Appendix M. Open Literature Review Summaries for Included ECOTOX Papers

Chemical Name: Esfenvalerate (study is about fenvalerate)

CAS No: 66230-04-4 (fenvalerate: 51630-58-1)

ECOTOX Record Number and Citation: 92825 Awchar, S. L., U. S. Satpute, D. N. Sarnaik and D. B. Sarode. 1995. Effect of certain chemical and botanical insecticides on some beneficial insects associated with mustard. J. Biol. Control 9(1):13-15.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: November 27, 2007

Summary of Study Findings: Mustard plants were treated twice (11 day interval) with twelve chemicals, including a number of "botanical" and conventional insecticides and observed for aphid, parasitoid, and bee activity from 64 – 75+ days after sowing. Fenvalerate resulted in significantly lower (56.7% versus 93.3% for controls) emergence of parasitoid larvae from aphid mummies and significantly higher reduction (79.3% versus 55.2% for controls) in bee visitation.

Description of Use in Document (QUAL, QUAN, INV): Qualitative

Rationale for Use: Provides further information on effects to beneficial insects, including species that are predators of pests.

Limitations of Study: Little detail is provided in the study. The statistical analysis is partially described (ANOVA), but the method of mean comparison is not. Details of the study methods (e.g., coincidence of the treatments with observations, how long observations were made) were not available.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

Chemical Name: Esfenvalerate

CAS No: 66230-04-4

ECOTOX Record Number and Citation: 89542 Bouldin, J.L., C.D. Milam, J.L. Farris, M.T. Moore, S. Smith Jr., and C.M. Cooper. 2004. Evaluating toxicity of Asana XL (esfenvalerate) amendments in agricultural ditch mesocosms. Chemosphere 56:677-683.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: November 27, 2007

Summary of Study Findings: A storm event (0.64 cm) producing runoff with esfenvalerate was simulated in an agricultural drainage ditch. Aqueous grab samples and a composite sediment sample from several locations were collected prior to the application. Aqueous and sediment samples were then taken after application at 0.5-, 3-, and 24 hours and 28 days post application at 0, 20, 80, 200, and 600 m downstream (also at 56 days for sediment). Reference upstream samples were also collected at -10 m. These were analyzed for esfenvalerate residues and were used in aqueous and sediment toxicity tests with fish and invertebrates. Toxicity tests were conducted on an aquatic invertebrate (*Ceriodaphnia dubia*) and a fish (*Pimphales promelas*), and sediment toxicity tests were conducted with midge (*Chironomus tentans*). The highest concentration of esfenvalerate was detected at the injection point (0 m) at 3 hours post application. Survival of *C. dubia* and *P. promelas* was 0% at 0 and 20 m at 0.5 and 3 hours post application. At 3 hours post application, survival of *C. dubia* was 0% at 80 m and was 17.5 % for *P. promelas*. Survival was ≥72.5% for all other times and distances, with the exception of *C. dubia* at 80m 24 hours post application (45 ± 44%) and *P. promelas* at 80 m 28 days post application (60 ± 25.8 %). Survival and growth of *Chironomus tentans* was significantly lower than control at the injection site only, but at all sampling times. Survival was highest 3 hours post application (25 ±16%) and declined through 56-days to 6.3 ± 7.4%). Pesticides were also measured in plant material at 20, 80, 200 and 6000 m from the injection site at 3 hours, 24 hours, 28 days, and 56 days post application. Concentrations in plant material was higest at 20 m, 3 hours post application (2010.34 ppb) and declined with distance and time.

Description of Use in Document (QUAL, QUAN, INV): Qualitative

Rationale for Use: The purpose of this study was to evaluate the potential for agricultural drainage ditches to reduce the effects and movement of pesticides in agricultural drainage systems. However, the study does demonstrate the potential effects of esfenvalerate runoff in a system with moving water

Limitations of Study: Reference is made to the application rate simulated by the methods, but the application rate is never provided. The amount of esfenvalerate added to the mixture to simulate the event was 86 mL, but the percentage of active ingredient in the test material was not provided.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate (study is about fenvalerate)

CAS No: 66230-04-4 (fenvalerate: 51630-58-1)

ECOTOX Record Number and Citation: 72820 Chauhan, L. K. S., P. N. Saxena, and S. K. Gupta. 1999. Cytogenetic effects of cypermethrin and fenvalerate on the root meristem cells of *Allium cepa*. Environ. Exper. Bot. 42(3):181-189.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: November 21, 2007

Summary of Study Findings: The purpose of the study was to test the dose-response of fenvalerate on onion root growth and cytogenesis. Onions were grown in test concentrations of fenvalerate of 7, 14, and 28 ppm for five days, and root growth compared to the control was determined on the fifth day. The EC50 was calculated as the concentration that inhibited growth by 50%, and this was determined to be 14.25 ppm. Through examinations of cells at the onion root tip, the authors concluded that growth reductions were caused by chromosome and mitosis aberrations.

Description of Use in Document (QUAL, QUAN, INV): Qualitative

Rationale for Use: EFED does not have any data by which to estimate the potential for risk to plants, and this study provides some indication that fenvalerate (and esfenvalerate) could result in effects to plants.

Limitations of Study: The volume of the liquid in which the onions are grown is not reported, so an estimate of the application rate that could result in this concentration in the soil cannot be determined.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate (study is about fenvalerate)
CAS No: 66230-04-4 (fenvalerate: 51630-58-1)

ECOTOX Record Number and Citation: 12714 Day, K., and N. K. Kaushik. 1987. An assessment of the chronic toxicity of the synthetic pyrethroid, fenvalerate, to *Daphnia galeata mendotae*, using life tables. Environ. Pollut. 44:13-26.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: November 21, 2007

Summary of Study Findings: The objective of this study was to examine the chronic effects of fenvalerate on the crustacean, *Daphnia galeata mendotae*, as measured by life table parameters. These parameters indicate population effects that may result from exposure. *Daphnia* were raised through several generations, and adults of the final generation were exposed to 0, 0.005, 0.01, 0.05, or 0.10 ppb ai fenvalerate from a stock solution of 30% ai emulsifiable concentrate (EC) formulated product. An additional EC control containing the EC without fenvalerate was included, and it was determined that the other ingredients did not have a toxic effect in the experiment. Survivorship was lower in all fenvalerate treatments except the 0.005 ppb concentration, in which survivorship was significantly higher. No young were produced at the 0.10 ppb concentration, and the average number of young produced at the 0.01 and 0.05 ppb concentrations were reduced due to lower survivorship. The average brood size was reduced in all treatments. Life table parameters were affected by the exposure to fenvalerate. The intrinsic rate of increase was reduced in the 0.05 ppb group and was reduced to 0 in the 0.10 ppb group. The net reproductive rate was reduced in the 0.01 ppb treatments and higher, and generation time was reduced in these treatments, as well.

Description of Use in Document (QUAL, QUAN, INV): Qualitative.

Rationale for Use: Provides additional information for chronic effects. Substantiates potential effects on populations.

Limitations of Study: The duration of the exposure is unclear. The authors argue that many chronic studies are not carried out for a sufficient length of time; however, it appears that the *Daphnia* in this study were exposed for the production of one generation only. More generations would produce better estimates of life table parameters. The life table parameters add some population information, but do little more than confirm what is inferred by examining effects on individuals. These measurements would have more value if the population had been followed for more generations, or if the authors had used the life table to make predictions about population effects.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate

CAS No: 66230-04-4

ECOTOX Record Number and Citation: 93363 El-Daly, F. A. 2006. Role of fenvalerate (pyrethroid) and cyanox (organophosphorus) insecticides on growth and some metabolic

activities during seedling growth of *Raphanus sativus* L. Pakistan Journal of Biological Sciences 9(12):2313-2317.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: October 23, 2007

Summary of Study Findings: Radish seeds were germinated on moist filter paper containing 1-1000 M concentration (0.42 – 420 mg/L) of fenvalerate. Germination and plant growth was observed immediately afterward. The study noted that with fenvalerate, an increase in growth was observed in some growth parameters at the lowest levels, but a decrease was observed at the highest levels. The authors also noted a decrease in percent germination, which was also not dose-dependent. The study does not provide information such that the amount to which the plants were exposed can be converted to lbs ai/acre.

Description of Use in Document (QUAL, QUAN, INV): Qualitative

Rationale for Use: Plant data are not available for esfenvalerate for determination of indirect effects. This study provides some qualitative information about the potential effects that this compound may have on plants.

Limitations of Study: The study lacks several details regarding the methods, including the sample size of each treatment group and statistical analyses that were performed. As mentioned above, the study also does not provide information such that the exposure amount in units of lbs ai/acre can be estimated.

Primary Reviewer: Shannon Borges, Biologist, EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate
CAS No: 66230-04-4

ECOTOX Record Number and Citation: 88266 Johansson, M., H. Piha, H. Kylin, and J. Merila. 2006. Toxicity of six pesticides to common frog (*Rana temporaria*) tadpoles. Environ. Toxicol. Chem. 25:3164-3170.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: November 21, 2007

Summary of Study Findings: Tadpoles of common frogs were exposed to 0.3, 1.3 and 5.0 ppb esfenvalerate for 72 hours in acute tests, wherein their mean dry weight, body length, and tail length were measured along with survival. Esfenvalerate did not show any significant effects on size parameters, indicating no effects on growth, nor was there any significant effect on survival. The study cites an estimate of esfenvalerate toxicity to amphibians (LC_{50} = 7.3 ppb ai), which it uses as a basis for setting the exposure levels for the study. However, they provide no information as to what species this value is for.

Description of Use in Document (QUAL, QUAN, INV): Qualitative.

Rationale for Use: Provides information about toxicity to amphibians, and possibly that amphibians are less sensitive than the surrogate species used to estimate risk. If so, then this information would provide evidence that the Agency's use of fish toxicity values result in a conservative estimate of risk.

Limitations of Study: If the goal was to determine a definitive toxicity value, then the values tested were apparently too low. The study provides little information about the toxicity of esfenvalerate to the common frog.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate
CAS No: 66230-04-4

ECOTOX Record Number and Citation: 15117 Materna E. J., C. F. Rabeni, and T. W. LaPoint. 1995. Effects of the synthetic pyrethroid insecticide, esfenvalerate, on larval leopard frogs (*Rana* spp.). Environ. Toxicol. Chem. 14(4):643-622.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: November 21, 2007

Summary of Study Findings: Tadpoles of three species of leopard frogs (*Rana pipiens*, *Rana sphenocephala*, and *Rana blairi*) were used to test acute effects of esfenvalerate in the laboratory and in the field. R. pipiens was exposed in the laboratory to concentrations of esfenvalerate at 0.8, 1.3, 2.2, 3.6, 6.0, and 10.0 ppb ai for 96 hours at 20°C, and behavioral effects, including convulsive and spasmodic behavior, twitching, and twisting of the body and tail. The test levels were based on a range-finding study in which mortality occurred at concentrations of 100 ppb ai and higher. Since the goal of the study was to examine sublethal effects, the test concentrations were set lower than this value. Additionally, the effects of temperature (18°C and 22°C) on behavior were observed in tadpoles exposed to nominal concentrations of 0.0, 1.23, 1.76, 2.64,

5.07, 7.47, and 11.47 ppb ai. In the field experiment, tadpoles of *R. blairi* and *R. sphenocephala* were contained within enclosures treated with 0.0, 3.6, 6.0 and 10.0 ppb ai, and growth and behavioral abnormalities were measured.

In the laboratory study, an EC_{50} of 4.85 ppb ai was determined based on behavioral effects. Some mortality was observed at 2.2, 6.0, and 10.0 ppb ai. The EC_{50} at 18°C was 3.4 ppb ai and was 6.14 ppb ai at 22°C based on tail-kink abnormalities. In the pond study, effects observed were decreased activity, convulsions, tail kinking, and mortality. Mortality occurred in nearly a dose-response fashion, but an LC_{50} could not be calculated due to extreme variability in the measured concentrations. Mortality reached nearly 85% in the highest concentration in this study, and occurred rapidly (within the 96-hour test period).

Description of Use in Document (QUAL, QUAN, INV): Qualitative.

Rationale for Use: Provides information about toxicity to amphibians, and possibly that amphibians are less sensitive than the surrogate species used to estimate risk. LC_{50}s would be expected to be higher than the EC50s calculated here, but these could not be calculated. However, this study also provides evidence that the Agency's use of fish toxicity values result in a conservative estimate of risk to amphibians.

Limitations of Study: There was wide variation in the nominal and measured concentrations, and the concentrations decreased by up to 80% of nominal in some of the laboratory tests. In the field test, the actual concentrations measured in the test chambers ranged 35% to 206% of nominal, which could have been the result of inadequate mixing within the test system.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate (study is about fenvalerate)
CAS No: 66230-04-4 (fenvalerate: 51630-58-1)

ECOTOX Record Number and Citation: 87183 Pieters, B. J., A. Paschke, S. Reynaldi, M. H. S. Kraak, W. Admiraal, and M. Liess. 2005. Influence of food limitation on the effects of fenvalerate pulse exposure on the life history and population growth rate of *Daphnia magna*. Environ. Toxicol. Chem. 24(9):2254-2259.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: December 4, 2007

Summary of Study Findings: The goal of this study was to examine the effects of low food conditions on life history characteristics of *Daphnia magna*, especially the intrinsic rate of increase (*r*), during pulses of pesticide exposure. Fenvalerate was used as a model pesticide, but the study does provide some information on the effects of this pesticide under field conditions.

Daphnia were exposed to control, 0.03, 0.1, 0.3, 0.6, 1.0, and 3.2 ppb fenvalerate concentrations (nominal) for 24 hours under two different feeding regimes (low and high). The effect on *r* was measured over the course of 21 days post-exposure. Under both food levels, the highest concentration caused 100% mortality by Day 8 post-exposure, and most mortality in all groups was complete by this day. In the high food group, mortality did not exceed 35% in any test concentration group, whereas in the low food group mortality was higher in all test concentrations above 0.1 ppb. Low food conditions significantly increased age at first reproduction and decreased mean brood number, mean brood size, and cumulative reproduction per living female by the end of the test (Day 21). As a result, r was significantly lower in the low food concentration test groups, indicating that greater detrimental population effects would be expected under these conditions.

Description of Use in Document (QUAL, QUAN, INV): Qualitative.

Rationale for Use: Provides additional information for chronic effects, and also substantiates potential effects on populations.

Limitations of Study: There are no substantial limitations.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate (study is about fenvalerate)

CAS No: 66230-04-4 (fenvalerate: 51630-58-1)

ECOTOX Record Number and Citation: 92483 Reynaldi, S., S. Duquesne, K. Jung,and M. Liess. 2006. Linking feeding activity and maturation of *Daphnia magna* following short-term exposure to fenvalerate. Environmental Toxicology and Chemistry 25(7):1826-1830.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: October 23, 2007

Summary of Study Findings: *Daphnia* were exposed to sublethal (0.1, 0.3, 0.6, and 1.0 ppb ai, and also 0 ppb ai for controls) concentrations of fenvalerate for 24 hours and feeding activity and body size were observed. Reduced feeding activity and smaller body size was observed in *Daphnia* exposed to 0.3 ppb ai and higher concentrations. Delayed maturation was observed at concentrations of 0.6 ppb ai and higher. Although filtering (feeding) rates recovered within 2 days after exposure, long-term effects due to reduced feeding, such as growth retardation, did

occur. Growth retardation leading to delayed maturity affects freshwater invertebrates at the population level, as this affects population dynamics through delayed reproduction. Therefore, this study provides an indication that even short-term sublethal exposure to fenvalerate (and presumably esfenvalerate) may have the effect of reducing populations of freshwater aquatic invertebrates.

Description of Use in Document (QUAL, QUAN, INV): Qualitative

Rationale for Use: This study provides further information about sublethal and long-term effects that may occur in freshwater invertebrates due to short term exposure.

Limitations of Study: The exposure is short, however, may be representative of a situation that could occur in the field.

Primary Reviewer: Shannon Borges, Biologist, EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate

CAS No: 66230-04-4

ECOTOX Record Number and Citation: 40531 Roberts, B. L. and H. W. Dorough. 1984. Relative toxicities of chemicals to the earthworm (*Eisenia foetida*). Env. Toxicol. Chem. 3:67-78.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: November 7, 2007

Summary of Study Findings: In this study, acute contact toxicity with fenvalerate was tested by exposing earthworms to technical grade fenvalerate soaked into a filter paper for 48 hours. Based on this study, the authors considered fenvalerate to be "very toxic," with an acute contact toxicity measured at 74.1 µg ai/cm^2.

Description of Use in Document (QUAL, QUAN, INV): Qualitative

Rationale for Use: There are no guideline requirements for studies with soil macroinvertebrates. However, this study does provide some information by which to make a qualitative judgment of the hazard of esfenvalerate to this taxon.

Limitations of Study: EFED has not established an acute contact toxicity rating based on these units, and it is not known from this study how much active ingredient the earthworms were exposed to.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A

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Chemical Name: Esfenvalerate

CAS No: 66230-04-4

ECOTOX Record Number and Citation: 41092 Toscano, N. C., F. V. Sances, M. W. Johnson, and L. F. LaPre. 1982. Effect of various pesticides on lettuce physiology and yield. J. Econ. Entom. 75: 738-741.

Purpose of Review (DP Barcode or Litigation): Litigation

Date of Review: November 7, 2007

Summary of Study Findings: This study utilized multiple varieties of lettuce and found no discernable effects of fenvalerate on these plants. Fenvalerate (2.4 EC) was applied via backpack sprayer at 0.22 kg ai/ha (0.20 lbs ai/ac) to lettuce. The lettuce plants received either one or two treatments per week over the course of approximately 1.5 months, and lettuce was harvested after approximately two months. No difference in growth (measured in mass) was observed between plants treated with fenvalerate one or two times and the untreated controls.

Description of Use in Document (QUAL, QUAN, INV): Qualitative

Rationale for Use: Study is scientifically sound and provides qualitative information about the effect of fenvalerate on plants. Guideline data for plants is not available for fenvalerate or esfenvalerate.

Limitations of Study: Applications at multiple rates were not made, so a definitive NOAEC cannot be determined. The study tests fenvalerate, rather than esfenvalerate. Esfenvalerate contains the same isomers, but contains a greater amount of the isomer with insecticidal action.

Primary Reviewer: Shannon Borges, Biologist, OPP/EFED/ERB2

Secondary Reviewer (required if study results are used quantitatively): N/A