Appendix G. Ecological Effects Data

a. Toxicity to Terrestrial Animals (see Appendix J for mammalian data)

Birds, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of *lambda*-cyhalothrin to birds. The preferred test species is either mallard duck (a waterfowl) or bobwhite quail (an upland gamebird). A single dose oral test with the mallard duck found *lambda*-cyhalothrin to be slightly toxic on an acute oral basis. Sub-lethal effects for MRID 00150854 included a slight loss in weight for the first days after dosing.

Avian Acute Oral Toxicity

Species	Toxicity value	Toxicity category	MRID No.	Study classification
Mallard duck **(***Anas platyrhynchos***)**	LD_{50} = 3950 mg ai/kg-bw	Slightly toxic	00151594	Acceptable
Mallard duck **(***Anas platyrhynchos***)**	LD_{50} > 5000 mg ai/kg-bw	Practically non-toxic	00150854	Acceptable

Two subacute dietary studies using the TGAI are required to establish the toxicity of *lambda*-cyhalothrin to birds. The preferred test species are mallard duck and bobwhite quail. In one bobwhite quail study (MRID 00151118), birds exhibited a slight weight loss; the other bobwhite study showed no sub-lethal effects. Sub-lethal effects in the mallard duck studies included: subdued behavior, unsteadiness, and decrease in body weight.

Avian Subacute Dietary Toxicity

Species	Toxicity Value	Toxicity Category	MRID No.	Study Classification
Northern Bobwhite quail *(Colinus virginianus)*	5-Day LC_{50} = 2354 mg a.i./kg-diet	Slightly toxic	00151118	Supplemental EPA re-calculated the LC_{50}.
Mallard duck **(***Anas platyrhynchos***)**	5-Day LC_{50} = 3948 mg a.i./kg-diet	Slightly toxic	00151595	Acceptable
Mallard duck **(***Anas platyrhynchos***)**	5-Day LC_{50} = 12488 mg ai/kg-diet	Practically non-toxic	00151117	Acceptable
Northern Bobwhite quail *(Colinus virginianus)*	5-Day LC_{50} > 5300 mg ai/kg-diet	Practically non-toxic	00151596	Acceptable

Birds, Chronic

Avian reproduction studies using the TGAI are required for *lambda*-cyhalothrin because the following conditions are met: (1) birds may be subject to repeated or continuous exposure to the pesticide, especially preceding or during the breeding season, (2) the pesticide is stable in the environment to the extent that potentially toxic amounts may persist in animal feed, (3**)** the pesticide is stored or accumulated in plant or animal tissues, and, (4) information derived from mammalian reproduction studies indicates reproduction in terrestrial vertebrates may be adversely affected by the anticipated use of the product. The preferred test species are mallard, duck, and bobwhite quail. The most sensitive NOEL (mallard duck MRID 41512101) was based on chemical residues detected in eggs. Other effects in mallard duck were residues in the liver and fat, number of eggs laid and set, egg fertility, and early embryonic mortalities. The bobwhite quail study exhibited no effects.

Avian Chronic Reproduction Toxicity

Species	NOEL	LOEL	MRID No.	Study Classification
Mallard duck **(***Anas platyrhynchos***)**	5 ppm	15 ppm	41512101	Acceptable
Northern Bobwhite quail *(Colinus virginianus)*	≥ 50 ppm	n/a	00153505	Acceptable
Mallard duck **(***Anas platyrhynchos***)**	5 ppm	50 ppm	00153504	Supplemental Effects may have been present at 5 ppm (ruptured ovaries), but raw data were not submitted for confirmation

Terrestrial Insects

Lambda-cyhalothrin is highly toxic to bees on an acute contact basis. A non-guideline study (MRID 40436303) documented possible repellency effects of *lambda*-cyhalothrin to honey bees through a choice test with simulated honeydew. A honey bee foliage acute toxicity test (MRID 4043602) established that it would be safe for honey bees to re-enter the field from 24 to 96 hours after application of *lambda*-cyhalothrin, depending on the application rate.

Acute Contact Toxicity in Terrestrial Insects

Species	Toxicity value	Toxicity category	MRID	Classification
Honey bee (*Apis mellifera*)	Performed with Technical 48-h contact LD_{50} = 0.038 µg ai/bee 48-h oral LD_{50} =	Highly toxic	40052409 (Accession number)	Acceptable

	0.909 µg ai/bee <u>Performed with Formulation</u> 48-h contact LD_{50} = 0.098 µg ai/bee 48-h oral LD_{50} = 0.483 µg ai/bee			
Honey bee (*Apis mellifera*)	n/a	n/a	40436303	Supplemental Non-guideline study
Honey bee (*Apis mellifera*)	LT_{50} = 4-12 hours (at 0.013 lb ai/A) LT_{50} = 23 hours (at 0.031 lb ai/A) NOEL = 24-48 hours (at 0.013 lb ai/A) NOEL = 96 hours (at 0.031 lb ai/A)	n/a	40436302	Acceptable

b. Toxicity to Aquatic Animals

Freshwater Fish, Acute

A number of freshwater fish acute toxicity studies using the TGAI or TEP were submitted to establish the toxicity of *lambda*-cyhalothrin to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Overall, *lambda*-cyhalothrin is very highly toxic to freshwater fish. The lowest endpoint was obtained from a study with the golden orfe; sub-lethal effects included quiescence, sounding, erratic swimming, spiraling, loss of balance, rapid respiration, labored respiration, swimming cessation, light discoloration, surfacing, irregular respiration, and gulping air. Similar sub-lethal effects were documented in the other studies as well. For rainbow trout, sub-lethal effects included: loss of equilibrium, quiescence, change in color, spiraling, rapid respiration, weakness, surfacing, coughing, and sounding. Sub-lethal effects to the bluegill sunfish included: sounding, loss of balance, quiescence, darkening of color, spiraling, and rapid and irregular respiration.

Freshwater Fish Acute Toxicity

Species	96-hr LC50	Toxicity Category	MRID No.	Study Classification
Golden orfe (*Leuciscus idus*)	0.078 µg ai/L	Very highly toxic	44584001	Supplemental Non-guideline test species
Bluegill sunfish (*Lepomis macrochirus*)	2.2 µg ai/L	Very highly toxic	00151598	Supplemental Performed with TEP
Rainbow trout	2.7 µg ai/L	Very highly	43908813	Acceptable

(*Oncorrhynchus mykiss*)		toxic		Performed with TEP
Rainbow trout (*Oncorrhynchus mykiss*)	0.24 µg ai/L	Very highly toxic	00151597	Acceptable
Rainbow trout (*Oncorrhynchus mykiss*)	3.4µ ai/L	Very highly toxic	00151600	Supplemental Performed with TEP
Bluegill sunfish (*Lepomis macrochirus*)	1.2 µg ai/L	Very highly toxic	43908812	Acceptable Performed with TEP
Bluegill sunfish (*Lepomis macrochirus*)	0.21 µg ai/L	Very highly toxic	259807 (Accession number)	Acceptable

Freshwater Fish, Chronic

A freshwater fish early life-stage test using the TGAI is required for *lambda*-cyhalothrin because (1) the end-use product is expected to be transported to water from the intended use site, (2) aquatic acute fish LC_{50}s and the waterflea EC_{50} are less than 1 mg/l, and (3) the EEC in water is equal to or greater than 0.01 of acute LC_{50}, and EC_{5O} values. The preferred test species is the rainbow trout.

There is one acceptable fish chronic toxicity study available. The NOEL of the full life cycle study was based on F_1 survival at 28 days, F_0 length at 56 days, male length and weigh at 300 days, and F_1 weight and length at 31 days.

Freshwater Fish Full Life Cycle Toxicity

Species	NOEL	LOEL	Effect	MRID No.	Study Classification
Fathead minnow (*Pimephales promelas*)	0.031 µg ai/L	0.062 µg ai/L	F_1 survival at 28 days F_0 length at 56 days Male length and weigh at 300 days F_1 weight and length at 31 days	41519001	Supplemental Methodology problems (including some contamination in the controls)

Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of *lambda*-cyhalothrin to aquatic invertebrates. The preferred test species is *Daphnia magna*. No sub-lethal effects were noted.

Freshwater Invertebrate Acute Toxicity

Species/Test Type	48-h toxicity value	Toxicity Category	MRID No.	Study Classification
Waterflea	LC_{50} = 0.18 µg	Very highly	43908811	Acceptable

(*Daphnia magna*)	ai/L	toxic		Performed with TEP
Waterflea (*Daphnia magna*)	LC_{50} = 0.09 µg ai/L	Very highly toxic	00151599	Supplemental Performed with TEP
Waterflea (*Daphnia magna*)	LC_{50} = 0.36 µg ai/L	Very highly toxic	00151599	Acceptable
Amphipod (*Gammarus pulex*)	LC_{50} = 0.00668 µg ai/L	Very highly toxic	00152730	Supplemental Test procedure did not follow the guidelines in terms of measuring DO, used dechlorinated tap water, and extrapolation procedures for the two lowest measured concentrations were not sound
Scud (*Hyalella azteca*)	EC_{50} = 1.4 ng ai/L	Very highly toxic	48911001	Supplemental Open literature study

Freshwater Invertebrates, Chronic

A freshwater aquatic invertebrate life-cycle test using the TGAI is required for *lambda*-cyhalothrin because the end-use product is expected to be transported to water from the intended use site, aquatic acute fish LC_{50}s and the waterflea EC_{50} are less than 1 mg/l, and the EEC in water is equal to or greater than 0.01 of acute LC_{50} and EC_{50} values. The preferred test species is *Daphnia magna.*

A toxicity endpoints derived from the chronic daphnid study were based on the number young per female and adult survival.

Species	NOEL	LOEL	MRID No.	Study Classification
Waterflea (*Daphnia magna*)	0.00198 µg ai/L	0.0035 µg ai/L	41217501	Supplemental Only one test vessel was sampled per treatment and chemical is known to adsorb to surfaces, making it difficult to maintain constant concentrations

Estuarine/Marine Fish, Acute

There is one registrant-submitted study testing the toxicity of *lambda*-cyhalothrin to marine/estuarine fish. Based on the study, *lambda*-cyhalothrin is very highly toxic to estuarine/marine fish. Sub-lethal effects included quiescence, loss of balance, weakness, hyperexcitability, and rapid respiration. Many of these effects were also documented for freshwater fish.

Estuarine/Marine Fish Acute Toxicity

Species	96-hr LC_{50}	Toxicity Category	MRID No.	Study Classification
Sheepshead minnow (*Cyprinodon variegatus*)	= 0.807 µg a.i./L	Very highly toxic	00153506	Acceptable

Estuarine/Marine Fish, Chronic

There is one registrant-submitted study testing the chronic toxicity of *lambda*-cyhalothrin to marine/estuarine fish. The endpoints derived in the study were based on weight.

Estuarine/Marine Fish Acute Toxicity

Species	NOEC	LOEC	MRID No.	Study Classification
Sheepshead minnow (*Cyprinodon variegatus*)	0.25 µg ai/L	0.38 µg ai/L	00152732	Acceptable

Estuarine/Marine Invertebrates, Acute

An acute toxicity study evaluating the effects of *lambda*-cyhalothrin to mysid shrimp determined it is very highly toxic. Another study on oyster larvae resulted in no effects and a toxicity classification of highly toxic.

Estuarine/Marine Invertebrate Acute Toxicity

Species	Toxicity Value	Toxicity Category	MRID No.	Study Classification
Mysid (*Americamysis bahia*)	96-h LC_{50} = 0.0049 µg ai/L	Very highly toxic	00152729	Acceptable
Pacific oyster larvae (*Crassostrea gigas*)	48-h LC_{50} > 0.59 mg ai/L	Highly toxic	00152728	Acceptable

Estuarine/Marine Invertebrates, Chronic

A chronic life cycle toxicity study evaluated the effects of *lambda*-cyhalothrin on the mysid shrimp. Toxicity values were based on reproduction endpoints.

Estuarine/Marine Invertebrate Chronic Toxicity

Species	NOEL	LOEL	MRID No.	Study Classification
Mysid (*Americamysis bahia*)	0.22 ng ai/L	0.49 ng ai/L	073989 (Accession number)	Supplemental Reproductive success could not be calculated because raw data were not provided.

c. Toxicity to Plants

Toxicity to Terrestrial Plants

There are no registrant-submitted studies for terrestrial plants. The reservoir of open literature was consulted for information. Two studies were identified as providing qualitative information about the effects of *lambda*-cyhalothrin on plants. Both studies were efficacy studies; thus the information on plant is secondary to the main purpose of the experiments. Additionally, the introduction of pests adds an extra factor to the study, potentially reducing the reliability of its results.

Terrestrial Plant Studies

Species	Parameter	NOAEC (lb a.i./A)	Citation	Study Classification
Wheat (*Triticum aestivum*)	Yield	0.02	Patton and Dively, 1999	Qualitative
Groundnut (*Arachis hypogaea*)	Yield	0.004	van Eeden et. al, 1995	Qualitative

Toxicity to Aquatic Plants

One study is available for aquatic plants. The EC_{50} was based on the growth rate of the algae.

Aquatic Plant Toxicity

Species	EC_{50}	MRID No.	Study Classification
Green algae (*Pseudokirchneriella subcapitata*)	> 310 µg ai/L	00152731	Supplemental Low recovery rates at the end of the experiment (3-11%) possibly because of solubility issues.