33PP

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 9 1994

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

**MEMORANDUM**

**SUBJECT:** **Transmittal of EFED List A Summary Report for Ethion (Chemical # 58401) Case # 0090**

**FROM:** Renée Lamb
Science Analysis and Coordination Staff
Environmental Fate and Effects Division

**THRU:** Evert K. Byington, Chief
Science Analysis & Coordination Staff
Environmental Fate and Effects Division

**TO:** Esther Saito, Chief
Reregistration Branch
Special Review & Reregistration Division

Attached please find the following documents for the completed EFED summary report of ethion.

1. EFGWB Science Chapter
2. EEB Science Chapter
3. SACS Reregistration Summary Report

Ethion exceeds the levels of concern for acute and chronic terrestrial animals. In addition, data gaps were identified for this reregistration case. If you have any questions concerning this case, please contact Renée Lamb at 305-5084.

CC:\

| | | |
|---|---|---|
| Anne Barton | Tony Maciorowski | Laura Dye |
| Hank Jacoby | Doug Urban | Larry Schnaubelt |
| Elizabeth Leovey | Evert Byington | Richard King |
| List A File | List A Cover Memo File | Peter Caulkins |

## C. Environmental Assessment

The environmental fate data base for Ethion is largely complete. Ethion is only slightly soluble in water, has low volatility, degrades slowly in soil and accumulates in fish tissue. The primary routes of dissipation appear to be hydrolysis under alkaline conditions (half-life of 18 days) and microbial degradation in soil (half-life of 101 days). In the laboratory studies, ethion degraded to carbon dioxide ($CO_2$), ethion monoxon, ethion dioxon, and several polar degradates including diethyl thiophosphate (ESOP), diethyl dithiophosphoric acid (ESSP), and formaldehyde and/or thioformaldehyde. Under anaerobic soil conditions, o,o-diethyl-S-(methylthio) methyl)phosphorodithoate was also identified. The only degradates isolated in the laboratory in quantities greater than 10 percent of applied were the polar degradates and $CO_2$. In aerobic soil, $CO_2$ comprised 35 percent of the applied after 102 days. After aging in silt for 30 days, ethion residues were not mobile. The mobility of unaged ethion is not conclusively known at this time; however, based on the laboratory and field data submitted thus far, including monitoring data compiled in EPA's *Pesticides in Ground Water Database* (9/92), it is not expected that ethion will pose a threat to ground water, though it may accumulate in soil if multiple applications are made during a growing season. The mobility of its toxicologically significant degradate, ethion monoxon, is unknown at this time.

Although it is not likely that ethion will contaminate surface water by way of dissolved runoff, movement into surface water may occur through erosion and/or spray drift. Erosion is the typical avenue of movement found in an orchard environment (the primary use site of ethion) because of the turf ground cover. Also, spray drift from aerial or airblast application can impact nearby bodies of water and canals. This is important because ethion is very highly toxic to aquatic organisms and because ethion bioaccumulates in fish tissue. The Spray Drift data requirements have been imposed in order to help assess how much and how far ethion can be expected to drift off-site.

Ethion has been shown, on an acute basis, to be highly to moderately toxic to mammals and birds, very highly toxic to all freshwater and estuarine invertebrate and fish species tested to date, and highly toxic to bees exposed directly to residues during application. Moreover, even though the data requirement is only partially satisfied, the result of the one acceptable avian reproduction study also indicates chronic effects to birds. Additional evidence suggests that ethion may display phytotoxic characteristics as well.

Although the majority of the data requirements for ethion have been fulfilled, there are several others which remain unsatisfied. These data are necessary before a complete assessment of risk to nontarget organisms can be completed.

### 1. Environmental Fate

At this time, four data requirements in the environmental fate guidelines are not fulfilled for ethion: Leaching and Adsorption/Desorption (163-1); Terrestrial Field Dissipation (164-1); and Spray Drift(201-1 and 202-1). EFED has sufficient data for comprehensive qualitative and quantitative environmental fate, ground and surface water assessments for ethion.

## a. Environmental Chemistry, Fate and Transport

### (1) Hydrolysis (161-1)

Ethion is stable to hydrolysis in acidic and neutral, sterilized water, but does hydrolyze slowly in alkaline environments. Methylene-labeled $^{14}C$-ethion at 0.25 ppm, was stable with a half-life of greater than 30 days in sterile aqueous pH 5 and 7 buffered solutions incubated in the dark at 25°C. At pH 9, $^{14}C$-ethion at 0.25 and 1.00 ppm degraded with a half-life of approximately 18 days.

$^{14}C$-Ethion decreased from 95-to-88.6 percent of the recovered radioactivity during 30 days of incubation at pH 5, from 93.5-to-81.3 percent at pH 7, and from 90-to-18.0 percent at pH 9. The majority of the $^{14}C$-residues at day 30 were polar degradates tentatively identified as formaldehyde and/or thioformaldehyde (3.7 percent of the recovered in the pH 5 solution; 8.6 percent in the pH 7 solution; and 79.1 percent in the pH 9 solution).

Ethion monoxon, at up to 7 percent of the recovered (day 30, pH 7), was present at all three pHs; unidentified organosoluble compounds comprised up to 4.5 percent of the recovered (maximum at day 3 in the pH 9 solution). The hydrolysis data requirement is satisfied. (MRID 00155507)

### (2) Photodegradation in water (161-2)

Ethion is stable to photolysis in water. Radiolabeled [$^{14}C$]ethion applied at 0.57 ppm, degraded in pH 7 buffer to diethyl dithiophosphoric acid (ESPP), sodium salt (ESOP), ethion monoxon, and two unknowns in both natural sunlight and dark control samples. Each unknown in both was less than 8 percent of the applied radiocarbon. The extrapolated half-life of light-exposed and dark control samples was 101 days and 154 days, respectively. A comparison of the results from the irradiated samples and dark controls indicates that photolysis in water is not a significant degradation process for ethion. The degradation profiles for light-exposed and dark control samples were similar.

In the irradiated test solutions, ethion was 97.9 percent of the applied immediately posttreatment, 65.4 percent at 3 days, 73.1-to-81.9 percent at 9-to-15 days, 59.5-to-65.0 percent at 22 days, and 66.9-to-

77.6 percent at 30 days. In the dark control solutions, ethion was 67.0-to-85.8 percent of the applied.

In the extracts from the irradiated test solutions from the 22-day sampling interval, the polar degradates were identified as ESOP, present at 15-to-25 percent; ESSP, at approximately 10 percent; ethion monoxon, at less than 2 percent; and, two unknowns, each present at less than 8 percent. In the irradiated samples, total $CO_2$ and organic volatiles were 5.4 percent and 0.4 percent of the applied radioactivity, respectively. This study is acceptable and satisfies the photodegradation in water data requirement. (MRID 41930201)

**(3) Photodegradation in soil (161-3)**

Photodegradation on soil does not appear to be a significant route of dissipation for ethion. [$^{14}$C]Ethion applied at 8.6 ppm, degraded slowly on a thin layer of sterilized sandy loam soil in both sunlight exposed and dark control samples. The extrapolated half-lives of the irradiated and dark control samples were 61.6 and 175.9 days, respectively.

Ethion declined from 86.7-to-87.8 percent of the applied radioactivity immediately after treatment to 66.8-to-68.5 percent at 7 days, and 50.0-to-67.3 percent at 18-to-31 days. In the dark control samples, ethion was 63.5-to-87.8 percent of the applied.

Following application to a thin soil layer and exposure to natural sunlight for 31 days, ethion degraded to $CO_2$, soil-bound residues and numerous, low yield, unidentified peaks detected by High Pressure Liquid Chromatography (HPLC). No photoproducts were detected at greater than 10 percent of the overall product yield. Up to 9.4 percent of applied radiocarbon occurred as a broad solvent-front peak by HPLC and as origin material on Thin-Layer Chromatography (TLC). The ion exchange chromatography step resolved this band into three peaks. This material was considered to consist of polar ethion hydrolysis products, but was observed in different yields in exposed and dark control samples. Less than 6 percent of the applied radiocarbon in 31 day light-exposed samples was tentatively identified as ethion monoxon. Unextracted radioactivity in the soil was 3.2-to-18.9 percent. In the irradiated samples, total $CO_2$ and organic volatiles were 5.1 and 5.2 percent of the applied radioactivity, respectively. In dark controls, $CO_2$ and organic volatiles were each 1.6 percent of the applied. This study is acceptable and satisfies the photodegradation on soil data requirement. (MRID 41930202)

**(4) Aerobic soil metabolism (162-1)**

Ethion degrades slowly in soil under aerobic conditions. Methylene-labeled [$^{14}C$] Ethion at 3.4 ppm degraded with a half-life of 101 days in sandy loam soil incubated in the dark at 25 $\pm$ 1° C and 77 percent of field moisture capacity. The major metabolite was $^{14}CO_2$. No nonvolatile degradates were isolated. At 102 days posttreatment, ethion comprised 47.2 percent of the applied radioactivity, water-soluble [$^{14}C$] residues comprised 0.8 percent, unextractable [$^{14}C$] residues comprised 9.0 percent, and $^{14}CO_2$ totaled 35.4 percent. This study is acceptable and satisfies the aerobic soil metabolism data requirement. (MRID 00155510)

**(5) Anaerobic soil metabolism (162-2)**

Ethion degrades slowly in flooded soil under anaerobic conditions. A case in point, within sandy loam soil that was incubated at 25°C and kept in the dark for 60 days, ethion degraded slowing. The extrapolated half-life of ethion under these conditions was 167 days following 31 days of aerobic incubation. Radiolabeled ethion [$^{14}C$ ethion] was 92.5-to-94.7 percent of the applied immediately posttreatment, 78.0-to-79.9 percent at 31 days (just prior to flooding), 72.6-to-73.4 percent at 14 days postflooding (45 days posttreatment), and 60.4-to-61.2 percent at 60 days postflooding (91 days posttreatment).

The major products formed were carbon dioxide ($^{14}CO_2$, which comprised up to 13.9 percent of the final products over the course of the study), and polar acidic compounds representing breakdown of the parent molecule into phosphoric acid esters. The degradates identified in the floodwater and soil were O,O-diethyl-S-[(methylthio)methyl] phosphorodithioate (FMC 78153), which increased to 0.16-to-0.18 percent of the applied during the 60 days of flooding; O,O-diethyl S-[[(diethoxyphosphinothioyl)thio]methyl]-phosphorothioate (ethion monoxon), which increased to 0.54-to-0.55 percent during flooding; and O,O,O',O'-tetraethyl S,S'-methylene bis(phosphorothioate) (ethion dioxon), which increased to 0.11-to-0.14 percent during flooding. The anaerobic soil metabolism data requirement (162-4) has been satisfied. (MRID 42276801)

**(6) Anaerobic aquatic metabolism (162-3)**

No data were required. There are no registered aquatic uses for ethion.

(7) **Aerobic aquatic metabolism (162-4)**

No data were required. There are no registered aquatic uses for ethion.

(8) **Leaching and adsorption/desorption (163-1)**

This data requirement is only partially satisfied by the study which is summarized here (MRID 41930203): Aged (30 days) [$^{14}$C]ethion residues were not mobile in columns of sandy loam soil that were leached with 20 inches of 0.01 N $CaCl_2$ solution. Eighty-five and one half percent of the applied radioactivity remained in the top inch of soil after leaching. Extractable residues in the 0-1" segment accounted for 77.25 percent of the applied dose and 95 percent of the extractable residues were identified as parent ethion. A range of 2.85-to-3.59 percent of the applied radioactivity was found in the leachate.

Batch equilibrium data on four soils are still needed for unaged ethion and its toxicologically significant degradate, ethion monoxon. The submitted study (MRID 41885801) was reviewed and found invalid for the following reasons:

a. Ethion degraded during the equilibration period. Therefore, accurate $K_d$ values cannot be determined. HPLC analyses of the adsorption supernatants showed the percent parent compound to be 74.65, 59.3, 60.5, and 40.4 percent for sandy, sandy loam, clay loam, and silt loam soils. The degradates were not identified or quantified.

Also, the registrant did not explain why ethion was unstable in the soil. Calcium chloride slurries are stable to hydrolysis at pH's 5 and 7; in this study, average pH ranged from 6.32-to-7.00 in the four soil/water systems. Also, ethion degraded with a half-life of 101 days in the aerobic soil metabolism study.

b. The preliminary study demonstrated that ethion binds extensively to glassware, both silanized and nonsilanized. Immediately after dosing with 0.5 ppm $^{14}$C-ethion in 20 ml of 0.1N $CaCl_2$ in the silanized and non-silanized 50 ml glass test containers, only 52.2 and 71.1 percent, respectively, of the applied radioactivity was in solution. After additional mixing for up to 3 hours, only 45-to-80 percent of the dosed radioactivity was in solution in the silanized glassware and 68-to-82 percent in the nonsilanized glassware. The study author attempted to account for this binding by letting the system equilibrate for 2 hours, measuring the "initial" concentration of ethion in solution, and then adding the soil. Data were not provided to confirm that no additional adsorption to the walls of the test container occurred during the 24 hour batch equilibrium testing interval. Likewise, no data were included which established that ethion did not later desorb from the glassware. In fact, according to the study author, additional adsorption to the test container did occur in at least the sandy soil test system. The failure to account for adsorption to the test container would result in miscalculation of the adsorption and desorption coefficients. It is not clear why another material such as polycarbonate, polyethylene, or polypropylene, for example, was not used instead of the 50 ml glass test containers.

c. According to the adsorption and desorption isotherm data, there was a higher concentration of ethion in soil (all soils except for sand) after desorption, than was present after the adsorption phase of the experiment. The x/m term was greater for desorption than for adsorption. In a correctly run batch equilibrium experiment, the concentration of pesticide in soil after desorption cannot be greater than what was present at the start of desorption because no additional pesticide is added to the system. A possible explanation for why this occurred in this experiment is that ethion that had previously adsorbed to the walls of the test container during the initial 2 hour equilibration or during the adsorption phase of the experiment, later desorbed and finally adsorbed to the soil.

The results of the study are therefore questionable. Both the adsorption and desorption $K_d$'s as well as the calculated material balances are affected by the problem described above.

**(9) Laboratory Volatility (163-2)**

Volatility from soil is not an important route of dissipation for ethion. The results of the study demonstrated that 98.3-to-99.5 percent of ethion applied to soil remained in the soil and was not released into the environment by volatilization. Ethion, formulated as Ethion 4 Miscible, volatilized at maximum rates of $5.04 \times 10^{-3}$ ug/cm$^2$/hour and $1.64 \times 10^{-3}$ ug/cm$^2$/hour from sandy soil adjusted to 50 percent of field moisture capacity and incubated at 25.5°C with airflow rates of 100 and 300 mL/minute, respectively. Ethion volatilized at maximum rates of $1.19 \times 10^{-3}$ ug/cm$^2$/hour and $2.35 \times 10^{-3}$ ug/cm$^2$/hour from sandy soil initially adjusted to 75 percent of field moisture capacity and incubated with airflow rates of 100 and 300 mL/minute, respectively. Maximum volatilization occurred within the 24-hour period following treatment.

The vapor pressure of ethion ranged from $1.16 \times 10^{-7}$ mmHg to $5.13 \times 10^{-6}$ mmHg. This study fulfills the data requirement for a laboratory volatility study. (MRID 42227201)

The study summarized below provides ancillary information. The study cannot be used to fulfill the laboratory volatility data requirement.

This study does not satisfy the laboratory volatility data requirement because ethion degraded extensively under the test conditions. The registrant did not explain why ethion was unstable in the test system while the half-life in the aerobic soil metabolism study was 101 days. Ethion was only 30.5-to-70.7 percent of the radioactivity, with no discernible pattern, based on HPLC analysis of soil extracts and test chamber rinses from the 7- and 14-day sampling intervals. Up to 69.5 percent of the radioactivity applied to the HPLC column was not identified. Trapped volatiles were not identified.

Residues volatilized slowly from sandy soil that was treated with a miscible formulation of [$^{14}$C]ethion plus unlabeled ethion at 1 lb a.i./A. The volatility rates ranged from $4.15 \times 10^{-4}$ to $9.44 \times 10^{-3}$ ug/cm$^2$/hr. The samples were incubated in the dark at $25 \pm 1$°C for up to 14 days at either 50 or 75 percent field moisture capacity with a flow rate of either 100 or 300 mL/min. The variable soil moisture and flow rate through the system did not appreciably affect the volatility. The vapor pressure ranged from $2.06 \times 10^{-7}$ to $4.87 \times 10^{-6}$ torr. The concentration of residues in air ranged from 4.27 ug/m$^3$ to $1.01 \times 10^2$ ug/m$^3$. (MRID 41885802)

**(10) Terrestrial field dissipation (164-1)**

This data requirement is partially satisfied by the following study (MRID 42113701):

Ethion shows moderate persistence and low mobility under actual field conditions. Ethion dissipated with half-lives of 67 and 68 days from the upper 6 inches of sandy soil collected from the drip line of trees, and 74-to-83 days from the upper 6 inches of sandy soil collected from the rows between the trees from two Florida sites planted to oranges, that were treated three times with ethion (Ethion 4 Miscible, 46.5 percent active ingredient) at 3 lbs a.i./A/application (total 9 lbs a.i./A; approximately 80 days between applications). The degradate ethion monoxide was detected in the 0- to 6-inch soil depth. Ethion residues were found primarily in the 0- to 6-inch horizon. The highest mean residues of ethion (0.42 and 0.44 ppm, respectively for

Trial 01 and 02) occurred in the drip-line samples taken at 1 day after the third application. Mean residues ranged from 0.25-to-0.44 ppm at one day after final application and declined to 0.03-to-0.07 ppm at the end of the study. Ethion residues were found at low levels (0.01 to 0.11 ppm) in the 6-to-12 inch horizon during the study but declined to nondetectable levels ($<0.01$ ppm) by the 182-day interval. Mean residues of ethion monoxon were found in the 0- to 6-inch horizon at very low levels (0.01 to 0.02 ppm) during the first 30 days after the final application. Ethion monoxon residues were not detected ($<0.01$ ppm) at later intervals or deeper depths during the study.

For complete fulfillment of the terrestrial field dissipation data requirement, an acceptable bare ground study is required. The study cited above was conducted in two citrus plots in Florida. Because of the application method (airblast to foliage) and dense canopy, the residues in soil were somewhat variable. This is not unexpected given the conditions under which the study was conducted. A bare ground study should provide a clearer understanding of the fate and transport of ethion and its degradates in soil under field conditions.

**(11) Aquatic field dissipation (164-2)**

No data were required. There are no registered aquatic uses for ethion.

**(12) Confined crop accumulation (165-3)**

No data were required. There are no registered aquatic uses for ethion.

**(13) Accumulation in Fish (165-4)**

Ethion accumulates in bluegill sunfish. Accumulated residues depurate slowly. Ethion residues in bluegill sunfish during 42 days of exposure to methylene-labeled $^{14}C$-Ethion at 0.66-to-2.6 parts per billion (ppb), with maximum bioconcentration factors of 880x in the edible (fillet) tissue, 1500x in the whole fish, and 2400x in the visceral tissue. The maximum concentration of $^{14}C$-residues occurred on day 35, with 1400 ppb in the edible tissue, 2400 ppb in the whole fish, and 3800 ppb in the visceral tissue. During 14 days of depuration, $^{14}C$-residues declined to 580 ppb in the edible tissue, 610 ppb in the whole fish, and 990 ppb in the visceral tissue. This study fulfills the data requirement for an accumulation in fish study. (MRID 00153553)

**(14) Droplet size spectrum (201-1)**

This data requirement has not been satisfied. Because ethion is very highly toxic to aquatic organisms and is applied both aerially and by airblast, the Spray Drift data requirements were imposed in order to assess the extent of exposure of nearby bodies of water to ethion. These studies are being held in reserve pending the work currently being conducted by industry's Spray Drift Task Force, of which FMC Corporation is a member.

**(15) Drift Field Evaluation (202-1)**

This data requirement has not been satisfied. Because Ethion is very highly toxic to aquatic organisms and is applied both aerially and by airblast, the Spray Drift data requirements were imposed in order to assess the extent of exposure of nearby bodies of water to ethion. These studies are being held in reserve pending the work currently being conducted by industry's Spray Drift Task Force, of which FMC Corporation is a member.

**b. Environmental Fate Assessment**

Ethion is moderately persistent in the environment and accumulates in fish tissue. The primary routes of dissipation appear to be chemical hydrolysis under alkaline conditions and microbial degradation. In the laboratory studies, it was determined that ethion degrades to $CO_2$, ethion monoxon, ethion dioxon, and several polar degradates including diethyl thiophosphate (ESOP), diethyl dithiophosphoric acid (ESSP), and formaldehyde and/or thioformaldehyde. Under anaerobic soil conditions, O,O-diethyl-S-(methylthio)methyl)phosphorodithioate was also identified. The only degradates isolated in the laboratory in quantities greater than 10 percent of applied were the polar degradates and $CO_2$. In aerobic soil, $CO_2$ comprised 35 percent of the applied after 102 days. After aging in soil for 30 days, ethion residues were not mobile. The mobility of unaged ethion is not conclusively known at this time, however based on the laboratory and field data submitted thus far, including monitoring data compiled in EPA's Pesticides In Ground Water Database - (9/92), it is not expected that ethion will pose a threat to ground water, though it may accumulate in soil if multiple applications are made during a growing season. The mobility of its toxicologically significant degradate, ethion monoxon, is unknown. Lastly, volatilization from soil is not an important route of dissipation.

Although it is not likely that ethion will contaminate surface water by way of dissolved runoff, movement into surface water may occur through erosion and/or spray drift. Erosion is the typical avenue of movement found in an orchard environment (the primary use site of ethion) because of the turf ground cover. Also, spray drift from aerial or airblast application can impact nearby bodies of water and canals. This is important because ethion is very highly toxic to aquatic organisms and because ethion bioaccumulates in fish tissue. The Spray Drift data requirements have been imposed in order to help assess how much and how far ethion can be expected to drift off-site.

Chemical degradation studies have demonstrated that ethion is stable to hydrolysis at pH's 5 and 7, and to photodegradation in water and on soil. Ethion does hydrolyze at pH 9. Ethion was stable (half-life >>30 days) in sterile aqueous pH 5 and 7 buffered solutions incubated in the dark at 25°C. At pH 9, ethion degraded with a half-life of approximately 18 days. Ethion decreased from 95-to-88.6 percent of the recovered radioactivity during 30 days of incubation at pH 5, from 93.5-to-81.3 percent at pH 7, and from 90-to-18.0 percent at pH 9. The majority of the $^{14}C$-residues at day 30 were polar degradates tentatively identified as formaldehyde and/or thioformaldehyde (3.7 percent of the recovered in the pH 5 solution; 8.6 percent in the pH 7 solution; and 79.1 percent in the pH 9 solution). Ethion monoxon, at up to 7 percent of the recovered (day 30, pH 7), was present at all three pH's.

In the photodegradation in water study, ethion degraded in pH 7 buffer to ESSP, ESOP, monoxon and two unknowns (each less than 8 percent of the applied radiocarbon) in both light exposed (natural sunlight) and dark control samples. The extrapolated half-life of light-exposed and dark control samples was 101 days and 154 days, respectively. A comparison of the results from the irradiated samples and dark controls indicates that photolysis in water is not a significant degradation process for ethion. The degradation profiles for light-exposed and dark control samples were similar. In the irradiated test solutions, ethion was 97.9 percent of the applied immediately posttreatment, 65.4 percent at 3 days, 73.1-to-81.9 percent at 9-to-15 days, 59.5-to-65.0 percent at 22 days, and 66.9-to-77.6 percent at 30 days. In the dark control solutions, ethion was 67.0-to-85.8 percent of the applied. In the extracts from the irradiated test solutions from the 22-day sampling interval, the polar degradates were identified as diethyl thiophosphate, sodium salt (ESOP), present at 15-to-25 percent; diethyl dithiophosphoric acid (ESSP), at approximately 10 percent; ethion monoxon, at less than 2 percent; and, two unknowns, each present at less than 8 percent. In the irradiated samples, total $CO_2$ and organic volatiles were 5.4 and 0.4 percent of the applied radioactivity, respectively. In the photodegradation on soil study, ethion degraded slowly on a thin layer of sterilized sandy loam soil in both light exposed (natural sunlight) and dark control samples. The extrapolated half-life of irradiated and dark control samples was 61.6 and 175.9 days, respectively. Ethion declined from 86.7-to-87.8 percent of the applied radioactivity immediately posttreatment to 66.8-to-68.5 percent at 7 days, and 50.0-to-67.3 percent at 18-to-31 days. In the dark controls, ethion was 63.5-to-87.8 percent of the applied. Photolysis on soil is not a major degradation process for ethion. Following application to a thin soil layer and exposure to natural sunlight for 31 days, ethion degraded to $CO_2$, soil-bound residues and numerous, low yield, unidentified peaks detected by HPLC. No photoproducts of greater than 10 percent yield were detected. Less than 6 percent of the applied radiocarbon in 31 day light-exposed samples was tentatively identified as ethion monoxon. Unextracted radioactivity in the soil was 3.2-to-18.9 percent. In the irradiated samples, total $CO_2$ and organic volatiles were 5.1 and 5.2 percent of the applied radioactivity, respectively. In dark controls, $CO_2$ and organic volatiles were each 1.6 percent of the applied.

Microbial degradation of ethion in soil is slow. Ethion degraded with a half-life of 101 days in sandy loam soil incubated under aerobic conditions in the dark at 25 ± 1°C and 77 percent of field moisture capacity. The major metabolite was $^{14}CO_2$. At 102 days posttreatment, ethion comprised 47.2 percent of the applied radioactivity, water-soluble [$^{14}$C]residues comprised 0.8 percent, unextractable [$^{14}$C]residues comprised 9.0 percent, and $^{14}CO_2$ totaled 35.4 percent. Ethion slowly degraded in sandy loam soil that was incubated under anaerobic conditions (flooded) at 25°C in the dark for 60 days (extrapolated half-life of 167 days) following 31 days of aerobic incubation. Ethion was 92.5-to-94.7 percent of applied immediately posttreatment, 78.0-to-79.9 percent at 31 days (just prior to flooding), 72.6-to-73.4 percent at 14 days postflooding (45 days posttreatment), and 60.4-to-61.2 percent at 60 days postflooding (91 days posttreatment). The major products formed were evolved $^{14}CO_2$ (up to 13.9 percent over the course of the study), and polar acidic compounds representing breakdown of the parent molecule into phosphoric acid esters. The degradates identified in the floodwater and soil were O,O-diethyl-S-[(methylthio)methyl] phosphorodithioate (FMC 78153), which increased to a range of 0.16 and 0.18 percent of the applied during the 60 days of flooding; O,O-diethyl S-[[(diethoxy-phosphinothioyl)thio]methyl]-phosphorothioate (ethion monoxon), which increased to a range of 0.54 and 0.55 percent during flooding; and O,O,O',O'-tetraethyl S,S'-methylene bis (phosphorothioate) (ethion dioxon), which increased to a range of 0.11 and 0.14 percent during flooding.

Aged ethion residues were not mobile in columns of sandy loam soil that were leached with 20 inches of 0.01 N $CaCl_2$ solution. Eighty-five and one-half percent of the applied radioactivity remained in the top inch of soil after leaching. Extractable residues in the 0-1 inch segment accounted for 77.25 percent of the applied dose and 95 percent of the extractable residues were identified as parent ethion. Only 2.85-to-3.59 percent of the applied radioactivity was found in the leachate.

Volatility from soil is not an important route of dissipation for ethion. The results of the study demonstrated that 98.3-to-99.5 percent of ethion applied to soil remained in the soil and was not released into the environment by volatilization. Ethion, formulated as Ethion 4 Miscible, volatilized at maximum rates of $5.04 \times 10^{-3}$ ug/cm$^2$/hour and $1.64 \times 10^{-3}$ ug/cm$^2$/hour from sandy soil adjusted to 50 percent of field moisture capacity and incubated at 25.5°C with airflow rates of 100 and 300 mL/minute, respectively. Ethion volatilized at maximum rates of $1.19 \times 10^{-3}$ ug/cm$^2$/hour and $2.35 \times 10^{-3}$ ug/cm$^2$/hour from sandy soil initially adjusted to 75 percent of field moisture capacity and incubated with airflow rates of 100 and 300 mL/minute, respectively. Maximum volatilization occurred within the 24-hour period following treatment. The vapor pressure of Ethion ranged from $1.16 \times 10^{-7}$ mmHg to $5.13 \times 10^{-6}$ mmHg.

In the field, ethion dissipated with half-lives of 67-to-68 days from the upper 6 inches of sandy soil collected from the drip line of trees, and 74-to-83 days from the upper 6 inches of sandy soil collected from the rows between the trees from two Florida sites planted to oranges, that were treated three times with ethion (Ethion 4 Miscible, 46.5 percent active ingredient) at 3 lbs a.i./A/application (total 9 lbs a.i./A; approximately 80 days between applications). The degradate ethion monoxide was detected in the 0-to 6-inch soil depth. Ethion residues were found primarily in the 0-to 6-inch horizon. The highest mean residues of ethion (0.42 and 0.44 ppm, respectively for Trial 01 and 02) occurred in the drip-line samples taken at one day after the third application. Mean residues ranged from 0.25-to-0.44 ppm at one day after final application and declined to 0.03 to 0.07 ppm at the end of the study. Ethion residues were found at low levels (0.01 to 0.11 ppm) in the 6-to 12-inch horizon during the study but declined to nondetectable (<0.01 ppm) by the 182-day interval. Mean residues of ethion monoxon were found in the 0-to 6-inch horizon at very low levels (0.01 to 0.02 ppm) during the first 30 days after the final application. Ethion monoxon residues were not detected (<0.01 ppm) at later intervals or deeper depths during the study.

Ethion accumulates in fish tissues and accumulated residues depurate slowly. Ethion residues accumulated in bluegill sunfish during 42 days of exposure to ethion at 0.66-to-2.6 ppb (average 1.7 ppb), with maximum bioconcentration factors of 880x in the edible (fillet) tissue, 1500x in the whole fish, and 2400x in the visceral tissue. The maximum concentration of $^{14}$C-residues occurred on day 35, with 1400 ppb in the edible tissue, 2400 ppb in the whole fish, and 3800 ppb in the visceral tissue. During 14 days of depuration, $^{14}$C-residues declined to 580 ppb in the edible tissue, 610 ppb in the whole fish, and 990 ppb in the visceral tissue.

## 2. Ecological Effects

### a. Ecological Effects Data

The ecotoxicological data base is adequate to characterize the toxicity of ethion to nontarget terrestrial and aquatic organisms when used on terrestrial food and feed sites.

### 1) Terrestrial Animal Data

In order to establish the toxicity of ethion to birds, the following tests are required using the technical grade material: one avian single-dose oral ($LD_{50}$) study on one species (preferably mallard or bobwhite quail); two subacute dietary studies ($LC_{50}$) on one species of waterfowl (preferably the mallard duck) and one species of upland game bird (preferably bobwhite quail or ring-necked pheasant).

Wild mammal testing is required on a case-by-case basis, depending on the results of the lower tier studies such as acute and subacute testing, intended use pattern, and pertinent environmental fate characteristics.

A honey bee acute contact $LD_{50}$ study is required if the proposed use will result in honey bee exposure.

#### (a) Avian Acute Toxicity

The Agency has reviewed several studies which indicate that ethion may range from highly toxic to practically nontoxic to birds on an acute oral basis. The guideline requirement for the avian acute oral $LD_{50}$ study is fulfilled. (MRID 00146309, 00146310, and 00001600)

| Avian Acute Oral Toxicity Findings | | | | | |
|---|---|---|---|---|---|
| **Species** | **%AI** | **$LD_{50}$ (CLS)** | **Year/MRID Authors** | **Category** | **Conclusion** |
| Bobwhite Quail | 92.1 | 127.8 mg/Kg (94-169) | 1989/00146309 Beavers, J. | CORE | Moderately toxic |
| Mallard Duck | 92.1 | >2000 mg/Kg | 1984/00146310 Beavers, J. | CORE | Practically nontoxic |
| Mallard Duck | 95 | ≥2560 mg/Kg | 1984/00001600 Hudson, et al | CORE | Practically nontoxic |
| Ringneck Pheasant | 95 | 1297 mg/Kg (745=2257) | 1984/00001600 Hudson et al | CORE | Slightly toxic |
| Starling | Tech | >304 mg/Kg | 1975/00020560 Shaefer | SUPL. | Moderately toxic |
| Redwing Blackbird | Tech. | 45 mg/Kg | 1975/00020560 Shaefer | SUPL. | Highly toxic |

### (b) Avian Subacute Dietary Toxicity

Ethion is practically nontoxic to birds on a subacute dietary basis. Three studies were conducted on two upland game birds and one waterfowl. Each study indicated $LC_{50}$s > 5000 ppm. The guideline requirement is fulfilled. (MRID 00022923)

| Avian Subacute Dietary Toxicity Findings | | | | | |
|---|---|---|---|---|---|
| **Species** | **%AI** | **$LC_{50}$** | **Year/MRID Author** | **Category** | **Conclusion** |
| Ringneck pheasant | 95 | >5000 ppm | 1975/00022923 Hill, et al | Core | Practically nontoxic |
| Japanese quail | 95 | >5000 ppm | 1975/00022923 Hill, et al | Supl. | Practically nontoxic |
| Mallard duck | 95 | >5000 ppm $LC_{44}$=5000 ppm | 1975/00022923 Hill, et al | Core | Practically nontoxic |

### (c) Avian Reproduction

Avian reproduction studies are required when birds may be exposed repeatedly or continuously through persistence, bioaccumulation, or multiple applications, or if mammalian reproduction tests indicate reproductive hazard. Present product labeling of ethion allows several applications of the end-use product per growing season. Also, ethion is persistent in both water and soil.

EFED has reviewed 2 avian reproduction toxicity studies. Only one study was found acceptable (due to unacceptable control mortality in the bobwhite quail study). The NOEL for this study indicates effects to avian reproduction in the mallard duck may occur at EEC levels greater than 75 ppm. The data requirement for an avian reproduction study has been partially fulfilled (MRID 42113705). An acceptable study must be submitted for a terrestrial species (preferably bobwhite quail).

| Avian Reproduction Toxicity Findings | | | | | |
|---|---|---|---|---|---|
| Species | %AI | NOEL | Year/MRID Authors | Category | Conclusion |
| Mallard duck | 92.1 | 75 ppm | 1991/42113705 Fletcher & Pederson | Core | LOEC = 150 ppm |
| Bobwhite quail | 92.1 | <300 ppm | 1991/42113706 Fletcher & Pederson | Invalid | N/A |

**(d) Toxicity to Nontarget Mammals**

The available mammalian data indicate that ethion is highly toxic to small mammals on an acute basis. (MRID 000157590)

| Mammalian Acute Oral Toxicity Findings | | | |
|---|---|---|---|
| Species | $LD_{50}$(mg/kg) | Category | Conclusion |
| Rat | 21 | Minimum | Highly toxic |

**(e) Nontarget Insect Toxicity**

There is sufficient information to characterize ethion as highly toxic to bees. The minimum data required to establish the acute toxicity to honey bees is an acute contact $LD_{50}$ study with the technical material. The guideline requirement is fulfilled. (MRID 05019782)

| Beneficial Insect Toxicity Findings | | | | |
|---|---|---|---|---|
| Species | % Test Material | $LD_{50}$ | Category | Conclusion |
| *Apis mellifera* | Technical | 0.85 μg/L | Core | Highly toxic |

## (2) Aquatic Animal Data

### (a) Freshwater Fish Toxicity

In order to establish the toxicity of a pesticide to freshwater fish, the minimum data required on the technical grade of the active ingredient are two freshwater fish toxicity studies. One study should use a coldwater species (preferably the rainbow trout), and the other should use a warmwater species (preferably the bluegill sunfish).

The results of the freshwater fish toxicity studies indicate that ethion is very highly toxic to both cold and warm water fish. The guideline requirement for acute toxicity testing of the technical on freshwater fish is fulfilled. (MRID 40098001, 05003592, 00003503)

The results of the freshwater fish chronic testing indicates that ethion is highly to very highly toxic to freshwater fish (MRID 42431901). In order to fulfill guideline requirements for chronic testing on freshwater fish, a fish full life cycle must be submitted (72-5). (This study is required when the EEC is greater than or equal to 1/10 NOEL for a tested fish species.)

| Freshwater Fish Toxicity Findings | | | | | |
|---|---|---|---|---|---|
| **Species** | **%AI** | **$LC_{50}$** | **Year/MRID Authors** | **Category** | **Conclusion** |
| Rainbow Trout | 81.9 | 193 µg/L | 1975/J00ETHO1 Johnson, et al | Supplemental | Highly toxic |
| Rainbow Trout | 100 | 500 µg/L | 1986/40098001 Mayer, F.L. | Core | Highly toxic |
| Bluegill | 81.9 | 73 µg/L | 1975/J00ETHO2 Johnson, et al | Supplemental | Very highly toxic |
| Bluegill | 100 | 210 µg/L | 1986/40098001 Mayer, F.L. | Core | Highly toxic |
| Bluegill | Tech. | 130 µg/L | 1969/05003592 Culley | Core | Highly toxic |
| Largemouth Bass | 100 | 173 µg/L | 1980/00003503 Johnson, et al | Core | Highly toxic |
| Cutthroat Trout | 100 | 720 µg/L | 1980/00003503 Johnson, et al | Core | Highly toxic |
| Fathead minnow | Tech. | 720 µg/L | 1986/40098001 Mayer, F.L. | Core | Highly toxic |
| Chronic | | MATC | | | |
| Fathead minnow | 92.1 | >0.013 <0.026 µg/L | 1992/42431901 Graves, et al | Core | Very Highly toxic |

### (b) Freshwater Invertebrate Toxicity

The minimum testing required to assess the hazard of a pesticide to freshwater aquatic invertebrates is a freshwater aquatic invertebrate toxicity test, preferably using first instar *Daphnia magna* or early instar amphipods, stoneflies, mayflies, or midges.

There is sufficient information to characterize ethion as very highly toxic to aquatic invertebrates. The guideline requirement is fulfilled. (MRID 00003503) A freshwater invertebrate acute study using the Typical End-Use Product (TEP) is required (72-2b) since the Technical Grade of the Active Ingredient (TGAI) is very highly toxic to aquatic invertebrates.

A freshwater invertebrate life cycle chronic toxicity test was submitted and found deficient (MRID 42639301). This guideline requirement (72-4b) has not been fulfilled.

| Freshwater Invertebrate Toxicity Findings | | | | | |
|---|---|---|---|---|---|
| **Species** | **% AI** | **$EC_{50}$** | **Year/MRID Authors** | **Category** | **Conclusion** |
| Daphnia magna | Tech | 48 hr-0.056 $\mu g/L$ | 1980/00003503 Johnson, et al | Core | Very highly toxic |
| Daphnia pulex | Tech | 48 hr-2.8 $\mu g/L$ | 1980/00003503 Johnson, et al | Core | Very highly toxic |
| Simocephalus sp. | Tech | 48 hr-4.7 $\mu g/L$ | 1980/00003503 Johnson, et al | Core | Very highly toxic |
| Gammarus faciatus | Tech. | 96 hr-9.4 $\mu g/L$ | 1980/00003503 Johnson, et al | Supplemental | Very highly toxic |
| Gammarus lacustris | 100 | 96 hr-1.8 $\mu g/L$ | 1980/00003503 Johnson, et al | Supplemental | very highly toxic |
| Pteronarchys c. | 100 | 96 hr-2.8 $\mu g/L$ | 1980/00003503 Johnson, et al | Core | Very highly toxic |
| **Chronic** | | **MATC** | | | |
| Invert lifecycle | | Unacceptable | 1992/42639301 | Invalid | N/A |

### (c) Estuarine/Marine Toxicity

There is sufficient information to characterize ethion as very highly toxic to estuarine organisms.

Acute toxicity testing with estuarine and marine organisms is required when an end-use product is intended for direct application to the marine/estuarine environment or is expected to reach this environment in significant concentrations. The terrestrial food use of ethion may result in exposure to the estuarine environment.

The requirements under this category include a 96-hour $LC_{50}$ for an estuarine fish, a 96-hour $LC_{50}$ for shrimp, and either a 48-hour embryo-larvae study or a 96-hour shell deposition study with oysters. The guideline requirement is fulfilled. (MRID 00155516, 402284-01, 00155518)

| Estuarine/Marine Toxicity Findings | | | | | |
|---|---|---|---|---|---|
| **Species** | **% AI** | **$EC_{50}$** | **Year/MRID Authors** | **Category** | **Conclusion** |
| Pink Shrimp | 92.1 | 15 μg/L | 1985/00155516 Ward, G | Core | Very highly toxic |
| Pink Shrimp | 95 | 19 μg/L | 1986/40228401 Mayer, F.L. | Supplemental | Very highly toxic |
| Eastern Oyster | 95 | 96 hr-40 μg/L | 1986/40228401 Mayer, F.L. | Core | Very highly toxic |
| Eastern Oyster | Tech. | 48 hr-2300 μg/L | 1985/00155518 Ward, G. | Core | Moderately toxic |
| Glass Shrimp | 100 | 96 hr- 5.6 μg/L | 1980/00003503 Johnson, et al | Supplemental | Very highly toxic |
| Brown Shrimp | 100 | 48 hr-2.4 μg/L | 1963/00043953 Kutz, E. | Supplemental | Very highly toxic |
| Atlantic silverside | Tech. | 49 μg/l | 1985/00155517 Ward, G. | Core | Very highly toxic |
| Spot | 95 | 48 hr-70 μg/L | 1986/40228401 Mayer, F.L. | Supplemental | Very highly toxic |

### (3) Terrestrial, Semi-Aquatic and Aquatic Plant Data

The Agency has not reviewed any plant toxicity data for ethion to the present date. There are some indications that ethion will display phytotoxicity to nontarget plants. The label precautions for FMC's Ethion 4 Miscible (46.5 percent active ingredient) mention that possible plant or crop injury may result from drift to nontarget crops. Studies submitted by Shell Chemical Company (Kutz, E.P.,1963) showed reduced productivity in marine phytoplankton communities (44 percent) when exposed to concentrations of 1.0 ppm for 4 hours. Thus, adverse effects to nontarget plant communities from exposure to ethion cannot be dismissed at this time. Further data is needed to mitigate this concern. The Tier I plant studies are required (122-1 seed germination, seedling emergence, and vegetative vigor and 122-2 aquatic plant growth). The Tier II studies (123-1 seed germination, seedling emergence, and vegetative vigor and 123-2 aquatic plant growth) are reserved pending review of the Tier I studies.

## (b) Ecological Effects Assessment

Postapplication ingestion of contaminated foliage offers lower hazard to avian species based on dietary studies with quail, mallard duck, and ringneck pheasant ($LC_{50}$ levels were above 5000 ppm). Avian oral and dietary study requirements are fulfilled by studies submitted to date. Avian reproduction studies produced reductions in egg fertility, embryo viability and offspring growth in mallard ducks at 300 ppm dietary concentrations. The bobwhite avian reproduction study was not found acceptable due to high control mortality and must be repeated to completely satisfy avian reproduction study requirements.

Acute oral ingestion of ethion (mixing areas, tank cleaning areas, or in concentrated puddles after rainfall) may prove highly toxic to some species of small mammals and birds (bobwhite quail $LD_{50}$ = 128 mg/Kg and redwing blackbird $LD_{50}$=45 mg/Kg) while having a lower toxicity to other species (mallard and pheasant $LD_{50}$ greater than 1200 mg/Kg). However, postapplication ingestion of contaminated foliage offers lower hazard to avian species based on dietary studies with quail, mallard duck, and ringneck pheasant ($LC_{50}$ levels were above 5000 ppm).

Based on data submitted to date, ethion displays high toxicity to nontarget insects directly contacted by foliar sprays at a concentration of 0.85 micrograms/bee for honeybees. Additional data indicate that direct contact by foliar sprays at a concentration of 0.50 lbs a.i./100 gallons of a 25 percent WP formulation is highly toxic to beneficial predatory wasps and coccinellids. Also, concentrations of 2.8 ug/L in water caused 50 percent mortality of stonefly larvae.

Insect mortality levels due to dietary ingestion of foliar residues of ethion are relatively low. Honey bee $LC_{50}$ levels were 20.22 ug/bee. Beneficial wasps and beetles showed little effect when allowed to feed on contaminated honey containing 0.0477 percent active ingredient of 25 percent ethion WP product (additional data).

Studies with freshwater aquatic organisms have indicated very high acute toxicity to all species tested to date. Seven freshwater aquatic invertebrate species were acutely effected at dosages ranging from 0.056 ug/L to 4.8 ug/L. Freshwater fish species showed 50 percent mortality levels at concentrations ranging from 73-to-720 ug/L. The chemical also displays a propensity to bioaccumulate in fish tissues with maximum fish visceral tissue residue factors as high as 3800X after 35 days of exposure at an average concentration of 1.7 ppb. This indicates the possibility that ethion is being transferred to higher levels in the aquatic and terrestrial food chains (in the case of piscivorous mammals and birds).

Estuarine organism studies also indicate high acute toxicity characteristics for ethion with 50 percent mortality levels seen for invertebrates (shrimp and oyster larvae) at concentrations ranging from 15-to-40 ug/L. Estuarine fish were effected at 70 ug/L.

The Agency has not received data on effects of ethion on nontarget plants. No assessment of risk is possible. Label statements for some products do contain precautions to avoid nontarget plant/crop contact.

**Explanation of the Risk Quotient (RQ) and the Level of Concern (LOC):** The Levels of Concern are criteria used to indicate potential risk to nontarget organisms. The criteria indicate that a chemical, when used as directed, has the potential to cause undesirable effects on nontarget organisms. There are two general categories of LOC (acute and chronic) for each of the four nontarget faunal groups and one category (acute) for each of two nontarget floral groups. In order to determine if an LOC has been exceeded, a risk quotient must be derived and compared to the LOC's. A risk quotient is calculated by dividing an appropriate exposure estimate, e.g. the estimated environmental concentration, (EEC) by an appropriate toxicity test effect level, e.g. the $LC_{50}$. The acute effect levels typically are:

-$EC_{25}$ (terrestrial plants),
-$EC_{50}$ (aquatic plants and invertebrates),
-$LC_{50}$ (fish and birds), and
-$LD_{50}$ (birds and mammals)

The chronic test results are the:

-NOEL (sometimes referred to as the NOEC) for avian and mammal reproduction studies, and either the NOEL for chronic aquatic studies, or the Maximum Allowable Toxicant Concentration (MATC), the geometric mean of the NOEL and the LOEL (sometimes referred to as the LOEC) for chronic aquatic studies.

When the risk quotient exceeds the LOC for a particular category, risk to that particular category is presumed to exist. Risk presumptions are presented along with the corresponding LOC's.

**Levels of Concern (LOC) and associated Risk Presumption**

**Mammals, Birds**

| IF THE | LOC | PRESUMPTION |
|---|---|---|
| acute RQ> | 0.5 | High acute risk |
| acute RQ> | 0.2 | Risk that may be mitigated through restricted use |
| acute RQ> | 0.1 | Endangered species may be affected acutely |
| chronic RQ> | 1 | Chronic risk, endangered species may be affected chronically, |

**Fish, Aquatic invertebrates**

| IF THE | LOC | PRESUMPTION |
|---|---|---|
| acute RQ> | 0.5 | High acute risk |
| acute RQ> | 0.1 | Risk that may be mitigated through restricted use |
| acute RQ> | 0.05 | Endangered species may be affected acutely |
| chronic RQ> | 1 | Chronic risk, endangered species may be affected chronically |

**Plants**

| IF THE | LOC | PRESUMPTION |
|---|---|---|
| RQ> | 1 | High risk |
| RQ> | 1 | Endangered plants may be affected |

Currently, no separate criteria for restricted use or chronic effects for plants exist.

**(1) Risk to Terrestrial Animals**

**Expected Terrestrial Concentrations:** Based on listed patterns of use and persistence characteristics attributed to ethion, the following table was developed to estimate possible residue levels to which terrestrial life might be exposed following multiple applications. The labeled application rate for Florida and Texas is 5-6 pints (2.5-3.0 lbs a.i.) of Ethion 4 Miscible per acre diluted in 250 gallons of spray mix for ground and in 10 gallons for aerial application. Based on the most typical use, estimated environmental concentrations (EECs) were calculated up to 2.5 lbs a.i./A.

**Expected Environmental Concentrations (EEC) and Risk Quotients**

| Rate | Surface Type | EEC 1st Application | EEC 2nd Application | EEC 3rd Application | EEC 4th Application | RQ Acute | RQ Chronic |
|---|---|---|---|---|---|---|---|
| 0.5 lbs | Grasses | 120 ppm | 228 ppm | 326 ppm | 415 ppm | 0.08 | 5.5 |
| a.i./Acre | Foliar | 63 ppm | 119 ppm | 170 ppm | 216 ppm | 0.04 | 2.8 |
| | Fruit | 3.5 ppm | 6.5 ppm | 9.5 ppm | 12 ppm | 0.002 | 0.16 |
| 1.0 lbs | Grass | 240 ppm | 456 ppm | 652 ppm | 829 ppm | 0.182 | 11 |
| a.i./Acre | Foliar | 125 ppm | 237 ppm | 339 ppm | 431 ppm | 0.086 | 5.7 |
| | Fruit | 7 ppm | 13 ppm | 19 ppm | 24 ppm | 0.004 | 0.32 |
| 2.5 lbs | Grass | 600 ppm | 1140 ppm | 1680 ppm | 2072 ppm | 0.41 | 27.6 |
| a.i./Acre | Foliar | 313 ppm | 593 ppm | 848 ppm | 1078 ppm | 0.22 | 14.3 |
| | Fruit | 17.5 | 32.5 ppm | 48 ppm | 60 ppm | 0.012 | 0.8 |

**RQ = EEC/$LC_{50}$, $LC_{50}$ > 5000 ppm (pheasant and duck), EEC used is 4th application**
**High Risk RQ ≥ 0.5**
**Restricted Use RQ ≥ 0.2**
**Endangered Species RQ ≥ 0.1 and Chronic risk ≥ 1**

Maximum expected residues on surrounding grasses near sprayed areas may range from 120-to-600 ppm from a single application. Ethion residues are expected to reside on a large number of potential food sources including seeds, fruits, and insects. As numerous species inhabit the areas of use and often nest in trees or near the crop areas where ethion is registered, exposure through dietary ingestion or direct dermal application is a distinct likelihood. At a 3.0 lbs a.i./A application rate, residues on insects may reach 174 ppm (58 ppm x 3.0). Small birds may ingest up to 20 percent of their own body weight in daily feeding activity. Thus, a 29 gram songbird may ingest up to 4.0 grams of insects or other food matter during a single day of foraging. This would amount to 0.69 mg residue of ethion on 4.0 grams of insect matter (172.5 ppm).

Foliar residues may be over 720 ppm at maximum application levels (720 mg/kg leafy matter) after a single application at the maximum rate or multiple applications at lower rates. Using the 102 day soil half-life value and calculating residues resulting from 3 applications at 90 day intervals with a 3 lbs a.i./A application rate on citrus the foliar residue levels may reach 1322 ppm (1322 mg of ethion/kg) on leafy or grassy matter or about 64 ppm on fruit. This might amount to from 5.2 to 0.26 mg of ethion consumed by a 20 gram songbird in one day. Though, this would not represent ingestion levels of equivalent to 1/5 the $LD_{50}$ for bobwhite quail, small songbirds may be more sensitive (redwing blackbird $LD_{50}$ = 45 mg/Kg). Dietary studies with juvenile mallard duck (Hill, et al) produced 44 percent mortality at 5000 ppm and 25 percent mortality at 2000 ppm dietary levels. The maximum residue levels for grasses would represent 1/3 the dosage required to cause 25 percent mortality in young mallard ducks.

Ethion demonstrated significant reproductive effects to mallard ducks at concentrations of 300 ppm. The NOEL of this study was 75 ppm. Based on this data and expected EEC levels, ethion is presently exceeding LOCs for chronic effects to avian life exposed to residues at present label rates.

Based on toxicity information and the terrestrial persistence of ethion residues EFED believes that present ethion uses offer high risk to avian species and possibly small mammalian species.

**a) Avian Subacute Dietary and Acute Oral**

As indicated in the previous EEC table, the Restricted Use and Endangered Species LOCs for avian acute toxicity have been exceeded for the grass and foliar residues which would occur after the application of 2.5 lbs a.i./A (the most typical application rate).

Acute oral ingestion of ethion (mixing areas, tank cleaning areas, or in concentrated puddles after rainfall) may prove highly toxic to some species of birds (bobwhite quail $LD_{50}$ = 128 mg/Kg and redwing blackbird $LD_{50}$=45 mg/Kg) while proving of low toxicity to other species (mallard and pheasant $LD_{50}$ greater than 1200 mg/Kg). However, postapplication ingestion of contaminated foliage is felt to offer lower hazard to avian species based on dietary studies with quail, mallard duck, and ringneck pheasant in which $LC_{50}$ levels were above 5000 ppm.

**b) Avian Chronic**

As indicated in the previous EEC table, the Level of Concern (LOC) for chronic effects have been exceeded at all application rates for both grasses and foliar residues. This indicates that ethion may cause adverse reproductive effects to avian species.

c) **Mammals**

Ethion is highly toxic to small mammals on an acute oral basis. Acute oral ingestion of ethion (mixing areas, tank cleaning areas, or in concentrated puddles after rainfall) may prove highly toxic to some species of small mammals.

d) **Nontarget Beneficial Insects**

Direct contact acute toxicity to nontarget terrestrial insects is high. Label precautions to prevent exposure of foraging honeybees are recommended for all labels. This may not protect valuable nontarget insects such as lady bugs and parasitic wasps which may be present in early morning or late evening. Exposure of aquatic insect larvae through contamination of streams or other adjacent water bodies will effect survival if EEC levels exceed 2.0 ug/L. Ethion does not appear to be highly toxic to insects feeding or foraging after application is complete. Dietary $LC_{50}$ for honeybees was over 20 ug/Bee.

(2) **Risk to Aquatic Animals**

**Expected Aquatic Concentrations:** Ethion displays very high toxicity to most aquatic organisms tested to date. $EC_{50}$ and $LC_{50}$ values for aquatic invertebrates (freshwater and estuarine) ranged from 0.056 ug/L to 40 ug/L. $LC_{50}$ values for freshwater and estuarine fish ranged from 49 to 720 ug/L. EFED calculated preliminary EEC levels based on runoff or direct contamination from drift to a 1 acre water body. These values are strict residue to volume calculations and do not take into account degradation of the compound. These EEC rates do not reflect runoff estimates resulting from multiple applications. Depending on the application interval ethion residues available for runoff could be much higher due to the persistence of the compound on soils. The use of aerial application at tree top level(citrus groves) increases the likelihood of aerial drift to surrounding aquatic habitats. Ethion does however display resistance to hydrolysis and photolysis. Thus the residues which reach aquatic habitats are expected to persist for over 1 month at pH 5.0 to 7.0.

A refined EEC is also included here. This EEC is determined using environmental fate and transport computer models. The Pesticide Root Zone Model (PRZM1) was used to simulate pesticides in field runoff and the Exposure Analysis Modeling System (EXAMS II) to simulate pesticide fate and transport in an aquatic environment (one acre body of water).

| Estimated Residues (ug ai/L) Single Event/Single Application | | | | | |
|---|---|---|---|---|---|
| Contamination Rates Depth > | 1-5% Runoff 6" Body of Water Surface | 1-5% Runoff to 2 ft Marsh | 1-5 % Runoff to 6 ft Body of Water | 5% Direct Drift to 1 A Surface | Risk Quotient Ranges Minimum-Maximum EEC's /Lowest LC50, EC50, or MATC |
| 0.5 lbs a.i./A | 37 - 183 | 9.2 - 45.7 | 3 - 15.2 | 18.35 | Invertebrates Acute: 53.5 to 328<br>Fish Acute: 0.06 to 0.37<br>Fish Chronic: 157 to 965 |
| 1.0 lbs a.i./A | 73.4 - 367 | 18.3 - 91.5 | 6.1 - 30.5 | 36.7 | Invertebrate Acute: 108 to 655<br>Fish Acute: 0.12 to 0.74<br>Fish Chronic: 321 to 1931 |
| 3.0 lbs a.i./A | 220 - 1101 | 55 - 274 | 18.3 - 91.5 | 110 | Invertebrate Acute: 326 to 1964<br>Fish Acute: 0.37 to 2.24<br>Fish Chronic: 963 to 5789 |
| Prizm1/ExamsII 96 Hr Loading-3 lbs a.i./A | Not calculated | Not calculated | 28 (170 ppb instant load) | Not calculated | Invertebrate Acute: 500 to 3035<br>Fish Acute: 0.57 to 3.47<br>Fish Chronic: 1474 to 8947 |

**EC50=0.056 PPB, Fish LC50 =49 PPB, MEAN CHRONIC MATC=0.019 PPB**
**High acute risk RQ ≥ 0.5 Restricted use RQ ≥ 0.1 Endangered Species RQ ≥ 0.05 and Chronic RQ ≥ 1**

### a) Fish Acute

As indicated in the above estimated residue table, the High Risk and Endangered Species acute LOCs for fish have been exceeded for the maximum application rate and for the refined EEC. The Restricted Use LOC for fish has also been exceeded for all application rates and for the refined EEC. This indicates that the use of ethion may cause adverse effects to fish when exposed to the chemical and/or its' residues.

### b) Fish Chronic

As indicated in the above estimated residue table, the fish chronic LOC has been exceeded at all application rates and the refined EEC by 157-to-8947 times. Adverse impacts are expected to fish reproductive success from the use of ethion.

### c) Invertebrate Acute

As indicated in the above estimated residue table, the invertebrate acute LOC has been exceeded at all application rates and the refined EEC. Therefore, aquatic invertebrates are likely to be adversely affected by the use of ethion.

### d) Invertebrate Chronic

The Agency has no acceptable data regarding the chronic effects of ethion on invertebrates.

### (3) Risk to Terrestrial, Semi-Aquatic and Aquatic Plants

The Agency has no acceptable data regarding the effects of ethion on nontarget plants. However, in studies with other phosphoro-dithoate compounds, some effects to motile algae have been noted (Ethoprop & Phorate). Also, the 1963 Shell Chemical Company Study mentioned previously indicates that productivity of marine phytoplankton will be reduced. Based on precautionary label statements found on the current Ethion 4 Miscible Insecticide-Miticide label regarding possible plant injury from drift to nontarget crops or noncrop areas, ethion is likely to adversely impact terrestrial plant species as well.

### (4) Risk to Endangered Species

Chronic effects to listed avian species is possible given the high application rates, wide use patterns, and application areas where birds may be nesting. Chronic effects to listed waterfowl feeding on contaminated vegetation may occur where EEC levels are greater than 75 and less than 300 ppm based on reproductive effects seen with the mallard duck. No acceptable data concerning terrestrial avian species reproductive effects has been reviewed to date. Acute oral ingestion of residues in contaminated puddles near spraying operations may result in potential hazard to sparrow sized songbirds or species similar in size to bobwhite quail.

Ethion is applied on citrus crops adjacent to many critical areas associated with nesting and/or feeding areas of endangered small mammals and birds. The Office of Endangered Species of the U.S. Fish and Wildlife Service (USFWS) has identified ethion as being likely to impact endangered aquatic organisms when used on certain crops. The attached table lists all avian, aquatic, and insect species found in citrus growing counties of Florida and Texas.

Also attached is the 1989 USFWS Biological Opinion for Ethion. Under the Endangered Species Act, the EPA requested a formal consultation with the USFWS on the use of 112 commonly used pesticides in order to safeguard endangered species. This biological opinion is the result of the consultation between the two agencies.

The Endangered Species Protection Program is expected to become final in 1995. Limitations in the use of ethion will be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the Fish and Wildlife Service will be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

| Listed Species | State(County)Locations With Citrus Crops |
|---|---|
| Bald Eagle | Florida(Alachua, Brevard, Broward, Charlotte, Citrus, Collier, Dade, DeSoto, Glades, Hardee, Hendry, Hernando, Highlands, Hillsborough, Indian River, Lake, Lee, Manatee, Marion, Martin, Okeechobee, Orange, Osceola, Palm Beach, Pasco, Pinellas, Polk, Putnam, Sarasota, St Lucie and Seminole counties)<br>Texas(Brazoria and Cameron counties) |
| Florida Scrub Jay | Florida(Alachua, Brevard, Charlotte, Citrus, Collier, DeSoto, Glades, Hardee, Hendry, Hernando, Highlands, Hillsborough, Indian River, Lake, Lee, Manatee, Marion, Martin, Okeechobee, Orange, Osceola, Palm Beach, Pasco, Polk, Putnam, Sarasota, St. Lucie, and Seminole counties) |
| Wood Stork | Florida(Alachua, Brevard, Broward, Charlotte, Citrus, Collier, Dade, DeSoto, Glades, Hardee, Hendry, Hernando, Highlands, Hillsborough, Indian River, Lake, Lee, Manatee, Marion, Martin, Okeechobee, Orange, Osceola, Palm Beach, Pasco, Pinellas, Polk, Putnam, Santa Rosa, Sarasota, and Seminole counties) |
| Red Cockaded Woodpecker | Florida(Alachua, Brevard, Broward, Charlotte, Citrus, Collier, Dade, Glades, Hardee, Hendry, Hillsborough, Indian River, Lake, Lee, Manatee, Marion, Martin, Okeechobee, Orange, Oceola, Palm Beach, Pasco, Polk, Putnam, St. Lucie, Sarasota, and Seminole couties) |
| Piping Plover | Florida(Brevard, Collier, Dade, Hillsborough, Lee, Manatee, Martin, Palm Beach, Pasco, Pinellas, Sarasota, and St. Lucie counties)<br>Texas(Brazoria, Cameron, and Willacy counties) |
| Everglades Snail Kite | Florida(Broward, Citrus, Collier, Dade, Glades, Hendry, Highlands, Indian River, Lake, Lee, Marion, Martin, Okeechobee, Orange, Osceola, Palm Beach, Polk, and St. Lucie counties) |
| Audubon's Crested Caracara | Florida(Charlotte, DeSoto, Glades, Hardee, Highlands, Indian River, Manatee, Martin, Okeechobee, Orange, Osceola, Palm Beach, Polk, Sarasota, and St. Lucie counties) |
| Cape Sable Seaside Sparrow | Florida(Collier and Dade counties) |
| Florida Grasshopper Sparrow | Florida(Dade, Glades, Highlands, Okeechobee, Osceola, and Polk counties) |
| Whooping Crane | Texas(Brazoria) |
| Peregrine Falcon | Texas(Brazoria, Cameron, Hidalgo, and Willacy counties) |
| Brown Pelican | Texas(Brazoria, Cameron, and Willacy counties) |
| Northern Aplomado Falcon | Texas(Cameron, Dimmit, Hidalgo, and Willacy counties) |
| Eskimo Curlew | Texas(Willacy county) |
| Southeastern Beach Mouse | Florida(Brevard county) |
| Southeastern Beach Mouse | Florida(St. Lucie county) |
| Squirrel Chimney Cave Shrimp | Florida(Alachua county) |
| Gulf Sturgeon | Florida(Hillsborough, Manatee, Pasco, and Pinellas counties) |
| Shortnose Sturgeon | Florida(Putnam county) |
| Schaus Swallowtail Butterfly | Florida(Dade) |
| Eastern Indigo Snake | Florida(All citrus production counties in Florida) |
| Atlantic Salt Marsh Snake | Florida(Brevard, and Indian River counties) |

## AQUATIC SPECIES (Request Parts 1 and 3): ETHION

| | OPINION | RPA | IT/RPM |
|---|---|---|---|
| Pearly mussel, Cumberland bean | J | 2+8+27 | 0 |
| Pearly mussel, Cumberland monkeyface | J | 2+8+27 | 0 |
| Pearly mussel, Curtis' | NJ | - | 3b |
| Pearly mussel, dromedary | J | 2+8+27 | 0 |
| Pearly mussel, green-blossom | J | 2+8+27 | 0 |
| Pearly mussel, Higgins' eye | NJ | - | 3a |
| Pearly mussel, little-wing | J | 2+8+27 | 0 |
| Pearly mussel, orange-footed | NJ | - | 3b |
| Pearly mussel, pale liliput | J | 2+8+27 | 0 |
| Pearly mussel, pink mucket | NJ | - | 3a |
| Pearly mussel, tubercled-blossom | NE | - | 0 |
| Pearly mussel, turgid-blossom | J | 2+8+27 | 0 |
| Pearly mussel, white cat's paw | NJ | - | 3b |
| Pearly mussel, white wartyback | J | 2+8+27 | 0 |
| Pearly mussel, yellow-blossom | J | 2+8+27 | 0 |
| Pigtoe, fine-rayed | J | 2+8+27 | 0 |
| Pigtoe, rough | J | 2+8+27 | 0 |
| Pigtoe, shiny | J | 2+8+27 | 0 |
| Pocketbook, fat | NJ | - | 3a |
| Pocketbook, speckled | NE | - | 0 |
| Riffle shell, tan | J | 2+8+27 | 0 |
| Spinymussel, James | NJ | - | 1a+d+m |
| Spinymussel, Tar River | J | 2+8+27 | 0 |
| Stirrup shell | J | 2+8+27 | 0 |
| Amphipod, Hay's spring | NE | - | 0 |
| Crayfish, [cave] | NE | - | 0 |
| Crayfish, Nashville | J | 2+8/13 | 0 |
| Crayfish, Shasta | NE | - | 0 |
| Isopod, Madison Cave | NJ | - | 0 |
| Isopod, Socorro | NE | - | 0 |
| Shrimp, Alabama cave | NE | - | 0 |
| Shrimp, California freshwater | NE | - | 0 |
| Shrimp, Kentucky cave | J | 7/13 | 0 |
| Naucorid, Ash Meadows | NE | - | 0 |

AQUATIC SPECIES (Request Parts 1 and 3): ETHION

| | OPINION | RPA | IT/RPM |
|---|---|---|---|
| Pearly mussel, Cumberland bean | J | 2+8+27 | 0 |
| Pearly mussel, Cumberland monkeyface | J | 2+8+27 | 0 |
| Pearly mussel, Curtis' | NJ | - | 3b |
| Pearly mussel, dromedary | J | 2+8+27 | 0 |
| Pearly mussel, green-blossom | J | 2+8+27 | 0 |
| Pearly mussel, Higgins' eye | NJ | - | 3a |
| Pearly mussel, little-wing | J | 2+8+27 | 0 |
| Pearly mussel, orange-footed | NJ | - | 3b |
| Pearly mussel, pale liliput | J | 2+8+27 | 0 |
| Pearly mussel, pink mucket | NJ | - | 3a |
| Pearly mussel, tubercled-blossom | NE | - | 0 |
| Pearly mussel, turgid-blossom | J | 2+8+27 | 0 |
| Pearly mussel, white cat's paw | NJ | - | 3b |
| Pearly mussel, white wartyback | J | 2+8+27 | 0 |
| Pearly mussel, yellow-blossom | J | 2+8+27 | 0 |
| Pigtoe, fine-rayed | J | 2+8+27 | 0 |
| Pigtoe, rough | J | 2+8+27 | 0 |
| Pigtoe, shiny | J | 2+8+27 | 0 |
| Pocketbook, fat | NJ | - | 3a |
| Pocketbook, speckled | NE | - | 0 |
| Riffle shell, tan | J | 2+8+27 | 0 |
| Spinymussel, James | NJ | - | 1a+d+m |
| Spinymussel, Tar River | J | 2+8+27 | 0 |
| Stirrup shell | J | 2+8+27 | 0 |
| Amphipod, Hay's spring | NE | - | 0 |
| Crayfish, [cave] | NE | - | 0 |
| Crayfish, Nashville | J | 2+8/13 | 0 |
| Crayfish, Shasta | NE | - | 0 |
| Isopod, Madison Cave | NJ | - | 0 |
| Isopod, Socorro | NE | - | 0 |
| Shrimp, Alabama cave | NE | - | 0 |
| Shrimp, California freshwater | NE | - | 0 |
| Shrimp, Kentucky cave | J | 7/13 | 0 |
| Naucorid, Ash Meadows | NE | - | 0 |

AQUATIC SPECIES (Request Parts 1 and 3): ETHION

| | OPINION | RPA | IT/RPM |
|---|---|---|---|
| Gambusia, Pecos | J | 2+4/3+8/13 | 0 |
| Gambusia, San Marcos | NE | - | 0 |
| Killifish, Pahrump | NE | - | 0 |
| Logperch, Conasauga | J | 2+8/13 | 0 |
| Madtom, Scioto | NJ | - | 4+4sm |
| Madtom, smoky | NE | - | 0 |
| Madtom, yellowfin | J | 2+8+27/12/13 | 0 |
| Minnow, loach | J | 2+4/3+8/13 | 0 |
| Pupfish, Ash Meadows Amargosa | NE | - | 0 |
| Pupfish, Comanche Springs | NJ | - | 1a+d/2d |
| Pupfish, desert | J | 2 | 0 |
| Pupfish, Devils Hole | NE | - | 0 |
| Pupfish, Leon Springs | NJ | - | 1a+d/2d |
| Pupfish, Owens | NE | - | 0 |
| Pupfish, Warm Springs | NE | - | 0 |
| Shiner, beautiful | NE | - | 0 |
| Shiner, Cape Fear | J | 2+8/13 | 0 |
| Shiner, Pecos bluntnose | J | 2+4/3+8/13 | 0 |
| Silverside, Waccamaw | J | 2+8/13 | 0 |
| Squawfish, Colorado | NJ | - | 1a |
| Spikedace | J | 2+4/3+8/13 | 0 |
| Spinedace, Big Spring | NE | - | 0 |
| Spinedace, Little Colorado | NE | - | 0 |
| Spinedace, White River | NE | - | 0 |
| Springfish, Hiko White River | NE | - | 0 |
| Springfish, Railroad Valley | NE | - | 0 |
| Springfish, White River | NE | - | 0 |
| Stickleback, unarmored threespine | NE | - | 0 |
| Sucker, June | J | 3/13 | 0 |
| Sucker, Lost River | J | 1 | 3a |
| Sucker, Modoc | J | 1 | 0 |
| Sucker, shortnose | J | 1 | 3a |
| Sucker, Warner | J | 1 | 0 |
| Topminnow, Gila | NE | - | 0 |
| Topminnow, Yaqui | NE | - | 0 |
| Trout, Apache | NE | - | 0 |
| Trout, Gila | NE | - | 0 |
| Trout, greenback cutthroat | NE | - | 0 |
| Trout, Lahontan cutthroat | NE | - | 0 |
| Trout, Little Kern golden | NE | - | 0 |
| Trout, Paiute cutthroat | NE | - | 0 |
| Woundfin | J | 3+8/13 | 0 |
| Mussel, Curtus' | J | 2+8+27 | 0 |
| Mussel, Judge Tait's | J | 2+8+27 | 0 |
| Mussel, Marshall's | J | 2+8+27 | 0 |
| Mussel, penitent | J | 2+8+27 | 0 |
| Pearlshell, Louisiana | J | 2+8+27 | 0 |
| Pearly mussel, Alabama lamp | J | 2+8+27 | 0 |
| Pearly mussel, Applachian monkeyface | J | 2+8+27 | 0 |
| Pearly mussel, birdwing | J | 2+8+27 | 0 |

## PESTICIDE PROFILE

PESTICIDE: EPTC TYPE: Herbicide

USES CONSIDERED IN CURRENT OPINION: Forests

TERRESTRIAL SPECIES (Request Part 3):

| | OPINION | RPA |
|---|---|---|
| Aster, Ruth's golden | NE NJ | - |
| Goldenrod, Blue Ridge | J | 20 |
| Gooseberry, Miccosukee | J | 20 |
| Heather, mountain golden | NE NJ | - |
| Mint, longspurred | NE NJ | - |
| Thistle, Sacramento Mountains | J | 26 20 |
| Townsendia, last chance | J NJ | 17 – |
| Vetch, Hawaiian | NE | - |



32

# PESTICIDE PROFILE

PESTICIDE: Ethion TYPE: Acaricide, insecticide

USES CONSIDERED IN CURRENT OPINION: Crops

AQUATIC SPECIES (Request Parts 1 and 3):

| | OPINION | RPA | IT/RPM |
|---|---|---|---|
| Salamander, San Marcos | NE | - | 0 |
| Salamander, Santa Cruz long-toed | NE | - | 0 |
| Salamander, Texas blind | NE | - | 0 |
| Toad, Houston | NE | - | 0 |
| Toad, Puerto Rican crested | NE | - | 0 |
| Toad, Wyoming | J | 17 | 0 |
| Catfish, Yaqui | NE | - | 0 |
| Cavefish, Alabama | J | 7 | 0 |
| Cavefish, Ozark | NJ | - | 3b |
| Chub, bonytail | NE | - | 0 |
| Chub, Borax Lake | NE | - | 0 |
| Chub, Chihuahua | NJ | - | 1a+d/2d |
| Chub, humpback | NE | - | 0 |
| Chub, Hutton tui | NE | - | 0 |
| Chub, Mohave tui | NE | - | 0 |
| Chub, Owens tui | NE | - | 0 |
| Chub, Pahranagat roundtail | NE | - | 0 |
| Chub, slender | NJ | - | 2d/3b |
| Chub, Sonora | NE | - | 0 |
| Chub, spotfin | NJ | - | 2d/3b |
| Chub, Yaqui | NE | - | 0 |
| Cui-ui | NE | - | 0 |
| Dace, Ash Meadows speckled | NE | - | 0 |
| Dace, blackside | J | 2+8/13 | 0 |
| Dace, desert | NE | - | 0 |
| Dace, Foskett speckled | NE | - | 0 |
| Dace, Kendall Warm Springs | NE | - | 0 |
| Dace, Moapa | NE | - | 0 |
| Darter, amber | J | 2+8/13 | 0 |
| Darter, bayou | J | 2+8/13 | 0 |
| Darter, boulder | J | 2+8/13 | 0 |
| Darter, fountain | NE | - | 0 |
| Darter, leopard | NE | - | 0 |
| Darter, Maryland | J | 3+16+27 | 0 |
| Darter, Niangua | NJ | - | 3b |
| Darter, Okaloosa | NE | - | 0 |
| Darter, slackwater | J | 2+8/13 | 0 |
| Darter, snail | J | 2+8/13 | 0 |
| Darter, watercress | NE | - | 0 |
| Gambusia, Big Bend | NE | - | 0 |
| Gambusia, Clear Creek | NE | - | 0 |