopherus agassizii*	Threatened	known

Mendocino (2246796 Acres)

		Status	County presence
Bird			
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
MURRELET, MARBLED	*Brachyramphus marmoratus marmoratus*	Threatened	known
OWL, NORTHERN SPOTTED	*Strix occidentalis caurina*	Threatened	known
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
Fish			
GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known
SALMON, CHINOOK (CALIFORNIA COASTAL ESU)	*Oncorhynchus (=Salmo) tshawytscha*	Threatened	known
SALMON, COHO (CENTRAL CALIFORNIA COAST POP)	*Oncorhynchus (=Salmo) kisutch*	Threatened	known
SALMON, COHO (SOUTHERN OR/NORTHERN CA COAST)	*Oncorhynchus (=Salmo) kisutch*	Threatened	known

Mendocino (2246796 Acres)

STEELHEAD, CENTRAL CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
STEELHEAD, NORTHERN CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Threatened	known

Insect

BUTTERFLY, BEHREN'S SILVERSPOT	*Speyeria zerene behrensii*	Endangered	known
BUTTERFLY, LOTIS BLUE	*Lycaeides argyrognomon lotis*	Endangered	known

Mammal

MOUNTAIN BEAVER, POINT ARENA	*Aplodontia rufa nigra*	Endangered	known

Plant

GOLDFIELDS, BURKE'S	*Lasthenia burkei*	Endangered	known
GOLDFIELDS, CONTRA COSTA	*Lasthenia conjugens*	Endangered	known
NAVARRETIA, FEW-FLOWERED	*Navarretia leucocephala ssp. pauciflora (=N. pauciflora)*	Endangered	possible
NAVARRETIA, MANY-FLOWERED	*Navarretia leucocephala ssp. plieantha*	Endangered	possible
ROCK-CRESS, MCDONALD'S	*Arabis mcdonaldiana*	Endangered	known
SPINEFLOWER, HOWELL'S	*Chorizanthe howellii*	Endangered	possible
STONECROP, LAKE COUNTY	*Parvisedum leiocarpum*	Endangered	possible
WALLFLOWER, MENZIE'S	*Erysimum menziesii*	Endangered	known

Reptile

TURTLE, OLIVE (PACIFIC) RIDLEY SEA	*Lepidochelys olivacea*	Endangered	known

Monterey (2119466 Acres)

Amphibian

FROG, CALIFORNIA RED-LEGGED	*Rana aurora draytonii*	Threatened	
SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	
SALAMANDER, SANTA CRUZ LONG-TOED	*Ambystoma macrodactylum croceum*	Endangered	known

Bird

CONDOR, CALIFORNIA	*Gymnogyps californianus*	Endangered	possible
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
MURRELET, MARBLED	*Brachyramphus marmoratus marmoratus*	Threatened	possible
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
RAIL, CALIFORNIA CLAPPER	*Rallus longirostris obsoletus*	Endangered	possible
TERN, CALIFORNIA LEAST	*Sterna antillarum browni*	Endangered	possible
VIREO, LEAST BELL'S	*Vireo bellii pusillus*	Endangered	possible

Monterey (2119466 Acres)

Crustacean

SHRIMP, LONGHORN FAIRY	*Branchinecta longiantenna*	Endangered	possible
SHRIMP, VERNAL POOL FAIRY	*Branchinecta lynchi*	Threatened	known

Fish

GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known
STEELHEAD, SOUTH-CENTRAL CALIFORNIA POP	*Oncorhynchus (=Salmo) mykiss*	Threatened	known

Insect

BUTTERFLY, SMITH'S BLUE	*Euphilotes enoptes smithi*	Endangered	known

Mammal

FOX, SAN JOAQUIN KIT	*Vulpes macrotis mutica*	Endangered	known
KANGAROO RAT, GIANT	*Dipodomys ingens*	Endangered	possible
OTTER, SOUTHERN SEA	*Enhydra lutris nereis*	Threatened	known

Plant

AMOLE, PURPLE	*Chlorogalum purpureum var. purpureum*	Threatened	known
CLOVER, MONTEREY	*Trifolium trichocalyx*	Endangered	known
CYPRESS, GOWEN	*Cupressus goveniana ssp. goveniana*	Threatened	known
DUDLEYA, SANTA CLARA VALLEY	*Dudleya setchellii*	Endangered	possible
GILIA, MONTEREY	*Gilia tenuiflora ssp. arenaria*	Endangered	possible
GOLDFIELDS, CONTRA COSTA	*Lasthenia conjugens*	Endangered	known
LAYIA, BEACH	*Layia carnosa*	Endangered	known
LUPINE, CLOVER	*Lupinus tidestromii*	Endangered	known
MILK-VETCH, COASTAL DUNES	*Astragalus tener var. titi*	Endangered	known
PIPERIA, YADON'S	*Piperia yadonii*	Endangered	known
POTENTILLA, HICKMAN'S	*Potentilla hickmanii*	Endangered	known
SPINEFLOWER, MONTEREY	*Chorizanthe pungens var. pungens*	Threatened	known
SPINEFLOWER, ROBUST	*Chorizanthe robusta (incl. vars. robusta and hartwegii)*	Endangered	known
TARPLANT, SANTA CRUZ	*Holocarpha macradenia*	Threatened	known
WALLFLOWER, MENZIE'S	*Erysimum menziesii*	Endangered	known

Reptile

TURTLE, OLIVE (PACIFIC) RIDLEY SEA	*Lepidochelys olivacea*	Endangered	known

Orange (510248 Acres)

Amphibian

TOAD, ARROYO SOUTHWESTERN	*Bufo californicus (=microscaphus)*	Endangered	known

California

County | Status | County presence

Orange (510248 Acres)

Bird

GNATCATCHER, COASTAL CALIFORNIA	*Polioptila californica californica*	Threatened	known
MURRELET, MARBLED	*Brachyramphus marmoratus marmoratus*	Threatened	possible
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
RAIL, LIGHT-FOOTED CLAPPER	*Rallus longirostris levipes*	Endangered	known
TERN, CALIFORNIA LEAST	*Sterna antillarum browni*	Endangered	known
VIREO, LEAST BELL'S	*Vireo bellii pusillus*	Endangered	possible

Crustacean

SHRIMP, RIVERSIDE FAIRY	*Streptocephalus woottoni*	Endangered	known

Fish

GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known
STEELHEAD, SOUTHERN CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Endangered	possible
SUCKER, SANTA ANA	*Catostomus santaanae*	Threatened	known

Mammal

MOUSE, PACIFIC POCKET	*Perognathus longimembris pacificus*	Endangered	known

Plant

BACCHARIS, ENCINITAS	*Baccharis vanessae*	Threatened	known
BIRD'S-BEAK, SALT MARSH	*Cordylanthus maritimus ssp. maritimus*	Endangered	known
BRODIAEA, THREAD-LEAVED	*Brodiaea filifolia*	Threatened	known
CROWN-BEARD, BIG-LEAVED	*Verbesina dissita*	Threatened	known
DUDLEYA, MARCESCENT	*Dudleya cymosa ssp. marcescens*	Threatened	possible
DUDLEYA, SANTA MONICA MOUNTAINS	*Dudleya cymosa ssp. ovatifolia*	Threatened	known
LIVEFOREVER, LAGUNA BEACH	*Dudleya stolonifera*	Threatened	known
MANZANITA, DEL MAR	*Arctostaphylos glandulosa ssp. crassifolia*	Endangered	known
MILK-VETCH, BRAUNTON'S	*Astragalus brauntonii*	Endangered	known
SPINEFLOWER, ORCUTT'S	*Chorizanthe orcuttiana*	Endangered	known
WOOLLY-STAR, SANTA ANA RIVER	*Eriastrum densifolium ssp. sanctorum*	Endangered	known

Riverside (4674085 Acres)

Amphibian

FROG, MOUNTAIN YELLOW-LEGGED	*Rana muscosa*	Endangered	known
SALAMANDER, DESERT SLENDER	*Batrachoseps aridus*	Endangered	known
TOAD, ARROYO SOUTHWESTERN	*Bufo californicus (=microscaphus)*	Endangered	known

Riverside (4674085 Acres)

Bird

EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
FLYCATCHER, SOUTHWESTERN WILLOW	*Empidonax traillii extimus*	Endangered	known
GNATCATCHER, COASTAL CALIFORNIA	*Polioptila californica californica*	Threatened	known
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
RAIL, YUMA CLAPPER	*Rallus longirostris yumanensis*	Endangered	known
VIREO, LEAST BELL'S	*Vireo bellii pusillus*	Endangered	known

Crustacean

SHRIMP, RIVERSIDE FAIRY	*Streptocephalus woottoni*	Endangered	known
SHRIMP, VERNAL POOL FAIRY	*Branchinecta lynchi*	Threatened	known

Fish

CHUB, BONYTAIL	*Gila elegans*	Endangered	possible
PUPFISH, DESERT	*Cyprinodon macularius*	Endangered	known
SQUAWFISH, COLORADO	*Ptychocheilus lucius*	Endangered	possible
SUCKER, RAZORBACK	*Xyrauchen texanus*	Endangered	known
SUCKER, SANTA ANA	*Catostomus santaanae*	Threatened	known

Insect

BUTTERFLY, QUINO CHECKERSPOT	*Euphydryas editha quino (=E. e. wrighti)*	Endangered	possible
FLY, DELHI SANDS FLOWER-LOVING	*Rhaphiomidas terminatus abdominalis*	Endangered	known

Mammal

KANGAROO RAT, SAN BERNARDINO	*Dipodomys merriami parvus*	Endangered	known
KANGAROO RAT, STEPHENS'	*Dipodomys stephensi (incl. D. cascus)*	Threatened	known
SHEEP, PENINSULAR BIGHORN	*Ovis canadensis*	Threatened	known

Plant

AMBROSIA, SAN DIEGO	*Ambrosia pumila*	Endangered	known
BARBERRY, NEVIN'S	*Berberis nevinii*	Endangered	known
BRODIAEA, THREAD-LEAVED	*Brodiaea filifolia*	Threatened	known
BUTTON-CELERY, SAN DIEGO	*Eryngium aristulatum var. parishii*	Endangered	known
CEANOTHUS, VAIL LAKE	*Ceanothus ophiochilus*	Threatened	known
CROWNSCALE, SAN JACINTO VALLEY	*Atriplex coronata var. notatior*	Endangered	known
DAISY, PARISH'S	*Erigeron parishii*	Threatened	known
GRASS, CALIFORNIA ORCUTT	*Orcuttia californica*	Endangered	known
MILK-VETCH, COACHELLA VALLEY	*Astragalus lentiginosus var. coachellae*	Endangered	known
MILK-VETCH, TRIPLE-RIBBED	*Astragalus tricarinatus*	Endangered	known

		Status	County presence
Riverside (4674085 Acres)			
MINT, OTAY MESA	*Pogogyne nudiuscula*	Endangered	known
NAVARRETIA, SPREADING	*Navarretia fossalis*	Threatened	known
ONION, MUNZ'S	*Allium munzii*	Endangered	known
SPINEFLOWER, SLENDER-HORNED	*Dodecahema leptoceras*	Endangered	known
WOOLLY-STAR, SANTA ANA RIVER	*Eriastrum densifolium ssp. sanctorum*	Endangered	known
Reptile			
LIZARD, COACHELLA VALLEY FRINGE-TOED	*Uma inornata*	Threatened	known
TORTOISE, DESERT	*Gopherus agassizii*	Threatened	known
San Bernardino (1.28675E+07			
Amphibian			
FROG, MOUNTAIN YELLOW-LEGGED	*Rana muscosa*	Endangered	known
SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	
TOAD, ARROYO SOUTHWESTERN	*Bufo californicus (=microscaphus)*	Endangered	known
Bird			
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
FLYCATCHER, SOUTHWESTERN WILLOW	*Empidonax traillii extimus*	Endangered	known
GNATCATCHER, COASTAL CALIFORNIA	*Polioptila californica californica*	Threatened	known
RAIL, YUMA CLAPPER	*Rallus longirostris yumanensis*	Endangered	known
VIREO, LEAST BELL'S	*Vireo bellii pusillus*	Endangered	known
Fish			
CHUB, BONYTAIL	*Gila elegans*	Endangered	known
CHUB, MOHAVE TUI	*Gila bicolor mohavensis*	Endangered	known
PUPFISH, DESERT	*Cyprinodon macularius*	Endangered	possible
SQUAWFISH, COLORADO	*Ptychocheilus lucius*	Endangered	possible
STICKLEBACK, UNARMORED THREESPINE	*Gasterosteus aculeatus williamsoni*	Endangered	known
SUCKER, RAZORBACK	*Xyrauchen texanus*	Endangered	known
SUCKER, SANTA ANA	*Catostomus santaanae*	Threatened	possible
Insect			
FLY, DELHI SANDS FLOWER-LOVING	*Rhaphiomidas terminatus abdominalis*	Endangered	known
Mammal			
KANGAROO RAT, SAN BERNARDINO	*Dipodomys merriami parvus*	Endangered	known
KANGAROO RAT, STEPHENS'	*Dipodomys stephensi (incl. D. cascus)*	Threatened	possible
VOLE, AMARGOSA	*Microtus californicus scirpensis*	Endangered	known

California

County | | Status | County presence

San Bernardino (1.28675E+07

Plant

BLADDERPOD, SAN BERNARDINO MOUNTAINS	*Lesquerella kingii ssp. bernardina*	Endangered	known
BLUECURLS, HIDDEN LAKE	*Trichostema austromontanum ssp. compactum*	Threatened	known
BLUEGRASS, SAN BERNARDINO	*Poa atropurpurea*	Endangered	known
BRODIAEA, THREAD-LEAVED	*Brodiaea filifolia*	Threatened	known
BUCKWHEAT, CUSHENBURY	*Eriogonum ovalifolium var. vineum*	Endangered	known
BUCKWHEAT, SOUTHERN MOUNTAIN WILD	*Eriogonum kennedyi var. austromontanum*	Threatened	known
CHECKER-MALLOW, PEDATE	*Sidalcea pedata*	Endangered	known
DAISY, PARISH'S	*Erigeron parishii*	Threatened	known
MILK-VETCH, CUSHENBURY	*Astragalus albens*	Endangered	known
MILK-VETCH, LANE MOUNTAIN	*Astragalus jaegerianus*	Endangered	known
MILK-VETCH, TRIPLE-RIBBED	*Astragalus tricarinatus*	Endangered	known
MUSTARD, SLENDER-PETALED	*Thelypodium stenopetalum*	Endangered	known
OXYTHECA, CUSHENBURY	*Oxytheca parishii var. goodmaniana*	Endangered	known
PAINTBRUSH, ASH-GREY INDIAN	*Castilleja cinerea*	Threatened	known
SANDWORT, BEAR VALLEY	*Arenaria ursina*	Threatened	known
SPINEFLOWER, SLENDER-HORNED	*Dodecahema leptoceras*	Endangered	known
TARAXACUM, CALIFORNIA	*Taraxacum californicum*	Endangered	known
WATERCRESS, GAMBEL'S	*Rorippa gambellii*	Endangered	known
WOOLLY-STAR, SANTA ANA RIVER	*Eriastrum densifolium ssp. sanctorum*	Endangered	known

Reptile

TORTOISE, DESERT	*Gopherus agassizii*	Threatened	known

San Diego (2713821 Acres)

Amphibian

TOAD, ARROYO SOUTHWESTERN	*Bufo californicus (=microscaphus)*	Endangered	known

Bird

EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
FLYCATCHER, SOUTHWESTERN WILLOW	*Empidonax traillii extimus*	Endangered	known
GNATCATCHER, COASTAL CALIFORNIA	*Polioptila californica californica*	Threatened	known
MURRELET, MARBLED	*Brachyramphus marmoratus marmoratus*	Threatened	possible
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
RAIL, LIGHT-FOOTED CLAPPER	*Rallus longirostris levipes*	Endangered	known
TERN, CALIFORNIA LEAST	*Sterna antillarum browni*	Endangered	known

California

County		Status	County presence
San Diego (2713821 Acres)			
VIREO, LEAST BELL'S	*Vireo bellii pusillus*	Endangered	known
Crustacean			
SHRIMP, RIVERSIDE FAIRY	*Streptocephalus woottoni*	Endangered	known
SHRIMP, SAN DIEGO FAIRY	*Branchinecta sandiegonensis*	Endangered	possible
Fish			
CHUB, MOHAVE TUI	*Gila bicolor mohavensis*	Endangered	known
GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known
PUPFISH, DESERT	*Cyprinodon macularius*	Endangered	known
STEELHEAD, SOUTHERN CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Endangered	known
STICKLEBACK, UNARMORED THREESPINE	*Gasterosteus aculeatus williamsoni*	Endangered	known
Insect			
SKIPPER, LAGUNA MOUNTAIN	*Pyrgus ruralis lagunae*	Endangered	possible
Mammal			
KANGAROO RAT, STEPHENS'	*Dipodomys stephensi (incl. D. cascus)*	Threatened	known
MOUSE, PACIFIC POCKET	*Perognathus longimembris pacificus*	Endangered	known
SHEEP, PENINSULAR BIGHORN	*Ovis canadensis*	Threatened	known
Plant			
AMBROSIA, SAN DIEGO	*Ambrosia pumila*	Endangered	known
BACCHARIS, ENCINITAS	*Baccharis vanessae*	Threatened	known
BIRD'S-BEAK, SALT MARSH	*Cordylanthus maritimus ssp. maritimus*	Endangered	known
BLUEGRASS, SAN BERNARDINO	*Poa atropurpurea*	Endangered	known
BRODIAEA, THREAD-LEAVED	*Brodiaea filifolia*	Threatened	known
BUTTON-CELERY, SAN DIEGO	*Eryngium aristulatum var. parishii*	Endangered	known
CROWN-BEARD, BIG-LEAVED	*Verbesina dissita*	Threatened	known
FLANNELBUSH, MEXICAN	*Fremontodendron mexicanum*	Endangered	known
GRASS, CALIFORNIA ORCUTT	*Orcuttia californica*	Endangered	known
MANZANITA, DEL MAR	*Arctostaphylos glandulosa ssp. crassifolia*	Endangered	known
MINT, OTAY MESA	*Pogogyne nudiuscula*	Endangered	known
MINT, SAN DIEGO MESA	*Pogogyne abramsii*	Endangered	known
MONARDELLA, WILLOWY	*Monardella linoides ssp. viminea*	Endangered	known
NAVARRETIA, SPREADING	*Navarretia fossalis*	Threatened	known
SPINEFLOWER, ORCUTT'S	*Chorizanthe orcuttiana*	Endangered	known
SPINEFLOWER, SLENDER-HORNED	*Dodecahema leptoceras*	Endangered	known
TARPLANT, OTAY	*Deinandra (=Hemizonia) conjugens*	Threatened	known

San Diego (2713821 Acres)

THORNMINT, SAN DIEGO	*Acanthomintha ilicifolia*	Threatened	known
WATERCRESS, GAMBEL'S	*Rorippa gambellii*	Endangered	known
Reptile			
TURTLE, OLIVE (PACIFIC) RIDLEY SEA	*Lepidochelys olivacea*	Endangered	known

San Joaquin (912800 Acres)

Amphibian			
SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	
Bird			
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
Crustacean			
SHRIMP, VERNAL POOL FAIRY	*Branchinecta lynchi*	Threatened	known
SHRIMP, VERNAL POOL TADPOLE	*Lepidurus packardi*	Endangered	known
Fish			
SMELT, DELTA	*Hypomesus transpacificus*	Threatened	known
STEELHEAD, CALIFORNIA CENTRAL VALLEY POP	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
Insect			
BEETLE, VALLEY ELDERBERRY LONGHORN	*Desmocerus californicus dimorphus*	Threatened	known
Mammal			
FOX, SAN JOAQUIN KIT	*Vulpes macrotis mutica*	Endangered	known
RABBIT, RIPARIAN BRUSH	*Sylvilagus bachmani riparius*	Endangered	known
WOODRAT, RIPARIAN	*Neotoma fuscipes riparia*	Endangered	known
Plant			
BIRD'S-BEAK, PALMATE-BRACTED	*Cordylanthus palmatus*	Endangered	known
FIDDLENECK, LARGE-FLOWERED	*Amsinckia grandiflora*	Endangered	known
OWL'S-CLOVER, FLESHY	*Castilleja campestris ssp. succulenta*	Endangered	known
Reptile			
SNAKE, GIANT GARTER	*Thamnophis gigas*	Threatened	known

Santa Barbara (1759699 Acres)

Amphibian			
SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	known
TOAD, ARROYO SOUTHWESTERN	*Bufo californicus (=microscaphus)*	Endangered	known

Santa Barbara (1759699 Acres)

Bird

CONDOR, CALIFORNIA	*Gymnogyps californianus*	Endangered	known
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
MURRELET, MARBLED	*Brachyramphus marmoratus marmoratus*	Threatened	possible
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
RAIL, LIGHT-FOOTED CLAPPER	*Rallus longirostris levipes*	Endangered	known
TERN, CALIFORNIA LEAST	*Sterna antillarum browni*	Endangered	known
VIREO, LEAST BELL'S	*Vireo bellii pusillus*	Endangered	known

Crustacean

SHRIMP, VERNAL POOL FAIRY	*Branchinecta lynchi*	Threatened	known

Fish

GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known
STEELHEAD, SOUTHERN CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Endangered	known
STICKLEBACK, UNARMORED THREESPINE	*Gasterosteus aculeatus williamsoni*	Endangered	known

Mammal

FOX, SAN JOAQUIN KIT	*Vulpes macrotis mutica*	Endangered	known
FOX, SAN MIGUEL ISLAND	*Urocyon littoralis littoralis*	Endangered	known
FOX, SANTA CRUZ ISLAND	*Urocyon littoralis santacruzae*	Endangered	known
FOX, SANTA ROSA ISLAND	*Urocyon littoralis santarosae*	Endangered	known
KANGAROO RAT, GIANT	*Dipodomys ingens*	Endangered	known
SEAL, GUADALUPE FUR	*Arctocephalus townsendi*	Threatened	known

Plant

BARBERRY, ISLAND	*Berberis pinnata ssp. insularis*	Endangered	known
BEDSTRAW, ISLAND	*Galium buxifolium*	Endangered	known
BIRD'S-BEAK, SALT MARSH	*Cordylanthus maritimus ssp. maritimus*	Endangered	known
BUSHMALLOW, SANTA CRUZ ISLAND	*Malacothamnus fasciculatus var.*	Endangered	known
DUDLEYA, MARCESCENT	*Dudleya cymosa ssp. marcescens*	Threatened	possible
DUDLEYA, SANTA CRUZ ISLAND	*Dudleya nesiotica*	Threatened	known
FRINGEPOD, SANTA CRUZ ISLAND	*Thysanocarpus conchuliferus*	Endangered	known
GILIA, HOFFMANN'S SLENDER-FLOWERED	*Gilia tenuiflora ssp. hoffmannii*	Endangered	known
GOLDFIELDS, CONTRA COSTA	*Lasthenia conjugens*	Endangered	possible
JEWELFLOWER, CALIFORNIA	*Caulanthus californicus*	Endangered	known
LAYIA, BEACH	*Layia carnosa*	Endangered	known

		Status	County presence
Santa Barbara (1759699 Acres)			
LIVEFOREVER, SANTA BARBARA ISLAND	*Dudleya traskiae*	Endangered	known
MALACOTHRIX, ISLAND	*Malacothrix squalida*	Endangered	known
MALACOTHRIX, SANTA CRUZ ISLAND	*Malacothrix indecora*	Endangered	known
MANZANITA, SANTA ROSA ISLAND	*Arctostaphylos confertiflora*	Endangered	known
NAVARRETIA, FEW-FLOWERED	*Navarretia leucocephala ssp. pauciflora (=N. pauciflora)*	Endangered	possible
NAVARRETIA, MANY-FLOWERED	*Navarretia leucocephala ssp. plieantha*	Endangered	possible
PAINTBRUSH, SOFT-LEAVED	*Castilleja mollis*	Endangered	known
PHACELIA, ISLAND	*Phacelia insularis ssp. insularis*	Endangered	known
ROCK-CRESS, HOFFMANN'S	*Arabis hoffmannii*	Endangered	known
STONECROP, LAKE COUNTY	*Parvisedum leiocarpum*	Endangered	possible
TARPLANT, GAVIOTA	*Deinandra increscens ssp. villosa*	Endangered	known
THISTLE, FOUNTAIN	*Cirsium fontinale var. fontinale*	Endangered	known
THISTLE, LA GRACIOSA	*Cirsium loncholepis*	Endangered	known
WOOLLY-THREADS, SAN JOAQUIN	*Monolopia (=Lembertia) congdonii*	Endangered	known
YERBA SANTA, LOMPOC	*Eriodictyon capitatum*	Endangered	known
Reptile			
LIZARD, BLUNT-NOSED LEOPARD	*Gambelia silus*	Endangered	known
LIZARD, ISLAND NIGHT	*Xantusia riversiana*	Threatened	known
Santa Cruz (286455 Acres)			
Amphibian			
SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	
SALAMANDER, SANTA CRUZ LONG-TOED	*Ambystoma macrodactylum croceum*	Endangered	known
Bird			
MURRELET, MARBLED	*Brachyramphus marmoratus marmoratus*	Threatened	possible
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
Fish			
GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known
SALMON, COHO (CENTRAL CALIFORNIA COAST POP)	*Oncorhynchus (=Salmo) kisutch*	Threatened	known
STEELHEAD, CENTRAL CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
STEELHEAD, SOUTH-CENTRAL CALIFORNIA POP	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
Insect			

Santa Cruz (286455 Acres)

BEETLE, MOUNT HERMON JUNE	*Polyphylla barbata*	Endangered	possible
BEETLE, OHLONE TIGER	*Cicindela ohlone*	Endangered	known
GRASSHOPPER, ZAYANTE BAND-WINGED	*Trimerotropis infantilis*	Endangered	possible

Mammal

OTTER, SOUTHERN SEA	*Enhydra lutris nereis*	Threatened	known

Plant

CYPRESS, SANTA CRUZ	*Cupressus abramsiana*	Endangered	known
PENTACHAETA, WHITE-RAYED	*Pentachaeta bellidiflora*	Endangered	possible
POLYGONUM, SCOTT'S VALLEY	*Polygonum hickmanii*	Endangered	known
SPINEFLOWER, BEN LOMOND	*Chorizanthe pungens var. hartwegiana*	Endangered	known
SPINEFLOWER, MONTEREY	*Chorizanthe pungens var. pungens*	Threatened	known
SPINEFLOWER, ROBUST	*Chorizanthe robusta (incl. vars. robusta and hartwegii)*	Endangered	known
SPINEFLOWER, SCOTTS VALLEY	*Chorizanthe robusta var. hartwegii*	Endangered	known
TARPLANT, SANTA CRUZ	*Holocarpha macradenia*	Threatened	known
WALLFLOWER, BEN LOMOND	*Erysimum teretifolium*	Endangered	known

Reptile

SNAKE, SAN FRANCISCO GARTER	*Thamnophis sirtalis tetrataenia*	Endangered	known

Sonoma (1015210 Acres)

Amphibian

SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	known

Bird

EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known
MURRELET, MARBLED	*Brachyramphus marmoratus marmoratus*	Threatened	known
OWL, NORTHERN SPOTTED	*Strix occidentalis caurina*	Threatened	known
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
RAIL, CALIFORNIA CLAPPER	*Rallus longirostris obsoletus*	Endangered	known

Crustacean

SHRIMP, CALIFORNIA FRESHWATER	*Syncaris pacifica*	Endangered	known

Fish

GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known
SALMON, CHINOOK (CALIFORNIA COASTAL ESU)	*Oncorhynchus (=Salmo) tshawytscha*	Threatened	known

County		Status	County presence
Sonoma (1015210 Acres)			
SALMON, CHINOOK (CENTRAL VALLEY SPRING RUN)	*Oncorhynchus (=Salmo) tshawytscha*	Threatened	known
SALMON, CHINOOK (SACRAMENTO RIVER WINTER RUN)	*Oncorhynchus (=Salmo) tshawytscha*	Endangered	known
SALMON, COHO (CENTRAL CALIFORNIA COAST POP)	*Oncorhynchus (=Salmo) kisutch*	Threatened	known
STEELHEAD, CALIFORNIA CENTRAL VALLEY POP	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
STEELHEAD, CENTRAL CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
STEELHEAD, NORTHERN CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
Insect			
BUTTERFLY, BEHREN'S SILVERSPOT	*Speyeria zerene behrensii*	Endangered	known
BUTTERFLY, MYRTLE'S SILVERSPOT	*Speyeria zerene myrtleae*	Endangered	known
Mammal			
MOUSE, SALT MARSH HARVEST	*Reithrodontomys raviventris*	Endangered	known
Plant			
ALOPECURUS, SONOMA	*Alopecurus aequalis var. sonomensis*	Endangered	known
BIRD'S-BEAK, PENNELL'S	*Cordylanthus tenuis ssp. capillaris*	Endangered	possible
CHECKER-MALLOW, KENWOOD MARSH	*Sidalcea oregana ssp. valida*	Endangered	known
CLARKIA, VINE HILL	*Clarkia imbricata*	Endangered	known
CLOVER, SHOWY INDIAN	*Trifolium amoenum*	Endangered	known
GOLDFIELDS, BURKE'S	*Lasthenia burkei*	Endangered	known
LARKSPUR, YELLOW	*Delphinium luteum*	Endangered	known
LILY, PITKIN MARSH	*Lilium pardalinum ssp. pitkinense*	Endangered	known
LUPINE, CLOVER	*Lupinus tidestromii*	Endangered	known
MEADOWFOAM, SEBASTOPOL	*Limnanthes vinculans*	Endangered	known
MILK-VETCH, CLARA HUNT'S	*Astragalus clarianus*	Endangered	known
SEDGE, WHITE	*Carex albida*	Endangered	known
SPINEFLOWER, SONOMA	*Chorizanthe valida*	Endangered	known
STICKYSEED, BAKER'S	*Blennosperma bakeri*	Endangered	known
Ventura (1187974 Acres)			
Amphibian			
TOAD, ARROYO SOUTHWESTERN	*Bufo californicus (=microscaphus)*	Endangered	known
Bird			
CONDOR, CALIFORNIA	*Gymnogyps californianus*	Endangered	known

County	Scientific name	Status	County presence
Ventura (1187974 Acres)			
PELICAN, BROWN	*Pelecanus occidentalis*	Endangered	known
PLOVER, WESTERN SNOWY	*Charadrius alexandrinus nivosus*	Threatened	known
RAIL, LIGHT-FOOTED CLAPPER	*Rallus longirostris levipes*	Endangered	known
TERN, CALIFORNIA LEAST	*Sterna antillarum browni*	Endangered	known
VIREO, LEAST BELL'S	*Vireo bellii pusillus*	Endangered	known
Crustacean			
SHRIMP, CONSERVANCY FAIRY	*Branchinecta conservatio*	Endangered	known
SHRIMP, RIVERSIDE FAIRY	*Streptocephalus woottoni*	Endangered	known
SHRIMP, VERNAL POOL FAIRY	*Branchinecta lynchi*	Threatened	known
Fish			
GOBY, TIDEWATER	*Eucyclogobius newberryi*	Endangered	known
STEELHEAD, SOUTHERN CALIFORNIA POPULATION	*Oncorhynchus (=Salmo) mykiss*	Endangered	known
Mammal			
FOX, SAN JOAQUIN KIT	*Vulpes macrotis mutica*	Endangered	possible
Plant			
BIRD'S-BEAK, SALT MARSH	*Cordylanthus maritimus ssp. maritimus*	Endangered	known
DUDLEYA, CONEJO	*Dudleya abramsii ssp. parva*	Threatened	known
DUDLEYA, SANTA MONICA MOUNTAINS	*Dudleya cymosa ssp. ovatifolia*	Threatened	known
DUDLEYA, VERITY'S	*Dudleya verityi*	Threatened	known
GRASS, CALIFORNIA ORCUTT	*Orcuttia californica*	Endangered	known
MALACOTHRIX, SANTA CRUZ ISLAND	*Malacothrix indecora*	Endangered	known
MILK-VETCH, BRAUNTON'S	*Astragalus brauntonii*	Endangered	known
MILK-VETCH, VENTURA MARSH	*Astragalus pycnostachyus var.*	Endangered	known
WATERCRESS, GAMBEL'S	*Rorippa gambellii*	Endangered	known
Reptile			
LIZARD, BLUNT-NOSED LEOPARD	*Gambelia silus*	Endangered	known
LIZARD, ISLAND NIGHT	*Xantusia riversiana*	Threatened	known
Yolo (654566 Acres)			
Amphibian			
SALAMANDER, CALIFORNIA TIGER	*Ambystoma californiense*	Endangered	
Bird			
EAGLE, BALD	*Haliaeetus leucocephalus*	Threatened	known

California

County		Status	County presence
Yolo (654566 Acres)			
Crustacean			
SHRIMP, VERNAL POOL TADPOLE	*Lepidurus packardi*	Endangered	known
Fish			
SALMON, CHINOOK (CENTRAL VALLEY SPRING RUN)	*Oncorhynchus (=Salmo) tshawytscha*	Threatened	known
SALMON, CHINOOK (SACRAMENTO RIVER WINTER *tshawytscha* RUN)	Endangered	*Oncorhynchus (=Salmo)* known	
SMELT, DELTA	*Hypomesus transpacificus*	Threatened	known
STEELHEAD, CALIFORNIA CENTRAL VALLEY POP	*Oncorhynchus (=Salmo) mykiss*	Threatened	known
Insect			
BEETLE, VALLEY ELDERBERRY LONGHORN	*Desmocerus californicus dimorphus*	Threatened	known
Plant			
BIRD'S-BEAK, PALMATE-BRACTED	*Cordylanthus palmatus*	Endangered	known
GRASS, COLUSA	*Neostapfia colusana*	Threatened	known
GRASS, SOLANO	*Tuctoria mucronata*	Endangered	known
Reptile			
SNAKE, GIANT GARTER	*Thamnophis gigas*	Threatened	known

F. Data Requirements

Table A. Ecological Effects Data Requirements for *Tau*-fluvalinate.				
Guideline Number	**Data Requirement**	**Are Further Data Needed?**	**Study ID #**	**Study Classification[a]**
71-1	Avian oral LD_{50}	No	00085444 00104671	Core
71-2	Avian dietary LC_{50}	No	00094601 00079964 00104672 00079965	Core
71-4	Avian reproduction	No	00149824 00149825	Core
72-1	Freshwater fish LC_{50}	Yes	00094599 00079962 00150125 00079961 00094598 00094600 00094596	Supplemental
72-2	Freshwater invertebrate acute EC_{50}	Yes	00094597 00079960 00127995	Supplemental Supplemental Supplemental
72-3(a)	Estuarine/marine fish LC_{50}	Yes	00155450 00160766	Supplemental
72-3(b)	Estuarine/marine mollusk LC_{50}	Yes	00160767	Supplemental
72-3(c)	Estuarine/marine shrimp LC_{50}	Yes	00127994	Supplemental
72-4(a)	Freshwater fish early life-stage	Yes	00127996	Supplemental
72-5	Estuarine/marine fish full life-cycle	No	00160768 43753501	Invalid Core
72-4(b)	Freshwater Aquatic invertebrate life-cycle	Yes	00127997	Supplemental
72-4(b)	Estuarine/marine invertebrate life-cycle	Yes	No study available	N/A

Table A. Ecological Effects Data Requirements for *Tau*-fluvalinate.				
Guideline Number	**Data Requirement**	**Are Further Data Needed?**	**Study ID #**	**Study Classification[a]**
72-5	Freshwater fish full life-cycle	No	Marine full life cycle study available	N/A
122-1(a)	Seed germination/seedling emergence (Tier I)	Yes	No study available	N/A
122-1(b)	Vegetative vigor (Tier I)	Yes	No study available	N/A
122-2	Aquatic algal growth	Yes	No study available	N/A
123-2	Duckweed (*Lemna gibba*)	Yes	No study available	N/A
123-1(a)	Seed germination/seedling emergence (Tier II)	No	No study available	N/A
123-1(b)	Vegetative vigor (Tier II)	No	No study available	N/A
123-2	Aquatic plant growth	Yes	No study available	N/A
144-1	Honey bee acute contact LD_{50}	No	41783901 41996203	Core
141-2	Honey bee residue on foliage	No	41996204	Core
850.1735	Whole sediment acute, freshwater	Yes	No study available, expected to bind to sediment	N/A
850.174	Whole sediment acute, marine	Yes	No study available, expected to bind to sediment	N/A

[a]Core: study satisfies guideline; Supplemental: study is scientifically sound, but does not satisfy guideline

Table B. Environmental Fate Data Requirements for Tau fluvalinate.					
Guideline #		**Data Requirement**	**Are further data needed?**	**MRID**	**Study Classification**
161-1	835.2120	Hydrolysis	Yes	76691 41597303 45769201 45769202	partially acceptable
161-2	835.2240	Photodegradation in Water	Yes	072938 41597305 45769203	supplemental
161-3	835.2410	Photodegradation on Soil	No	83757 41597307 45769201	acceptable
161-4	835.2370	Photodegradation in Air	waived	NA	NA
162-1	835.4100	Aerobic Soil Metabolism	No	126102 41889715 45769201	acceptable
162-2	835.4200	Anaerobic Soil Metabolism	NA	NA	NA
162-3	835.4400	Anaerobic Aquatic Metabolism	Yes	41889715 45769201	supplemental
162-4	835.4300	Aerobic Aquatic Metabolism	Yes	NA	NA
163-1	835.1240 835.1230	Leaching-Adsorption/Desorption	Yes	126102 41597309	supplemental
163-2	835.1410	Laboratory Volatility	reserved	NA	NA
163-3	835.8100	Field Volatility	reserved	NA	NA
164-1	835.6100	Terrestrial Field Dissipation	reserved	NA	NA
164-2	835.6200	Aquatic Field Dissipation	reserved	NA	NA
164-3	835.6300	Forestry Dissipation	reserved	NA	NA

Table B. Environmental Fate Data Requirements for Tau fluvalinate.					
Guideline #		**Data Requirement**	**Are further data needed?**	**MRID**	**Study Classification**
165-4	850.1730	Accumulation in Fish	No	92069044	acceptable
165-5	850.1950	Accumulation – Aquatic Non-target Organisms	reserved	NA	NA
166-1	835.7100	Groundwater – Small Prospective	reserved	NA	NA
201-1	840.1100	Droplet Size Spectrum	1	1	1
202-1	840.1200	Spray Drift Field Evaluation	1	1	1

1. The registrant is a member of the Spray Drift Task Force and the data requirement is covered by the data produced by this coalition.

G. AgDRIFT Analysis

Surface water modeling using PRZM/EXAMS assumes 5% and 1% drift deposition integrated across the surface of a pond adjacent to a treated field for aerially and ground applied pesticides, respectively. A comparison of these default values can be made with those from the first screening-level spray drift predictions from the AgDRIFT model (Version 2.01). **Table G-1** presents AgDRIFT predictions for deposition of spray drift (fraction of application rate) integrated across the surface of a standard pond which is immediately adjacent and downwind to a treated field and which has a 208.7-foot downwind width. In situations where the Agency's screening models suggest that spray drift is a significant source of exposure and therefore risk, the following information is considered in the risk characterization to evaluate the confidence of risk assessment conclusions.

Table G-1 Comparison of Current PRZM/EXAMS Default Spray Drift Percentages versus AgDRIFT Determined Percentages Under Various Potential Application Conditions

Application Method	Drift Assumption	Drift Assumptions	AgDRIFT Estimated Drift Value
Ground Application			
Low Boom Height	1	very fine to fine spray, 50th percentile of measured data	1.5
	1	very fine to fine spray, 90th percentile of measured data	2.72
	1	fine to medium/coarse spray, 50th percentile of measured data	0.9
	1	fine to medium/coarse spray, 90th percentile of measured data	1.1
High Boom Height	1	very fine to fine spray, 50th percentile of measured data	5.5
	1	very fine to fine spray, 90th percentile of measured data	6.2

Table G-1 Comparison of Current PRZM/EXAMS Default Spray Drift Percentages versus AgDRIFT Determined Percentages Under Various Potential Application Conditions			
Application Method	**Drift Assumption**	**Drift Assumptions**	**AgDRIFT Estimated Drift Value**
	1	fine to medium/coarse spray, 50th percentile of measured data	1.5
	1	fine to medium/coarse spray, 90th percentile of measured data	1.7
Aerial Application - 90th Percentile Application Conditions (Based on Best Professional Judgment)			
	5	coarse to very coarse	6.9
	5	medium to coarse	8.9
	5	fine to medium	12.7
	5	very fine to fine	24.3

From this comparison, the baseline assumptions of drift currently used for PRZM/EXAMS modeling exceed the 90th percentile of drift predictions from AgDRIFT modeling for ground applications only for the medium/coarse spray from low boom sprayer (50th percentile assumption). Aerial drift assumptions are below drift levels predicted by AgDRIFT for all droplet spectra sprays using 90th percentile application conditions. The exact extent to which the currently used aerial drift assumption represents more frequently encountered application conditions is not presently quantified.

The extent to which a 5% versus another drift assumption alters estimated aqueous concentration estimates depends on specific use scenarios and can be influenced by the degree to which runoff contributes to the overall receiving water concentration. For example, if a persistent pesticide with low affinity for soils is used in a high runoff potential use area, drift may be only a minor route for pesticide loading to the receiving waters and the magnitude of assumed drift may have a limited effect on the concentration estimate. However, for non-persistent chemicals with high affinity for soils used in low runoff areas, drift may be the dominant route of pesticide entering receiving waters, and the particular level of spray drift chosen may appreciably influence aqueous pesticide concentration estimates.

It should be noted that the baseline drift assumptions for a water body located adjacent to a treated field are much higher than upper bound values for water bodies located at greater distances from the treated area. The table below shows distances from the treated area where AgDRIFT assumptions for aerial drift to a water body would be approximated by the baseline drift assumption of 5%. Water bodies located closer to the treated field than shown below would be predicted to have drift loadings greater than the 5% assumption. The greater the distance from the treated field required to reach 5% drift, the greater the likelihood that actual water bodies could receive drift levels higher than the baseline 5% assumption.

Spray Category	Water Body Distance from Treated Field to Reach 5% Surface Integrated Drift in AgDRIFT Model (ft)
Coarse to very coarse spray	13.12
Medium to coarse spray	39.4
Fine to medium spray	105
Very fine to fine spray	643

This comparison suggests that the OPP assumption of 5% aerial drift would reasonably represent high-end estimates of drift for most water bodies when medium to very coarse sprays are used because a few water bodies are usually found within 40 feet of treatment areas. However, for very fine to medium spray uses, the confidence that the 5% drift assumption adequately characterizes drift to water bodies is diminished because a higher number of water bodies can be assumed to be located within 650 feet from treated fields. It should be noted that quantitative probabilities of water body locations from treated fields are likely to be crop and regionally specific.

In order to test this further, EFED conducted an analysis using the Tier I model within AgDRIFT to estimate the downwind distance for various droplet size spectra for aerial applications. The analysis indicates that for most taxa and droplet size spectra the limits of the Tier I model are exceeded. The analysis is presented in **Table G-2**.

Table G-2 Estimated Downwind Distances for Various Spray Drift Scenarios Needed to Get Estimated Exposure Concentrations Due to Drift Below The Endangered Species Level of Concern for All Aquatic Taxa

Tier I Aerial Spray Drift Analysis

Taxa	Toxicity Value	Very Fine to Fine	Fine to Medium	Medium to Coarse	Coarse to Very Coarse

Table G-2 Estimated Downwind Distances for Various Spray Drift Scenarios Needed to Get Estimated Exposure Concentrations Due to Drift Below The Endangered Species Level of Concern for All Aquatic Taxa					
Freshwater Fish	0.35 ppb	> 1000	> 1000	> 1000	> 1000
Freshwater Invertebrate	0.31 ppb	> 1000	> 1000	> 1000	> 1000
Estuarine Fish	10.8 ppb	> 1000	154	62	26
Estuarine Invertebrate	0.018 ppb	> 1000	> 1000	> 1000	> 1000
Tier I Ground Spray Drift Analysis					
Low Boom Height					
Taxa	**Toxicity Value**	**Very Fine to Fine - 50th%**	**Very Fine to Fine - 90th%**	**Fine to Medium/Coarse - 50th%**	**Fine to Medium/Coarse - 90th%**
Freshwater Fish	0.35 ppb	321	702	131	387
Freshwater Invertebrate	0.31 ppb	374	790	160	456
Estuarine Fish	10.8 ppb	0	0	0	0
Estuarine Invertebrate	0.018 ppb	> 1000	> 1000	> 1000	> 1000
High Boom Height					
Taxa	**Toxicity Value**	**Very Fine to Fine - 50th%**	**Very Fine to Fine - 90th%**	**Fine to Medium/Coarse - 50th%**	**Fine to Medium/Coarse - 90th%**
Freshwater Fish	0.35 ppb	709	978	276	564
Freshwater Invertebrate	0.31 ppb	764	> 1000	315	637
Estuarine Fish	10.8 ppb	6.6	9.8	0	0
Estuarine Invertebrate	0.018 ppb	> 1000	> 1000	> 1000	> 1000

Further analysis of alternative spray drift conditions was conducted for the aerial application using the estuarine invertebrate which is the most sensitive species tested. The AgDRIFT model (Version 2.01) was used to refine the spray drift exposure estimate for estuarine invertebrates. Downwind spray drift buffers were developed for possible use in mitigating risks to endangered freshwater invertebrates in aquatic ecosystems that are within close proximity to agricultural fields that may be treated with liquid spray applications of dodine. The model was used to estimate spray buffer distances for aerial application to reach the EEC in the ecological water body for which the endangered species LOC for invertebrates would not be exceeded (0.0009 ppb).

A summary of the results of the AgDRIFT modeling for aerial applications of *tau*-fluvalinate is presented in **Table G-3**. Spray drift buffers or distances required to reduce spray drift such that endangered species LOCs for invertebrates are not exceeded are estimated for aerial applications of *tau*-fluvalinate at the highest maximum national use rates. The range of dissipation distances is dependant on a number of input variables including droplet size, release height, canopy characteristics etc., which are discussed in further detail for aerial applications below.

Drift dissipation distances for endangered species, based on aerial applications, are expected to exceed the 1,000 foot limit of the AgDRIFT Tier II aerial model based on conservative defaults (*i.e.*, fine spray, 15 foot release height and 15 mph wind speed). Modeled dissipation distances for endangered invertebrates, based on aerial application of *tau*-fluvalinate at 0.15 lbs ai/acre assuming a 10 foot release in wind speeds of 10 mph and a medium droplet size, are expected to exceed the range of the Tier II AgDRIFT model which is 1000 feet.

Table G-3. Summary of AgDRIFT Modeling Results for Endangered Invertebrates

Crop/ Application rate	Tier II Aerial Model Inputs			Buffer Distance for Aerial Application [a] (ft)
	ASEA 572 Droplet Size	Release Height (ft)	Wind Speed (mph)	
Carrots, Brassica, and Cole Crops @ 0.15 lbs ai/acre	Fine	15	15	>1000
		10	10	>1000
	Medium	15	15	>1000
		10	10	>1000

a Tier II aerial model

All of the analysis presented above suggest that for the most sensitive species tested (estuarine invertebrate) the spray drift buffer needed to reduce EECs from spray drift only are expected to exceed the range of the model. This suggests that while spray drift is a significant component of the total exposures for estuarine invertebrates, estimation of the effectiveness of spray drift buffers is beyond the range of the Tier I and Tier II versions of the model. There is also significant uncertainty with these estimates due to the uncertainty surrounding the toxicity values used in this assessment. The toxicity data for all aquatic species were classified as supplemental due to issues with the use of co-solvent and the potential sorption of *tau*-fluvalinate to the glass chambers. These factors suggest that the toxicity of *tau*-fluvalinate could be even greater which would result in even larger spray drift buffer estimations.

H. Environmental Fate Bibliography

Guideline: 161-1   Hydrolysis

MRID: 76691

Staiger, L.E.; Milligan, L.E.; Quistad, G.B.; et al. (1979) Hydro- lytic Stability of Fluvalinate. (Unpublished study received May 13, 1981 under 20954-EX-18; submitted by Zoecon Corp., Palo Al- to, Calif.; CDL:070094-A)

MRID: 41597303

Yu, C.; Ekdawi, M. (1989) Hydrolysis of Fluvalinate: Lab Project Number: 480605-7. Unpublished study prepared by Sandoz Crop Protection Corp. 37 p.

MRID: 45769201

Doran, T. (2002) Response to "Fluvalinate: Status of Studies Proposed for Support of Reregistration", (Internal EPA Memo, Dated April 3, 2002 from Kylie Rothwell, Special Review and Reregistration Division): Lab Project Number: 0201-WE. Unpublished study prepared by North Coast RegSci, LLC. 12 p.

MRID: 45769202

Ekdawi, M. (1991) Fluvalinate--Addendum to a Previous Hydrolysis Study: Lab Project Number: 480605: 14: 480605-14. Unpublished study prepared by Sandoz Crop Protection Corporation. 32 p.

Guideline: 161-2   Photodegradation-water

MRID: 41597305

Yu, C.; Ekdawi, M. (1990) Photodegradation Study of Fluvalinate in Aqueous Solution: Lab Project Number: 480605-9. Unpublished study prepared by Sandoz Crop Protection Corp. 37 p.

MRID: 45769201

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MRID: 45769203

Yu, C. (1991) Addendum to Photodegradation Study of Fluvalinate in Aqueous Solution: Addendum to Final Report: Lab Project Number: 480605: 9A: DP300681. Unpublished study prepared by Sandoz Crop Protection Corporation. 9 p.

Guideline: 161-3 Photodegradation-soil

MRID: 83757

Staiger, L.E.; Milligan, L.E.; Quistad, G.B.; et al. (1979) Photo- degradation of Fluvalinate. (Unpublished study received May 13, 1981 under 20954-EX-18; submitted by Zoecon Corp., Palo Alto, Calif.; CDL:070094-C)

MRID: 150126

Zoecon Corp. (19??) Metabolism Studies, Analytical Methods and Res- idue Studies [for Fluvalinate]. Unpublished compilation. 151 p.

MRID: 41597307

Yu, C.; Ekdawi, M. (1989) Photodegradation Study of Fluvalinate on Soil: Lab Project Number: 480605-8. Unpublished study prepared by Sandoz Crop Protection Corp. 58 p.

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Doran, T. (2002) Response to "Fluvalinate: Status of Studies Proposed for Support of Reregistration", (Internal EPA Memo, Dated April 3, 2002 from Kylie Rothwell, Special Review and Reregistration Division): Lab Project Number: 0201-WE. Unpublished study prepared by North Coast RegSci, LLC. 12 p.

MRID: 45769204

Skinner, W.; Dennis, P. (1991) Adsorption-Desorption of Fluvalinate in Soil: Final Report: Lab Project Number: 480605: 16: DP-300687. Unpublished study prepared by Sandoz Crop Protection Corporation. 75 p.

Guideline: 162-1 Aerobic soil metabolism

MRID: 76692

Staiger, L.E.; Milligan, L.E.; Quistad, G.B.; et al. (1979) Aerobic Soil Metabolism of Fluvalinate. (Unpublished study received May 13, 1981 under 20954-EX-18; submitted by Zoecon Corp., Palo Al- to, Calif.; CDL:070094-B)

MRID: 126102

Staiger, L.; Quistad, G. (1982) Degradation and Movement of Fluvalinate in Soil. (Unpublished study received Feb 8, 1983 under 20954-115; submitted by Zoecon Corp., Palo Alto, CA; CDL:249513-B)

MRID: 141181

Staiger, L.; Quistad, G. (1984) Degradation of [Benzyl-Carbon 14] Fluvalinate in Soil: Report No. 3760-2-01-84. Unpublished study prepared by Zoecon Corp. 13 p.

MRID: 41889715
Tong, T. (1991) Aerobic Soil Metabolism of Fluvalinate: Lab Project Number: DP-300166: 480605. Unpublished study prepared by Sandoz Crop Protection Corp. 61 p.

MRID: 45769201
Doran, T. (2002) Response to "Fluvalinate: Status of Studies Proposed for Support of Reregistration", (Internal EPA Memo, Dated April 3, 2002 from Kylie Rothwell, Special Review and Reregistration Division): Lab Project Number: 0201-WE. Unpublished study prepared by North Coast RegSci, LLC. 12 p.

Guideline: 162-3 Anaerobic aquatic metab.

MRID: 41996201
Blumhorst, M. (1991) Anaerobic Aquatic Metabolism of Fluvalinate: Lab Project Number: 111-010. Unpublished study prepared by EPL Bio-Analytical Services, Inc. 238 p.

MRID: 42742501
Blumhorst, M. (1993) Anaerobic Aquatic Metabolism of Fluvalinate: Amendment No. 1: Lab Project Number: 111-010. Unpublished study prepared by EPL Bio-Analytical Services, Inc. 7 p.

Guideline: 163-1 Leach/adsorp/desorption

MRID: 126102
Staiger, L.; Quistad, G. (1982) Degradation and Movement of Fluvalinate in Soil. (Unpublished study received Feb 8, 1983 under 20954-115; submitted by Zoecon Corp., Palo Alto, CA; CDL:249513-B)

MRID: 129014
Staiger, L.; Quistad, G. (1982) Degradation and Movement of Flu- valinate in Soil: Report No. 7270-1A-01-82. (Unpublished study received Jun 8, 1983 under 20954-EX-19; submitted by Zoecon Corp., Palo Alto, CA; CDL:250536-A)

MRID: 150126
Zoecon Corp. (19??) Metabolism Studies, Analytical Methods and Res- idue Studies [for Fluvalinate]. Unpublished compilation. 151 p.

MRID: 150616
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MRID: 41597309
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MRID: 45769201
Doran, T. (2002) Response to "Fluvalinate: Status of Studies Proposed for Support of Reregistration", (Internal EPA Memo, Dated April 3, 2002 from Kylie Rothwell, Special Review and Reregistration Division): Lab Project Number: 0201-WE. Unpublished study prepared by North Coast RegSci, LLC. 12 p.

Guideline: 163-2   Volatility - lab

MRID: 150126
Zoecon Corp. (19??) Metabolism Studies, Analytical Methods and Res- idue Studies [for Fluvalinate]. Unpublished compilation. 151 p.

Guideline: 164-1   Terrestrial field dissipation

MRID: 41996202
Bryant, J. (1991) Fluvalinate/Bare Ground--No Crop Soil Dissipation Study/Regulatory ?Interim Report|: Lab Project Number: 30003601. Unpublished study prepared by Plant Sciences, Inc. 407 p.

MRID: 42351601
Bryant, J. (1992) Fluvalinate/Bare Ground--No Crop Soil Dissipation Study/Regulatory Trial I. D. Number 30003601: Laboratory Final Report: Lab Project Number: 914803: DP300842. Unpublished study prepared by Plant Sciences, Inc. and Chemalysis, Inc. 411 p.

Guideline: 165-4   Bioaccumulation in fish

MRID: 92069044
Levin, A. (1990) Sandoz Crop Protection Corporation Phase 3 Summary of MRID 00027698. Carbon-14-Trifluoromethyl Fluvalinate: Uptake, Depuration and Bioconcentration by Bluegill Sunfish: Report Nos. ABC 27698, 7270-1A-06-81. 13 p.

I. Ecotoxicity Bibliography

Guideline: 71-1 Avian Single Dose Oral Toxicity

MRID: 85444
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MRID: 104671
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Levin, A. (1990) Sandoz Crop Protection Corporation Phase 3 Summary of MRID 00085444. Technical Fluvalinate Acute LD50 Test-Bobwhite Quail: Project 102-107.: 13 p.

MRID: 92069002
Levin, A. (1990) Sandoz Crop Protection Corporation Phase 3 Summary of MRID 00104671. Fluvalinate Half Resolved Acute LD50 Test--Bobwhite Quail: Project 102-113. Prepared by WILDLIFE INTERNATIONAL. 12 p.

Guideline: 71-2 Avian Dietary Toxicity

MRID: 79964
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MRID: 79965
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MRID: 104672
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MRID: 143787
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MRID: 149823
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MRID: 92069004
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MRID: 92069005
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MRID: 92069006
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Guideline: 71-4 Avian Reproduction

MRID: 77048
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MRID: 77049
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MRID: 77050
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MRID: 149824
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MRID: 149825
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MRID: 92069007
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Guideline: 72-1 Acute Toxicity to Freshwater Fish

MRID: 77047
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MRID: 79962
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MRID: 94596
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MRID: 92069010
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MRID: 92069014
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Guideline: 72-2 Acute Toxicity to Freshwater Invertebrates

MRID: 79960
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MRID: 127995
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MRID: 92069015
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MRID: 92069016
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Guideline: 72-3 Acute Toxicity to Estuarine/Marine Organisms

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MRID: 155450
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MRID: 160766
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MRID: 44106501
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MRID: 92069018
Levin, A. (1990) Sandoz Crop Protection Corporation Phase 3 Summary of MRID 00155450. Fluvalinate Half Resolved: Acute Toxicity--Sheepshead Minnow: Project BW-85-12-1897.: 12 p.

MRID: 92069019
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Guideline: 72-4 Fish Early Life Stage/Aquatic Invertebrate Life Cycle Study

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MRID: 127996
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MRID: 127997
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MRID: 160768
Surprenant, D. (1986) Chronic Toxicity of Fluvalinate to Sheephead Minnows (Cyprinodon variegatus): Report # BW-86-4-2007: Study # 10828.0885-6105-520. Unpublished study prepared by Spring- born Bionomics, Inc. 36 p.

MRID: 92069021
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MRID: 92069022
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Guideline: 72-5 Life cycle fish

MRID: 43753501
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Guideline: 72-7 Simulated or Actual Field Testing

MRID: 43093001
Springer, T.; Jackson, W.; Krueger, H. (1993) An Evaluation of the Effects of Fluvalinate Insecticide Exposure in Simulated Aquatic Ecosystems: Lab Project Number: 131-156: 480608-3: DP-300768. Unpublished study prepared by Wildlife International Ltd. 577 p.

Guideline: 81-1 Acute oral toxicity in rats

MRID: 79947
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MRID: 79958
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MRID: 94100
Hansen, K.L.; Hewett, T.A.; Beck, L.S.; et al. (1981) Comparative Acute Oral LDI50^ Toxicity Study: Racemic ZR-3210 Technical: Project No. 1654-D. (Unpublished study received Feb 4, 1982 un- der 20954-19; prepared by Elars Bioresearch Laboratories, Inc., submitted by Zoecon Corp., Palo Alto, Calif.; CDL:070660-B)

MRID: 94102
Hansen, K.L.; Hewett, T.A.; Beck, L.S.; et al. (1981) Comparative Acute Oral LDI50^ Toxicity Study: Half-resolved ZR-3210 Techni- cal: Project No. 1654-D. (Unpublished study received Feb 4, 1982 under 20954-19; prepared by Elars Bioresearch Laboratories, Inc., submitted by Zoecon Corp., Palo Alto, Calif.; CDL: 070661-B)

MRID: 94103
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MRID: 94119
Mayhew, D.A.; Abbott, L.; Altringer, L.; et al. (1981) Acute Oral Toxicity Study in Albino Rats with Mavrik^(R)I 2E ZPA 1457: WIL- 80203. Final rept. (Unpublished study received Feb 4, 1982 under 20954-19; prepared by WIL Research Laboratories, Inc., submitted by Zoecon Corp., Palo Alto, Calif.; CDL:070664-F)

MRID: 118398
Hansen, K.; Billings, B.; Hepler, D.; et al. (1982) Acute Oral Toxicity Study: Mavrik 2F (Half-resolved): Project No. 1767-D. Fi- nal rept. (Unpublished study received Nov 10, 1982 under 20954- 123; prepared by Elars Bioresearch Laboratories, Inc., submitted by Zoecon Corp., Palo Alto, CA; CDL:248822-C)

MRID: 146789

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MRID: 149681
Costello, B. (1984) Summary of Results of an Acute Oral Toxicity Study: Project No. 84-3963A. Unpublished study prepared by Biosearch Inc. 6 p.

MRID: 149684
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MRID: 150113
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MRID: 150114
Costello, B. (1984) Summary of Results of an Acute Oral Toxicity Study: Project No. 84-3963A. Unpublished study prepared by Biosearch Inc. 6 p.

MRID: 150115
Hansen, K. (1981) Comparative Acute Oral LD50 Toxicity Study m- Phenoxymandelonitrile: Project No. 1654-D. Unpublished study prepared by Elars Bioresearch Laboratories, Inc. 18 p.

MRID: 92069023
Levin, A. (1990) Sandoz Crop Protection Corporation Phase 3 Summary of MRID 00094100. Fluvalinate Technical: Acute Toxicity in the Rat: Project 1654-D.: 11 p.

MRID: 92069024
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Guideline: 82-1   Subchronic Oral Toxicity: 90-Day Study

MRID: 94113
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Feb 4, 1982 under 20954-19; prepared by Litton Bionetics, Inc., submitted by Zoecon Corp., Palo Alto, Calif.; CDL:070663-D; 070664)

Guideline: 83-3 Teratogenicity -- 2 Species

MRID: 77026
Reno, F.E.; Hoberman, A.M.; Mossburg, P.A.; et al. (1980) Pilot Teratology Study in Rats: ZR 3210 Technical: Project No. 777- 129. Final rept. (Unpublished study received May 13, 1981 un- der 20954-EX-18; prepared by Hazleton Laboratories America, Inc., submitted by Zoecon Corp., Palo Alto, Calif.; CDL: 070097-A)

MRID: 77027
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MRID: 94111
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