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U. S. ENVIRONMENTAL PROTECTION AGENCY
Washington, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

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MEMORANDUM

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SUBJECT: EFED RED Chapter for **Methyl Parathion**
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This memo summarizes the attached EFED Environmental Risk Assessment for the methyl parathion RED. It includes suggestions for labeling and mitigation measures and identifies gaps and uncertainties resulting from outstanding data requirements. The assessment identified the following major issues of concern:

- Methyl parathion is very highly toxic to birds, aquatic invertebrates and small mammals, and poses a high acute risk to birds and aquatic invertebrates, as well as high chronic risk to birds.

- Methyl parathion is very highly toxic to pollinating insects such as bees, and has a well documented history of bee-kill incidents.

Use Characterization

The environmental risk assessment is based on the following use information for methyl parathion:

- Methyl parathion is an organophosphate insecticide registered for use on 48 crops. Cotton and corn account for about two-thirds of the nine million pounds used annually.

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- Methyl parathion is sold in microencapsulated and emulsifiable concentrate formulations.

- The maximum single application rate (3 lb. ai/acre) is for cotton. Ten seasonal applications are permissible at a minimum 7 day interval, for a maximum seasonal rate of 30 lb. ai/acre;

Ecological Risk Characterization

EFED concludes with a great deal of certainty that the use of methyl parathion poses significant risk to nontarget organisms in terrestrial and aquatic environments. The toxicological and exposure data suggest strongly that acute and chronic effects on birds, acute effects on bees, and acute effects on aquatic invertebrates are likely to occur as a result of methyl parathion applications.

Substantial data suggest that the overall ecological risk from methyl parathion is quite high:

- Methyl parathion is "very highly toxic" to birds, and RQs calculated for avian effects far exceed levels of concern. The level of certainty in this assessment is high. Studies cited in this chapter indicate that a suite of effects occur with short exposure to methyl parathion. These include direct mortality, as well as acute sublethal effects such as reproduction effects, changes in maternal care and viability of young birds, anorexia, increased susceptibility to predation, and greater sensitivity to environmental stress.

- The aquatic RQs are calculated based on PRZM-EXAMS simulations, which may overestimate exposure levels. However, the resulting risk quotients are so high that the aquatic invertebrates LOCs would be exceeded with even an order-of-magnitude reduction in the RQs.

- Extensive data over 20 years indicate that methyl parathion is "very highly toxic" to nontarget beneficial insects such as honey bees. Currently, warning language is on labels for the microencapsulated Penncap-M formulation, because the microencapsules are inadvertantly collected by honey bees along with pollen. Continued bee-kill incidents indicate that the current label language is not sufficient to mitigate this concern. Studies cited in this chapter suggest that the EC formulation of methyl parathion is also hazardous to bees; warning language from the Penncap-M label should be required on all EC products, as well.

The uncertainty in the environmental fate database for the highly toxic degradate methyl paraoxon may lead to an *underestimation* of avian and mammalian exposure to biologically active methyl parathion residues. This point is particularly important because degradation of parent to methyl paraoxon on the surfaces of leaves and avian food items may result in an exposure to toxic residues which can result in prolonged acute and/or chronic effects to birds, mammals, and reptiles. Avian exposure to biologically active degradates which may be present during and after the parent compound's dissipation is particularly important since *negative effects on bird reproduction have been observed for methyl parathion exposure periods as short as 8 days.*

Water Resources Assessment

The water resource assessment, based on the known fate properties of methyl parathion along with limited monitoring data, concludes:

- Parent methyl parathion is not likely to move appreciably through the soil to ground water, except in areas where the ground water is particularly vulnerable (shallow depth to ground water, highly permeable soils with low adsorption capacities).

- Methyl parathion can be expected to move to surface water via runoff or spray drift. Parent methyl parathion has been detected at low concentrations (< 2ppb) in non-targeted surface-water monitoring programs, but these instances are rare, and isolated. Targeted monitoring data from the State of California resulted in maximum detections as high as 6 ppb. Monitoring results from the same locations have consistently been below 1 ppb since the imposition of mitigation requirements such as a 300 foot downwind buffer for aerial sprays and rice-field water-holding requirements.

- Estimated concentrations of methyl parathion in surface-water sources of drinking water (DWEC) were based on PRZM-EXAMS simulations, due to inadequate direct drinking-water monitoring data. Estimated drinking water concentrations for HED were derived using model simulations of the maximum cotton use rates. The DWECs derived from this modeling were 214 ug/L for acute risk and 4.2 ug/L for chronic risk.

- The targeted monitoring data from the State of California indicate that acute concentrations may not be as high as simulated by PRZM-EXAMS. While the data collected by the California Department of Pesticide Regulation (CDPR) did not corresponded to the highest allowable use rates (rice @ 0.75 lb ai/acre as opposed to cotton @ 3.0 lb ai/acre), the quality of this data is high. EFED believes that acute (peak) concentrations of methyl parathion in surface water can at least be periodically detected in the range of 0 to 6 ppb, based on CDPR data taken before mitigation measures were adopted in the early 1990's. It is likely that higher concentrations could be encountered in connection with uses that have higher uses rates and numbers of annual applications. Still, the peak concentration of 6 ppb detected in this study should be given greater weight than the peak concentration of 95 ppb simulated by GENEEC for rice, especially for drinking-water estimates.

- Similarly, the peak concentration of 214 ppb estimated for the cotton use should be considered highly conservative. The USGS is currently analyzing targeted water samples from Mississippi River tributaries flowing through areas of heavy cotton culture and methyl parathion use. Methyl parathion has not yet been detected in these surface-water samples, but only a small portion of the collected samples has yet been analyzed.

- EFED believes, qualitatively, that methyl parathion is not likely to pose a significant chronic risk to drinking water nationally. Targeted and non-targeted monitoring data over many years have yielded a low detection rate in both surface water and ground water. It should be noted, though, that the quality of the monitoring data is not uniformly known. In addition, even the recent data collected from the USGS NAWQA study had analytical recovery problems for methyl parathion. Even still, the monitoring data cited in this RED chapter have maximum concentrations several multiples below the modeling estimates. The chronic DWEC from PRZM-EXAMS of 4.12 ppb should be considered to be conservative.

A first-tier assessment of possible transport of the major degradate 4-nitrophenol (paranitrophenol) to ground water and surface water is included in this chapter. This degradate is toxic, but since it has a different mode of action than methyl parathion and methyl paraoxon, it is not included in HED's tolerance expression. There is significant uncertainty in the results of this assessment beyond that introduced by the GENEEC screening model, because: 1) the environmental fate database for 4-nitrophenol is incomplete, requiring the use of conservative default assumptions, and 2) 4-nitrophenol is introduced into the environment by other natural and industrial processes.

Data Gaps

Environmental Fate: Most environmental fate data requirements for methyl parathion have been satisfied. However, the following study requirements have not been fully satisfied:

- 162-1Aerobic soil metabolism (for degradate identification and quantification)

- 162-3 Anaerobic aquatic metabolism (for storage stability, degradate identification and quantification)

- 163-1 Leaching and adsorption/desorption (soils were autoclaved, need confirmatory data)

- 163-3 Field volatility (in response to USGS detections of methyl parathion in air and rain samples)

- 164-1Two terrestrial field dissipation study for the microencapsulated formulation, and an additional field dissipation study for the EC formulation to replace previous unacceptable study.

In addition, the formation of the degradate methyl paraoxon cannot be quantified with existing data. This is significant because this degradate is of apparent toxicological concern. Estimates of environmental concentrations for the HED drinking water assessment did not explicitly include methyl paraoxon. Based on supplemental data which suggested that methyl paraoxon is formed in small quantities in the environment, it was assumed that the maximum combined residues of methyl parathion and methyl paraoxon would be less than the maximum surface and ground-water concentrations of methyl parathion estimated by EFED screening models. In order to better estimate potential concentrations of methyl paraoxon in surface water and ground water, additional data, particularly soil and aquatic metabolism studies, are needed.

Ecological Effects: The ecological toxicity data base is complete except:

- an estuarine/marine invertebrate chronic toxicity study (72-4(b)). The study is needed because both acute and chronic LOCs are exceeded for freshwater invertebrates and acute LOCs are exceeded for estuarine/marine invertebrates;

- vegetative vigor (122-1) and seedling emergence (122-1) studies;

- aquatic plant growth (122-2) studies using both *Lemna gibba* and *Kirschneria subcapitatum*. These studies are needed to further characterize risk to aquatic organisms.

Suggestions for Risk Reduction

In addition to the label language proposed below, EFED suggests the following measures to reduce risk to nontarget organisms from exposure to methyl parathion. These measures are expected to reduce the overall risk, but not necessarily below the level of concern. It should be noted that qualitative and field evaluations of these reduction methods have not been completed. These recommendations may need to be upgraded in the future.

- EFED recommends that no-spray buffer zones of 300 feet be observed around all potentially sensitive bodies of water for any aerial application of methyl parathion. The CDPR has had success in reducing methyl parathion drift to surface water bodies by setting a 300-foot downwind buffer zone from any agricultural drain, and prescribing specific equipment for aerial sprays.. Given the apparent effectiveness of this and other measures mandated by CDPR, we believe that buffer we recommend is likely to mitigate the significant effects methyl parathion residues may have on nontarget aquatic organisms. However, given the possibility of changes in wind direction during application and the potential problems associated with enforcing a wind-directional buffer, EFED recommends that the buffer be mandated regardless of wind direction.

EFED is currently awaiting comments from external peer reviewers on the Spray Drift Task Force (SDTF) laboratory and field database and AgDRIFT, a spray-drift simulation model. EFED hopes to use AgDRIFT as a sanctioned risk assessment tool to refine its evaluation of appropriate buffer zones for spray drift mitigation. Once the use of AgDRIFT has been approved. EFED and Cheminova can reconsider how wide a buffer would be appropriate for methyl parathion.

- EPA and the registrants of methyl parathion should discuss significant reductions in the maximum use rate and number of applications for most uses. One reason cited by the CDPR for the success of their mitigation program for methyl parathion on rice was the decline of methyl parathion use over the 10-year sampling period. Discussions with crop experts from around the country detailed in this document indicate that the maximum label rates requested by the registrants for most uses are generally significantly higher than what is actually used in the field.

- For ground applications of methyl parathion adjacent to water bodies such as lakes, reservoirs, rivers, permanent streams, marshes or natural ponds, estuaries, and commercial fish ponds, a natural vegetative buffer strip will reduce adverse impacts to aquatic organisms.

- Risk of exposure to sensitive aquatic areas should be reduced by avoiding applications when wind direction is toward the aquatic area.

EFED notes that methyl parathion is already classified as a restricted use pesticide.

Suggested Label Language

The bee-kill incidents reported in the EFED RED chapter indicate that current label language and mitigation measures have not sufficiently reduced the risk of methyl parathion use to honey bees. EFED recommends that current label language be strengthened to better avert additional honey bee and wild pollinator losses in the future. EPA has participated in the State Labeling Issues Panel (SLIP) to develop appropriate language for the methyl parathion label. This panel included representatives from the following groups, State or Federal agencies or departments:

Apiary Inspectors of America (state of Washington)
North Carolina Department of Agriculture
South Dakota Department of Agriculture
New Jersey Department of Environmental Protection
Washington Department of Agriculture
Nebraska Department of Agriculture

Arizona Department of Agriculture
EPA Regions 1-10
American Beekeeping Federation
American Honey Producers
Agriculture Retailers Association
National Aviation Association
American Farm Bureau
Washington State University
EPA, OPP, EFED
OECA, OC, AB
OPP, RD
OPP, FEAD, PRSB

With input from these organizations, labeling changes are being considered by the Office of Pesticide Programs' Field and External Affairs Division and the bee expert from the Environmental Fate and Effects Division. A draft Pesticide Registration Notice would add the following language to the methyl parathion label:

> This product is highly toxic to bees during application and for ___ (hours or days)* after application. Bees may be present due to blooming or pollen shedding crops or weeds in the treatment area and adjacent areas. Do not apply this product if this pesticide will be toxic to bees that are present or are likely to be present in the treatment area or in adjacent areas. Your state or tribal pesticide agency may have additional regulatory requirements. Also, your local cooperative extension office may have recommendations for the protection of bees.
>
> *The time period to be inserted is based on bee toxicity data for the product.

If future methyl parathion labels add public health uses, the third sentence of the above statement should read:

> "For non-public health uses, do not apply if this pesticide will be toxic to bees that are present or are likely to be present due to bloom or pollen shed."

Definitions of key terms in the above statements include:

> **Blooming crops** (including cover crops) - five or more blooms per square yard on the average in a given field or one or more open blooms per tree or vine in an orchard or vineyard. Blooming crops that are not attractive to bees include, but are not limited to: barley, lentils, white blossomed peas, second bloom of pears, potatoes and wheat.
>
> **Blooming weeds** - five or more open weed blooms per square yard on the average for the area being measured for ground cover in orchards or vineyards, fence lines, ditch

banks, or field, vineyard or orchard edges.

Pollen shedding corn - ten percent or more of the corn plants in any one quarter portion of that field are showing spike anthers.

This labeling has been given to the SLIP and presented to the State/FIFRA Issues Research Evaluation Group (SFIREG) at a recent meeting.

The EC formulation of methyl parathion is also toxic to honey bees. EFED recommends that label warnings in the Environmental Hazard Section, and crop-specific label precautions to protect bees, be included on the EC formulation label as they are for Penncap-M.

SRRD/SRB has suggested long-term pollinator protection awareness and training programs as another potential mitigation measure. The registrants should sponsor long-term pollinator protection awareness and training programs, which would be mandatory for pest control operators applying for certification or recertification. A new section on bee protection could be added to the materials on which pest control operators are tested. A manual could be published that addresses the importance of native and commercial pollinators, the recognition of common native and commercial bees, pollinator protection measures, and methods for rapidly determining the relative abundance of blooming crop and non-crop plants in the area to be sprayed.

Although these two methods of mitigation would be expected to reduce bee kills it is difficult to prevent hive contamination because bee can forage so far from the hive. Also, labeling which warns a beekeeper of an application may not be practical. Hives are heavy and not easily moved. In some cases it is necessary to move a large number of hives which may be impractical.

Statement to minimize the potential for surface water contamination for all end-use products:

This chemical can contaminate surface water through aerial and ground spray applications. Under some conditions, it may also have a high potential for runoff into surface water after application. These include poorly draining or wet soils with readily visible slopes toward adjacent surface waters, frequently flooded areas, areas overlaying extremely shallow ground water, areas with in-field canals or ditches that drain to surface water, areas not separated from adjacent surface waters with vegetated filter strips, and areas overlaying tile drainage systems that drain to surface water.

Other label statements for toxicity to nontarget organisms:

Manufacturing Use Products

This pesticide is very highly toxic to aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries oceans or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

End Use Products: Non-granular formulations

This pesticide is very highly toxic to aquatic invertebrates and wildlife. Birds in treated areas may be incapacitated, have reduced number of offspring or be killed. Shrimp and other aquatic organisms may be killed at recommended application rates. For terrestrial uses, do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water. Runoff and drift from target areas may be hazardous to aquatic organisms in adjacent aquatic sites. Do not apply when weather conditions favor drift or runoff from target areas. Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.

End-Use Products: Microencapsulated formulations

This pesticide is very highly toxic to aquatic invertebrates and wildlife. Birds in treated areas may be incapacitated, have reduced number of offspring or be killed. Shrimp and other aquatic organisms may be killed at recommended application rates. For terrestrial uses, do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water. Runoff and drift from target areas may be hazardous to aquatic organisms in adjacent aquatic sites. Do not apply when weather conditions favor drift or runoff from target areas. Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.

Peer Reviewers

This chapter was peer-reviewed by Ed Odenkirchen, Ed Fite, Brian Montague and Arnet Jones.

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INTRODUCTION AND USE CHARACTERIZATION

Methyl parathion is an insecticide and acaricide used to control boll weevils and many biting or sucking insect pests of agricultural crops. Methyl parathion is in the organophosphate class of insecticides and kills insects by contact, stomach and respiratory action.

Methyl parathion has been registered for agricultural use since 1954. It has been classified as a Restricted Use Pesticide (RUP) since 1978 based upon its acute toxicity to humans and birds. Therefore, it can only be sold or distributed to, and used by, Certified Pesticide Applicators or persons under their direct supervision. Methyl parathion is registered for outdoor, agricultural uses only.

There are two main registrants for methyl parathion. Cheminova Agro AS produces all of the technical methyl parathion sold in the United States. Cheminova also produces a 4 lb ai/acre emulsifiable concentrate formulation, and a 6/3 EC mixture with their insecticide ethyl parathion. Elf Atochem North America is the registrant of the Penncap-M formulation, which has been registered in the United States since 1974. Penncap-M is formulated into microcapsules which range in size from approximately 5 to 50 microns (about the size of dust or pollen particles).

Cheminova and Elf Atochem are supporting the use of methyl parathion on 45 crops, with 24C registrations in effect for 3 other crops (sweet potatoes, almonds and walnuts) on a local basis. More than two-thirds of the estimated 9,000,000 pounds of methyl parathion used annually is on cotton and corn. The cotton market accounts for more than half of the usage in the United States, and is dominated by Cheminova's EC formulation.

Because cotton accounts for a majority of methyl parathion sales, use of methyl parathion is heaviest in the southern United States and California. Cotton production is most concentrated in five regions of widely varying climate and hydrogeology: the Mississippi Delta, the High Plains and southern tip of Texas, California's Southern Valley, and southwest Arizona. However, although cotton is the most important market for methyl parathion, data provided by Cheminova indicates that this chemical is used in almost every state in the Union.

Penncap-M accounts for most of the use of methyl parathion on corn, and corn is consistently the largest market for this formulation. Over the last decade, Cheminova has withdrawn its registration of the EC formulation for several crops that are now served only by Penncap-M. These include stone fruits, pome fruits, tree nuts, tomatoes, grapes, peanuts and lentils.

In an agreement dated July, 1996, Cheminova stated its intention to voluntarily cancel the registration of methyl parathion for certain other crops. These include apricots, garden beets, clover, cucumber, garlic, gooseberry, kohlrabi, pumpkin, rape greens, rutabagas, safflower, squash, strawberry, sweet potato (24C remains), tobacco and vetch. Since Cheminova has decided not to support these uses with tolerances, they will not be included in EFED's methyl parathion risk assessment.

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Organophosphate insecticides such as methyl parathion are generally highly toxic compounds which work "primarily by phosphorylation of the acetylcholinesterase enzyme at nerve endings." Acetylcholinesterase inhibition interferes with "normal transmission of nerve fibers to innervated tissues" (Morgan, 1976). Organophosphate poisoning can be fatal to non-target organisms, often through depression of respiration, or by causing a variety of sublethal effects which may adversely affect survival.

The current label includes language warning of the hazards this chemical can pose to human health, birds, bees, aquatic invertebrates and other wildlife. In response to problems related to product misuse, Cheminova has agreed to several mitigative measures for the EC formulation in addition to methyl parathion's RUP classification. These include the addition of a stenching agent to allow detection of methyl parathion and to discourage indoor use, the sole packaging of the chemical in containers 15 gallons and larger, unique tracking numbers on each returnable, refillable container, and the limitation that no formulation contain more than 5 pounds of the active ingredient per gallon. Cheminova has also developed an education and product stewardship program to promote safe and proper use.

The cumulative risk from other organophosphates must be considered along with methyl parathion under the requirements of the Food Quality Protection Act. Since label warnings and mitigation measures have already been implemented for methyl parathion, there are fewer options still available for mitigation of potential human health or ecological concerns. Given that either organophosphate and carbamate pesticides are applied to 70% of the acres treated with insecticides in the United States (Gianessi, 1997), it is imperative that mitigation measures be developed to reduce human health and ecological risks to acceptable levels. Possible mitigation measures are recommended in the Risk Characterization.

EXPOSURE ASSESSMENT

Environmental Fate Assessment

The environmental fate assessment for methyl parathion is based on acceptable and supplemental data. A common problem in the metabolism studies was the inability to identify all degradation products of methyl parathion. Since methyl paraoxon is a toxicologically significant degradate, EFED is concerned that methyl paraoxon may be an unidentified degradation product in the metabolism studies. Although the weight of evidence from supplemental data and open literature suggest that methyl paraoxon is not formed in aerobic soil environments, EFED believes that additional aerobic soil metabolism studies are needed to confirm that methyl paraoxon is not formed.

The major routes of dissipation for methyl parathion are microbial degradation, aqueous photolysis, hydrolysis, and incorporation into soil organic matter. Methyl parathion degrades rapidly ($t_{1/2}$< 5 days) in soil and water. It also is expected to photodegrade ($t_{1/2}$=49 hours) in aquatic environments. **Other degradation processes appear to be less important routes of methyl parathion dissipation. Methyl parathion slowly hydrolyzed ($t_{1/2}$=68 days at pH 5, $t_{1/2}$=40 days at pH 7, $t_{1/2}$=33 days at pH 9) in buffer solutions and slowly photodegraded ($t_{1/2}$=61 days) on soil surfaces.**

The major (>10% of applied) degradation product of methyl parathion is 4-nitrophenol. This degradate is formed through the hydrolytic cleavage of nitrophenyl C-O-P bond. Other minor degradates (<10% of applied) that have been found in laboratory studies include methyl paraoxon, monodesmethyl parathion, phosphorothioic acid, O,S-dimethyl o-(4-nitrophenyl)ester, nitrophenyl phosphoric acid, mono (4-nitrophenyl) ester and CO_2. Of these, only methyl paraoxon is included in HED's tolerance expression. Methyl paraoxon has only been detected (2.1% of applied) in the anaerobic aquatic metabolism study. This degradate is formed through a desulfonation (P=S to P=O) reaction. It should be noted, however, that the amount of methyl paraoxon derived by aerobic soil metabolism is not clear at this time. In addition, analyses for methyl paraoxon in two field dissipation studies are questionable because of storage stability issues.

Methyl parathion is mobile to relatively mobile in soil and thus runoff and leaching could be potential routes of dissipation. However, the low persistence of methyl parathion is expected to limit the extent off-site movement. Supplemental data on parent methyl parathion indicate that it is very mobile to somewhat mobile [K_{oc}s =230-to-670 l/kg] in mineral soils. Since the soils used in the batch equilibrium experiment were sterilized by autoclaving, confirmatory batch equilibrium data are needed. Another route of dissipation is the secondary movement through volatilization of methyl parathion from soil and leaf surfaces. Although laboratory studies indicate that methyl parathion volatilization is not a major route of dissipation, methyl parathion has been detected in air and rain samples across the United States. These detections appear to be correlated to use on cotton, soybeans, wheat, and tobacco.

Methyl parathion, formulated as EC, dissipated rapidly (<1 day) in a field dissipation study performed in a cotton field in California. Methyl parathion was not detected below 4 inches. Acceptable field studies have not been performed using the microencapsulated formulation Penncap-M.

Status of Environmental Fate Data

The current status of environmental fate data requirements for support of registration of methyl parathion is detailed below. Included are responses to rebuttals the registrant has submitted to previous EFED data reviews:

(1) Satisfied:

161-1. **Hydrolysis (Satisfied)- MRID #0013275,40784501**

Phenyl ring-labeled [^{14}C]methyl parathion (radiochemical purity >99%), at 3.87-3.95 mg/L, hydrolyzed with half-lives of 68 days at pH 5, 40 days at pH 7, and 33 days at pH 9 in sterile aqueous buffered solutions at 25 C. Major hydrolysis degradates (10% of applied) of methyl parathion are monodesmethylparathion-methyl and 4-nitrophenol. Impurities and "unknowns" comprised a maximum of 2% of the applied during the 30-day study. In an earlier unacceptable study, methyl parathion hydrolyzed in unbuffered distilled water containing 0.1% acetone. Methyl paraoxon was not detected in abiotic hydrolysis studies.

REBUTTAL: EFED originally deemed the abiotic hydrolysis study (MRID 40784501) to be partially unacceptable because there was microbial contamination in two replicates of the pH 5 treatments at the termination of the experiment. The pH 7 and 9 treatments were deemed as scientifically valid. The registrant (Cheminova) stated that the microbial contamination seen in the two replicates did not represent contamination of the test solution itself, but inadvertent contamination during the dosing of the bacterial culture plates used to confirm sterility. This claim is based on the fact that the results of the hydrolysis study are consistent with those from the dark, sterile control aqueous photolysis study (MRID 40809701). Based on the registrant's calculation, the hydrolysis half-life of methyl parathion is 68 days in pH 5 buffer solution. Although the 68 day half-life is extrapolated well beyond the last sampling point, EFED believes the body of environmental fate data provided by the registrant shows that microbial-mediated degradation of methyl parathion is expected to be the dominate degradation pathway in soil and water. EFED believes that repeating abiotic hydrolysis studies in pH 5 buffer solution will not alter the environmental fate assessment for methyl parathion. Therefore, the hydrolysis data requirement is satisfied at this time. No additional hydrolysis data are needed.

161-2. **Photodegradation in Water (Satisfied)** MRID #40809701.
161-3. **Photodegradation on Soil (Satisfied)** MRID #00061200,00072377,40809702.

[^{14}C]Methyl parathion (radiochemical purity >99%), at 4.71 mg/L, photodegraded with a half-life of 49 hours in sterile aqueous pH 5 buffered solutions that were irradiated continuously for 212 hours with a xenon arc lamp at 25 C. In the dark control solutions (incubation conditions not described), methyl parathion was relatively stable. Major photodegradation products (8-13%) were 4-nitrophenol and monodesmethylparathion-methyl. Unidentified degradates (fractions "A" and "B", which each contained more than one compound) each comprised up to 38% of the recovered radioactivity, and radioactivity designated as "remainder", which included paraoxon-methyl, comprised a maximum of 16% of the recovered. $^{14}CO_2$ accounted for 18.4-30.9% of the applied radioactivity at 212 hours posttreatment, and organic volatiles comprised a maximum of 3.0-5.3% of the applied.

In two photodegradation studies on soils under artificial light, [^{14}C]methyl parathion (radiochemical purity >99%), at approximately 14 μg/cm^2, degraded with a biphasic half-life of an initial half-lives of 3.9 to 4.5 days and a secondary half-lives of 8.6 to 24 days on sandy loam soil when irradiated continuously for 281 hours with a xenon arc lamp at 25-28°C. Methyl parathion was stable ($t_{1/2}$=29 to 54 days) in dark controls.

In a photodegradation study on soil under natural light, [^{14}C]methyl parathion (radiochemical purity >99%), at >14 μg/cm^2, degraded with a dark control corrected half-life of 61 days on sandy loam soil. The soil was irradiated with sunlight outdoors for 22 days at approximately 25 C at Monheim, Germany, beginning July, 1987. Methyl parathion was relatively stable ($t_{1/2}$ = 106 days) in dark control treatments. The major photodegradate was 4-nitrophenol. However, unidentified radioactivity reached a maximum of 17.8% of the recovered radioactivity. Unextracted methyl parathion residues comprised a maximum of 20.1 to 41% of the applied radioactivity. At 281 hours posttreatment, $^{14}CO_2$ totaled 2.0 to 16.1% of the applied radioactivity, and organic volatiles were <0.1%.

REBUTTAL: EFED deemed the photodegradation in water (MRID 40809701) and photodegradation on soil (MRID 40809702) studies to be upgradable with submission of the following information: 1.) Information concerning the incubation conditions of the dark controls; 2.) The intensity of the light reaching the samples; 3.) The wavelength distribution of the light source for the entire visible spectrum; and 4.) A comparison of the light source to natural sunlight for the entire visible spectrum. In addition, EFED stated in the review of the photodegradation on soil study that "no evidence was provided to support the characterization of unidentified degradates (comprising up to 16% of the applied) as diffuse radioactivity" in the photolysis on soil study.

The registrant reported that "the dark controls were performed in the same quarz (sic) vessels" as the experimental samples where aluminum foil was used to exclude light. Although the incubation conditions were variable, the stability of methyl parathion in dark control treatments suggest the scientific integrity of the study design was not compromised. Cheminova also provided a graph showing the intensity of a light from an Xenon lamp at wavelengths from 290 to 400 nm because methyl parathion absorbs light at wavelengths up to 380 nm. The xenon light in the study was as much as 37 times greater than that calculated for natural sunlight within the methyl parathion light absorption band. The registrant notes that "the calculated half-life of 2.1 days (49 hours) was comparable to the 2.8 day half-life calculated according to Zepp and Cline using the quantum yield of photodegradation in water... and the UV-absorption spectrum of parathion methyl". While the intensity of the light source was different than that of natural sunlight, the use of a xenon lamp is consistent with EPA guidance (Pesticide Reregistration Rejection Rate Analysis, 1993). The registrant also provided all the HPLC chromatograms. EFED believes the HPLC chromatograms support Cheminova's contention that only peaks for methyl parathion and paranitrophenol are distinguishable above background. Therefore, the photodegradation in water and photodegradation on soil data requirements are satisfied, and no additional data are needed at this time.

162-1. **Aerobic Soil Metabolism (Upgradable Supplemental)**-MRID #41735901.

Ring-labeled [^{14}C]methyl parathion (radiochemical purity 97.2%) degraded with a registrant calculated half-life of 4.7 days in sandy loam soil that was incubated in the dark at 25 C. Since methyl parathion degradation appears to be biphasic, EFED recalculated a half-life of 3.75 days for methyl parathion using non-linear fitting techniques of the first-order degradation kinetic model to non-transformed data. Minor degradates (<10% of applied) were 4-nitrophenol and O,O-bis(4-nitrophenyl)-O-methyl phosphorothioate. Unidentified degradates ("solvent front") each comprised up to 4.97% of the applied radioactivity. Unextracted radioactivity in the soil was a maximum of 38.72% of the applied at 1 month posttreatment. Unextracted methyl parathion was predominately detected in the fulvic acid (31.9-15.7%) and humin fraction (38.5 to 45.1%). At 6 months posttreatment, volatilized $^{14}CO_2$ totaled 62.72% of the applied, and organic volatiles totaled 1.37% of the applied.

REBUTTAL: Cheminova reported a half-life of 4.7 days in a sandy loam. After further review of the aerobic soil metabolism data (MRID 41735901) and the registrant's rebuttal, EFED found the aerobic soil metabolism data to exhibit a biphasic degradation pattern. Therefore, EFED recalculated a half-life of 3.75 days using non-linear fitting techniques of the first-order degradation kinetic model to non-transformed data. Because of uncertainties associated with analytical procedures in degradate quantification, confirmatory data are needed to substantiate the quantity and

identity of degradates in the aerobic soil metabolism study. The aerobic soil metabolism (162-1) data requirement provides upgradable supplemental data on the metabolism of methyl parathion. The data requirement can be fulfilled with the submission of additional data on the identification and quantification of degradation products of methyl parathion.

162-2. **Anaerobic Soil Metabolism**; not required if Anaerobic Aquatic Metabolism is made acceptable by the submission of supplemental data.

162-3. **Anaerobic Aquatic Metabolism (Not Satisfied)-** MRID #41768901.

Uniformly ring-labeled [^{14}C]methyl parathion (radiochemical purity 95%), at a nominal concentration of 10 µg/g, degraded with a half-life of 12.2 hours in flooded sandy loam soil (10 g soil:20 mL water) that was incubated under anaerobic conditions in the dark at 25 $\pm$ 1 C. Methyl parathion (50% EC, Metacid), at 25 ppm, degraded with an observed half-life of 1-2 days in flooded alluvial soil incubated at 28 $\pm$ 4 C for 12 days. The major degradate of methyl parathion was p-nitrophenol. Minor degradates (< 10% of applied) of methyl parathion are S-methyl parathion; O,O-bis-(4-nitrophenol)-O-methyl-phosphorothioate; methyl paraoxon; amino-methyl parathion; and S-phenyl-methyl parathion. Five unidentified degradates (Unknowns 2-6) were detected at maximum concentrations of 1.2-14.4% of the initial radioactivity. At 12 months posttreatment, unextracted [^{14}C]residues in the soil totaled 75.2% and $^{14}CO_2$ totaled 2.74% of the initial radioactivity. Unextracted [^{14}C]residues in the 14-day and 9-month samples were predominately detected in the fulvic acid (13.2-15.3%) and humin (20.1-20.2%) organic matter fraction. No organic volatiles were detected (detection limit not reported).

REBUTTAL: EFED indicated the anaerobic aquatic metabolism study (MRID 41768901) was not acceptable because formal storage stability studies were not provided in the original study submission and numerous degradates were not identified in the study. The registrant (Cheminova) stated that methyl parathion was stable when stored frozen in the original samples and was not stable in separated frozen extracts of soil and water. According to the registrant, the samples that led ABC laboratories to conclude low stability methyl parathion were taken from frozen reserve samples (water and soil combined samples). The registrant submitted data that showed methyl parathion in water was stable (106% recovery) after a ten month storage period. The registrant claims that soil stability studies are not needed because soil samples (Days 0 through 7) were extracted immediately, stored frozen, and analyzed within 8 days. EFED believes the registrant's rebuttal on existing storage stability study data is confusing and contradictory because 1.) the registrant is not clear about the difference of methyl parathion stability in original samples and separated soil/water extracts and 2.) the registrant did not provide a reason that storage stabilities in soil are not needed. The registrant also stated that degradates were not identified because the degradates were less than 10% of an exaggerated application rate (20 lbs ai/A). Since the application rate is 10 ppm in the study, all degradates with concentrations exceeding 1 ppm should be identified. Based on the previous EFED review, there are degradates (Unknowns 2-6) with concentrations approaching 1.63 ppm.

EFED believes the anaerobic soil metabolism study (MRID 41768901) provides unacceptable data on the anaerobic metabolism of methyl parathion and its degradates. The study can be upgraded with 1.) submission of new storage stability studies or a complete clarification on the stability data submitted in the registrant's rebuttal and 2.) identification of all degradates exceeding 10% of the application rate (Unknown 2).

162-4. **Aerobic Aquatic Metabolism (Satisfied)-**MRID# 0013361, 00128789, 42069601

Radiolabeled methyl parathion degraded with a half-life of approximately 4.1 days in sandy loam soil that was flooded with water incubated for 30 days in the dark at 25°C (MRID 42069601). Methyl parathion was primarily associated with the soil fraction; it was not detected in the flood waters after 2 days posttreatment. The only degradate identified was paranitrophenol.

REBUTTAL: EFED deemed the aerobic aquatic metabolism study (MRID 42069601) to be unacceptable because the major degradates (> 10% of applied) were not identified. The registrant (Cheminova) responded that they believed the Agency had misread the data. They note that the table shows that a maximum of 8.8% of applied radioactivity in the soil extracts remained at the TLC origin, not 14.2%. Upon further review of the data, EFED concedes that the registrant is correct. The maximum remainder at the TLC origin was 8.8%. The 14.2% in the table referred to paranitrophenol. Therefore, the aerobic aquatic metabolism (162-4) data requirement is fulfilled at this time.

163-1. **Leaching and Adsorption/Desorption (Not Satisfied-Supplemental)**-MRID 40999001

Based on batch equilibrium experiments conducted using autoclaved soils, [^{14}C]methyl parathion (radiochemical purity 98.8%), at 1.86-19.1 ug/mL, is expected to be very mobile in sand and sandy loam soil:0.01 N calcium chloride solution slurries and mobile in silt loam and clay loam soil:solution slurries (3:10 for sand and sandy loam soils, 1:10 for silt loam and clay loam soils) that were equilibrated for 24 hours at 25 C. Freundlich K_{ads} and exponential (1/n) values were 0.574 (1/n=0.96) for the sand soil, 1.82 (1/n=0.909) for the sandy loam soil, 7.09 (1/n=0.917) for the silt loam soil, and 8.71(1/n=0.961) for the clay loam soil. Since there is a correlation of methyl parathion sorption and soil organic matter content, it is appropriate to use the K_{oc} model for describing methyl parathion sorption (Sanchez-Martin and Sanchez-Camazano, 1991). K_{oc} values were 230 for the sand soil, 456 for the sandy loam soil, 591 for the silt loam soil, and 670 for the clay loam soil. Following desorption in pesticide-free calcium chloride solution for 24 hours, 43.12-54.26% of the radioactivity that had been adsorbed to the soils was desorbed from the silt loam and clay loam soils, 57.23-67.84% was desorbed from the sandy loam soil, and 98.62-112.35% was desorbed from the sand soil.

In earlier supplemental soil column studies, methyl parathion was mobile in sand and relatively immobile in sandy loam, silty clay loam, and silt loam through 30 cm soil columns eluted with 15.7 inches of water (MRID 00071198). Methyl parathion was only detected in the leachate of the sand soil. Open literature data indicate that methyl parathion sorption on soil is correlated to soil organic matter content (Sanchez-Martin and Sanchez-Camazano, 1991). Methyl parathion had an average K_{oc} of 697 ml/g across 8 mineral soils. In contrast, methyl paraoxon sorption was correlated to clay content. Methyl paraoxon had distribution coefficients (K_ds) ranging from 1.77 to 14.3 ml/g in 8 mineral soils..

REBUTTAL: The adsorption/desorption study (MRID 40999001) was deemed to be unacceptable because the test soils were autoclaved before use in the study. The registrant responded that the study was performed according to current EPA guidance. Although the study was performed under then-current EPA-guidelines, EFED believes that the adsorption/desorption study provides supplemental data on the mobility of methyl parathion in soil. Batch equilibrium data are needed to confirm that autoclaving effects on soil did not alter the soil sorption affinity of methyl parathion. Additionally, there are no mobility data for the degradates of methyl parathion. Therefore, the batch equilibrium/soil column (163-1) data requirement is not fulfilled at this time. Additional batch equilibrium data are needed for methyl parathion to serve as confirmatory data. Aged residue mobility data are needed for toxicologically significant degradates (methyl paraoxon and p-nitrophenol). Since the aged mobility data may be used in a quantitative environmental fate and transport assessment, batch equilibrium data are preferred.

163-2. **Laboratory Volatility (Satisfied)-** MRID #42264201, 41194001

Methyl parathion, formulated as 4 lb ai/gallon EC, volatilized slightly (<0.51% of applied) from a Sesquatchie sandy clay loam soil that had been moistened to 50 or 75% at 1/3 of field capacity and then incubated in the dark at 25°C for 9 days. The maximum air concentration and volatility rate of methyl parathion was 55.88 $\mu g/m^3$ and 0.0128 $\mu g/cm^2$/hour, respectively, when incubated at 75% of the soil water holding capacity and 300 mL/minute air exchange rate.

163-3. **Field Volatility-(Not Satisfied)-**MRID 41194001

Methyl parathion, applied at 1 lb ai/A either as EC or MCAP formulations (concentration of methyl parathion in the formulations not specified) to tobacco plots (soil not characterized) near Raleigh, North Carolina, volatilized with maximum mean air concentrations (110-cm sampling level immediately posttreatment) of 7400 and 3800 ng/m^3 for the EC and MCAP formulations, respectively.

In a USGS review, methyl parathion has been detected in air samples in Alabama, Florida, and Mississippi at concentrations ranging from 5.4 to 129 ng/m^3 (Majewski and Capel, 1995). Methyl parathion in air also was detected (0.4 to 42 ng/m^3) throughout the southeastern United States. Methyl parathion has also been detected (1.60 $\mu g/L$) in Iowa precipitation. The USGS suggested the methyl parathion concentrations in air tend to correspond with methyl parathion use areas associated with cotton, soybeans, wheat, and tobacco production.

164-1. **Terrestrial Field Dissipation (Partially Satisfied)- MRID 41481001, 41752501, 41481002, 41752502**

Methyl parathion rapidly dissipated with a half-life of approximately 1 day from plots of sandy loam soil located in California following the last of six applications of methyl parathion (4 lb/gal EC) to cotton at 1 lb ai/A/application (total application 6 lb ai/A). Supplemental field dissipation data indicate that methyl parathion (4 lb ai/gal EC), applied at six weekly applications at 1 lb ai/A/application (total 6 lb ai/A) to cotton on plots of loam soil located near Steele, Missouri, beginning July 28, 1988, decreased from an average of 0.052 ppm immediately following the last treatment to below the detection limit (0.05 ppm) by 1 day following the last treatment in the surface 4 inches of soil. Methyl parathion was not detected in the soil by 7 days posttreatment. Methyl parathion did not appear to accumulate or move into the soil as a result of repeated applications.

Rebuttal: The terrestrial field dissipation study in Missouri (MRID 41481002 and 41752502) was deemed not acceptable because the concentration of methyl parathion in the soil immediately following the final application was too low to establish a pattern of decline. The registrant responded that the rapid dissipation of methyl parathion in the Missouri study is consistent with the results of the California terrestrial field dissipation study, which was deemed acceptable. The registrant believes that the differences between the two studies are slight enough that it would be inconsistent to ask that the Missouri study be repeated. However, EFED believes the data from the two studies are different. The residues measured in the California study do in fact show a recognizable decline, from an original average concentration of 0.37 ppm on day 0 to 0.085 ppm on day 35, the day of the sixth and final application. The Missouri study showed no such evidence of decline. The average residue concentrations on days 0 and 7 are 0.039 and 0.030 ppm, respectively; these "averages" include assumed concentrations of 0.0 ppm for detections below the 0.05 ppm level of detection (LOD). The average residue concentrations thereafter rise and fall near the LOD until the final, day 35 application. The average concentration measured on that day was 0.052; from day 36 onward the residue concentrations are below the 0.05 ppm LOD. Therefore, a clear dissipation pattern was not established for methyl parathion in the Missouri study. Additionally, a major route of dissipation was not established in the Missouri study.

The terrestrial field dissipation study in Missouri (MRID 41481002 and 41752502) provides unacceptable data on the field dissipation behavior of EC formulation of methyl parathion. The California field study (MRID 41481001 and 41752501) partially satisfies the field dissipation (164-1) data requirement to support reregistration of the methyl parathion EC formulation applied at a single application rate of $\leq$ 1 lb ai/A with a total seasonal application rate not to exceed 6 lb ai/A. Since methyl parathion is used under a broad range of geographical and agronomic conditions, an additional field dissipation study is needed to support reregistration of the EC formulation of methyl parathion. Field dissipation studies are also needed to support reregistration of Penncap-M (microencapsulated) formulations of methyl parathion. EFED notes the registrant (ELF ATOCHEM North America) submitted incomplete field dissipation study for Penncap-M (FAX from V. Banks, 4/27/98). If methyl paraoxon, however, is detected in additional aerobic soil metabolism studies then additional field dissipation studies will be needed to evaluate the fate and transport of methyl paraoxon.

164-2. **Aquatic Sediment Dissipation (Satisfied)**-MRID #41481003 and 41752503.

Methyl parathion dissipated from irrigation water with an observed half-life of approximately 1 day following the last of six weekly treatments of methyl parathion (4 lb ai/gal EC) at 0.75 lb ai/A/application (total 4.5 lb ai/A) to plots of irrigated (6-inch depth) sandy loam soil that was planted to rice and located near Madera, California; methyl parathion had totally dissipated from the irrigation water by 7 days post-treatment. Methyl parathion dissipated from irrigation water with an observed half-life of <7 days following the last of six weekly treatments of methyl parathion (4 lb ai/gal EC) at 0.75 lb ai/A/application (total 4.5 lb ai/A) to plots of irrigated (3-inch depth) loam soil planted to rice that were located near Steele, Missouri. Methyl parathion did not accumulate in the water as a result of repeated applications. The degradate p-nitrophenol was isolated in the irrigation water.

Rebuttal: Aquatic field dissipation studies (MRID# 41481003 and 41481004) were deemed unacceptable because storage stability studies are needed for water and plant samples. The registrant (Cheminova) submitted a supplemental storage stability study for two water samples from the Missouri aquatic field dissipation study. These data indicate methyl parathion concentrations ranged from 72 to 93% in original samples and samples stored frozen for 11-13 months, respectively. The extraction procedures were slightly modified from the original study; acetone extractions were reconcentrated in toluene for GC analysis. Since the water samples were analyzed within 48 days after sampling, the registrant contends the supplemental stability data indicate methyl parathion is stable in water. EFED believes these data in conjunction with soil storage stability studies provide acceptable storage stability data for methyl parathion in water and soil samples. However, the soil storage stability of methyl paraoxon is marginally acceptable in the aquatic field dissipation study (MRID# 41481003). In future studies, the registrant should provide storage stability studies of methyl parathion and its degradates in water and soil.

The registrant believes that storage stability studies in plant samples are not needed because methyl parathion dissipated rapidly in water and soil samples and hence was not available for plant uptake. EFED believes that plant storage stability studies are needed to assess the impact of sample storage on plant residue concentrations. The registrant also believes that air and soil temperature data submitted in the original study are adequate for the field accumulation in irrigated crops portion of the study. EFED believes that climate data should bracket the whole study period.

The aquatic field dissipation studies (MRID# 41481003 and 41481004) provide marginally acceptable data on dissipation of methyl parathion in aquatic environments. These studies do not provide reliable data on methyl paraoxon.

165-4 **Accumulation in Fish (Satisfied)**-MRID #41001901.

Bluegill sunfish exposed to radiolabeled methyl parathion at 0.104 mg/L had steady-state bioaccumulation factors of 39X in edible tissues, 108X in nonedible tissues, and 71X in whole body over a 28 day accumulation period. Steady-state conditions were obtained within 3 days. Radiolabeled residues in whole fish tissues were identified as 0,0-dimethyl-0-4-nitrophenyl phosphorothioate (methyl parathion 22.6%), 0-methyl-0-4-nitrophenyl phosphorothioate (46.3%), 0-methyl-0-4-nitrophenylphosphate (5.7%), 4-nitrophenol (18.1%), and 4-NP-gluconuride (1.2%). Unextracted residues represented 6.1%.

WATER RESOURCE ASSESSMENT

First-Tier Water Assessment for Methyl Parathion

SURFACE WATER ASSESSMENT FOR METHYL PARATHION:

EFED uses the GENEEC screening model to estimate surface water concentrations for first-tier exposure assessments. GENEEC is a screening model designed by the Environmental Fate and Effects Division (EFED) to estimate the concentrations found in surface water for use in ecological risk assessment. As such, it provides upper-bound values on the concentrations that might be found in ecologically sensitive environments because of the use of a pesticide. It was designed to be simple and require data which is typically available early in the pesticide registration process. GENEEC is a single event model (one runoff event), but can account for spray drift from multiple applications. GENEEC is hardwired to represent a 10-hectare field immediately adjacent to a 1-hectare pond that is 2 meters deep with no outlet. The pond receives a spray drift event from each application plus one runoff event. The runoff event moves a maximum of 10% of the applied pesticide into the pond. This amount can be reduced due to degradation on the field and the effects of soil binding in the field. Spray drift is equal to 1 and 5% of the applied rate for ground and aerial spray application, respectively.

Modeling results indicate that methyl parathion has the potential to move into surface waters. This estimate is based on the maximum application rate for cotton, which represents the highest application rate for any crop used to support residue tolerances. Coincidentally, cotton also accounts for the majority of methyl parathion use in the United States, according to data provided by Cheminova. EFED notes that higher use rates are reported on product labels but the registrant has stated they will not support rates greater than those defined in crop residue studies. Based on the inputs shown in Table 1 the peak GENEEC estimated environmental concentration (EEC) of methyl parathion in surface water is 452 ppb (Table 2). This was the value recommended to HED as the highly conservative Tier I estimate of *acute* drinking-water exposure for their human health risk assessment. EFED recommended a highly conservative Tier I *chronic* drinking-water exposure estimate of 50 ppb, based on the 56 day average GENEEC value obtained with the highest use-rate for methyl parathion.

Table 1: GENEEC Environmental Fate Input Parameters for Methyl Parathion

DATA INPUT	INPUT VALUE	DATA ASSESSMENT	SOURCE
Application Rate	3.0 lbs ai/A		Cheminova
Maximum Number of Applications	10		Cheminova
Application Interval	3 days		Cheminova
Batch Equilibrium (Koc)	230 mL/g*	Acceptable	MRID 40999001
Aerobic Soil Metabolism	$t_{1/2}$ = 11.25 days**	Supplemental	MRID 41735901
Solubility	60 ppm	Acceptable	Reported by registrant
Aerobic Aquatic Metabolism	$t_{1/2}$ = 4.1 days	Acceptable	MRID 41768901
Photolysis	$t_{1/2}$ = 49 hours	Acceptable	MRID 40809701

* The smallest K_{oc} value was used in order to produce the highest (most conservative) exposure value.
** Half-life is upper 90th percentile prediction.

Table 2: Surface Water Results for Methyl Parathion

USE	App. Rate (lbs/ac)	# Apps/ year	App. Int. (days)	GENEEC Peak EEC (ppb)	GENEEC 56 Day EEC (ppb)
Cotton	3.0	10	3	452.05	50.28

Tier II Estimated Concentrations for Surface- Water Exposure Assessment: Since the

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EECs derived from first-tier GENEEC simulations were above HED's levels of concern (LOCs) for drinking water, Tier II EEC's were calculated using PRZM 3.1 to simulate the agricultural field, and EXAMS 2.97.5 to simulate fate and transport in surface water. Each Tier II assessment simulated a single site which represents a high exposure scenario for the use of methyl parathion on a particular crop. The weather and agricultural practices were simulated over multiple years, in this case 24 to 36, so that the probability of an EEC occurring at that site could be estimated.

Nine application scenarios were simulated, using crops which represent more than 80% of methyl parathion use in the United States. The EEC's derived from these simulations were lower than those generated by Tier I GENEEC runs, with the exception of that for methyl parathion on cotton (see Table 5). Seven further crops have methyl parathion application rates, numbers of applications and application intervals identical to one of the nine crops simulated. The EEC's generated from the nine scenarios can be used as surrogates for these seven crops, recognizing that these crops might not be grown on the same soils.

Tier II surface-water concentrations estimated from the PRZM-EXAMS screening models for human health risk assessments, based on the cotton scenario, are 214 ppb for acute exposure, and 4.2 ppb for chronic exposure

Details of Specific PRZM-EXAMS Scenario Input Parameters

EFED has prepared standard PRZM input files for the following nine crops: cotton, corn, alfalfa, peaches, potatoes, pecans, cherries, grapes and sweet potatoes. While the locations used to build these scenarios may not represent areas of greatest methyl parathion use, they are located in states where methyl parathion is registered for these uses. Soils and weather data for these standard scenarios were extracted from the program PIRANHA, an input shell developed by ORD-Athens for the PRZM model. EFED has prepared draft summary documents which describe the input parameters used to develop the standard scenarios. Once these documents have been finalized, they can be provided upon request.

The nine input files were adapted to simulate the application of methyl parathion for the respective crops and states represented in the standard scenarios. Chemical-specific input for methyl parathion was derived to the greatest extent possible from the environmental fate database submitted to the EPA by registrant Cheminova. Application rates, numbers of applications, and application intervals simulated were consistent with the maximum values requested by the registrants for establishing tolerances. Planting and harvest dates, and likely dates of methyl parathion application, were chosen based on conversations with academic and extension crop specialists, usage data provided by the registrant and grower groups, or by back-calculating from the pre-harvest interval for a particular crop. Further details are presented below:

<u>Chemical-Specific Input</u>

Persistence and mobility numbers used in the first-tier GENEEC simulations were also used for the Tier II assessment. Chemical specific input parameters for PRZM and EXAMS are summarized in Table 1. Certain assumptions were made for chemical dissipation parameters included in PRZM 3.1 but not GENEEC:

1. The aerobic soil-metabolism half-life of 11.25 days was used for the adsorbed and dissolved half-life throughout the soil column. Subsoil layers were assumed not to be anaerobic, as the deepest soil column simulated was only 150 cm deep;

2. Volatilization from the soil or foliage were not simulated (set to zero). EFED assumes that aerobic soil metabolism studies are not performed to account for volatilization, which therefore should be reflected in the aerobic soil metabolism half-life.

3. Dissipation pathways such as plant uptake and foliar degradation were not simulated;

4. Foliar wash off of 0.5 cm^{-1} was simulated, although data exists showing complete wash off of organophosphate pesticides with the first 0.1 cm of rainfall.

5. A conservative application efficiency of 95% was assumed for all application methods. As for GENEEC, drift from aerial applications was assumed to be 5% of the applied mass of methyl parathion. Drift from ground or airblast applications was assumed to be 1% of the applied mass. A 95% application efficiency for aerial spray was derived from Spray Drift Task Force data (MRID 43803501) (Personal Communications with Dr. R. David Jones, 11/23/98).

PRZM and EXAMS require that degradation half-lives be converted into rate constants. The aerobic soil metabolism half-life of 11.25 days (as explained above) was converted to a daily rate constant for PRZM 3.1 by the equation $\ln 2/(T_{1/2})$. The aerobic aquatic (input variable KBACW), anaerobic aquatic (KBACS), and photolysis (KDP) half-lives for EXAMS were converted to hourly rate constants using the formula $\ln 2/(T_{1/2} \times 24)$. Hydrolysis half-lives at pH 7(KNH) and pH 9 (KBH) were converted to rate constants by solving two simultaneous equations with the stable pH 5 (KAH) constant set to zero.

<u>Crop-Specific Inputs</u>

<u>Cotton</u>

This input file was adapted from EFED's standard PRZM scenario for cotton grown on the Loring silt loam in Mississippi, dated October 20, 1997. This soil is located in Major Land Use Area (MLRA) 134. However, weather data from Major Land Resource Area (MLRA) 131 is suggested for this standard scenario, as it represents a closer weather station (Jackson, MS). PRZM-EXAMS was run using both weather files.

Table 3: Agronomic Modeling Input Parameters for Cotton				
Crop	Planting Dates	Harvest Dates	Application Dates	Application Method
Cotton	April 15 to June 5	Sept. 20 to 25	June 10 to 20 July 20-	Aerial

Local dates for planting and harvesting cotton, and likely dates of methyl parathion application, were provided by Dr. Mike Williams, Extension Entomologist of the Mississippi State University cooperative Extension Service (Table 3). This PRZM simulation reflects the maximum label rate (3.0 lb ai/a), number of applications (10/year) and application interval (3 days) sought by the registrants for methyl parathion on cotton. Dr. Williams noted that these usage parameters do not reflect what is actually used on cotton in Mississippi. He indicated that one or two applications might be made at the "pinhead square" stage of cotton growth, and then up to 5 more times starting on July 20th. Each of these applications are typically made at a rate of 0.25 to 0.5 lb ai/a, not the label maximum of 3.0 lb ai/a. Dr. Williams indicated that he is not aware of any situation in which methyl parathion was applied at a rate greater than 1.5 lb ai/a.

Atochem reports that typical applications of Penncap-M are at 0.25 to 0.5 lb ai/a by ground spray. It should be noted, however, that aerial application of the EC formulation dominates the market.

Corn

This input file was adapted from EFED's standard PRZM scenario for corn grown on the Cardington silt loam in Ohio, dated January 16, 1998. Thirty-six years (1948-83) of weather data from MLRA 111 are used for this simulation. Application dates used in this simulation reflect the average pre-harvest interval (30 days) reported to EPA by Elf Atochem, registrant of Penncap-M (Table 4).

Table 4: Agronomic Input Parameters for Corn				
Crop	Emergence Date	Harvest Dates	Application Dates	Application Method
Corn	May 16	October 11	Sept. 1 to 11	Aerial

This PRZM simulation reflects the maximum label rate (1.0 lb ai/a), number of applications (6/year) and application interval (2 days) sought by the registrants for methyl parathion on corn. In their QUA+ response, Atochem states that application is made from July to August at rates of 0.25 to 0.5 lb ai/a. For sweet corn, typical use is 0.5 to 1.0 lb ai/a later in the season, with one or two applications being typical. Food processor Del Monte reports that they use 0.5 to 0.75 lb ai/a only once per season on 10% of their crop, while competitors use 0.5 to 1.0 lb ai/a 1 to 4 times a year, on 50% of their crop.

Alfalfa

This input file was adapted from EFED's standard PRZM scenario for alfalfa grown on the Fury silty clay loam in Oregon, dated January 15, 1998. Thirty-six years (1948-83) of weather data from MLRA 23 are used for this simulation. Application dates used in this simulation reflect the average pre-harvest interval (15 days) reported to EPA by Elf Atochem, registrant of Penncap-M. Emergence, maturation and harvest dates were provided to EFED by Dr. Ben Simko, Extension Entomologist with the Malheur County, OR Cooperative Extension (Table 5).

Table 5: Agronomic Input Parameters for Alfalfa

Crop	Planting Date	Harvest Date	Application Dates	Application Method
Alfalfa	March 22	September 7	April 19 to August 23	Aerial

This PRZM simulation reflects the maximum label rate (1.0 lb ai/a), number of applications (4/year) and application interval (42 days) sought by the registrants for methyl parathion on alfalfa. Atochem notes in their response for BEAD's QUA+ that one application each of 0.75 lb ai/a is made at the first and second cuttings. Usage is primarily on western alfalfa grown for seed.

Peach

This input file was adapted from EFED's standard PRZM scenario for peaches grown on the Boswell sandy loam in Georgia, dated December 22, 1997. Thirty-six years (1948-83) of weather data from MLRA 137 are used for this simulation.

Local dates for petal fall and peach harvest, and likely dates of methyl parathion application, were provided by Dr. M.E. "Butch" Ferree, Professor of Horticulture and peach specialist at the University of Georgia (Table 6).

Table 6: Agronomic Input Parameters for Peaches				
Crop (Surrogates)	Petal Fall	Harvest Dates	Application Dates	Application Method
Peaches (Nectarine, Plum)	March 15 to 20	Mid-May to Aug 1 (max: Jun 10-Jul 20)	May 16 to June 19	Air Blast

This PRZM simulation reflects the maximum label rate (1.5 lb ai/a), number of applications (6/year) and application interval (7 days) sought by the registrants for methyl parathion on peaches. Dr Ferree indicated that peach growers in Georgia follow certain cultural practices, such as mowing, that reduce the amount of insecticides used on peaches. By following these practices, growers are able to apply insecticides by an "alternate middles" regime, effectively cutting the application rate in half.

Dr. Ferree reported that methyl parathion is not used during bloom, due to its high toxicity to bees. In addition, the first application after petal fall is usually not methyl parathion, but a pyrethroid chemical. Methyl parathion is most likely to be used thereafter, due to its efficacy for mites, and because it does not harm many beneficial insects. The application dates used in the simulation reflect this information, and the preharvest interval of 21 days reported by Dr. Ferree and Elf Atochem.

Atochem does not comment on the rates used on nectarines and peaches, but stresses that use does not occur during bloom, due to concerns over bee safety. They state that Penncap "should not be sprayed when weeds (especially clover) are blooming under the canopy", and that they "have worked hard to teach applicators proper timing".

Potato

This input file was adapted from EFED's standard PRZM scenario for potatoes grown on the Conant silt loam in Maine, dated February 13, 1998. Thirty-six years (1948-83) of weather data from MLRA 143 are used for this simulation. Application dates used in this simulation were provided by Dr. Jim Dwyer of the Aroostook County Office of the University of Maine Cooperative Extension Service. Emergence, maturation and harvest dates used in the simulation were confirmed by Dr. Matthew Kleinhenz, also from the Aroostook extension office (Table 7).

Table 7: Agronomic Input Parameters for Potatoes				
Crop (Surrogates)	Planting Date	Harvest Date	Application Dates	Application Method
Potato (Cabbage, Mustard, Tomato)	May 5	September 18	July 1 to Aug. 5	Aerial

This PRZM simulation reflects the maximum label rate (1.5 lb ai/a), number of applications (6/year) and application interval (7 days) sought by the registrants for methyl parathion on potatoes. However, Dr. Kleinhenz reported that methyl parathion is not commonly used in Maine on potatoes. Atochem reports that use in the East is limited due to resistance in the Colorado potato beetle.

Pecans

This input file was adapted from EFED's standard PRZM scenario for pecans grown on the Williston loamy sand in Georgia, dated January 21, 1998. Thirty-six years (1948-83) of weather data from MLRA 138 are used for this simulation. Application dates used in this simulation were provided by Dr. Jim Dutcher of the University of Georgia Department of Entomology (Table 8). Dr. Dutcher indicated that harvest is 25% complete by Thanksgiving, and completed by Christmas.

Table 8: Agronomic Input Parameters for Pecans				
Crop (Surrogates)	"Emergence" Date	Harvest Date	Application Dates	Application Method
Pecans (Almonds)	May 11	October 25	July 9 to Oct. 1	Air Blast

This PRZM simulation reflects the maximum label rate (2.0 lb ai/a), number of applications (8/year) and application interval (14 days) sought by the registrants for methyl parathion on pecans. However, Dr. Dutcher explained that it is unlikely that growers could get around to make that many applications in a season, given the size of the orchards. He reported that two applications of 1 to 2 lb ai/a methyl parathion might be made for stinkbug control. The first would occur about two weeks after shell hardening, around the 20th of August. A second might be made two weeks after that. In order to accommodate 6 applications, the 14-day application interval, and the 30-day pre-harvest interval, applications are simulated in the model before and after these dates.

Atochem confirms that the main use is for stinkbug during nut development, but states that Penncap should not be used when flowering weeds are on the orchard floor. The National Pecan Shellers Association reports that 85% of methyl parathion use is at 0.5 lb ai/a, and the rest at 0.75 lb ai/a. They estimate that Penncap-M has 30 to 40% of the pecan market for stinkbug control.

Cherries

This input file was adapted from EFED's standard PRZM scenario for cherries grown on the Kewaunee silt loam in Wisconsin, dated December 28, 1997. Thirty-six years (1948-83) of weather data from MLRA 96 are used for this simulation. The harvest date was provided by Dr. Daniel Mahr, from the University of Wisconsin-Madison Department of Entomology (Table 9).

Table 9: Agronomic Input Parameters for Cherries

Crop (Surrogates)	Petal Fall	Harvest Date	Application Dates	Application Method
Cherries (Prunes)	May-June	late July (July 28)	June 1 to July 6	Airblast

This PRZM simulation reflects the maximum label rate (1.5 lb ai/a), number of applications (6/year) and application interval (7 days) sought by the registrants for methyl parathion on cherries. However, Mr. Richard Weidman, Superintendent of the Peninsula Agricultural Research Station, indicated that methyl parathion might be applied twice in a growing season to control plum curculio and cherry fruit fly maggot. One could occur during late petal fall, in the middle of June. A second application might occur two weeks later, as late as the 4th of July.

Atochem also states in their QUA+ response that typical use of Penncap-M is one or two times later in the season at rates between 1.0 and 1.5 lb ai/acre. The Cherry Marketing Institute suggests that while use of methyl parathion has declined due to bee toxicity, it is still applied to sweet or tart cherries at 0.6 lb ai/a when applied alternate row middle, or at 1.0 lb ai/a if every row is treated, up to two applications.

Grapes

This input file was adapted from EFED's standard PRZM scenario for grapes grown on the Hornell silt loam in New York, dated December 16, 1997. Twenty-three years (1961-83) of weather data from MLRA 100 are used for this simulation. Emergence, maturation and harvest dates were provided by Phillip Throop of Cornell U. and Fredonia Regional Extension. Application dates were chosen to correspond with the 60-day average PHI reported by Elf Atochem (Table 10).

Table 10: Agronomic Input Parameters for Grapes				
Crop	Emergence (Early Bloom)	Harvest Date	Application Dates	Application Method
Grapes	May 31	October 15	August 9 to 16	Ground spray

This PRZM simulation reflects the maximum label rate (3.0 lb ai/a), number of applications (2/year) and application interval (7 days) sought by the registrants for methyl parathion on grapes. The Concord Grape Association reports typical use of 0.5 to 1.0 lb ai/a in New York, with 1 to 3 applications per year. They describe methyl parathion as a "minor but important pesticide for our area".

Atochem did not comment on the application rates used, but stated that the bulk of their share in the grape market is during the dormant to pre-bloom stage. They report that the share of methyl parathion in the grape market is quite small, and that the grape pandemis is resistant to methyl parathion in the Northwest.

Sweet Potatoes

This input file was adapted from EFED's standard PRZM scenario for sweet potatoes grown on the Calhoun silt loam in Louisiana, dated January 19, 1998. Thirty-six years (1948-83) of weather data from MLRA 133b are used for this simulation. Planting and harvest dates were provided by Dr. Donald LaBonte, of the Louisiana State University Agricultural Center (Table 11).

Table 11: Agronomic Input Parameters for Sweet Potatoes				
Crop	Planting Dates	Harvest Date	Application Dates	Application Method
Sweet Potatoes	May- June 15 (used May 25)	110 days after planting (9/13)	July 1 to Aug. 19	Aerial

This PRZM simulation reflects the maximum label rate (0.75 lb ai/a), number of applications (8/year) and application interval (7 days) sought by the registrants for methyl parathion on sweet potatoes. Dr. Abner Hammond of the LSU Ag. Center confirmed these dates as realistic, stating that methyl parathion might be applied from July 4 until October 1. Atochem suggests that Penncap-M is used typically at 0.38 lb ai/a 3 to 5 times a year. The 24C approvals are for use in Louisiana, Mississippi. Alabama, and Arkansas, with another pending for Texas.

Results

The Tier II EECs for methyl parathion are listed in Table 12. The EECs have been calculated so that in any given year, there is a 10% probability that the maximum average concentration of that duration in that year will equal or exceed the EEC at the site.

Table 12: Tier II upper tenth percentile EEC's for Methyl Parathion for simulated crops.

Crop	Maximum ($\mu g \cdot L^{-1}$)	4 Day ($\mu g \cdot L^{-1}$)	21 Day ($\mu g \cdot L^{-1}$)	60 Day ($\mu g \cdot L^{-1}$)	90 Day ($\mu g \cdot L^{-1}$)	Long-term Mean ($\mu g \cdot L^{-1}$)
Cotton	214.20	162.00	70.062	31.83	22.41	6.83
Corn	39.45	27.28	12.225	5.35	3.60	.97
Alfalfa	4.33	2.9	1.432	.77	.61	.29
Peach	31.65	22.24	9.220	4.24	3.08	.85
Potato	36.91	24.45	11.162	5.81	4.54	1.9
Pecan	12.30	9.38	6.012	3.74	3.25	1.1
Cherry	20.67	14.58	7.204	4.19	2.91	.81
Grape	6.41	4.5	2.254	1.00	.67	.19
Sweet Potato	36.39	24.76	10.766	5.69	4.2	1.2

Limitations of this Analysis

The use of simulation models to estimate possible drinking-water exposure introduces several degrees of uncertainty to a human health or ecological risk assessment. The greatest of these may be the conservative assumptions of the modeling that are intended to ensure the maximum protection for human health. The scenario simulated by both GENEEC and PRZM-EXAMS is a single 10-hectare field draining to a 1-hectare pond with no outlet. This represents a highly conservative assumption, since this scenario does not accurately reflect the dynamics in a watershed large enough to support a drinking water facility.

Additional assumptions ensure that the resulting Tier 2 EEC's are sufficiently conservative to protect human health and the environment:

- Sites simulated in Tier 2 modeling are chosen by best professional judgement to be among the most vulnerable for each crop to which the pesticide is applied.

- The 10-hectare field is assumed to be planted completely to the crop in question;

- The entire annual application of the pesticide is assumed to occur over the 10 hectares within one day; and

- The application rates and timing for each crop are the maximum allowed on the product label.

A watershed large enough to support a drinking-water facility would rarely be planted completely to a single crop, and treated uniformly with the same pesticide at the maximum label rate.

These conservative assumptions are intentionally chosen, in part, to account for other sources of uncertainty associated with the use of simulation models in risk assessment. The first of these is the quality of the input data used in the simulations, which is detailed to some extent above. For instance, data from invalidated environmental fate studies calls the input parameters derived from the studies to question. In addition, the precipitation data used is limited to a maximum of 36 years, with no irrigation simulated in any year. Finally, direct deposit to the pond by spray drift is simulated to be 1% and 5% of the application rate for ground and aerial applications, respectively. Outstanding data from the Spray Drift Task Force may require that these numbers be revised for future assessments.

Finally, the models themselves are a source of uncertainty in the assessments. While the models are some of the best environmental fate estimation tools available, they have significant limitations in their ability to represent some processes. Several of the algorithms (volume of runoff water, eroded sediment mass) are well validated and well understood, but no adequate validation has yet been made of PRZM 3.1 for the amount of pesticide transported in runoff events. Other limitations of the models used include the inability to handle spatial variability within the simulated 10-hectare field, a lack of crop-growth algorithms, and a simplistic soil water transport algorithm (the "tipping bucket" method).

Therefore, given these limitations, a Tier II EEC should be considered a reasonable upper bound estimate of the concentration that could be found in drinking water, and not a prediction of concentrations that would commonly be detected. Risk assessment using Tier II values can be used as refined screens to demonstrate that the risk to human health or the environment is below a level of concern. When Tier II EEC values are above levels of concern, additional data or proactive mitigation measures may be necessary, depending on the magnitude of the LOC exceedence.

Surface Water Monitoring

Direct drinking-water data for methyl parathion are not readily available, and it is not likely that such data have been collected. Public drinking-water supply systems must periodically analyze drinking water for contaminants that either: 1) have a Maximum Contaminant Level (MCL) established by the Office of Water, or 2) are included on the Unregulated Contaminant Monitoring List (UCML). While the Office of Water has established a lifetime health advisory (HA) of 2 ppb, methyl parathion does not have an established MCL, and is not included on the UCML. Therefore, public drinking water supply systems are unlikely to have analyzed for methyl parathion.

Methyl parathion has been included as an analyte in several national-scale surface-water monitoring studies since the early 1970's. Methyl parathion was detected in 2% or fewer of the samples taken in these studies, with maximum concentrations of 1 ppb or less. In a recent example, Goolsby and Battaglin's Mississippi River and tributary study of the early 1990's, methyl parathion was detected at a maximum concentration of 0.008 ppb in 316 samples[4].

Methyl parathion is among the analytes included in the United States Geological Survey's National Water Quality Assessment Program (NAWQA). Low levels of methyl parathion were reported in preliminary results from samples collected from 1991-1995 from 20 major watersheds around the country[5]. The maximum concentrations detected are in Table 13.

Table 13: Surface Water Results, 1991-1995, USGS NAWQA Program			
Type of Stream	# of Streams	# of Samples	Maximum Conc. (ppb)
Agricultural	37	1530	0.3
Urban	11	603	0.072
"Integrator"	14	555	0.028

The concentrations in the studies cited above are below those predicted by the GENEEC screening model. It should be noted that the analytical recoveries for methyl parathion in the NAWQA study is 46% (SD=13%). Such low recoveries limit extensive quantitative interpretation of the monitoring data. However, the monitoring data are expected to be lower than GENEEC because of the conservative assumptions used in the model for a first-tier assessment. Just as significant, however, is the fact that the Mississippi River and NAWQA programs were *non-targeted* monitoring surveys. These studies were designed to study the effects of agricultural runoff, but methyl parathion is only one of a suite of many pesticides included in the water analyses. There is no guarantee of how well samples taken in these programs correspond to times or locations of actual methyl parathion use.

A few reports are available that detail more targeted monitoring for methyl parathion. The California Environmental Protection Agency Department of Pesticide Regulation (CDPR) has a continuing, 10-year study of rice pesticides in surface water, which includes methyl parathion. CDPR samples the Colusa Basin Drain, an agricultural discharge channel that collects outflow from rice fields from about 20 to 100 miles north of Sacramento, and west of the Sacramento River. This area is used for many continuous miles of rice monoculture on heavy clay soils.

According to the CDPR, methyl parathion was detected at concentrations of up to 6 ppb in 1989. CDPR was concerned with surface water contamination by a suite of rice pesticides. By the late 1980s, CDPR had instituted a control program to reduce the surface water impacts of rice herbicides. In the early 1990s, the CDPR expanded the program to include rice insecticides.

The program includes both irrigation and application controls to reduce direct input of pesticides to the Colusa Basin Drain, which drains to the Sacramento River. Rice farmers are required to hold water on flooded rice fields for prescribed periods of time before releasing it to the drainage system, periods which depend on the pesticides applied. The holding time for methyl parathion is 24 days, but it is held longer if applied concurrently with another pesticide that must be held longer. Application controls include requirements such as positive shutoff systems for aircraft nozzles, use of drift control agents, and a 300-foot buffer from water bodies for aerial applications.

CDPR has seen measurable improvements in the samples they have taken each year from early or mid-April to mid-June. For instance, the peak concentration of methyl parathion detected in 1996, the last year for which a report has been prepared, was 0.12 ppb. A maximum concentration of 0.107 ppb was detected in 32 samples taken in 1997. **The results of this targeted study present data that are more realistic, but less conservative, than Tier I and Tier II estimates.** These data reflect successful mitigation, and also a reduction in methyl parathion use in the area over 15 years.

The surface-water database maintained by the CDPR includes 14 positive detections out of 1034 samples taken since 1991. Eleven of those detections were 1995-97 data from the Colusa Basin Drain study cited above. Two other detections connected with rice culture were collected from the Butte Flue in Yolo County; measured concentrations were 0.19 and 0.07 ppb. The only other detection in the database to date is from the San Joaquin Valley, a detection of 0.02 ppb in 1991, where methyl parathion is used in fruit production.

The USGS has collected several hundred surface water samples in their targeted "Cotton Pesticides of the Mississippi Delta" study. The stated goal of this study is to fill the "gap in our knowledge of the transport and fate of cotton pesticides and their metabolites". Samples were taken from five tributaries of the Mississippi River near fields of cotton and rice pesticide use, including samples taken to correspond with likely times of application. Preliminary results from 80 samples analyzed to date have not yielded detections of methyl parathion; analysis of the remaining samples should be completed by the end of this year. Methyl paraoxon and 4-nitrophenol were not included as analytes for these samples.

Heath, et al. (1993) cites data from a study that reported mean methyl parathion detections of 0.66 ppb in water from the Colusa Basin Drain in central California. This agricultural drain, which flows into the Sacramento River, accepts drainage from rice fields which are often treated with methyl parathion. The San Francisco Estuary Institute has reported as-yet unquantified detections of methyl parathion in regular (24 stations, 3 times yearly) sampling. A database maintained by Spectrum Laboratories reports that 15 ppb of methyl parathion was detected in storm water runoff following a foliar application. However, until a citation can be provided for this data, it must be considered anecdotal.

GROUND WATER ASSESSMENT FOR METHYL PARATHION

SCI-GROW is a screening level model developed by Dr. Michael Barrett (U.S. EPA/OPP/EFED) to estimate the "maximum" groundwater concentration from the application of a pesticide to crops. SCI-GROW is based on the fate properties of the pesticide, the application rate, and the existing body of data from small-scale groundwater monitoring studies[6]. The model assumes that the pesticide is applied at its maximum rate in areas where the groundwater is particularly vulnerable to contamination. In most cases , a considerable portion of any use area will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimates. As such, the estimated "maximum" concentration derived using SCI-GROW should be considered a high-end to bounding estimate of drinking-water exposure from a ground-water source. If the risk associated with this estimate is exceeded, either at the acute or chronic end-points, refinement of the exposure estimate will be necessary to better characterize actual exposures. Table 14 provides the EEC for groundwater using the SCI-GROW model.

Table 14: Ground-Water Results for Methyl Parathion

CROP	App. Rate (lbs/ac)	# Apps./Yr	SCI-GROW Acute EEC (ppb)
Cotton	3.0	10	0.60

Ground-Water Monitoring

Methyl parathion has been detected in ground water, but these detections have been at low concentrations. The Pesticides in Ground Water Database (PGWDB) includes data from 3,357 wells, of which 20 showed positive detections of methyl parathion. The highest ground-water concentration reported from these wells was 0.256 ppb, from a well in Mississippi, although 13 wells in a 1987 Virginia study had detections below a 5 ppb level of quantification. The PGWDB reports that methyl paraoxon was not detected in samples taken from 125 wells in two states.

Methyl parathion was detected in 53 of 65 samples reported in a USGS study performed in Berkeley County, WV[7]. However, all of the detections were at levels below the quantification limit of 0.01 ppb. Berkeley County is an area underlain by karst geology, which can be considered as highly vulnerable to ground-water contamination. The samples in this study were taken from wells and springs.

In addition, methyl parathion was detected in ground water in samples taken from the NAWQA program. The maximum concentration detected from 1130 samples collected between 1991-1995 was 0.062 μg/L. **As with the surface-water monitoring, it should be noted that the analytical recoveries for methyl parathion in the NAWQA study is 46% (SD=13%). Such low recoveries limit extensive quantitative interpretation of the monitoring data.** Additionally, the NAWQA ground-water monitoring study was not specifically targeted for times and areas of methyl parathion use.

Methyl parathion was included, but not detected in the 1995 USGS Midcontinent Pesticide Study. The investigators analyzed 94 samples for methyl parathion, with an analytical reporting limit of 0.008 ppb. This study was not targeted specifically to methyl parathion, but did occur in corn and soybean growing areas.

This study included an analysis of the "age" of the ground water collected, measuring radioactive tracers to determine when the water recharged from the surface. Tritium levels in the water give an indication of whether the ground-water recharged from the surface before or after 1953, which marks the advent of atmospheric nuclear weapon testing. The year 1953 predates the registration of most current pesticides, including methyl parathion.

Analysis indicated that 19% of the samples collected were water that recharged prior to 1953. This water was more likely to occur in near-surface bedrock aquifers (50% of samples) than in near surface unconsolidated aquifers (9.1%). Pesticides were much less likely to be detected in pre-1953 water (16%) than in post-1953 water (70.3% of samples). The cause of the detections (atrazine at 3 to 9 ppt) in three "pre-1953" samples was likely the result of mixing with a small amount of post-1953 water in the aquifer.

The results of these analyses have important implications for ground-water derived drinking-water assessments. Large public drinking-water supply wells are often drilled deep into bedrock aquifers, and may represent water that recharged from the surface long before the advent of many modern pesticides. However, as indicated by the "pre-1953" water with atrazine detections described above, pesticides can persist in ground-water for lengths of time not consistent with laboratory degradation studies. Ground-water "age" data is rarely included with ground-water monitoring studies.

Methyl Parathion Degradates in Drinking Water

Degradate 4-nitrophenol, which is a degradate common to both methyl parathion and ethyl parathion, has been detected in drinking water. The EPA's National Pesticide Survey (NPS) reported that 4-nitrophenol was found in four samples, of which two were community water supply systems, and two private rural drinking-water wells. However, the study said that the analytical method used to detect 4-nitrophenol (GC/MS with electron capture) could not reliably quantify the concentration of the degradate in water.

It is important to note that 4-nitrophenol can be introduced into the environment by other pathways in addition to being a degradate of methyl parathion and ethyl parathion. This chemical is released in wastewater during the production of methyl parathion, ethyl parathion, and N-acetyl-p-aminophenol (pain-killer acetaminophen). 4-nitrophenol is also produced by photochemical reactions in the air connected with vehicular exhaust gas, and found on suspended particulate matter in the atmosphere.

Although 4-nitrophenol has been found in drinking water, the Health Effects Division has indicated that methyl paraoxon is the only degradate of methyl parathion included in the tolerance expression for methyl parathion. Degradate 4-nitrophenol is toxic to humans, but it has a different mode of action and toxic endpoint than methyl parathion and methyl paraoxon. The endpoint of concern for 4-nitrophenol is children under 3 months old, due to concerns about methemoglobin anemia. The EPA Office of Water has established one-day, ten-day and longer term Health Advisory levels (HA) for 4-nitrophenol of 800 ppb for a 10-kg child.

Therefore, some assessment of the potential of 4-nitrophenol to contaminate drinking water is warranted, in spite of the fact that it does not share a common mode of action with methyl parathion and methyl paraoxon. The uncertainty of such an assessment is significant, because EFED has not required that a full suite of environmental fate studies be performed for this chemical. Since 4-nitrophenol is produced in its own right as a fungicide used in the treatment of leather and cork insulation, EPA issued a RED for 4-nitrophenol in 1991. However, since 4-nitrophenol is only registered for indoor uses, the only environmental fate study that EFED requested be performed was the hydrolysis study. There is no indication that this study was ever submitted by registrant Monsanto.

The EFED chapter for 4-nitrophenol notes an aerobic soil metabolism half-life of 16 days, and a Koc value of 214. No details are given on the sources of these data, nor the conditions under which these values were derived. A better source of peer-reviewed data comes from the National Library of Medicine, which has prepared a review of open literature studies on the chemical properties of 4-nitrophenol. EFED performed a first-tier drinking water assessment for 4-nitrophenol using the data cited in that review:

Table 15. GENEEC Environmental Fate Input Parameters for 4-Nitrophenol		
DATA INPUT	**INPUT VALUE**	**SOURCE**
Effective Application Rate	0.52 lb ai/A (from methyl parathion 0.13 lbs ai/A (from ethyl parathion)	Label rates adjusted* for % of degradate and difference in molecular weight
Maximum Number of Applications	10 (m-parathion) 6 (e-parathion)	Cheminova
Application Interval	3 days (methyl-parathion) 7 days (ethyl-parathion	Cheminova
Batch Equilibrium (Koc)	55 ml/g	National Lib. Of Medicine
Aerobic Soil Metabolism	$t_{1/2}$ = 1.2 days**	National Lib. Of Medicine
Solubility	16000 ppm	National Lib. Of Medicine
Aerobic Aquatic Metabolism	stable	N/A
Hydrolysis	stable	N/A
Photolysis	$t_{1/2}$ = 6.7 days	National Lib. Of Medicine

* Maximum application rate of parent compounds multiplied by the maximum amount of 4-nitrophenol detected (as % of applied parent) in any laboratory study submitted by the registrant, multiplied by a molecular weight correction factor (i.e. MW of 4-nitrophenol/MW of parent)
** Half-life is from agricultural top soil experiment

Table 16. Surface Water Results for 4-Nitrophenol						
Use	**App. Rate of Parent (lbs/acre)**	**Adjusted app. rate for degradate (lbs/acre)**	**# Apps/year**	**App. Int. (days)**	**GENEEC Peak EEC (ppb)**	**GENEEC 56 Day EEC (ppb)**
Cotton	3.0 (MP)	0.52	10	3	42.42	40.66
Cotton	1.0 (EP)	0.13	6	7	8.02	7.69
Total	———	———	———	———	50.44	48.35

The values above include several conservative assumptions beyond those inherent in the GENEEC screening model itself.

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1) The application rates used for 4-nitrophenol can be derived from the maximum rates at which parents methyl parathion and ethyl parathion are applied. These maximum rates were multiplied by the highest percentage of 4-nitrophenol found in any of the laboratory studies cited above and then multiplied by the molecular weight correction factor (i.e. M.wt.of 4-nitrophenol/M.wt of parent) . The maximum 4-nitrophenol derived from methyl parathion was 33%, from the anaerobic aquatic metabolism study. The maximum amount derived from ethyl parathion was 27%, from the aerobic aquatic metabolism study. Using these percentages to calculate an effective application rate assumes that other degradative processes are not occurring to degradate 4-nitrophenol as it is produced by the aquatic metabolism processes above. This is a *very* conservative assumption which should be considered when evaluating the results of this first-tier screen.

2) Since aerobic aquatic metabolism data is not readily available for 4-nitrophenol, this degradate was assumed to be stable to that process;

3) Since hydrolysis data is not readily available for 4-nitrophenol, this degradate was assumed to be stable to that process;

4) The additive risk from 4-nitrophenol derived from methyl parathion and ethyl parathion assumes that the uses of the parent compounds chosen are occurring in the same area for the GENEEC simulation. This is also quite a conservative assumption.

5) No other potential sources of 4-nitrophenol in drinking water are considered in this assessment. EFED is not aware of the magnitude of discharge of 4-nitrophenol in wastewater, or potential deposition in rainwater. It is possible that these sources might result in a more significant contamination of drinking water by 4-nitrophenol than the degradation of methyl parathion and ethyl parathion. No attempt to quantify the risk posed by other sources of 4-nitrophenol is attempted here.

In spite of the conservative assumption detailed above, the estimated concentrations of 4-nitrophenol in drinking water do not approach the 800 ppb HA for a 10-kg child. These values do not exceed OW's lifetime HA for a 70-kg adult of 60 ppb, and HED has indicated that adults are not an endpoint of concern for this chemical, in any case.

Ground-Water Assessment for 4-Nitrophenol

Results of a SCI-GROW assessment for 4-nitrophenol are shown below. The assumptions made and chemical properties used to perform this assessment are the same as for the GENEEC run, with one exception. The aerobic soil metabolism half-life used in this assessment is 40 days, which was cited by the National Library of Medicine literature review as the half-life measured in subsoil samples. Using this half-life assumes that 4-nitrophenol quickly leaches to the subsoil, before degradation can occur in the top soil at the shorter half-life cited above.

Table 17. Ground-water results for 4-Nitrophenol				
Crop	**App. Rate of Parent (lbs/acre)**	**Adjusted app. Rate (lbs/acre)**	**# Apps./Year**	**SCI-GROW Acute EEC (ppb)**
Cotton	3.0 (MP)	0.52	10	3.70
Cotton	1.0 (EP)	0.13	6	0.55
Total	-------	-----	-----	4.25

The PGWDB reports that 4-nitrophenol was detected in 3 of 263 wells sampled in Mississippi from 1982 to 1990, at concentrations ranging from 0.004 to 0.02 ppb. No detections were reported in 81 wells sampled in Washington in 1988. EFED recommends that a concentration of 4.25 ppb be used for a first-tier assessment of drinking water derived from a ground-water source.

ECOLOGICAL HAZARD ASSESSMENT

The toxicity of a pesticide is determined through laboratory testing of representative surrogate species. For instance, two surrogate species each are used in toxicity testing to represent all freshwater fish (>2000 species) and birds (>680 species) in the United States. Acute mammalian studies are usually performed using the laboratory strain of the Norway rat or the house mouse as surrogate species. Estuarine/marine testing is limited to a crustacean, mollusk, and fish. Reptiles and amphibians are not tested. Avian toxicity studies are used as surrogates for reptilian toxicity assessments. Fish toxicity studies are used as surrogates for addressing the risk to amphibians, assuming that the tadpole stage has the same sensitivity as a fish.

The tabular data below present the results of selected studies for surrogate and most sensitive species of those tested for each endpoint. This in no way represents the extensive number of studies which have been reviewed or conducted with methyl parathion. A full tabular summary of ecotoxicological data is presented in Appendix 1. Open literature studies on the ecological effects of methyl parathion, as well as incident reports that show these effects, are included in the risk assessment.

a. Toxicity to Terrestrial Animals

I. Birds and Reptiles, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of methyl parathion to birds and reptiles. The preferred test species is either mallard duck (a waterfowl) or bobwhite quail (an upland game bird). Results of this test requirement are tabulated below. Also shown are results for American Kestrel which was the most sensitive species tested.

Avian Acute Oral Toxicity

Species	% ai	LD50 (mg/kg)	Toxicity Category [1]	MRID No: Author/Year	Study Classification[2]
Mallard duck *Anas platyrhynchos*	80	6.6 (4.42-9.88)	"very highly toxic"	00160000 Hudson/ 1984	Core
Northern bobwhite quail *(Colinus virginianus)*	80	7.56(5.7-10)	"very highly toxic"	00160000 Hudson/ 1984	Core
American Kestrel *(Falco sparverius)*	98.2% Technical	3.08(2.29-4.14)	"very highly toxic"	44371701 Rattner/1983	Supplemental

[1] "Very highly toxic" designates chemicals whose LD_{50} is <10 mg/kg."Highly toxic" designates chemicals whose LD50 is between 10 and 506J mg/kg. "Moderately toxic" designates chemicals whose LD50 is between 51 and 500 mg/kg (Brooks (1973).
[2] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline)
he following dermal studies were available:

Because the lowest LD_{50} is less than 10 mg/kg, methyl parathion is "very highly toxic" to avian species on an acute oral basis. The guideline (71-1) is fulfilled (MRID 00160000).

Dermal studies were performed by dosing test birds with methyl parathion on their feet or under their

Avian Acute Dermal Toxicity

Species	%a.i.	LD50 mg/kg	Toxicity Category	MRID No. Author/Year	Study Classification
Bobwhite Quail (*Colinus virginianus*)	45.42 EC	2.9 (2.3-3.7)	"very highly toxic"	71200/ Beavers/1980	Supplemental
Bobwhite Quail (*Colinus virginianus*)	22.0 Penncap-M	9.127	"very highly toxic"	83103/ Beavers/1980	Supplemental
Mallard duck (Anas platyrhynchos)	80.00	53.6 (39.3- 72.9) Feet exposed	"Moderately toxic"	00160000 Hudson/1984	Supplemental

Two subacute dietary studies using the TGAI are required to establish the toxicity of methyl parathion to birds. The preferred test species are mallard duck and bobwhite quail. It appears that dermal toxicity values are nearly the same as the acute oral study values. Hence, we assign the same toxicity category of "very highly toxic." More species are likely to suffer adverse effects because of the dermal toxicity. Dermal poisoning does not require preference for contaminated food, but only that a bird walk through a contaminated area.

Results of these tests are tabulated below.

Avian Subacute Dietary Toxicity

Species	% ai	5-Day LC50 (ppm)[1]	Toxicity Category[2]	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	Tech	28.2(22-35.3)	"very highly toxic"	102329 Pennwalt/ 1972	Supplemental
Mallard duck *(Anas platyrhynchos)*	80	336(269-413)	"highly toxic"	00022923 Hill/1975	Core
Ring-necked Pheasant *(Phasianus colchicus)*	80	91(77-107)	"highly toxic"	00022923 Hill/1975	Core

[1] "Very highly toxic" designates chemicals whose LD_{50} is <10 mg/kg."Highly toxic" designates chemicals whose LD50 is between 10 and 50 mg/kg. "Moderately toxic designates chemicals whose LD50 is between 51 and 500 mg/kg (Brooks (1973).

Methyl parathion is "very highly toxic" to avian species on a subacute dietary basis. The guideline (71-2) is fulfilled (MRID # 00022923).

ii. Birds and Reptiles, Chronic

Avian reproduction studies using the TGAI are required for methyl parathion because the following conditions are met: (1) birds may be subject to repeated or continuous exposure to the pesticide, especially preceding or during the breeding season, and (2) information derived from mammalian reproduction studies indicates reproduction in terrestrial vertebrates may be adversely affected by the anticipated use of the product. The preferred test species are mallard duck and bobwhite quail. Results of these tests are tabulated below.

Avian Reproduction

Species/ Study Duration	% ai	NOEC (ppm)	LOEC (ppm)	LOEC Endpoints	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	Tech	6.27	15.5	Number of eggs laid; eggs set/hen; adult female bodyweight	41179302 Beavers/1988	Core
Mallard duck *(Anas platyrhynchos)*	Tech	14.7	>14.7	No effects at highest conc.	41179301 Beavers/1988	Supplemental

The mallard duck study (44179301) is supplemental because it did not determine an effect level. Since the bobwhite quail study shows that the quail is more sensitive, a new mallard study is not required. Risk quotients (RQs) were determined using the lowest value. The guideline (71-4) is considered fulfilled (MRID 41179302).

iii. Mammals, Acute and Chronic

The mammalian toxicity values shown below were obtained from the Agency's Health Effects Division (HED):

Mammalian Toxicity

Species/ Study Duration	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID No.
laboratory rat 96 hours	80	Oral LD50	3.6 (1.63-7.92) mg/kg ♂ 23.0 (13.7-38.6) mg/kg ♀	Mortality	243414
Laboratory rat	NR	Dermal LD50	6 mg/kg (NR)	Mortality	(HED chapter)
Laboratory rat	NR	Inhalation LC50	<0.163 mg/L	Mortality	256961
Laboratory rat 96 hours	99	Dietary LC50	110 (85-196) ppm	Mortality	43961101 McCann
Feeding-3 month rat	Technical	Feeding	NOEL=2.5 ppm (converts to 0.25 mg/kg) LEL=25 ppm (2.5 mg/kg) -	Clinical changes (lowered hemacrit; elevated SAP & urine specific gravity; depressed RBC, brain & plasma ChE.)	74299
Rat 2 generation	95.8	Repro-duction	Reproduction NOEL =5 ppm; Mat. NOEL=5 ppm	Significant decreased pup survival Reduced bodyweight during lactation	00119087

Methyl parathion is "very highly toxic" (NOEL <10 mg/kg) to small mammals on an acute oral basis (MRID No. 243414), and "highly toxic" to small mammals on an acute dietary basis (MRID No. 43961101). The feeding 3 month NOEL was very low at 2.5 ppm (MRID No. 74299) and the reproduction NOEL is 5 ppm (MRID No. 00119087).

iv. Insects

A honey bee acute contact study using the TGAI is required for methyl parathion because its use on flowering crops will result in honey bee exposure. Results of this test are tabulated below:

Nontarget Insect Toxicity

Species	% ai	Results	MRID No. Author/ Year	Study Classification
Honey bee (*Apis mellifera*)	---	LD50 0.111 μg/bee	44038201 Atkins/ 1981	Core
Honey bee (*Apis mellifera*)	Penncap-M	LD50 0.214 μg/bee	44038201 Atkin/ 1981	Core
Honey bee (*Apis mellifera*)	Penncap-M	"The average mortality of the adult honey bees was from 29 to 72 times higher than normal the first 48 hours after pollen containing Penncap -M, stored 13.5 and 14.5 months in the cells of wax combs, was introduced into nucleus colonies. After 1 week adult mortality was still 4 to 10 times higher than normal. After 4 weeks, mortality was nearly normal again. . .. Chemical analysis of the stored pollen showed 26 ppm methyl parathion."	160948 Rhodes/ 1980	Supplemental

Methyl parathion is very highly toxic to bees on acute contact basis and suggest strongly that mortality will occur under fields conditions. Additional evidence from the open literature is cited in the risk assessment. Field reports of bee kills are provided Appendix 2. Also, a study has shown that methyl parathion is toxic to bees exposed to foliar residues (Waller, 1984 MRID 138663). The guideline requirements 141-1 and 141-2 are fulfilled by the cited studies.

b. Toxicity to Freshwater Aquatic Animals

I. Freshwater Fish and Amphibian Acute Toxicity

Two freshwater studies using the TGAI are required to establish the toxicity of methyl parathion to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Results of tests on selected surrogate and other sensitive species are tabulated below.

Freshwater Fish and Amphibian Acute Toxicity

Species/	% ai	96-hour LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Rainbow trout (*Oncorhynchus mykiss*)	43.2	2.2(1.5-2.7)	"moderately toxic"	40932101 Surprenant/1988	Core
Bluegill sunfish (*Lepomis macrochirus*)	77	1.0(0.6-1.6)	"highly toxic"	40098001 Mayer/1986	Core
Channel catfish (*Ictalurus punctatus*)	90	5.24(4.27-6.44)	"moderately toxic"	40094602 Johnson/1980	Core

Freshwater Fish and Amphibian Acute Toxicity

Species/	% ai	96-hour LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Chorus frog (*Pseudacris triseriata*)	90	3.7(N.R.)	"moderately toxic"	40098001 Mayer/1986	Supplemental
Cutthroat trout (Oncorrhychus clark)	90	1.85 (1.39-2.47)	"moderately toxic"	40094602 Johnson/1980	Core

[1] Brooks (et al.,1973) toxicity classification indicates that LC50 values >1 to 10 ppm are "moderately toxic".

Because these LC_{50}s fall in the range of >1 to 10 ppm, methyl parathion is "moderately to highly toxic" to freshwater fish on an acute basis. The guideline (72-1) is fulfilled (MRID 40932101, 40098001, and 40094602). Methyl parathion is also moderately toxic to larval stages of developing frogs and possibly other amphibian species.

ii. Freshwater Fish, Chronic

A freshwater fish early life-stage test using the TGAI is required because residues may reach surface water. Also, the PRZM-EXAMS EEC for cotton is three-tenths of the early life-stage NOEC which exceeds the trigger that the EEC is equal to or greater than one-tenth of the NOEC for the early life-stage. The results for fathead minnow and rainbow trout are shown below. The guideline (72-4) is fulfilled (MRID No. 233438)

Freshwater Fish Early Life-Stage Toxicity Under Flow-through Conditions

Species/ Study Duration	% ai	NOEC/LOEC (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Fathead Minnow (*Pimephales promelas*)	80	0.31/0.38	Weight	233438 Jarvinen/1988	Core
Rainbow trout (*Oncorhynchus mykiss*)	Tech-nical 75.1	ND/<0.08	Length and weight	250628 Bailey/1983	Supplemental

Methyl parathion causes chronic effects in fish at concentrations less than 80 ppb.

iii. Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of methyl parathion to aquatic invertebrates. The preferred test species is *Daphnia magna*. Results of selected tests with *Daphnia* and crayfish are tabulated below.

Freshwater Invertebrate Acute Toxicity

Species	% ai	48-hour LC50/ EC50 (ppb)	Toxicity Category	MRID No. Author/Year	Study Classification

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Freshwater Invertebrate Acute Toxicity

Waterflea (*Daphnia magna*)	90	0.14(0.09-0.2)	"very highly toxic"	40094602 Johnson/1980	Core
Crayfish (*Orconectes nais*)	90	15(N.R.)	"very highly toxic"	40094602 Johnson/1980	Supplemental

[1] Brooks (et al., 1973) classification indicates the LC50 of 0.1 to 1 ppm are in the "highly toxic" range and those greater than 1 to 10 ppm are in the "moderately toxic" range.

Because the LC_{50}/EC_{50} is < 100 ppb, methyl parathion is in the "very highly toxic" range for aquatic invertebrates on an acute basis. The guideline (72-2) is fulfilled (MRID No. 40094602).

iv. Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle test using the TGAI is required for methyl parathion because: 1) the rice use and multiple applications to turf (see EEC) are expected to result in contamination of natural water, (2) the aquatic acute EC_{50} is less than 1 mg/L, and (3) the EEC in water is equal to or greater than the 0.01 of the acute EC_{50}.

Freshwater Aquatic Invertebrate Life-Cycle Toxicity

Species/ Flow-through)	% ai	21-day NOEC/LOEC (ppb)	Endpoints Affected	MRID No. Author/Year	Study Classification
Waterflea (*Daphnia magna*)	96	0.178/0.562	Survival, growth, and offspring/parent Daphnia	41506801 Heimbach/1987	Supplemental
Waterflea (*Daphnia magna*)	80%	0.02/0.25	Neonates produced, survival, growth (length)	44371716 Fernandez-Casalderrey	Supplemental
Waterflea (*Daphnia magna*)	75.1 Technical	0.16/2.51	Young produced/ reproductive day and average No. of young produced	250628 Bailey/1983	Core

The guideline (72-4) is fulfilled (MRID No.250628).

Methyl parathion causes chronic effects in *Daphnia magna* at concentrations of <0.25 ppb.

c. Toxicity to Estuarine and Marine Animals

I. Estuarine and Marine Fish, Acute

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Acute toxicity testing with estuarine/marine fish using the TGAI is required for methyl parathion because the active ingredient is expected to reach the estuarine/marine environment because of its use in coastal counties. The preferred test species is sheepshead minnow. Results of sheepshead minnow and other more sensitive species are tabulated below.

Estuarine/Marine Fish Acute Toxicity

Species	% ai	96-hour LC50 ppm	Toxicity Category	MRID No. Author/Year	Study Classification
Spot (*Leiostmous xanthurus*)	99	0.059 (0.045-0.074)	" very highly toxic"	40228401 Mayer/1986	Supplemental
Striped bass (*Morone saxatilis*	80	0.79 (0.17-1.4)	"highly toxic"	05000819 Korn/1974	Core
Sheepshead minnow (*Cyprinodon variegatus*)	43.2	3.4 (2.8-4.1) a.i., not product	"moderately toxic"	40932103 Surprenant/1988	Core

[1] Brooks (et al.,1973) classification indicates that LC50s greater than 1 to 10 ppm are "moderately toxic".

Methyl parathion is "moderately to very highly toxic" to estuarine/marine fish on an acute basis. The guideline (72-3a) is fulfilled (MRID 40932103 and 05000819).

ii. Estuarine and Marine Fish, Chronic

Because the acute LC_{50} is less than 1 ppm, and the pesticide is expected to be transported to water, an *estuarine/marine fish early life-stage toxicity test using the TGAI is required.* Since freshwater fish are significantly more tolerant to methyl parathion exposure, the freshwater fish study cannot be used as a surrogate study to fulfill this guideline requirement.

iii. Estuarine and Marine Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates using the TGAI is required for methyl parathion because the active ingredient is expected to reach the estuarine/marine environment because of its use in coastal counties. The preferred test species are mysid and eastern oyster. Results of selected tests are tabulated below.

Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50/EC50 (ppb) (measured)	Toxicity Category[1]	MRID No. Author/Year	Study Classification
Eastern oyster (*Crassostrea virginica)*	99	12000 (10000-16000)	"slightly toxic"	40228401 Mayer/1986	Core

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Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50/EC50 (ppb) (measured)	Toxicity Category[1]	MRID No. Author/Year	Study Classification
Mysid *(Americamysis bahia)*	43.2	0.35 (0.31-0.39) a.i., not product	"very highly toxic"	40932104 Surprenant/1988	Core*
Mysid (Americamysis bahia)	99	0.78 (0.58- 1.1)	"very highly toxic"	40228401 Mayer/1986	Core

[1] Based on Brook's (et al. 1973) toxicity categories indicate that chemicals with an LC50 < 0.1 ppm are "very highly toxic" and those between 10 and 100 ppm are "slightly toxic" . *Indicates core only for the formulated product.

Because the methyl parathion LC_{50}/EC_{50}s fall in the range of >0.1-1 ppm, methyl parathion is "highly toxic" to estuarine/marine invertebrates on an acute basis. The guideline (72-3b and 72-3c) is fulfilled (MRID 40228401, 40932104).

iv. Estuarine and Marine Invertebrate, Chronic

An estuarine/marine invertebrate life-cycle toxicity test using the TGAI is required for methyl parathion. Methyl parathion meets the following criteria for requiring this test: (1)The end-use product may be expected to be transported to the estuarine/marine environment from the intended use sites. Methyl parathion has been found in estuarine environments as a result of its use on rice; (2) the aquatic acute EC_{50} is less than 1 mg/L; (3) the EEC in water is equal to or greater than the 0.01 of the acute EC_{50}, and (4) methyl parathion may persist with a half-life greater than 4 days. The preferred test species is mysid. Results of this test are tabulated below:

Estuarine/Marine Invertebrate Life-Cycle Toxicity

Species/(Static Renewal or Flow-through)	% ai	21-day NOEC/LOEC (ppb)	MATC[1] (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Mysid *(Americamysis bahia)*		0.11/0.37	0.20	Survival and Number of offspring/♀	66341 Lowe/1981	Core

[1] defined as the geometric mean of the NOEC and LOEC.

The guideline (72-4) is fulfilled (MRID No. 66341).

d. Toxicity to Plants

I. Terrestrial

Terrestrial plant testing (122-1 a and b) is required for pesticides other than herbicides if data from the literature indicate that a pesticide is phytotoxic. Environmental Health Criteria 145 from the World Health Organization (WHO) 1993 reports that phytotoxic effects of methyl parathion have been observed in cotton and lettuce and that methyl parathion has been shown to cause a reduction of growth in sorghum. However, given its widespread use on a variety of important crops, terrestrial plant data for methyl parathion are not needed at this time.

ii. Aquatic Plants

Aquatic plant testing is required for insecticides applied to aquatic food, aquatic nonfood, and forestry sites. In these cases aquatic plant testing is required (122-2) on *Kirschneria subcapitatum*, *Lemna*, *Skeletonema costatum*, *Anabaena flos-aquae*, and a freshwater diatom. The following test was found in Mayer, 1986 (MRID 48228401). It indicates that methyl parathion is "moderately toxic" to marine diatoms.

Nontarget Aquatic Plant Toxicity (Tier II)

Species	% ai	EC50/ (ppm)	MRID No. Author/Year	Study Classification
Nonvascular Plants				
Marine diatom (*Skeletonema costatum*)	99	5.3 (4.3-5.7)	Lowe 66341/1981	Supplemental

Methyl parathion has shown phytotoxic effects to terrestrial plants. Based on this fact, aquatic species testing (122-2, aquatic plant growth) is required using a marine diatom (Kirschneria subcapitatum) and a freshwater diatom (Anabaena flos-aquae).

ECOLOGICAL RISK ASSESSMENT

<u>Unsupported Uses</u>

Although the uses shown below appear on current methyl parathion labels, the registrant has informed SRRD that these uses will no longer be supported by tolerances. These uses, which are not included in this risk assessment, will be removed from the label. Future use of methyl parathion on these crops will not be permitted after a 30-month phaseout period. If any potential registrant requests that use on these crops be resumed, a new risk assessment will be needed.

Apricot	Kohlrabi
Artichoke	Rutabaga
Beets	Safflower
Cucumber	Tobacco
Gooseberry	

The addition of additional uses, such as public health mosquito control, would similarly require a new risk assessment.

Risk Quotients and Levels of Concern

EFED uses an indexing method of risk assessment which considers exposure and toxicity components. Risk quotients (RQs) are calculated by dividing exposure estimates by toxicity values, both acute and chronic.

RQ = EXPOSURE/TOXICITY

The resultant quotient is then compared to predetermined levels of concern (LOCs). This quotient is used as a screen to show relative risk.

The LOC criteria are defined as follows:

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

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

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

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

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

Risk presumptions, along with the corresponding RQs and LOCs, are tabulated below.

Risk Presumptions for Terrestrial Animals

Risk Presumption	RQ	LOC
Birds and Mammals		
Acute High Risk	EEC[1]/LC50 or LD50/sq ft or LD50/day[3]	0.5
Acute Restricted Use	EEC/LC50 or LD50/sq ft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sq ft or LD50/day	0.1
Chronic Risk	EEC/NOEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items

[2] $\frac{mg/ft^2}{LD50 * wt. of bird}$ [3] $\frac{mg of toxicant consumed/day}{LD50 * wt. of bird}$

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Risk Presumptions for Aquatic Animals

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or EC50	0.5
Acute Restricted Use	EEC/LC50 or EC50	0.1
Acute Endangered Species	EEC/LC50 or EC50	0.05
Chronic Risk	EEC/MATC or NOEC	1

[1] EEC = (ppm or ppb) in water

Risk Assessment for Nontarget Terrestrial Animals

For pesticides applied as liquids, the estimated environmental concentrations (EECs) on food items following product application are compared to LC50 values to assess risk. The predicted 0-day maximum residues of a pesticide that may be expected to occur on selected avian or mammalian food items immediately following a direct single application at 1 lb ai/A are tabulated below.

Estimated Environmental Concentrations (EECs) on Avian and Mammalian Food Items (ppm) Following a Single Application at 1 lb ai/A)

Food Items	EEC (ppm)[1]
Short grass	240
Tall grass	110
Broadleaf/forage plants, and small insects	135
Fruits, pods, seeds, and large insects	15

[1] Maximum EEC are for a 1 lb ai/A application rate and are based on Fletcher *et al.* (1994).

EECs resulting from multiple applications are calculated from the maximum number of applications, minimum application interval, and foliar half-life data. Willis and McDowell (1987) reported a number of methyl parathion foliar half-lives ranging from 0.1 to 13.5 days, with most values being <2 days.. This assessment uses a foliar half-life of 2.4 days which is the upper 90th percentile confidence limit of the mean value.

It is important to note that foliar dissipation considers only the degradation of the parent compound and does not account for the formation of toxic degradates. Methyl paraoxon, which is highly toxic, may form on plant foliage after the parent degrades. This analysis may underestimate avian risk because it does not consider potential avian exposure methyl paraoxon.

These EEC estimates consider the effect and timing of multiple applications by assuming first-order decay of parent using a foliar half-life of 2.4 days.

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Avian Risk Assessment

The major uses of methyl parathion are likely to pose significant risk to birds. EFED has summarized potential risk from use on 10 major crops in the table below. In addition to mortality, a number of sublethal effects has been documented in avian species. These include adverse reproduction effects, negative impacts on nesting birds and their young, damage to food resources, reduced feeding and detrimental behavioral changes, and greater vulnerability to predation and environmental stress. For some crops, RQs exceed LOCs by more than two orders of magnitude.

The acute and chronic RQs for broadcast applications of liquid products tabulated below are based on a bobwhite quail (LC50 = 28.2 ppm; reproduction NOEC = 6.27 ppm).

Avian Acute and Reproduction Risk Quotients for Single and Multiple Applications for Major Use Crops

				Single Application		Multiple Application	
Site[1] (# Apps, App. Interval in days)	App.Rate (lbs ai/A)	Food Items	Maximum EEC (ppm)	Acute RQ (EEC/ LC50)	Reproduction RQ (EEC/ NOEC)	Acute RQ (EEC/ LC50)	Reproduction RQ (EEC/ NOEC)
Rice, Grasses (6,3)	0.79	Short grass	190	6.74	30.30	40.44	181.80
		Tall grass	87	3.09	13.88	18.54	83.28
		Broadleaf plants/Insects	107	3.79	17.07	22.74	102.42
		Seeds	12	0.43	1.91	2.58	11.46
Sunflower (3,5)	1	Short grass	240	8.51	38.28	25.53	114.84
		Tall grass	110	3.90	17.54	11.70	52.62
		Broadleaf plants/Insects	135	4.79	21.53	14.37	64.59
		Seeds	15	0.53	2.39	1.59	7.17
Soybean, Sorghum, (6,3) Corn (all) (6,2)	1	Short grass	240	8.51	38.28	51.06	229.68
		Tall grass	110	3.90	17.54	23.40	105.24
		Broadleaf plants/Insects	135	4.79	21.53	28.74	129.18
		Seeds	15	0.53	2.39	3.18	14.34
Alfalfa (4,42)	1	Short grass	240	8.51	38.28	34.04	153.12

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Avian Acute and Reproduction Risk Quotients for Single and Multiple Applications for Major Use Crops

Site[1] (# Apps, App. Interval in days)	App.Rate (lbs ai/A)	Food Items	Maximum EEC (ppm)	Single Application: Acute RQ (EEC/ LC50)	Single Application: Reproduction RQ (EEC/ NOEC)	Multiple Application: Acute RQ (EEC/ LC50)	Multiple Application: Reproduction RQ (EEC/ NOEC)
		Tall grass	110	3.90	17.54	15.60	70.16
		Broadleaf plants/Insects	135	4.79	21.53	19.16	86.12
		Seeds	15	0.53	2.39	2.12	9.56
Apple, Pear (5,7)	2	Short grass	480	17.02	76.56	85.10	85.10
		Tall grass	220	7.80	35.09	39.00	39.00
		Broadleaf plants/Insects	270	9.57	43.06	47.85	47.85
		Seeds	30	1.06	4.78	5.30	5.30
Cotton (10,3)	3	Short grass	720	25.53	114.83	255.30	1,148.30
		Tall grass	330	11.70	52.63	117.00	526.30
		Broadleaf plants/Insects	405	14.36	64.59	143.60	645.90
		Seeds	45	1.60	7.18	16.00	71.80

The single and multiple application scenarios estimate that all methyl parathion applications will result in endangered species, restricted use, and avian acute high risk LOC exceedences. The avian reproduction LOC is exceeded at all application rates.

Dermal exposure to methyl parathion is hazardous to birds. In two studies, bobwhite quail were exposed to methyl parathion under their wings. The resulting LD50 values of 2.9 and 9.127 mg/kg indicate that methyl parathion is "very highly toxic" by dermal exposure. Another study, in which mallard ducks' feet were exposed to methyl parathion for 24 hours, resulted in an LD50 of 53.6 mg/kg. This would place methyl parathion in the "moderately toxic" category.

Driver, et al., 1991 (MRID 44357804) also investigated the importance of other routes of exposure. In wind-tunnel experiments, "routes of uptake in order of contribution to toxicologic response from 8 to 48 h post-spray were dermal > preening ≥ oral > inhalation." Since poisoning can occur by multiple routes of exposure, RQ index values may underestimate the risk, since they consider only dietary exposure.

Acute Effects

Acute oral LD50s are available for mallard duck, northern bobwhite quail, ring-necked pheasant, kestrel, and grackle. All but the grackle are in the highest category - "very highly toxic" - with grackle in the second highest toxicity category - "highly toxic."

Pen studies using northern bobwhite quail and incident reports document methyl parathion's acute toxicity to birds (see table below). Shellenberger (1970) reported 40% mortality (8 birds) of caged, 12-week-old northern bobwhite quail exposed to eight weekly sprays of 1 lb ai/A methyl parathion EC. Another study reported mortality rates of 8 to 67% and increases in stress in bobwhite quail exposed to microencapsulated (Penncap-M) and EC formulations of methyl parathion (Pennwalt 1980; MRID 00061213). Edwards (1968; MRID 00090488) observed mortality rates of 5 and 20% for caged quail and pheasants, respectively, in an alfalfa hayfield treated with 0.5 lb/acre methyl parathion. Another study of 42 penned pheasants reported 11 deaths and sickness in half of birds treated with three applications of methyl parathion at 3 lb ai/A (Smith, 1987). Another study with caged bobwhites showed potentially lethal levels of acetylcholinesterase (AChE) inhibition (55.3% and 59.9%), respectively for both Penncap-M and Technical methyl parathion when sprayed at 1 lb ai/A (Knittle, 1973; MRID 093632). ACHE inhibition of ≥50% may cause death (Ludke et al. 1975). The relevance of pen studies is supported by White, et al. (1990; MRID 44357806) who reported that free bobwhites spent 60% of the time they were observed in or within 100 m of a Georgia sorghum and cotton fields treated with methyl parathion.

Tipton et al (1980; MRID 44378603), working with computer simulations to estimate mortality using laboratory and field data from Smithson and Sanders (1978; MRID 44378606), predicted bird mortality of up to 99% mortality after 6 weekly methyl parathion applications.

Adverse Sublethal Effects

Lethargy

Lethargy, a potentially hazardous behavioral effect of acute methyl parathion intoxication, is likely to increase a bird's susceptibility to predation. Hyperglycemia may explain the lethargy commonly associated with AChE inhibitors (Mineau, 1991). Mineau (1991) reports of a study where, "... northern bobwhite quail were given one of three oral doses of methyl parathion. Average brain AChE inhibition in quail from each treatment group and a control (corn oil only) were subjected to predation by a domestic cat following 30 minutes of acclimation to the test arena. Quail that were captured had greater brain ChE inhibition (mean =33%) and spent more time being still than quail that avoided capture (mean AChE inhibition=17%)."

Reproduction Effects

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Studies show that successful bird reproduction is very sensitive to methyl parathion exposure. Exposure periods of 8 and 21 days can cause the same reproductive effects as longer exposure periods (Bennett et al., 1990; MRIDs 44371601 and 44371602). Methyl parathion avian reproduction results provided levels almost identical to the acute values. The acute dietary LC50 is 28 ppm. The surrogate study with bobwhite quail showed effects (number of eggs laid and survival of offspring) at 15.5 ppm (LOEC). The reproductive LOC is exceeded by the risk quotient (EEC/NOEC) for all crops.

Bennett, et al. 1990 (MRID 44371608) showed that nesting success in mallards may be impacted by short dietary exposures to methyl parathion, particularly during early incubation. The number of hatchlings at several stages in the nesting cycle for dosed birds (400 ppm) was only 43 to 61% of the number in the control group. This report noted that "except for the numbers of adult mortalities, all dose-related effects observed in the long-term exposure test also were observed in the short-term test."

Effects on Young Birds

Young birds display additional stress behavior and reduced survival when raised in or near methyl parathion treated fields. Brewer et al. (1988; MRID 44271604) found that fewer ducklings (16%) survived in a treated field than in the control (58%). Because of the additional stress of surviving in the wild, young birds died when exposed to lower concentrations than in the laboratory (Christensen. 1971; MRID 44342001). Skin penetration, probably due to the lack of feathers on young birds, is a major route of exposure. (Driver et al. 1991; MRID 44357804).

Young birds, like adult birds, may demonstrate behavioral effects from a sublethal dose. Fairbrother et al. (1988; MRID 44371601) reported that dosed duckling "preened and loafed" on the land while their siblings fed and swam. Mineau (1991) reports that two-week old northern bobwhite quail did not discriminate between untreated food and diets containing 45 or 90 ppm methyl parathion, and initially (0-24 hour post-dose) chose treated over untreated food. This indicates that there will be little avoidance of treated food sources.

Effects of Reduced Food Supply

Methyl parathion is "very highly toxic" to aquatic and terrestrial invertebrates, with RQs of up to 1500 (see aquatic risk assessment). It may therefore have effects on birds by killing invertebrates and reducing food supply (USDI, 1951; Martin et al. 1951). Several authors made the following points concerning the effects of reduced food supply on ducklings in the prairie-pothole region of the U.S.:

1. Grue et al. (1988; MRID 44357080) noted that ducklings of dabbling ducks are dependent on emerging insects during their first few days of life.

2. Krapu (1979), Swanson et al. (1979), and Swanson et al. (1985) reported that during egg-

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laying, female waterfowl are also dependent of aquatic invertebrates as source of protein and calcium.

3. Nest losses (e.g., due to predation) force many females to re-nest one or more times during the breeding season, thereby increasing the amount or time that females require high-protein invertebrate diets to meet the nutrient demands (1988; MRID 44357080)

4. Reduced food availability may lengthen the pre-fledgling period, increasing the period of maximum vulnerability of ducklings to predation (Brown and Hunter 1984, 1985)

5. Overland movement of females and their broods in search of adequate food may increase losses to predation (Ball et al. 1975, Talent et al. 1982)

Bioconcentration in Avian Food Items

Bioconcentration of methyl parathion in prey such as tadpoles can lead to poisoning of ducklings. Hall and Kolbe (1980; MRID 44042901) reported that tadpoles concentrated pesticides from water up to 60 times over aquatic concentrations and those exposed to 1 ppm ethyl parathion and 5 ppm fenthion were lethal when fed to mallards. These results are applicable to methyl parathion because the LD50 of fenthion (5.9 mg/kg) is similar to methyl parathion (6.6 mg/kg); the bioconcentration of fenthion is 62X for tadpoles while the bioconcentration factor for methyl parathion is 71X in bluegill. When exposure from bioconcentrated residues in food is added to other sources of exposure such as direct ingestion of other contaminated items, preening, dermal exposure from plant surfaces, inhalation, and drinking water, risk to waterfowl can be high.

Effects on Maternal Behavior

Various studies report adverse changes in maternal behavior due to methyl parathion exposure. Such behavioral changes are expected to increase juvenile mortality through increased exposure to predation. Brewer et al. (1988; MRID 44371604) reported brood abandonment and mortality among wood duck and teal hens in a field treated with 1.25 lb ai/acre methyl parathion, but not in a control field. Two-thirds of the nesting hens from the treated field had significantly depressed brain cholinesterase levels. Mortality among ducklings in the treated field (84%) was greater than that in the control field (42%) by 22 days post-spray.

Buerger et al. (1991; MRID 44371606) reported that the higher mortality due to increased predation of northern bobwhites in treated fields than in untreated fields may be due to negative effects on covey integrity caused by methyl parathion exposure.

Kendall, et al. (1984; MRID 44413601) reported a 39% increase in mortality among nesting starlings in a treated field. Since this effect did not correlate with ChE depression, the authors surmised that changes in maternal behavior or depressed food abundance might have been to blame. This same study reported nest abandonment by mallards and teals adjacent to a field treated at 0.6 lbs ai/A. Therefore, intoxication of mother birds may result in increased juvenile mortality due to insufficient care and increased predation.

Anorexia

In addition to environmental stresses, the loss of appetite in the wild can be life threatening. Food is not always readily available and animals need a minimum number of calories to survive. Two studies show these effects. Grue (1982; MRID 44371606) studied the behavioral and physiological responses of common grackles to ingestion of methyl parathion and three other organophosphates. The study showed that mortality was largely due to pesticide-induced anorexia that lasted as long as 12 hours after exposure. Grackles that died lost an average of 28 to 36% of their body weight. Edwards (1968; MRID 00090488) noted that birds sprayed with 0.5 lb ai/A of methyl parathion suffered a 20% weight loss shortly after the spraying, but recovery was rapid. Based on the availability of food, amount of stored calories, and energy needs, a bird may not survive anorexia. Also, a higher dose may be lengthen the effect or exposure and add additional poisonous effects. Therefore, birds exposed to methyl parathion experiencing the stresses of living in the wild may not consume sufficient calories to survive.

Increased Toxicity from Environmental Stress

Environmental stress affects the toxicity of methyl parathion. Rattner and Franson (1983; MRID 44371701) reported that cold was found to enhance methyl parathion toxicity in kestrels, as a dose considered sublethal at thermoneutral temperature resulted in 60% mortality at -5°C." Also, Fairbrother et al. (1988; MRID 44342007) observed that 40% of 5-day-old mallards given a sublethal oral dose (based on laboratory studies) of methyl parathion died within the first hour after the broods were placed on outdoor ponds in cold weather. Therefore, environmental stresses such as cold weather are likely to reduce the amount of methyl parathion needed to cause intoxication.

Mammalian Risk Assessment

Methyl parathion is "very highly toxic" to mammals on an acute basis (LD50 = 3.6 mg/kg for laboratory rat). The acute herbivores/insectivores RQs for the lowest application rate (0.1 lb ai/A) range between 1 and 6.33. All mammalian acute LOCs are exceeded.

In the animal, hydrolysis of the sulfur/phosphate bond creates methyl paraoxon which is more toxic than methyl parathion. HED's mammalian studies therefore account for methyl paraoxon. Feeding and reproduction studies also show effects at low dietary concentrations (2.5-5 ppm). Hence, the RQs are high and exceed the chronic LOC of 1. RQs for short grass, which has the highest expected concentration of methyl parathion for any of the food items listed, ranged from 6.4 to 320.

RQs for reproduction were as high as 641 for multiple applications. The feeding study showed stomach lesions, reduced brain cholinesterase, and reduced hematocrit for a laboratory rat. The reproduction study showed decreased pup survival for mice. These effects are expected to cause reduced reproduction and increased mortality due to the inability to efficiently gather or catch food and avoid predators. Also, predators may be indirectly affected by reduced food supply because of lower numbers of small herbivores and insectivores.

Mammals are also very sensitive to dermal exposure (rat dermal LC50 = 6 mg/L; HED tox category I) and to inhalation of methyl parathion (LC50 = 0.163 mg/L; tox category I). Unlike birds, mammals are less able to readily escape treated fields, and hence are very sensitive to the multiple routes of exposure.

Estimating the potential for adverse effects to wild mammals is based upon EFED's draft 1995 SOP of mammalian risk assessments and methods used by Fletcher *et al.* (1994). The concentration of methyl parathion in the diet that is expected to be acutely lethal to 50% of the test population (LC_{50}) is determined by dividing the LD_{50} value (usually rat LD_{50}) by the percent body weight consumed. A risk quotient is then determined by dividing the EEC by the derived LC_{50} value. RQs are calculated for three separate weight classes of mammals (15, 35, and 1000 g), each presumed to consume four different kinds of food (grass, forage, insects, and seeds). The following RQ tables for liquid applications are based on a rat LD50 of 3.6 mg/kg.

Mammalian (Herbivore/Insectivore) Acute Risk Quotients for Single Broadcast of Liquid Products

Site/ Rate in lbs ai/A	% Body Weight Consumed	EEC (ppm) Short Grass	EEC (ppm) Forage & Small Insects	EEC (ppm) Large Insects	Acute RQ[1] Short Grass	Acute RQ Forage & Small Insects	Acute RQ Large Insects
Rice Grasses 0.79	95	190	107	12.00	50.14	28.24	3.17
	66				34.83	19.62	2.20
	15				7.92	4.46	0.50
Corn Field Sweet Sorghum Soybean Sunflower 1.0	95	240	135	15.00	50.67	35.63	3.96
	66				35.20	24.75	2.75
	15				8.00	5.63	0.63
Alfalfa Barley Oats Rye Wheat 1.25	95	300	169	18.75	79.17	44.60	4.95
	66				55.00	30.98	3.44
	15				12.50	7.04	0.78

Mammalian (Herbivore/Insectivore) Acute Risk Quotients for Single Broadcast of Liquid Products

Site/ Rate in lbs ai/A	% Body Weight Consumed	EEC (ppm) Short Grass	EEC (ppm) Forage & Small Insects	EEC (ppm) Large Insects	Acute RQ[1] Short Grass	Acute RQ Forage & Small Insects	Acute RQ Large Insects
Apple Peach 2.0	95	480	270	30.00	126.67	71.25	7.92
	66				88.00	49.50	5.50
	15				20.00	11.25	1.25
Cotton 3	95	720	405	45.00	190.00	106.88	11.88
	66				132.00	74.25	8.25
	15				30.00	16.88	1.88

[1] $RQ = \frac{\text{EEC (ppm)}}{\text{LD50 (mg/kg)/\% Body Weight Consumed}}$

Mammalian (Granivore) Acute Risk Quotients for Single Application

Site/ /Rate in lbs ai/A	% Body Wt Consumed	EEC (ppm) Seeds	Acute RQ[1] Seeds
Grasses Rice 0.79	21	11.85	0.69
	15		0.06
	3		0.01
Corn - field, sweet Sorghum Soybean Sunflower 1.0	21	15.00	0.88
	15		0.63
	3		0.13
Alfalfa Barley Oats Rye Wheat 1.25	21	18.75	1.09
	15		0.78
	3		0.16
Almond Apple Peach 2.0	21	30.00	1.75
	15		1.25
	3		0.25
Soybean 2.5	21	37.50	2.19
	15		1.56
	3		0.31

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Mammalian (Granivore) Acute Risk Quotients for Single Application

Site/ /Rate in lbs ai/A	% Body Wt Consumed	EEC (ppm) Seeds	Acute RQ[1] Seeds
Cotton 3	21	45.00	2.63
	15		1.88
	3		0.38

[1] The three percent bodyweight consumed values (21, 15, and 3) represent three sized animals 15, 35, and 1000 gram animals.

[2] $RQ = \frac{EEC\ (ppm)}{LD50\ (mg/kg)/\%\ Body\ Weight\ Consumed}$

The following table shows mammalian RQs for multiple applications of methyl parathion. Since all herbivore and insectivore LOCs are exceeded for single applications, they are not included in this table. Multiple application RQs for granivores are shown only for those uses for which RQs do not exceed LOCs after a single application.

Mammalian (Granivores) Acute Risk Quotients for Multiple Applications of Liquid Products (Broadcast) that Do Not Exceed LOCs from a Single Application

#Apps() Site (Interval)	Rate in lbs ai/A	Body Weight (g)	% Body Weight Consumed	Rat LD50 (mg/kg)	EEC (ppm) Seeds	Acute RQ Seeds
Ag. Uncult. (4)(7)	0.1	15	21	3.6	2	0.1
		35	15			0.1
		1000	3			0.02
Ornamental Herbs (6)(7)	0.5	15	21	3.6	10	0.6
		35	15			0.4
		1000	3			0.1
Rape or Canola (4)(3)	0.5	15	21	3.6	15	0.9
		35	15			0.6
		1000	3			0.1
Lentils (6)(3)	0.5	15	21	3.6	19	1.1
		35	15			0.8
		1000	3			0.2

The lowest application rate, 0.1 lb ai/A with 2 applications with a 7-day interval, exceeds the endangered species and restricted use LOCs for granivores. Two additional applications raise the RQs above the high risk LOC. The 0.5 lb ai/A rate exceeds all three LOCs.

[1] $RQ = \dfrac{\text{EEC (ppm)}}{\text{LD50 (mg/kg)/\% Body Weight Consumed}}$

The chronic RQs below for broadcast applications of liquid products are based on a mouse NOEC of 2.5 ppm in a feeding study and a rat NOEC of 5 ppm in a reproduction study.

Mammalian Chronic Risk Quotients for Single Applications

Site (# of Apps) (Interval App)	App. Rate Lbs a.i./A	Food Items	Maximum EEC[1] (ppm)	Chronic Feeding RQ (EEC/ NOEC)	Repro-ductive RQ (EEC/ NOEC)
Ag. Uncultivated (4)(7)	0.1	Short grass	24	9.6	4.8
		Tall grass	11	4.4	2.2
		Broadleaf plants/ Insects	14	5.6	2.8
		Seeds	2	0.8	0.4
Ornamental Herbs (6)(7) Rape or Canola (8)(14) Lentils Onion, green Onion, bulb	0.5	Short grass	120	48.0	24.0
		Tall grass	55	22.0	11.0
		Broadleaf plants/ Insects	68	27.2	13.6
		Seeds	8	3.2	1.6
Rice, Grasses (6,3)	0.79	Short grass	190	76.0	38.0
		Tall grass	87	34.8	17.4
		Broadleaf plants/ Insects	107	42.8	21.4
		Seeds	12	4.8	2.4
Sunflower (3,5) Sorghum Soybean (6,3) Corn (6,2) Alfalfa (4,42)	1	Short grass	240	96.0	48.0
		Tall grass	110	44.0	22.0
		Broadleaf plants/ Insects	135	54.0	27.0

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Mammalian Chronic Risk Quotients for Single Applications

Site (# of Apps) (Interval App)	App. Rate Lbs a.i./A	Food Items	Maximum EEC[1] (ppm)	Chronic Feeding RQ (EEC/ NOEC)	Reproductive RQ (EEC/ NOEC)
		Seeds	15	6.0	3.0
Barley Oat Rye Wheat (6,3)	1.25	Short grass	300	120.0	60.0
		Tall grass	138	55.2	27.6
		Broadleaf plants/ Insects	169	67.6	33.8
		Seeds	19	7.6	3.8
Apple, Pear (5,7)	2	Short grass	480	192.0	96.0
		Tall grass	220	88.0	44.0
		Broadleaf plants/ Insects	270	108.0	54.0
		Seeds	30	12.0	6.0
Cotton (10, 3)	3	Short grass	720	288.0	144.0
		Tall grass	330	132.0	66.0
		Broadleaf plants/ Insects	405	162.0	81.0
		Seeds	45	18.0	9.0

All three LOCs have been exceeded by all single application rate scenarios, with the exception of the RQs for seed consumption at the lowest application rate. Since estimated EECs for multiple application are higher than single application scenarios, all multiple treatments would also exceed the LOCs. Therefore, calculation of RQs for chronic effects from multiple applications are not necessary.

Risk to Pollinating Insects

Methyl parathion is very highly toxic to bees and other similar insects. The effect of methyl parathion exposure on honey bees has been of concern for many years to EPA, State regulators, and beekeepers, among others. Methyl parathion has caused very serious damage to colonies across the country, and continues to do so in spite of concerted efforts to mitigate the problem. The bee contact LD_{50} study indicates that the methyl parathion is "very highly toxic" to bees. It may not be possible to eliminate the risk of methyl parathion use to bees. Label precautions to mitigate risk to bees are recommended later in this document, based on results of acceptable studies.

Pollinators (bees, wasps, bumble bees. etc) fill an important ecological niche. They help transfer pollen between plants to ensure fruit and vegetable growth and seed viability. Pollinators can be very specialized. For example, the alkali bee is especially apt at opening the alfalfa flower and extracting pollen. Therefore, loss of specific pollinators can change ecological relationships which can reduce yield of a given crop, or in the case of wild plants reduce viability. Reduced viability would reduce the success of a given plant and make unintended changes in flora. Changes in the flora may also affect the animal population which relies on the plants for cover, feeding, etc.

EPA documented its concern for methyl parathion effects on bees in a 1979 HED position paper. This paper, and subsequent studies in the open literature, document the following risk to bees from Penncap-M, the microencapsulated formulation of methyl parathion:

1. Bees forage microcapsules and transport contaminated pollen back to the hive, leading to decreased viability or complete mortality of the colony. (Burgett and Fischer, 1977; Johansen and Kious, 1978; Russell, et al., 1998)

2. The tendency of the microcapsules to adhere to bees is much greater than with standard powder formulations (Johansen and Kious, 1978, Barker et al., 1979).

3. Because of its special formulations, Penncap-M residues on crops may remain toxic for days, rather than hours (Johnansen and Kious, 1978).This increases the length of time the microcapsules remain toxic to foraging bees.

4. Foragers returning to the hive bearing Penncap-M contaminated pollen loads can enter the hive unchallenged by the guard bees (Stoner et al., 1978).

5. The encapsulated methyl parathion formulation may remain toxic in stored pollen from one season to the next (Johansen and Kious, 1978), or as long as 19 months (Barker et al., 1979).

6. Although Penncap-M causes a lower initial knockdown than other insecticides, it causes a delayed-action break in honeybee brood cycles about two weeks after an application is made (Johansen & Kious, 1978) The lower initial knockdown may result in a greater mass of methyl parathion being transported to the hive by a greater number of bees (Mason, 1986) .

Both formulations of methyl parathion have killed bees. Anderson and Glowa (1984) and Anderson and Wojtas (1986) reported that non-encapsulated methyl parathion can be returned and incorporated into a beehive.

Honey Bee Mortality Incidents

The risk to honeybees reported in the studies above is well illustrated by two decades of bee kills. When Penncap-M was first marketed in the 1970's large bee kills were reported and EPA required more restrictive labeling. In 1989, when Elf Atochem began marketing Penncap-M in new areas, including fruit orchards and corn, another wave of bee kills occurred. For instance, the Washington State Department of Agriculture reported that 12,500 honey bee colonies were poisoned by insecticides in 1992, half by Penncap-M. Millions of dollars were lost in both production and fruit crops that suffered from inadequate pollination. North Carolina had a similar outbreak of apple orchard-related bee kills in the years of 1993-1995. A more detailed table of known methyl parathion bee kill incidents is attached.

In response to bee kills in the 1990s, some states have instituted bee-protection programs, such as educational programs, hive registration and notification systems (farmer informs beekeeper of spray plans), and even funding to help a beekeeper move hives when spraying is planned. The States of Washington and California have imposed regulations more restrictive than EPA's regarding Penncap-M use. For instance, Washington farmers cannot spray Penncap-M on corn when it is shedding pollen. The North Carolina Department of Agriculture and Consumer Services is funding a project to reduce bee kills through training and outreach to both apple growers and beekeepers. Russell et al.(1998; MRID 44552705) published recommendations to State and Federal agencies based on monitoring study results which found bee incidents in New Jersey.

The American Beekeeping Federation, Inc. did a survey of its members to determine the extent of damage to bee colonies due to pesticide exposure. This survey was compiled through June 16, 1997. Sixty beekeepers, operating 127,950 colonies in 22 states, reported that bee losses from pesticides are a significant issue in their operations. The following table is a state-by-state breakdown of respondents who considered damage from pesticides to be a significant issue in their operations

Resident Beekeepers Responding	State	Colonies in Operation	Colonies Damaged	
			Year 95	Year 96

1	Arizona	5,000	1,000	1,000
0	*Arkansas	0	200	300
19	California	47,059	9,950	13,432
4	Colorado	7,650	2,100	2,050
0	*Delaware	0	100	110
3	Florida	3,350	2,150	2,070
2	Georgia	425	46	62
4	Idaho	16,612	3,102	3,003
1	Illinois	1,200	0	0
1	Maryland	1,400	600	650
5	Minnesota	5,800	603	450
1	Missouri	500	150	30
3	Nebraska	5,000	3,300	2,500
2	New Jersey	4,000	4,000	2,700
5	New York	4,800	1,495	1,115
0	*North Dakota	0	350	300
1	Oregon	350	3,104	2,250
3	South Dakota	7,800	1,400	1,600
2	Texas	8,000	820	1,270
1	Washington	5,000	300	500
1	Wisconsin	1,204	0	0
1	Wyoming	2,800	1,200	800
Total 60		127,950	35,970	36,192

The survey also listed the pesticides in order according to number of bee kill responses as follows: Ferritin, Penncap-M, Sevin, and Parathion (ethyl). Based it appears second on this survey, it appears that Penncap-M bee kills were occurring as late as 1996. Therefore, in spite of efforts by State and Federal regulators, further mitigation is still necessary to reduce the exposure of bees to methyl parathion.

Other Insects

Brown, et al. (1978) demonstrated that predators of a cereal aphid were highly susceptible to methyl parathion.

b. Exposure and Risk to Nontarget Freshwater Aquatic Animals

EFED calculates acute and chronic EECs for aquatic organisms using predicted surface water concentrations from the GENEEC screening model, which is described in the Drinking Water assessment, above. Acute risk assessments are performed using peak EEC values for single and multiple applications. Chronic risk assessments are performed using the 21-day EECs for invertebrates and 56-day EECs for fish. A representative subset of EECs derived from GENEEC model predictions are tabulated below.

GENEEC Estimated Environmental Concentrations (EECs) For Aquatic Exposure

Site	Application Method Simulated	Application Rate (lbs ai/A)	# of Apps.; Interval Between Apps. (days)	Initial (PEAK) EEC (ppb)	21-day average EEC (ppb)	56-day average EEC (ppb)
Rice, Grasses	Aerial	0.79	6;3	95.90	27.64	10.63
Sunflower	Aerial	1.00	3;5	69.80	20.23	7.78
Sorghum, Soybean	Aerial	1.00	6;3	120.80	34.98	13.45
Corn	Aerial	1.00	6;2	137.90	39.95	15.37
Alfalfa	Aerial	1.00	4;42	33.70	9.80	3.77
Barley, Oat Rye, Wheat	Aerial	1.25	6;3	151.00	43.73	16.82
Peach	Ground	1.50	6;7	120.80	34.75	13.37
Apple, Pear	Aerial	2.00	5;7	153.21	44.35	17.06
Cotton	Aerial	3.00	10;3	452.05	130.74	50.28

GENEEC exposure estimates are used in EFED's first-tier assessment of risk to aquatic organisms. If EEC's from GENEEC simulations exceed LOCs, the assessment is refined using EFED's second-tier exposure model, PRZM-EXAMS. As indicated below, GENEEC-derived EEC's for methyl parathion exceed LOC's for many aquatic organisms. Therefore, a refined assessment was performed, using PRZM-EXAMS to simulate methyl parathion application to major crops.

PRZM-EXAMS Estimated Environmental Concentrations (EECs) For Aquatic Exposure

Site	Application Method Simulated	Application Rate (lbs ai/A)	# of Apps.; Interval Between Apps.	Initial (PEAK) EEC (ppb)	21-day average EEC (ppb)	60-day average EEC (ppb)
Corn	Aerial	1.00	6;2	39.45	12.23	5.35
Alfalfa	Aerial	1.00	4;42	4.32	1.43	0.77
Peach	Air Blast	1.50	6;7	31.65	9.22	4.23
Cotton	Aerial	3.00	10;3	214.20	70.06	31.83

ii. Freshwater Fish and Amphibians

Laboratory studies suggest that freshwater fish are not as sensitive to methyl parathion as other aquatic organisms. The high acute risk LOC and chronic LOC were not exceeded for any methyl parathion application scenario. The only exceedences were for the endangered species and restricted use LOCs for use on cotton. However, open literature studies suggest that indirect effects to fish may occur as a result of methyl parathion use.

Acute and chronic RQs tabulated below are based on a bluegill sunfish LC50 of 1.0 (0.6-1.6) ppm and a rainbow trout NOEC of <80 ppb. Note that an NOEC was not determined for rainbow trout because the lowest level tested showed effects.

Risk Quotients for Freshwater Fish and Amphibians

Site/ Rate in lbs ai/A (No. of Apps.) (App. Interval)	EEC Initial/Peak (ppb)	EEC 56-Day Ave. (ppb)	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC)
Rice, Grasses 0.79 (6,3)	95.44	10.63	0.10	0.11

Risk Quotients for Freshwater Fish and Amphibians

Site/ Rate in lbs ai/A (No. of Apps.) (App. Interval)	EEC Initial/Peak (ppb)	EEC 56-Day Ave. (ppb)	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC)
Sunflower 1.0 (3,5)	69.79	7.78	0.07	0.08
Sorghum, Soybean 1.0 (6,3)	120.81	13.45	0.12	0.13
PRZM-EXAMS Corn 1.0 (6,2)	39.45	5.35	0.04	0.05
Corn 1.0 (6,2)	137.87	15.37	0.14	0.15
PRZM-EXAMS Alfalfa 1.0 (4,42)	4.324	0.77	0.00	0.01
Alfalfa 1.0 (4,42)	33.73	3.77	0.03	0.04
Barley, Oat Rye, Wheat 1.25 (6,3)	151.01	16.82	0.15	0.17
Collards 1.5 (2,7)	76.4	8.53	0.08	0.09
PRZM-EXAMS Peach 1.5 (6)(7)	31.66	4.24	0.03	0.04
Peach, Plum 1.5 (6,7)	120.76	13.37	0.12	0.13
Apple, Pears 2.0 (5,7)	153.21	17.06	0.15	0.17
PRZM-EXAM Cotton 3.0 (10,3)	214.20	31.83	0.21	0.32

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Risk Quotients for Freshwater Fish and Amphibians

Site/ Rate in lbs ai/A (No. of Apps.) (App. Interval)	EEC Initial/Peak (ppb)	EEC 56-Day Ave. (ppb)	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC)
Cotton 3.0 (10,3)	452.05	50.28	0.45	0.50

Ecological and Sublethal Effects to Aquatic Organisms

Although submitted studies indicate that methyl parathion is only moderately toxic to freshwater fish, studies in the open literature indicate that methyl parathion can cause sublethal and ecological effects in aquatic environments:

Rossland (1984; MRID 44371714) found that growth of rainbow trout was affected when parathion was added to three outdoor ponds. He also discovered a secondary effect which would not have been seen in laboratory studies: "An increase in populations of *Diaptomus* in treated ponds was probably caused by mortality of predators and competitors. A bloom of filamentous algae which then collapsed, leading to severe depletion of dissolved oxygen and fish deaths, may have been triggered by mortality of herbivorous mayflies and daphnids." Rossland (1988; MRID 44371712) performed another small pond study with three ponds which showed growth reduction in rainbow trout. After three weeks, control fish had grown 6.3% per day, whereas growth was 4.3% per day in the pond treated with 10 μg/L methyl parathion, and 3.7% per day in the 40μg/L- treated pond. These growth reductions were apparently caused by damage to the invertebrate food supply. These are concentrations well below estimates from PRZM-EXAMS.

Henry et al.(1984) reported that exposure to methyl parathion resulted in an involuntary whole body flinch (which moved sequentially from head to tail), rapid and repeated "S-jerks" and fin flicks. These involuntary spasms increased with methyl parathion concentration in the water, but occurred at concentrations as low as 3 ppb. The most dominant and submissive individuals suffered these effects "more pronouncedly" than "intermediately ranked fish". Such disruptions to the social hierarchy could affect reproduction and ultimately the survival of an exposed bluegill population "if associated courtship territoriality, aggression, feeding and comfort movements are disrupted."

In addition, several other studies reported subacute effects at concentrations well below the LC50 value. Chakraborty, et al. (1989; MRID 44378601) studied the effect of methyl parathion on brain and olfactory organ acetylcholinesterase activity (AChE) of the fish, *Heteropneustes fossilis*. The brain AChE activity depleted significantly (up to 95.39% in olfactory organ) during 2-4 hours at 0.025 to 0.20 ppm of the pesticide. Rastogi, et al. (1990; MRID 44371715) reported that sublethal doses of methyl parathion caused severe damage to ovaries of the carp minnow *Rasbora daniconius*, and caused damage and size reduction in oocytes. These effects increased with the length of exposure. The ovarian damage caused by methyl parathion was greater than that caused by carbofuran and endosulfan. Rao, et al., 1985 (MRID 44371713) report that sublethal levels of methyl parathion have a profound effect on the rate of oxygen consumption by the fish *Tilapia mossambica* over a 48-hour study, based on results from whole-fish and specific tissue sampling.

Based on these observations the RQ analysis may underestimate the total effect on freshwater fish and amphibians.

ii. Freshwater Invertebrates

Laboratory studies submitted to EPA indicate that methyl parathion will cause adverse affects in freshwater invertebrates under all labeled methyl parathion use scenarios. The freshwater invertebrate acute and chronic RQs tabulated below are based on a *Daphnia magna* EC50 of 0.14 ppb and a *Daphnia magna* NOEC of 0.02 ppb. All RQs listed below (for major use scenarios) exceed all freshwater invertebrate LOCs.

Risk Quotients for Freshwater Invertebrates

Site/ Application Method/ Rate in lbs ai/A (No. of Apps.)	EEC Initial/Peak (ppb)	EEC 21-Day Average	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC or MATC)
Rice, Grasses 0.79 (6,3)	95.44	27.64	681.71	1,382.00
Sunflower 1.0 (3,5)	69.79	20.23	498.50	1,011.50
Soybean, Sorghum 1.0 (6,3)	120.81	34.98	862.93	1,749.00
PRZM-EXAMS Corn 1.0 (6,2)	39.45	12.23	281.77	611.50
Corn 1.0 (6,2)	137.87	39.95	984.79	1,997.50
PRZM-EXAMS Alfalfa 1.0 (4,42)	4.324	1.43	30.89	71.50

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Risk Quotients for Freshwater Invertebrates

Site/ Application Method/ Rate in lbs ai/A (No. of Apps.)	EEC Initial/Peak (ppb)	EEC 21-Day Average	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOEC or MATC)
Alfalfa 1.0 (4,42)	33.73	9.8	240.93	490.00
Barley, Oat Rye, Wheat 1.25 (6,3)	151.01	43.73	1,078.64	2,186.50
PRZM-EXAMS Peach 1.5 (6,7)	31.66	9.22	226.11	461.00
Peach, Plum 1.5 (6,7)	120.76	34.75	862.57	1,737.50
Apple, Pear 2.0 (5,7)	153.21	44.35	1,094.36	2,217.50
PRZM-EXAMS Cotton 3.0 (10,3)	214.20	70.06	1,530.00	3,503.00
Cotton 3.0 (10,3)	452.05	130.74	3,228.93	6,537.00

Estuarine and Marine Animals

Acute Risk

The RQs calculated with the PRZM-EXAMS model exceeded endangered species LOCs for all crops simulated. Acute estuarine and marine species RQs exceed all LOCs for four crops: corn (1.0 lbs/A), potato (1.5 lbs/A), peach (1.5 lb/A) and cotton (3.0 lbs/A). Restricted use and endangered species LOCs were also exceeded by the cherry (1.5 lbs/A), pecan (2.0 lbs/A), and grape (3.0 lb/A) use scenarios.

Risk Quotients for Estuarine/Marine Fish Based on a Spot LC50 of 59 ppb

Site/Appl Method Rate-ai/A(no. appl,interval)	EEC Initial/ Peak (ppb)	Acute RQ (EEC/LC50)
Rice, Grasses 0.79 (6,3)	95.44	1.62
Sorghum, Soybean 1.0 (6,3)	120.81	2.05
PRZM-EXAMS Corn 1.0 (6,2)	39.45	0.67
Corn 1.0 (6,2)	137.87	2.34
PRZM-EXAMS Alfalfa 1.0 (4,42)	4.324	0.07
Alfalfa 1.0 (4,42)	33.73	0.57
Barley, Wheat 1.25 (6,3)	151.01	2.56
PRZM-EXAMS Peach (surrogate for citrus) 1.5 (6)(7)	31.66	0.54
Apple, Pears 2.0 (5,7)	153.21	2.60
PRZM-EXAMS Cotton 3.0 (10,3)	214.20	3.63
Cotton 3.0 (10,3)	452.05	7.66

Effects of methyl parathion exposure on estuarine and marine fish species include behavioral changes, growth reduction from damage to the food supply, and indirect mortality. The RQs for estuarine and marine fish indicate that they are more sensitive to methyl parathion than freshwater species. The most sensitive freshwater species has an LC50 of 1.0 mg/L (bluegill sunfish). In comparison, the LC50 for the estuarine spot is 0.059 mg/L.

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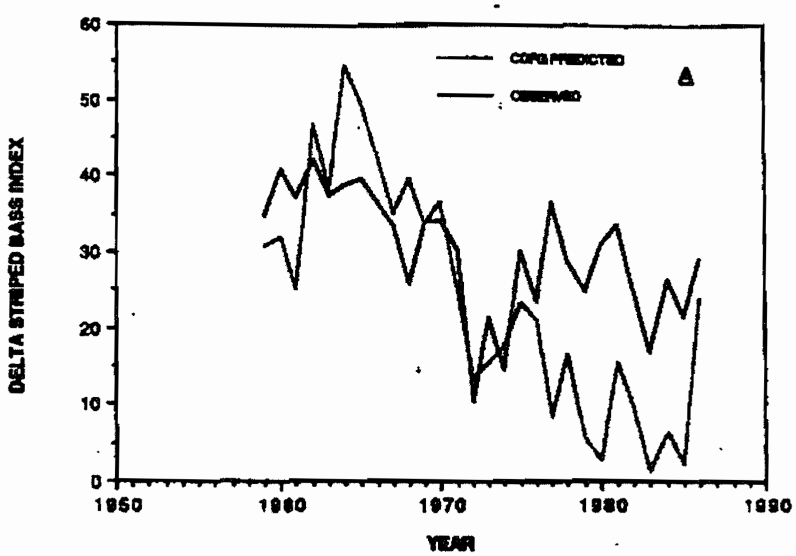
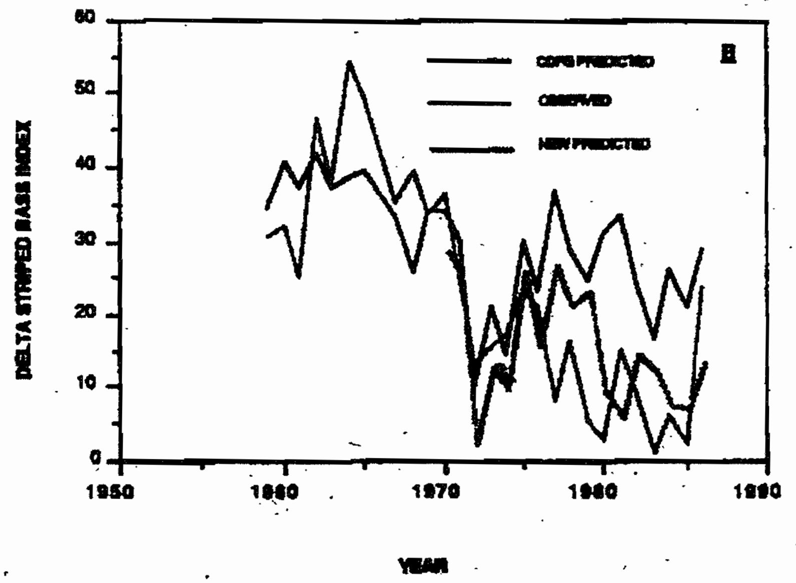
Foe et al. (1991) and Heath, A.G.et al.(1993)(MRID No.44378602) investigated the effects of rice cultivation on the striped bass population in the San Francisco Bay and its tributaries. Foe et al.(1991) correlated the larval bass population in the delta between the Sacramento and San Joaquin Rivers with the pounds of methyl parathion applied to rice in that drainage basin. The following figures, 6a and b from Foe et al. (1991), show that methyl parathion use (lbs/A) correlates with the striped bass population decline in this portion of the estuary:





Figures 6a and b. (a) Relationship between the California Department of Fish and Game's Delta portion of the striped bass index and the actual number of fish observed in the Sacramento-San Joaquin Delta between 1959 and 1986. The index ceased to predict abundance well after 1977. Data provided by Mr. Lee Miller, CDFG, Stockton. (b) Same relationship as in 6a with the exception that the "new predicted" curve is the result of the inclusion of an additional term (-(3.34 (lbs methyl parathion applied to rice fields/Sacramento River flow rate) + 2.83)) in the index. Th new equation improves the predictive power of the old index in all years after 1977 except for 1986.

Heath et al. (1993; MRID 44378602) studied the effects of methyl parathion at concentrations found in the San Francisco Bay estuary on newly hatched striped bass. In an attempt to simulate larvae exposed in the river which then float downstream away from the contamination, the larvae were exposed to methyl parathion for 4 days and observed for 10 days in uncontaminated water. The two most significant effects were abnormal swimming performance (swimming on their side) and increased AChE inhibition, especially if food was restricted. Spawning of striped bass occurs during May and early June in the Sacramento river between Colusa and Knights Landing, California. Methyl parathion is one of several rice insecticides used extensively in this area at the time of striped bass spawning (Cornacchia et al. 1984; Finlayson and Faggella 1986).

Heath et al. (1993) suggested that poorer swimming performance during times of food scarcity is significant because it can affect the ability of striped bass to avoid predation. This risk is compounded by the fact that adult fish require days or weeks to recover to normal ACHE activity levels, depending on the degree of cholinesterase inhibition caused by methyl parathion exposure. As indicated in the estuarine/marine invertebrate assessment below, methyl parathion contamination may affect their invertebrate food supply at concentrations reported in Heath, et al. (1993).

Unfortunately, this experiment was limited to only one estuary and one species. Acute toxicity studies submitted to EPA show that striped bass is not the most sensitive estuarine/marine fish species. While the striped bass LC50 is 0.79 ppm, the spot LC50 is 0.059 ppm, many times more sensitive than the striped bass. If we assume that the relationship between the sensitivity of striped bass and spot holds for subacute effects, then subacute effects in spot, and possibly other species, would be expected at much lower concentrations.

Eisler (1970; MRID 44378611) also showed toxicity increased by changes in environmental conditions, such as the length of exposure to methyl parathion, salinity and temperature. He found that extending the exposure period from 96 to 240 hours reduced the LC50 by a factor of 8.3 for mummichog, (*Fundulus heteroclitus*). In a second experiment, fish were moved to methyl parathion-free water after a 96 hour exposure and observed for 72 and 240 hours. The 72 hours observation period allowed time for mortality to increase 1.33 times over the mortality at the end of the treatment period. For the 240 hours observation period mortality increased 2 times. Eisler (1970) also indicated that mummichogs, "unlike other groups, were sluggish and refused to feed during the observation period." By increasing the temperature 5° C from 20 to 25°C the LC50 value became the LC100. Similarly, toxicity was seen to increase with salinity. The LC50 at 24‰ salinity was equal to the LC100 at 36‰. The observation period, temperature and salinity increases are expected to decrease the concentration of methyl parathion needed to cause mortality or sublethal effects.

Methyl parathion may reduce available food resources for estuarine and marine fish which feed on invertebrates. Both estuarine and marine aquatic freshwater invertebrates are highly sensitive to methyl parathion (see below). In addition, insects with an aquatic life stage can be

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killed by methyl parathion sprays while still in their terrestrial stage, and therefore not be available to produce larvae, a food source for fish.

Chronic Effects

Although no acceptable fish early-life stage study is available for estuarine /marine fish, chronic effects in estuarine and marine fish are likely. The NOEC is assumed to be 0.01 of the acute LC50, in this case 0.059 ppb (59 ppt). The maximum estuarine concentration of methyl parathion reported in Heath et al. (1993; MRID 44378602) is 660 ppt, and the lowest concentration estimated by PRZM-EXAMS is 770 ppt. Therefore, the chronic high risk LOC of 1 is expected to be exceeded.

Estuarine/ Marine Invertebrates

Methyl parathion is very highly toxic to estuarine/marine invertebrates, at concentrations that have been found in surface water. The *daphnia* (freshwater) EC50 is 0.14 ppb and the mysid (saltwater) EC50 is 0.35 ppb. Concentrations of methyl parathion in the Colusa Basin Drain study mentioned above (Heath et al, 1993; MRID 44378602) were as high as 0.66 ppb. GENEEC and PRZM-EXAMS RQs for all use scenarios exceed all LOCs. It should be noted, however, that GENEEC and PRZM-EXAMS do not simulate estuarine or marine scenarios.

Other open literature studies report effects of methyl parathion exposure on estuarine/marine invertebrates. Finlayson et al. (1993; MRID 44572901) reported methyl parathion toxicity to a mysid species (*Neomysis mercedis*) in a California estuary. The author reported that of three pesticides identified in the Colusa Basin Drain (carbofuran, malathion, and methyl parathion), methyl parathion was most likely responsible for observed effects on mysids, since survival was best correlated with the presence or absence of that contaminant. *Neomysis mercedis* is an important food source for juvenile striped bass, and an important component of both the pelagic and the epibenthic communities.

Lowe (1981; MRID 66341) showed that survival and number of offspring in *Mysidopsis bahia* were affected at concentrations between 110 and 370 ppt..

RQs for estuarine/marine invertebrates are based on a mysid EC50 of 0.35 ppb, and an NOEC of 0.11 ppb.

Risk Quotients for Estuarine/Marine Invertebrates

Site/ Application Method	EEC Initial/ Peak (ppb)	EEC 21-day Average	Acute RQ (EEC/LC50)	Chronic RQ (EEC/ NOEC)
Rice, Grasses 0.79 (6,3)	95.44	27.64	272.69	251.27

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Risk Quotients for Estuarine/Marine Invertebrates

Site/ Application Method	EEC Initial/ Peak (ppb)	EEC 21-day Average	Acute RQ (EEC/LC50)	Chronic RQ (EEC/ NOEC)
Sorghum, Soybean 1.0 (6,3)	120.81	34.98	345.17	318.00
PRZM-EXAMS Corn 1.0 (6,2)	39.45	12.23	112.71	111.18
Corn 1.0 (6,2)	137.87	39.95	393.91	363.18
PRZM-EXAMS Alfalfa 1.0 (4,42)	4.324	1.43	12.35	13.00
Alfalfa 1.0 (4,42)	33.73	9.80	96.37	89.09
Barley, Wheat 1.25 (6,3)	151.01	43.73	431.46	397.55
PRZM-EXAMS Peach (surrogate for citrus) 1.5 (6,7)	31.66	9.22	90.45	83.82
Apple, Pear 2.0 (5,7)	153.21	44.35	437.74	403.18
PRZM-EXAMS Cotton 3.0 (10,3)	214.20	70.06	612.00	636.91
Cotton 3.0 (10,3)	452.05	130.74	1,291.57	1,188.55

All acute and chronic LOCs are greatly exceeded by Rqs for estuarine and marine invertebrates.

d. Exposure and Risk to Nontarget Plants

I. Terrestrial and Semi-aquatic

Terrestrial and semi-aquatic plant testing are required. Youngman, et al., (1989) suspected possible phytotoxic effects based on the phytotoxicity of ethyl parathion, and the chemical relationship of 4-nitrophenol to the herbicide DNOC (2-methyl-4, 6-dinitrophenol). Their subsequent study showed a nearly 50% dry-weight reduction in whole lettuce plants treated with methyl parathion.

Therefore, vegetative vigor (122-1) and seedling emergence (122-1) studies are required.

ii. Aquatic Plants

Exposure to nontarget aquatic plants may occur through runoff or spray drift from adjacent treated sites. An aquatic plant risk assessment for acute high risk is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. Non-vascular acute high aquatic plant risk assessments are performed using either algae or a diatom, whichever is the most sensitive species. An acute aquatic plant risk assessment for endangered species is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. Runoff and drift exposure is computed from GENEEC. The RQ is determined by dividing the pesticide's initial or peak concentration in water by the plant EC_{50} value.

Methyl parathion is "practically non-toxic" *to Skeletonema costatum.* However, data are lacking on other aquatic plants. These data are important because it is known that methyl parathion is very toxic to aquatic invertebrates, and any detrimental effects on aquatic plants could result in further damage to invertebrates which, in turn, could have significant effects on fish. Accordingly, testing of additional species (*Kirchneria subcapitatum*, *Lemna,* and *Anabaena flos-aquae*) for aquatic plant growth (122-2) is needed.

Endangered and Threatened Species

At currently proposed rates, endangered species LOCs are exceeded for all species groups except plants. The Agency has developed a program (the "Endangered Species Protection Program") to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that will eliminate the adverse impacts. At present, the program is being implemented on an interim basis as described in a Federal Register notice (54 FR 27984-28008, July 3, 1989), and is providing information to pesticide users to help them protect these species on a voluntary basis. As currently planned, the final program will call for label modifications referring to required limitations on pesticide uses, typically as depicted in county-specific bulletins or by other site-specific mechanisms as specified by state partners. A final program, which may be altered from the interim program, will be described in a future Federal Register notice. The Agency is not imposing label modifications at this time through the RED. Rather, any requirements for product use modifications will occur in the future under the Endangered Species Protection Program. Currently available county specific information, maps and a downloadable version of the Endangered Species data base can be found on the Internet at the Agency's web site,

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http://www.epa.gov/ESPP.

RISK CHARACTERIZATION

EFED concludes with a great deal of certainty that the use of methyl parathion poses significant risk to nontarget organisms in terrestrial and aquatic environments. The toxicological and exposure data suggest strongly that acute and chronic effects on birds and mammals, acute effects on bees, and acute and chronic effects on aquatic invertebrates are likely to occur as a result of methyl parathion applications.

Monitoring data include detections of methyl parathion residues in ground and surface water, but suggest that the risk of drinking water exposure is less than that predicted by simulation models.

Drinking Water

Surface Water

Direct drinking-water data for methyl parathion are not readily available, and it is not likely that much of such data has been collected. While the Office of Water has established a lifetime health advisory (HA) of 2 ppb, methyl parathion does not have an established Maximum Contaminant Level, and is not included on the Unregulated Contaminant Monitoring List. Therefore, public drinking water supply systems are not required to analyze for methyl parathion. Consequently, EFED relied on simulation models and other surface- and ground-water monitoring data for this risk assessment.

Surface-water concentrations estimated from the PRZM-EXAMS screening model for human health risk assessments are quite high (acute- 214 ppb, chronic- 4.2 ppb), and exceed drinking water levels of concern. However, these screening estimates are significantly higher than the concentrations seen in monitoring studies. This can be attributed in part to the conservative nature of the models themselves. As detailed in the drinking water section above, the assumptions are intentionally conservative to ensure the maximum protection of human health. There is fairly high uncertainty in the assessment that methyl parathion exceeds acute and chronic drinking water LOCs.

Acute Risk

Data from targeted monitoring studies such as those in California and the Mississippi River basin may provide a better estimate of possible acute drinking water concentrations than the models. First, the scenario of a canal or river that drains a watershed which is extensively treated with methyl parathion is a more realistic scenario for predicting drinking-water contamination than the models' 10-hectare field draining to a 1-acre pond. In addition, the California data show the effects of mitigation on concentrations detected year-to-year in surface water. Previous to a mitigation program instituted by California EPA's Department of Pesticide Regulation (CDPR) in the early 1990's, peak concentrations of methyl parathion in the Colusa Basin Drain were as high as 6 ppb. Since the implementation of buffer zones, the requirement for applicators to use specific equipment to mitigate spray drift, and holding time requirements for water on rice fields, peak concentrations have been at the sub-ppb level.

Although monitoring data are more realistic than modeling results, they don't necessarily reflect the use scenarios most vulnerable to contamination. For instance, the CDPR monitoring of the Colusa Basin Drain is targeted to methyl parathion use on rice. It includes sampling which coincides with times of application, but the maximum rate at which methyl parathion is applied to rice is one quarter of the maximum rate applied to cotton, with fewer applications annually. In addition, retention of water on treated fields is a mitigation measure relevant only to rice, and not other crops to which methyl parathion is applied.

The USGS Cotton Pesticides in the Mississippi Delta program includes sampling of five Mississippi River tributaries in areas of intensive cotton and/or rice culture, but the study is on-going. The USGS has not detected methyl parathion in the 80 surface-water samples they have analyzed to date; the rest of the several hundred samples it has collected should be analyzed by the end of 1998. The final results of this study should provide the best evaluation yet of the fate of methyl parathion in a large Cotton Belt watershed.

Based on the data that are currently available, EFED believes that acute (peak) concentrations of methyl parathion in surface water can at least be periodically detected in the range of 0 to 6 ppb, based on CDPR data taken before mitigation measures were adopted in the early 1990's. It is likely that higher concentrations could result from uses that have higher application rates and numbers of annual applications. However, acute concentrations are unlikely to be as high as simulated by PRZM-EXAMS. Although the CDPR Colusa Basin Drain study only includes 10 years of data, the data are of high quality. Therefore, the peak concentration of 6 ppb detected in this study should be given greater weight than the peak concentration of 95 ppb simulated by PRZM-EXAMS for rice.

Since similar targeted monitoring studies are not available in connection with other methyl parathion uses, surface-water concentrations simulated with PRZM-EXAMS for drinking water assessments should be considered highly conservative, but should not be arbitrarily reduced. The conservativeness of the EECs should only be considered when developing mitigation to protect human health, non-target organisms, and water resources. The CDPR rice study shows clearly that mitigation measures and reduced use of methyl parathion led to a significant decline in surface-water contamination. Potential mitigation measures are detailed below.

Chronic Risk

Non-targeted surface-water survey studies performed over 30 years have not shown concentrations of methyl parathion at chronic levels predicted in modeling assessments.

Concentrations from available studies were below the 2 ppb HA, with the highest reported at 1 ug/L. The results of the more recent studies in the Mississippi River Basin and NAWQA study areas resulted in lower concentrations. It should be noted, though, that these recent studies are not specifically targeted to methyl parathion use areas, and that the analytical recoveries for methyl parathion in the NAWQA study averaged only 46%. **Such low recoveries limit extensive quantitative interpretation of the monitoring data.** However, the monitoring data are expected to be lower than the modeling predictions because of the conservative assumptions used in the models.

Therefore, the consistent indication that methyl parathion is not a widespread contaminant in surface water adds greater uncertainty to the Tier I and Tier II chronic water exposure estimates. Although the available monitoring data do not allow a definitive assessment, EFED does not believe that chronic concentrations of methyl parathion in surface water will reach the 2 ppb HA.

Ground Water

Using the screening model SCI-GROW, EFED calculated a ground-water concentration of 0.6 ppb for first-tier human-health risk assessment. Data collected from a variety of sources did not identify any known instance in which a ground-water concentration higher than this was detected, although individual detections have been within the same order of magnitude. Therefore, EFED suggests that 0.6 ppb is a reasonable conservative estimate of possible acute concentrations of methyl parathion in drinking water derived from ground water.

Since methyl parathion has been detected in ground-water rarely in all studies evaluated, the concentration of 0.6 ppb does not seem appropriate for chronic risk assessments. For instance, methyl parathion was not found in the Mid-Continent Pesticide Study (from Barbash and Resek, 1996), and was found at a maximum of 0.062 ppb in 1130 samples taken between 1991 and 1995 in the USGS NAWQA study. Again, these studies were not specifically targeted to methyl parathion, and the uncertainty of the NAWQA results is increased because of analytical recovery problems. EFED does not have a tool for estimating second-tier ground water concentrations for dietary risk assessments. However, EFED concludes that methyl parathion does not pose a chronic concern for drinking water derived from ground water.

Ecological Effects

Avian Risk Characterization

EFED concludes with a high level of certainty that methyl parathion poses significant acute and chronic risk to birds. This certainty is founded on (1) the consistent toxicological data, (2) the potential for degradation products to be highly toxic, (3) the widespread use of the compound on many crops that are attractive to wildlife, and (4) field-observed effects during use.

There is very little uncertainty in the toxicology data because of the consistent results reported in registrant and open literature studies. Studies cited in this chapter indicate that a suite of effects occur with short exposure to methyl parathion. These include direct mortality, as well as acute sublethal effects such as:

- reproduction effects,
- changes in maternal care and viability of young birds,
- anorexia,
- increased susceptibility to predation, and
- greater sensitivity to environmental stress.

For several reasons, most of the uncertainty in this risk analysis is associated with the terrestrial exposure component. First, there were no direct field measurements of residues used in the avian risk assessment. Furthermore, while the application method and timing are such that one can reasonably assume exposure of birds each time methyl parathion is applied, there are little direct data (e.g. incidents) showing avian exposure.

Finally, the uncertainty in the environmental fate database for the highly toxic degradate methyl paraoxon may lead to an *underestimation* of avian and mammalian exposure to biologically active methyl parathion residues. This point is particularly important because degradation of parent to methyl paraoxon on the surfaces of leaves and avian food items may result in a prolonged exposure to toxic residues which can result in acute and/or chronic effects to birds, mammals, and reptiles.

The use of methyl parathion is expected to coincide with the timing of waterfowl breeding. The major breeding grounds for waterfowl are in the prairie-pothole region of North America, with the greatest concentration of breeding ducks per square mile found in the Dakotas (see Appendix 3). Grue, et al. (1988) reported that about 75% of cultivated land in North Dakota is in the prairie-pothole region where important crops include spring wheat, barley and sunflowers; methyl parathion is used on each of these crops. Grue also reported effects of methyl parathion exposure to waterfowl and the freshwater invertebrates upon which they feed.

Cotton and rice use in Mississippi River watersheds and in California are expected to affect resident bird populations (non-migratory birds) with nests near treated fields. In addition to waterfowl, a large number of shorebirds such as gulls, cranes, herons, plovers, sandpipers, egrets, stilts, terns and others are found in and around aquatic resources that could be contaminated with methyl parathion.

Mortality and reproductive impairment of survivors pose important risk to the maintanence of viable populations of avian species. Because these species are representative of the more than 50 avian species known to occur in and around cotton fields, the potential for adverse population impacts to many avian species from methyl parathion exposure is great. The table below presents trends in breeding bird populations of several avian species relevant to this risk characterization. These data originate from National Biological Service (Sauer et al. 1997). All the species shown exhibit downward trends in population in three or more cotton states since 1966. Four species (white-eyed vireo, mourning dove, northern cardinal, and red-winged blackbird) showed population declines that were statistically signifiant ($p < 0.05$) in three or more states. While these data do not establish causality for population declines (a variety of factors are likely to contribute to population declines), they do suggest that populations of many bird species at a state-wide level of resolution could be sensitive to additional acute or reproductive effects from exposure to methyl parathion.

Population Status of Important Bird Species in Cotton States

State	Trends in Breeding Bird populations 1966-1996					
	Carolina Wren	**White-Eyed Vireo**	**Northern Cardinal**	**Blue Grossbeak**	**Mourning Dove**	**Red-Winged Blackbird**
AL	negative	positive	negative	positive	negative	negative*
AR	negative	negative*	positive	positive	negative	positive*
AZ	no data	no data	negative	positive	negative	positive
CA	no data	no data	no data	positive	negative*	positive
FL	positive	negative	negative	positive	positive	negative*
GA	positive	negative	negative*	positive	negative	negative*
LA	positive	negative	negative	positive	positive	negative
MO	positive	negative	negative*	positive	negative*	positive
MS	positive	positive	negative	negative	negative	negative*
NC	positive	positive	negative	positive	negative	negative
NM	no data	no data	no data	positive	negative	negative
OK	positive	positive	positive	negative	negative*	positive
SC	negative	stable	negative*	positive	negative	negative*
TN	positive	negative*	negative*	positive	negative	positive
TX	positive	negative*	positive	negative	negative*	negative
VA	positive	positive	negative*	positive	negative	negative*

* denotes declines significant to $p < 0.05$

Further avian exposure to methyl parathion is likely in the 80 million acres in the United States planted to corn which accounts for more than 11% of methyl parathion applied annually. As shown in Appendix 4, at least 200 bird species are found in and around corn, the majority of which is produced in three regions (the Corn Belt - Iowa, Missouri, Illinois, Indiana, Ohio; the Great Lakes states - Minnesota, Michigan, Wisconsin; and the northern plain states - North and South Dakota, Nebraska, Kansas, and Colorado). Methyl parathion applied to corn planted near prairie-potholes in the Great Lakes and northern plains regions would be expected to affect waterfowl. Application of methyl parathion to corn in states that border the Gulf of Mexico and the Atlantic and Pacific Oceans is also expected to result in exposure to waterfowl and water birds.

Aquatic Organisms

The uncertainty in the assessment of potential concentrations of methyl parathion in surface water (see above) has ramifications for risk assessments for aquatic organisms.

Freshwater Fish

Calculated EECs indicate that only use at the highest label rates might result in exposure to freshwater fish above acute LOCs. The PRZM-EXAMS RQ for cotton was 0.21, which exceeds the restricted use (0.1) and endangered species (0.05) LOCs. Given the uncertainty in the exposure estimates derived from PRZM-EXAMS, the level of certainty in these LOC exceedences is not high.

However, outside data indicate that methyl parathion exposure has detrimental effects on freshwater fish, including behavioral changes, growth reduction from damage to the food supply, and indirect mortality. Given that the cotton use area extends in the southern United States from California to Virginia, a large number of freshwater species could be affected by methyl parathion exposure. Therefore, although there is substantial uncertainty in the magnitude of the exposure calculated using simulation models, sublethal or indirect effects from exposure in the cotton use area seem likely.

Freshwater Aquatic Invertebrates

Laboratory studies submitted to EPA indicate that methyl parathion is likely to cause adverse effects in freshwater invertebrates under all labeled methyl parathion use scenarios. The PRZM-EXAMS cotton (3.0 lb ai/A) RQs are 1530 and 3503 for acute and chronic exposure, respectively. Use on nonagricultural areas, the use with the lowest application rate (0.1 lbs ai./A), yields RQs of 36 and 74 for acute exposure and chronic exposure, respectively. Hence, all LOCs are exceeded by all application scenarios. The acute RQ values above exceed LOCs by at least an order of magnitude. Therefore, even considering the uncertainty of exposure estimates from PRZM-EXAMS, the certainty that methyl parathion will cause acute adverse effects in freshwater invertebrates is high.

Damage to populations of freshwater aquatic invertebrates can cause additional damage to the ecosystem, as discussed above. For instance, Crossland (MRID 44371714) reported that damage to freshwater invertebrates led to an algae bloom which caused a fish kill by depleting dissolved oxygen in treated ponds.

Although chronic data are not available for freshwater invertebrates, the magnitude of the acute

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RQs indicates that it is highly likely that toxic exposure will occur on a chronic basis as well.

Estuarine and Marine Fish

EFED concludes with a high level of certainty that methyl parathion poses significant acute and chronic risk to estuarine and marine fish. This certainty is founded on consisent toxicological data submitted by the registrants and in the open literature and the widespread use of the compound on many crops that may result in transport of methyl parathion to surface-water bodies.

The certainty of the toxicity analysis for estuarine and marine fish is high. The RQs calculated with the PRZM-EXAMS model exceeded endangered species LOCs for all crops simulated. Acute estuarine and marine species RQS exceed all LOCs for four crops: corn (1.0 lbs/A), potato (1.5 lbs/A), peach (1.5 lb/A) and cotton (3.0 lbs/A). Restricted use and endangered species LOCs were also exceeded by the cherry (1.5 lbs/A), pecan (2.0 lbs/A), and grape (3.0 lb/A) use scenarios.

In addition, open literature studies attest to adverse affects of methyl parathion exposure to estuarine and marine fish. For instance, a study of methyl parathion effects on striped bass spawn in the delta between the Sacramento and San Joaquin Rivers correlated declines in the larval bass population with the pounds of methyl parathion applied to rice in that drainage basin (Foe et al.,1991). Other studies have also reported acute sublethal effects on estuarine and marine fish, such as behavioral changes, cholinesterase inhibition, and ovarian damage.

As with freshwater fish, there is significant uncertainty associated with the likely magnitude of exposure to methyl parathion. As noted above, targeted monitoring data from the Colusa Basin Drain in California produced a peak surface-water concentration that was about an order-of-magnitude less than predicted for rice by GENEEC. However, the Colusa Basin Drain study reflected usage before mitigation measures were put into effect for methyl parathion application to rice. Furthermore, while the California study considered the use of methyl parathion on rice, higher application rates are used on a greater number of cotton acres in coastal areas of Texas, Louisiana and Alabama. A more detailed discussion of species that might be exposed to methyl parathion in cotton-growing areas can be found below.

An assessment of the **chronic** effects of methyl parathion use on estuarine species is complicated by the lack of chronic estuarine study data. In the absence of such data, the LOC is assumed to be 0.01 of the acute LC50, in this case 0.59 ppb. This concentration is on the order of that found in surface water studies cited above, although these concentrations have not been detected in surface water on a sustained basis. Cheminova should perform chronic estuarine studies to clarify the possible chronic risk to estuarine and marine fish. Given the lack of data needed to derive the chronic LOC, the certainty in this assessment is low.

Estuarine and Marine invertebrates

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As reported in the toxcity portion of this RED, estuarine/marine invertebrates are extremely sensitive to methyl parathion, with the exception of mollusks. The certainty of this toxicity is quite high. GENEEC and PRZM-EXAMS RQs exceed all LOC's for all use scenarios, and EC50s for species such as daphnia (0.14 ppb) and mysids (0.35 ppb) are at concentrations that have been detected in surface water.

Open literature studies show that use of methyl parathion under normal use conditions has contaminated the estuarine/marine environment and had an effect on estuarine invertebrate species. For instance, Finlayson (1993)(MRID 44572901) reported methyl parathion toxicity to a mysid species (*Neomysis mercedis*). However, the CDPR has performed *Ceriodaphnia dubia* bioassays concurrently with their surface water sampling, and reported no observable effects connected with methyl parathion concentrations since mitigation measures were instituted in response to a decline in striped bass populations.

The following mitigation methods have been applied to the use of methyl parathion on rice to control tadpole shrimp in California:

1. Planting the seed and quickly flooding fields so that the tadpole shrimp eggs do not mature in time to significantly damage the rice.
2. Holding contaminated water on the field longer so that the chemical has time to degrade.
3. Educating rice growers that overuse has caused resistance.
4. Prescribing specific equipment for aerial spraying;
5. Use of copper sulfate as an alternative;
6. Observing a 300 foot buffer zone from bodies of water for aerial sprays.

Mitigation measures instituted in California for rice may not be appropriate in other states. For instance, the use of copper sulfate and flooding to control tadpole shrimp are not appropriate for the Gulf States, because the tadpole shrimp is not a pest in that region. In addition, while rice in California is grown during the dry season, the Gulf states do not have a distinct dry season. Therefore, water held on a rice field in the Gulf States may flow off the field during rain events.
Finally, mitigation measures such as holding water on a field are not applicable for crops such as cotton, soybeans, hay, corn, and sorghum.

Therefore, given the magnitude of the RQs for estuarine/marine invertebrates, and the evidence of adverse effects in California before mitigation was instituted, the certainty in the overall risk to estuarine/marine invertebrates continues to be high. However, based on the success California has had in reducing surface-water concentrations of methyl parathion, other mitigation measures listed above, such as education, buffer zones, and spray-drift reduction measures, are recommended below as potential ways to reduce aquatic exposure of non-target orgainsms.

Estuarine/Marine Fish and Invertebrates Likely to Be Affected

In addition to California, where effects on estuarine species has been observed in connection with methyl parathion use on rice, the coastal areas of the Gulf States include a vast area of wetland habitats for estuarine species. For instance, Texas has over 300,000 acres of tidal flats, the most in the nation. Tidal flats are an important habitat and feeding ground for coastal shorebirds, fish and invertebrates such as crabs, oysters, clams, shrimp and mussels. Texas ranks second in the nation in total area of salt marshes, with about 480,000 acres, and third in the nation in freshwater marshes with approximately 530,300 acres. Freshwater marshes, which are located upstream along river valleys, support a variety of species of fish, birds, and fur-bearing animals, as well as shrimp and crayfish.

Game fish, shrimp and crabs will visit shallow water of these estuarine habitats in the late spring and summer when methyl parathion runoff is likely. Species such as red and black drum, sea trout and blue crabs spawn in estuaries or shallow bays, and male crabs remain there after breeding. Black drum thrive in water so shallow that their backs are exposed, and red drum feed in water shallow enough that their tails emerge from the water when they feed. Other important commercial species such as yellow flounder and brown, white and pink shrimp also spend a portion of their lives in estuaries. Therefore, runoff of methyl parathion into shallow aquatic areas is likely to cause hazardous exposure to many commercially important estuarine species.

Mammals

Acute and chronic exposure studies indicate that methyl parathion is very highly toxic to mammals. Calculated risk quotients exceed at least one LOC for all labeled application rates. Mammals are expected to be adversely affected by methyl parathion through oral, dermal, and inhalation exposure pathways.

Herbivores and insectivores are more likely than granivores to be adversely affected by **oral** methyl parathion exposure, because they must consume a greater amount of food in proportion to their body weight each day. All herbivore and insectivore LOCs are exceeded after a single application of methyl parathion at the lowest application rate (0.1 lb ai/A), except by the RQ for the large insect food source. The single-application LOCs for small (15 g) granivores are all exceeded at application rates equal to or greater than 0.75 lb ai/A. All LOCs for 35-gram granivores are exceeded for application rates at or above 1.0 lb ai/A. Therefore, both the corn and cotton uses will result in acute LOC exceedences for these mammals after a single application. All chronic and reproduction LOCs for grass, foliage and seed are exceeded after a single application of 0.5 lb ai/A.

The risk posed by exposure to methyl parathion is expected to increase with the number of applications. The minimum number of applications as recommended on the label is 2 and the maximum is 10. Acute, chronic, and reproductive RQs are greater for multiple applications. The risk assessment for multiple applications to cotton at the maximum application rate of 3.0 lb ai/A predicts the exceedence of every LOC for herbivores, insectivores and granivores of all sizes.

Dermal exposure to methyl parathion is highly likely for mammals. Small mammals, such as meadow voles or field mice, live in and around the treated fields and find it difficult to impossible to escape the treated area. In addition, mammals have bare skin showing on the nose and feet and must travel through treated crop or nearby edge of grass.

Young mammals are expected to be at greater risk than adults. The young of almost any species eat more than adults. In addition, very young mammals are hairless and may be susceptible to dermal exposure from a variety of sources including residue on the fur of the mother.

Effects on Bees and Beneficial Insects

The effects of methyl parathion exposure on bees has long been recognized, and is reflected in label language on the Penncap-M label. The EECs calculated for bees and beneficial insects are far above levels of concern, and a large body of data submitted to EPA and found in the open literature documents bee mortality and colony destruction connected to methyl parathion exposure. Therefore, the certainty in this assessment is very high.

There has long been concern about the effect of Penncap-M on bees, since microencapsulated methyl parathion is similar in size to pollen. The warning statement on the Penncap-M label warns against exposing blooming plants to the pesticide, whether directly or through drift. However, the bee-kill incidents detailed in this chapter indicate that current label language and mitigation measures have not sufficiently reduced the risk of methyl parathion use to honey bees.

EFED recommends that current label language be strengthened to better avert additional honey bee and wild pollinator losses in the future. Since studies show that the emulsifiable concentrated formulation is also very highly toxic to bees, warning language found on the Penncap-M label should be included on the EC label, as well.

In spite of efforts to strengthen label language, however, it is quite possible that the risks of methyl parathion exposure to bees cannot be mitigated below levels of concern. The EECs calculated in this chapter exceed levels of concern for all application rates (0.1 lb ai/acre and above). While efforts have been made in some States to better ensure that beekeepers are informed of impending application of methyl parathion to nearby fields, it may not be practical for beekeepers to move their hives in anticipation of such events.

Persistence of Toxicity

Risks from Methyl Parathion and Other Pesticides Due to Simultaneous and Sequential Applications

The concern attached to the use of methyl parathion is compounded by uses of other organophosphates, which share a common mode of action (cholinesterase inhibition). Under FQPA the risk posed by different pesticides with the same mode of action must be considered together. The EC combination with ethyl parathion is the most obvious example. Ethyl parathion is used extensively on cotton and on other crops on which methyl parathion is used. To the extent that different OPs are used in tank mixes, or in the same area as methyl parathion, the risk is compounded. EFED is currently working on REDs for other OPs which may be applied simultaneously with methyl parathion.

Unless the label of a registered pesticide specifically prohibits tank mixing a particular combination, it is legal in the United States to mix and simultaneously apply pesticides. In addition, labels may specify intervals between multiple applications of the same pesticide, but do not prohibit sequential applications of different pesticides or specify an application interval in these instances. Experiments completed in 1978, and again in 1984, with organophosphate and carbamate insecticides demonstrated that interactions do occur between organophosphate and carbamate insecticides. Treatment of laboratory birds with an organophosphate and later with a carbamate resulted in a 5- to 15-fold decrease in toxicity of the carbamate, whereas treatment with a carbamate and then an organophosphate resulted in a 3- to 8-fold increase in toxicity of the organophosphate.[1, 2]

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Appendix 1: Methyl parathion laboratory toxicity tests

Avian Acute Oral Toxicity

Species	% ai	LD50 (mg/kg)	Toxicity Category [1]	MRID No. Author/Year	Study Classification[2]
Mallard duck *Anas platyrhynchos*	80	6.6 (4.42-9.88)	"very highly toxic"	00160000 Hudson/ 1984	Core
Mallard duck *Anas platyrhynchos*	80	10 (6.12-16.3)	"highly toxic"	0016000 Hudson/ 1984	Core
Mallard duck (*Anas platyrhynchos*)	80	60.5(18.2-201)	"moderately toxic"	00160000 Hudson/ 1984	Core
Northern bobwhite quail (*Colinus virginianus*)	80	7.56(5.7-10)	"very highly toxic"	00160000 Hudson/ 1984	Core
[redacted]					
Ring-necked Pheasant (*Phasianus colchicus*)	80	8.21(5.69-11.9)	"very highly toxic"	00160000 Hudson/ 1984	Supplemental
Red-winged blackbird (*Agelaius phoeniceus*)	80	23.7 (17.1-32.9)	"very highly toxic"	00160000 Hudson/ 1984	Supplemental
American Kestrel (*Falco sparverius*)	98.2% Technical	3.08(2.29-4.14)	"very highly toxic"	44371701 Rattner/1983	Supplemental

[1] "Very highly toxic" designates chemicals whose LD_{50} is < 10 mg/kg. "Highly toxic" designates chemicals whose LD50 is between 10 and 50 mg/kg. "Moderately toxic" designates chemicals whose LD50 is between 51 and 500 mg/kg (Brooks (1973).
[2] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline)

Because the lowest LD_{50} is less than 10 mg/kg, methyl parathion is "very highly toxic" to avian species on an acute oral basis. The guideline (71-1) is fulfilled (MRID 00160000).

In addition to acute oral studies, the following dermal studies were available:

Avian Acute Dermal Toxicity

Species	%a.i.	LD50 mg/kg	Toxicity Category	MRID No. Author/Year	Study Classification
Bobwhite Quail (*Colinus virginianus*)	45.42 EC	2.9 (2.3-3.7)	"very highly toxic"	71200/ Beavers/1980	Supplemental
Bobwhite Quail (*Colinus virginianus*)	22.0 Penncap-M	9.127	"very highly toxic"	83103/ Beavers/1980	Supplemental

It appears that dermal toxicity values are nearly the same the acute oral study values. Hence, we assign the same toxicity category of "very highly toxic".

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Avian Subacute Dietary Toxicity

Species	% ai	5-Day LC50 (ppm)[1]	Toxicity Category[2]	MRID No. Author/Year	Study Classification
Mallard duck *(Anas platyrhynchos)*	80	336(269-413)	"highly toxic"	00022923 Hill/1975	Core
Mallard duck *(Anas platyrhynchos)*	80	692(5451-892)	"moderately toxic"	00022923 Hill/1975	Core
Mallard duck *(Anas platyrhynchos)*	43.2	898 Product	"slightly toxic"	40809703 Hill/1975	Core
Mallard duck *(Anas platyrhynchos)*	45.42 EC	2500 Product 1100(735-1640) a.i	"slightly toxic"	72382 Good/1979a	Supplemental
Mallard duck *(Anas platyrhynchos*	22 Penncap-M	3850 Product 840(306-2300)a.i.	"moderately toxic"	71199 Good/1979b	Supplemental
Northern bobwhite quail *(Colinus virginianus)*	Tech	28.2(22-35.3)	"very highly toxic"	102329 Pennwalt/ 1972	Supplemental
Northern bobwhite quail *(Colinus virginianus)*	22% Penncap M	33.3(25.1-40.9) Product	"very highly toxic"	102329 Pennwalt/ 1972	Supplemental
Northern bobwhite quail *(Colinus virginianus)*	80	90(73-11)	"highly toxic"	00022923 Hill/1975	Core
Northern bobwhite quail *(Colinus virginianus)*	39.5	114.7(78.1-197.1)	"highly toxic"	44173913 Dreamed/ 1996	Core
Japanese quail *(Coturnix japonica)*	80	79(65-1000)	"highly toxic"	00022923 Hill/1975	Supplemental
Ring-necked Pheasant *(Phasianus colchicus)*	80	91(77-107)	"highly toxic"	00022923 Hill/1975	Core

[1] "Very highly toxic" designates chemicals whose LD_{50} is <10 mg/kg."Highly toxic" designates chemicals whose LD50 is between 10 and 50 mg/kg. "Moderately toxic designates chemicals whose LD50 is between 51 and 500 mg/kg (Brooks (1973).

Methyl parathion is "very highly toxic" to avian species on a subacute dietary basis. The guideline (71-2) is fulfilled (MRID # 00022923).

Avian Reproduction

Species/ Study Duration	% ai	NOEC (ppm)	LOEC (ppm)	LOEC Endpoints	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	Tech	6.27	15.5	Number of eggs laid; eggs set/hen; adult female bodyweight	41179302 Beavers/1988	Core
Northern bobwhite quail *(Colinus virginianus)*	Tech	None	10	Reduced food consumption; Number of eggs laid; Number of 14-d-old chicks	44371608 Bennett/1990	Supplemental
Mallard duck *(Anas platyrhynchos)*	Tech	14.7	None	No effects at highest conc.	41179301 Beavers/1988	Supplemental
Japanese quail *(Coturnix coturnix)*	93.1	12 None	48 3	Cracked eggs, eggs laid, egg weight, 14 day old survivors Brain cholinesterase	44359601 Solecki/1996	Supplemental
Northern bobwhite quail *(Colinus virginianus)*	Penncap-M 21.2%	15	None	----	0250628 Beavers/1983	Supplemental
Mallard duck *(Anas platyrhynchos)*	Penncap-M 21.2%	15	None	----	0250628 Beavers/1983	Supplemental

Mammalian Toxicity

Species/ Study Duration	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID No.
laboratory rat 96 hours	80	Oral LD50	3.6 (1.63-7.92) mg/kg ♂ 23.0 (13.7-38.6) mg/kg ♀	Mortality	243414
Laboratory rat 96 hours	Technical	Oral LD50	14.0 (11.02-17.78) mg/kg ♂; 18.5 (11.21-30.53 mg/kg) ♀	Mortality	243414
Laboratory rat 96 hours	80 Niran M/8	Oral LD50	10 (N.R.) mg/kg ♂; 15 mg/kg ♀	Mortality	256258
Laboratory rat NR	NR	Oral LD50	weanlings 3.5 (2.8-4.4) mg/kg Adults 5.8 (5.0-6.7) mg/kg	Mortality	NR
Laboratory rat NR	NR	Oral LD50	4.0(NR) mg/kg♂ 6.3(NR) mg/kg ♀	Mortality	256256
Laboratory rat NR	NR	Oral LD50	11(NR) mg/kg♂ 16 (NR) mg/kg♀	Mortality	256257

Mammalian Toxicity

Species/ Study Duration	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID No.
Laboratory rat NR	NR	Oral LD50	10 (NR) mg/kg♂ 15 (NR) mg/kg♀	Mortality	256258
Laboratory rat NR	NR	Oral LD50	11.78 (9.78-14.2)♂ 8.89 (2.56-30.85)♀ 10.73 (6.4-17.98)♂♀	Mortality	256964
Laboratory rat NR	NR	Oral LD50	600 (513-702) mg/kg♂ 660 (545-799) mg/kg♀	Mortality	41805601
Laboratory rat	NR	Dermal LD50	6 mg/kg (NR)	Mortality	(HED chapter)
Rabbit	NR	Dermal LD50	>2000 mg/kg♂♀	Mortality	256256
Rabbit	NR	Dermal LD50	>2000 mg/kg♂♀	Mortality	256257
Rabbit	NR	Dermal LD50	>2000 mg/kg♂♀	Mortality	256258
Rabbit	NR	Dermal LD50	1249 (975-1601)♂ 1782 (1468-2162)♀ 1453 (1150- 1837)♂♀	Mortality	256965
Laboratory rat	NR	Inhalation LC50	<0.163 mg/L	Mortality	256961
Laboratory rat 96 hours	99	Dietary LC50	110 (85-196) ppm	Mortality	43961101 McCann
Laboratory rat	99	Dietary LC50 96 hours LC50	249 (192-334) ppm	Mortality	43961101 McCann

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Mammalian Toxicity

Species/ Study Duration	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID No.
Feeding-3 month rat	Technical	Feeding	NOEL=2.5 ppm (converts to 0.25 mg/kg) LEL=25 ppm (2.5 mg/kg) -	Clinical changes (lowered hemacrit; elevated SAP & urine specific gravity; depressed RBC, brain & plasma ChE.)	74299
Feeding - 3 month mice	Technical	Feeding	NOEL < 10 ppm (converts to 1.5 mg/kg/day)	Clincal changes (decr. Body and Testes wt. (No abnormal histopathology) (ChE not measured)	72513
Feeding - 3 month dog	94.32	Feeding	ChE NOEL = 0.3	Clinical changes (mg/kg RBC & plasma ChE.)	72512
Rat 2 generation	95.8	Repro-duction	Reproduction NOEL =5 ppm; Mat. NOEL=5 ppm	Significant decresed pup survival Reduced bodyweight during lactation	00119087

The results indicate that methyl parathion is "very highly toxic" (<10 mg/kg) to small mammals on an acute oral basis (MRID No. 243414), and "highly toxic" to small mammals on an acute dietary basis (MRID No. 43961101). The feeding 3 month NOEL was very low at 2.5 ppm (MRID No.: 74299), and the reproduction NOEL is 5 ppm (MRID No.: 00119087). (Brooks et al. 1973).

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Nontarget Insect Toxicity

Species	% ai	Results	MRID No. Author/ Year	Study Classification
Honey bee *(Apis mellifera)*	---	LD50 0.111 μg/bee	44038201 Atkins/ 1981	Core
Honey bee *(Apis mellifera)*	Penncap-M	LD50 0.214 μg/bee	44038201 Atkin/ 1981	Core
[redacted]				
Honey bee *(Apis mellifera)*	Penncap-M	"The average mortality of the adult honey bees was from 29 to 72 times higher than normal the first 48 hours after pollen containing Penncap -M, stored 13.5 and 14.5 months in the cells of wax combs, was introduced into nucleus colonies. After 1 week adult mortality was still4 to 10 times higher than normal. After 4 weeks, mortality was nearly normal again. . .. Chemical analysis of the stored pollen showed 26 ppm methyl parathion."	160948 Rhodes/ 1980	Supplemental
Honey bee *(Apis mellifera)*	Penncap-M	Damage to colonies and the level of methyl parathion residues in bee and bee products decrease as apiary distance from the treated fields increased.	138662 Ross/ 1980	Supplemental
Honey bee *(Apis mellifera)*	Penncap-M & EC	When blooming sunflowers were treated with microencapsulated methyl parathion (Penncap-M), nearby colonies showed a mean loss of 460 honeybee workers during a 5-day period compared with a mean loss of 1990 bees by colonies near a sunflower field treated with methyl parathion EC. Bees recovered from dead bee traps the day after treatment had 0.27 and 1.28 ppm methyl parathion residues from these two formulations, respectively.	138663 Waller/ 1984	Supplemental
Honey bee *(Apis mellifera)*	Penncap-M	"Colonies fed 10 ppm had significantly ($P < 0.05$) fewer frames of adult bees, less sealed brood, and greater mortality of adult bees than treatments fed either lower levels of Penncap-M, or the control... However, emulsifiable concentrate methyl parathion is more toxic than Penncap-M when fed in the hive. Queens did not die from poisoning when 10 ppm Penncap-M was fed to the adult populations of workers, but rather from lack of care or feeding by attendants."	138665 Stoner/ 1984	Supplemental
Honey bee *(Apis mellifera)*	Penncap-M	Application of Penncap-M to corn (1 lb a.i. in 2 gal. water per acre) immediately increased the number of dead bees in front of nearby colonies on day 1; there was a further increase on day 2. Numbers of dead bees declined rapidly from day 3 onward.	138667 Smith/ 1984	Supplemental

The results indicate that methyl parathion is very highly toxic to bees on acute contact basis. These studies show that under fields conditions mortality will occur. Additional

Freshwater Fish Acute Toxicity

Species/	% ai	96-hour LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Rainbow trout *(Oncorhynchus mykiss)*	Technical 75.1	7.5(6.2-9.1)a.i	"moderately toxic"	250628 Bailey/1983	Core
Rainbow trout *(Oncorhynchus mykiss)*	90	3.7(3.13-4.38)	"moderately toxic"	40094602 Johnson/1980	Core
Rainbow trout *(Oncorhynchus mykiss)*	43.2	2.2(1.5-2.7)	"moderately toxic"	40932101 Surprenant/1988	Core
Rainbow trout *(Oncorhynchus mykiss)*	21.2 Penncap M	6.44(5.1-8.2)	"moderately toxic"	250628 Bailey/1983	Core
Rainbow trout *(Oncorhynchus mykiss)*	22 Penncapp M	161(N.R.) Assume Product	"moderately toxic"	00061214 Kuc/1977	Supplemental
Brown Trout (*Salmo trutta*)	90	4.7(3.9-5.75)	"moderately toxic"	40094602 Johnson/1980	Core
Lake Trout (*Salvelinus namaycush*)	90	3.78(2.81-5.09)	"moderately toxic"	40094602 Johnson/1980	Core
Coho Salmon (*Oncorhychus kisutch*)	90	5.3(4.9-5.6)	"moderately toxic"	40094602 Johnson/1980	Core
Cutthroat Trout (*Oncorhynchus clarki*)	90	1.85(1.39-2.47)	"moderately toxic"	40094602 Johnson/1980	Core
Bluegill sunfish *(Lepomis macrochirus)*	77	1.0(0.6-1.6)	"moderately toxic"	40098001 Mayer/1986	Core
Bluegill sunfish *(Lepomis macrochirus)*	90	4.38(3.48-5.51)	"moderately toxic"	40094602 Johnson/1980	Core
Bluegill sunfish *(Lepomis macrochirus)*	44	24 hr 6.47(N.R.)	"moderately toxic"	44352001 McCann/1972	Supplemental
Bluegill sunfish *(Lepomis macrochirus)*	80	2.4(N.R.)	"moderately toxic"	35796 Pickering/1962	Core
Bluegill sunfish *(Lepomis macrochirus)*	22 Penncap M	13.3(N.R.) Assume Product	"slightly toxic"	00061214 Kuc/1977	Supplemental
Bluegill sunfish *(Lepomis macrochirus)*	44.6	11.2(10.6-11.8) Product	"slightly toxic"	76148 McCann/1968	Core
Bluegill sunfish *(Lepomis macrochirus)*	44.6	24 hr 14.5(N.R.)	"slightly toxic"	46110 McCann/1968	Core
Green sunfish (*Lepomis cyanellus*)	90	6.86(5.59-8.42)	"moderately toxic"	40094602 Johnson/1980	Supplemental
Green sunfish (*Lepomis cyanellus)*		>5 (N/A)	"moderately toxic"	44378608	Supplemental
Fathead minnow (*Pimephales promelas*)	77	7.2(5.7-9.1)	"moderately toxic"	40098001 Mayer/1986	Core

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Freshwater Fish Acute Toxicity

Species/	% ai	96-hour LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Fathead minnow (*Pimephales promelas*)	90	8.9(7.78-10.2)	"moderately toxic"	40094602 Johnson/1980	Supplemental
Fathead minnow (*Pimephales promelas*)	80	10.4 (N.R.)	"slightly toxic"	57051 Henderson/1957	Core
Fathead minnow (*Pimephales promelas*)	80	9.4(N.R.)	"moderately toxic"	57051 Henderson/1957	Core
Fathead minnow (*Pimephales promelas)*	80	9.5(N.R.)	"moderately toxic"	35796 Pickering/1962	Core
Fathead minnow (*Pimephales promelas)*	98% 4-Nitro-phenol	58.6 (56.2-61.1)	"slightly toxic"	Geiger/1985	Supplemental
Fathead minnow (*Pimephales promelas)*	98% 4-Nitro-phenol	41 (37.7-44.6)	"slightly toxic"	Geiger/1985	Supplemental
Fathead minnow (*Pimephales promelas)*	98% 4-Nitro-phenol	37.3 (34.4-40.5)	"slightly toxic"	Geiger/1985	Supplemental
Mosquitofish (*Gambusia affinis*)	99	13.4813.2-13.7)	"slightly toxic"	44338801 Chambers/1974	Supplemental
Largemouth bass (*Micropterus salmoides*)	90	5.22(4.32-6.31)	"moderately toxic"	40094602 Johnson/1980	Supplemental
Yellow perch (*Perca flavescens*90)	90	3.06(2.53-3.7)	"moderately toxic"	40094602 Johnson/1980	Supplemental
Goldfish (*Carassius auratus*)	90	9.0(8.1-9.9)	"moderately toxic"	40094602 Johnson/1980	Supplemental
Carp (*Cyprinus carpio*)	90	7.13(6.44-7.87)	"moderately toxic"	40094602 Johnson/1980	Supplemental
Bullhead catfish (*Ictalurus melas)*	90	6.64(4.97-8.88)	"moderately toxic"	40094602 Johnson/1980	Supplemental
Channel catfish *(Ictalurus punctatus)*	90	5.24(4.27-6.44)	"moderately toxic"	40094602 Johnson/1980	Core
Chorus frog (*Pseudacris triseriata*)	90	3.7(N.R.)	"moderately toxic"	40098001 Mayer/1986	Supplemental

[1] Brooks (et al.,1973) toxicity classification indicates that LC50 values >1 to 10 ppm are "moderately toxic".

Because these LC_{50} fall in the range of >1 to 10 ppm, methyl parathion is "moderately toxic" to freshwater fish on an acute basis. The guideline (72-1) is fulfilled (MRID# Acc# 40094602, 40098001, and ESVIIF5).

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Freshwater Fish Early Life-Stage Toxicity Under Flow-through Conditions

Species/ Study Duration	% ai	NOEC/LOEC (ppm)	MATC[1] (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Fathead Minnow (*Pimephales promelas*)	80	0.31/0.38	0.34	Weight	233438 Jarvinen/1988	Core
Fathead Minnow (*Pimephales promelas*)	Penn-cap M	0.38/0.59	0.47	Weight	233438 Jarvinen/1988	Core
Rainbow trout (*Oncorhynchus mykiss*)	Tech-nical 75.1	<0.08	---	Length and weight	250628 Bailey/1983	Supplemental
Rainbow trout (*Oncorhynchus mykiss*)	21.2 Penn-cap M	<0.1	0.141	Length and weight	250628 Bailey/1983	Supplemental

[1] defined as the geometric mean of the NOEC and LOEC.

Freshwater Invertebrate Acute Toxicity

Species	% ai	48-hour LC50/ EC50 (ppb)	Toxicity Category	MRID No. Author/Year	Study Classification
Waterflea *(Daphnia magna)*	90	0.14(0.09-0.2)	"very highly toxic"	40094602 Johnson/1980	Core
Waterflea *(Daphnia magna)*	43.1	8.7(6.4-11)	"very highly toxic"	40932102 Roberts/1988	Supplemental
Waterflea *(Daphnia magna)*	22 ME	28.2(N.R.)	"very highly toxic"	022397 Vilkas/1977	Supplemental
Daphnid (*Simocephalus serrulatus*)	90	0.37(0.23-0.57)	"very highly toxic"	40094602 Johnson/1980	Core
Scud (*Gammarus fasciatus*)	90	96 hour 3.8(2.6-5.5)	"very highly toxic"	40094602 Johnson/1980	Supplemental
Crayfish (*Orconectes nais*)	90	15(N.R.)	"very highly toxic"	40094602 Johnson/1980	Supplemental
Shrimp (*Palaemonetes kadiakensis*,Bluff Lake strain)	Technical	24 hr 3.7 (2.1-5.5)	"very highly toxic"	41237806 Naqvi/1970	Supplemental
Shrimp (*Palaemonetes kadiakensis*, Hollandale strain)	Technical	24 hr 14.1 (11.3-17.0)	"very highly toxic"	41237806 Naqvi/1970	Supplemental
Shrimp (*Palaemonetes kadiakensis*, Belzoni strain)	Technical	24 hr 23.2 (18.8-2.81	"very highly toxic"	41237806 Naqvi/1970	Supplemental

Freshwater Invertebrate Acute Toxicity

Shrimp (*Palaemonetes kadiakensis*, Sky Lake strain)	Technical	24 hr 2.5 (1.4-3.9)	:very highly toxic"	41237806 Naqvi/1970	Supplemental
Copepod (*Acaris tonsa*)	99	28(16-49)	"very highly toxic"	40228401	Supplemental
Mayfly (*Hexagenia sp.*)	93.1	17 (9.8-27)	"very highly toxic"	43491401 Putt/1994	Supplemental
Damselfly (*Ischnura sp.*)	90	33(N.R.)	"very highly toxic"	40094602 Johnson/1980	Supplemental

[1] Brooks (et al., 1973) classification indicates the LC50 of 0.1 to 1 ppm are in the "highly toxic" range and those greater than 1 to 10 ppm are in the "moderately toxic" range.

Because the LC_{50}/EC_{50} falls in the range of < 100 ppb, methyl parathion is in the "very highly toxic" range for aquatic invertebrates on an acute basis.

Freshwater Aquatic Invertebrate Life-Cycle Toxicity

Species/ Flow-through)	% ai	21-day NOEC/LOEC (ppb)	MATC[1],[2] (ppb)	Endpoints Affected	MRID No. Author/Year	Study Classification
Waterflea *(Daphnia magna)*	96	0.178/0.562	0.3407	Survival, growth, and offspring/parent daphnia	41506801 Heimbach/1987	Supplemental
Waterflea *(Daphnia magna)*	95.7	0.43/0.85	0.6046	Survival, weight, first brood day	43035401 Blasberg/1993	Supplemental
Waterflea *(Daphnia magna*	21.2 Penncap-M	0.25/0.55	0.3708	Length	250628 Bailey/1983	Core
Waterflea *(Daphnia magna)*	75.1 Technical	0.16/2.51	0.6337	Young produced/ reproductive day and average No. of young produced	250628 Bailey/1983	Core
Waterflea *(Daphnia magna)*	80%	0.02/0.25	0.22	Neonates produced, survival, growth (length)	44371716 Fernàndez-Casalderrey	Supplemental

[1] defined as the geometric mean of the NOEC and LOEC.

Estuarine/Marine Fish Acute Toxicity

Species	% ai	96-hour LC50 ppm	Toxicity Category	MRID No. Author/Year	Study Classification
Spot (*Leiostmous xanthurus*)	99	0.059 (0.045-0.074)	" very highly toxic"	40228401 Mayer/1986	Supplemental
Spot (*Leiostmous xanthurus*)	99	0.093 (0.056- 0.32)	"very highly toxic"	40228401 Mayer/1986	Supplemental
Striped bass (*Morone saxatilis*	80	0.79 (0.17-1.4)	"highly toxic"	05000819 Korn/1974	Core
Sheepshead minnow (*Cyprinodon variegatus*)	43.2	3.4 (2.8-4.1)	"moderately toxic"	40932103 Surprenant/1988	Core
Sheepshead minnow (*Cyprinodon variegatus*)	90	12.0 (10-40.0)	"slightly toxic"	40228401 Mayer/1986	Core
Sheepshead minnow (*Cyprinodon variegatus*)	99	48 hr 0.8 (NR)	"highly toxic"	40228401 Mayer/1986	Supplemental
Mosquito fish (*Gamgusia affinis*)	99	13.48 (13.24-13.72)	"slightly toxic"	44338801 Chambers/1974	Supplemental

[1] Brooks (et al.,1973) classification indicates that LC50s greater than 1 to 10 ppm are "moderately toxic".

Methyl parathion is "moderately toxic" to estuarine/marine fish on an acute basis.

Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50/EC50 (ppb) (measured)	Toxicity Category[1]	MRID No. Author/Year	Study Classification
Eastern oyster (*Crassostrea virginica*)	99	12000 (10000-16000)	"slightly toxic"	40228401 Mayer/1986	Core
Eastern oyster (*Crassostrea virginica*)	99	>800 (N.R.)	"highly toxic"	40228401 Mayer/1986	Core
Mysid (*Americamysis bahia*)	43.2	0.35 (0.31-0.39)	"very highly toxic"	40932104 Surprenant/1988	Core
Mysid (*Americamysis bahia*)	99	0.78 (0.58-1.1)	"very highly toxic"	40228401 Mayer/1986	Core
Mysid (*Americamysis bahia*)	99	0.98 (0.81-1.2)	"very highly toxic"	40228401 Mayer/1986	Core
Pink Shrimp (*Penaeus duorarum*)	99	1.2 (0.91-1.4)	"very highly toxic"	40228401 Mayer/1986	Supplemental
Pink Shrimp (*Penaeus duorarum*)	99	1.9 (1.5-2.7)	"very highly toxic"	40228401 Mayer/1986	Supplemental
White Shrimp (*Penaeus stylirostris*)	99	1.4 (1.3-1.6)	"very highly toxic"	40228401 Mayer/1986	Core
Brown Shrimp (*Penaeus aztecus*)	99	2.6 (N.R.)	"very highly toxic"	40228401 Mayer/1986	Supplemental

Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC50/EC50 (ppb) (measured)	Toxicity Category[1]	MRID No. Author/Year	Study Classification
Glass shrimp (*Palaemonetes kadiakensis*)	Tech	2.5 (1.4-3.9)	"very highly toxic"	40228401???/ Mayer/1986	Supplemental
Copepod (*Acartia tonsa*)	99	28(16-49)	"very highly toxic"	40228401 Mayer/1986	Supplemental

[1] Based on Brook's (et al. 9173) toxicity categories indicate that chemicals with an LC50 < 0.1 ppm are "very highly toxic" and those between 10 and 100 ppm are "slightly toxic" .

Because the methyl parathion LC_{50}/EC_{50}s fall in the range of >0.1-1 ppm, methyl parathion is "highly toxic" to estuarine/marine invertebrates on an acute basis.

Estuarine/Marine Invertebrate Life-Cycle Toxicity

Species/(Static Renewal or Flow-through)	% ai	21-day NOEC/LOEC (ppb)	MATC[1] (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Mysid *(Americamysis bahia)*		0.11/0.37	0.20	Survival and Number of offspring/♀	Lowe 66341/1981	Supplemental

[1] defined as the geometric mean of the NOEC and LOEC.

Nontarget Aquatic Plant Toxicity (Tier II)

Species	% ai	EC50/ (ppm)	MRID No. Author/Year	Study Classification
Nonvascular Plants				
Marine diatom *(Skeletonema costatum)*	99	5.3 (4.3-5.7)	Lowe 66341/1981	Supplemental

Methyl parathion is "practically non-toxic" *to Skeletoma costatum.*

Appendix 2: Methyl Parathion Bee Incidents

Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
1/ 1978	7,800 to 10,400 all hives were reduced below maintenance level and 50 hives were lost.	Corn	IA	Methyl parathion (Penncap-M)	Dead worker bee	1. 0.91 2. 0.60 3. 2.00 4. 2.00
					Dying worker bees	1. 0.28 2. 0.84
					Pollen from brood nest comb	1. 0.281 2. 0.0072
Applied at 1 lb a.i./A to pollen producing corn for European corn borer. Two apiaries, one 500 yards and another within 1 1/4 miles. (Source: Stoner, 1979)						
2/ 1978	58 hives destroyed 111 severely damaged 80 moderately damaged 21 Undamaged	155 A. Alfalfa for Hay	WY	Methyl parathion	item miles	
					pollen 0.7	0.33
					0.7	1.52
					0.7	0.08
					1.2	0.06
					1.2	0.04
					0.6	0.06
					0.6	1.25
					1.5	0.07
					1.5	0.22
					honey 0.7	0.01
					0.7	0.02
					0.7	0.02
					0.6	0.01
					1.5	0.01
					wax 0.7	+
					0.7	+
					0.6	0.1
					wax & honey 0.7	0.01
					dead bees 0.7	0.7
					0.7	0.9
					0.6	1.0
Aerial applied at rate 0.5 lbs a.i./A to control aphids. Because climatic conditions were excellent for the application, the kill could not be attributed to drift (it was calm, with little or no wind) and temperatures were in the range that allowed the spray to settle immediately.						
1/ 1992		Apple orchard	WA			
This concerns 33 bee kill complaints, mostly from Yakima County but including Grant, Okanogan, Columbia, Benton, and Franklin counties, stemming from the use of microencapsulated methyl parathion. It had been applied to orchards that had blooming plants in the cover crop. Both the pesticide label and rules of the Department of Agriculture prohibit this practice. To prevent similar occurrences in the future the WA Dept of Agriculture adopted an emergency rule which requires pesticide dealers to provide users with a copy of the Department rules relating to methyl parathion.(WSDA)						

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Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
2/ 12/23/92	Not reported	Apple Orchards	NC	Methyl parathion (Penncap-M)	bees	0.67 ppm
				Chlorpyrifos		0.03 ppm
Some owners of the apple orchards admit using methyl parathion and/or chlorpyrifos, however, it was impossible for the inspector to identify whose application ie responsible for the killing. (NCDA)						
2/ 6/10/93	6 of 94 damaged	Apple Orchards	NC	Methyl parathion	Apple leaves (orchard A)	15 ppm
				Guthion		0.8 ppm
				Carbaryl		0.02 ppm
				Methyl parathion	Bees	0.73 ppm
				Guthion		nd
				Carbaryl		nd
				Methyl parathion	Bees	0.93 ppm
				Guthion		nd
				Carbaryl		nd
				Methyl parathion	Honey	nd
				Guthion		nd
				Methyl parathion	Honey	nd
				Guthion		nd
				Methyl parathion	Brood Rack	0.03 ppm
				Guthion		nd
				Methyl parathion	Brood Rack	nd
				Guthion		nd

Table 1: Terrestrial Methyl Parathion Incidents -Bees

					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
				Methyl parathion Guthion Captan Endosulfan Sulfate	Vegetation (Orchard B)	nd 40 ppm 9 ppm 1.3
				Methyl parathion Guthion Captan Endosulfan Sulfate	Vegetation (Orchard B)	nd nd nd 1.2
In an effort to determine the if the bees were exposed to pesticides bees samples were taken. To determine what pesticide was used by the two nearby orchard vegetation samples were taken.(NCDA)						
3/ 6/10/93	Not reported	Apple orchards	NC	Methyl parathion (Penncap-M)	Bees	Not reported
Because there are so many orchards near the bees is possible to how they received the pesticide.(NCDA)						
3/ 6/16/93	Not reported	Apple Orchard	NC	Methyl parathion (Penncap-M)	Bees	0.67 ppm and 0.80 ppm
(See next incident for narrative)						
4/ 8/10/93	Not reported	Apple Orchard	NC	Methyl parathion	Bees	0.54, 1.10 and 2.00 ppm
Owners of the nearby orchards were interviewed and vegetation samples 4 of 6 orchards showed the presence of methyl parathion.(NCDA)						
5/ 7/6/93	Not reported	Apple orchard	NC	Methyl parathion Chlorpyrifos	bees	0.79 ppm
An analysis of the bees showed the presence of methyl parathion at 0.79 ppm which would be lethal. Suspected causes of the problem were two orchards not far removed from the scene of the bee kill but one of them has not been maintained and therefore not sprayed, and the other one used Lorban (chlorpyrifos). Neither had used methyl parathion, so the source of the problem was not found but there is little question about the cause of death of the bees.(NCDA)						

1098136

Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
6/ 8/13/93	Not reported	Orchard	NC	Methyl parathion (Penncap-M)	Bees	0.71 ppm
				Phosmet (Imidan)		1.12 ppm
				Guthion		0.29 ppm
				Methyl parathion	Vegetation from apple trees (Orchard L)	0.50 ppm
				Phosmet		nd
				Guthion		28 ppm
				Methyl parathion	Vegetation from apple trees (Orchard W)	nd
				Phosmet		0.69 ppm
				Guthion		0.65 ppm
				Methyl parathion	Vegetation from apple trees (Orchard B)	25 ppm
				Phosmet		0.93 ppm
				Guthion		5.3 ppm
				Methyl parathion	Vegetation from apples trees (Orchard B2)	0.25 ppm
				Phosmet		nd
				Guthion		0.44 ppm
				Methyl parathion	Vegetation from apple trees (Orchard L2)	1.0 ppm
				Phosmet		nd
				Guthion		nd
				Methyl parathion	Vegetation from apple trees (Orchard L3)	0.27 ppm
				Phosmet		nd
				Guthion		168 ppm

1108136

Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
				Methyl parathion Phosmet Guthion	Vegetation from apple trees (Orchard B3)	41 ppm nd 20 ppm
				Methyl parathion Phosmet Guthion	Vegetation from apple trees (Orchar M)	18 ppm nd 0.61 ppm
				Methyl parathion Phosmet Guthion	Vegetation from apple trees (Orchard L4)	0.15 ppm nd 0.12 ppm
Results of samples from the orchards showed the presence of Guthion in eight orchards sampled. Methyl parathion was detected in seven orchards and phosmet was detected in one orchard.(NCDA)						
7/ 8/17/93	Not reported	Apple Orchard	NC	Methyl parathion Chlorpyrifos	Bees	3.3 ppm nd
				Methyl parathion Chlorpyrifos	Vegetation from apple orchard	nd 2.9 ppm
				Methyl parathion Chlorpyrifos	Vegetation from apple orchard	nd 1.1 ppm
				Methyl parathion Chlorpyrifos	Vegetation from apple orchard	nd 1.7 ppm
An analysis of bees showed methyl parathion. Inspection of nearby orchards showed use of chlorpyrifos. This suggests the bees traveled farther than had been anticipated.(NCDA)						

1118136

Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
8/ 6/26/94	Not reported	Apple orchard	NC	Methyl parathion (Penncap-m)	Bees	0.2 ppm
				Guthion		nd
				Methyl parathion (Penncap-m)	Vegetation from apple tree	3.2
				Guthion		nd
Only one large orchard was in the vicinity of the bee hive (3 miles). Methyl parathion residues were found on both the bee and apple foliage samples.						
9/ 8/94	50 colonies 7 Beekeepers	Corn	CO	Methyl parathion	hive top	Not reported
					bees	
					nontarget corn	
Applied to 12 cornfields, none in pollen shed stage. The hive top residue suggests that drift was 1057 feet. Bees were foraging in a 20 acre nontarget corn field was also contaminated as well as wild species in the edge.						
9/ 8/15/94	Not reported	Apple orchard	NC	Methyl parathion	Bees	0.77 ppm
				Phosmet		nd
				Guthion		nd
				Chlorpyrifos		0.001 ppm
				Captan		nd
				Endosulfan		nd
				Methyl parathion	Vegetation on apple trees	0.12 ppm
				Phosmet		nd
				Guthion		nd
				Chlorpyrifos		0.012 ppm
				Captan		0.013 ppm
				Endosulfan		0.13 ppm

1129136

Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
					Vegetation from apple trees	
				Methyl parathion		0.029 ppm
				Phosmet		nd
				Guthion		nd
				Chlorpyrifos		0.58
				Captan		0.12
				Endosulfan		nd
Two orchards were approximately two miles from the affected hives. As showed above both showed several different pesticides. Only two insecticides, methyl parathion and chlorpyrifos, were found on the dead bees.(NCDA)						
10/ 4/28/95	Not reported	Apple Orchard	NC		Bees	
				Methyl parathion		3.1 ppm
				Chlorpyrifos		0.10 ppm
				Captan		nd
				Dimethoate		1.7 ppm
				Endosulfan		0.20
				Carbaryl		nd
					Vegetation from apple orchard (J)	
				Methyl parathion		nd
				Chlorpyrifos		0.04 ppm
				Captan		225.0 ppm
				Dimethoate		5.5 ppm
				Endosulfan		0.30 ppm
				Carbaryl		nd

1138136

Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
					Vegetation from apple orchard (L)	
				Methyl parathion		nd
				Chlorpyrifos		0.12 ppm
				Captan		3.8 ppm
				Dimethoate		0.09 ppm
				Endosulfan		0.10 ppm
				Carbaryl		nd
					Vegetation from apple orchard (S)	
				Methyl parathion		nd
				Chlorpyrifos		0.24 ppm
				Captan		0.21 ppm
				Dimethoate		0.13 ppm
				Endosulfan		75 ppm
				Carbaryl		0.21 ppm
					Vegetation from apple trees(LY)	
				Methyl parathion		nd
				Chlorpyrifos		18 ppm
				Captan		0.32 ppm
				Dimethoate		0.05 ppm
				Endosulfan		0.02 ppm
				Carbaryl		nd
					Vegetation from apple trees (D)	
				Methyl parathion		nd
				Chlorpyrifos		3.9 ppm
				Captan		nd
				Dimethoate		nd
				Endosulfan		0.01 ppm
				Carbaryl		5.2 ppm

1148136

Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
Notice that none of the orchard samples showed the presence of methyl parathion. Also the pesticides that were found have the potential to kill bees. However, the concentration on the bees show methyl parathion.(NCDA)						
11/ 6/5/95	Not Reported	Apple orchards	NC	Methyl parathion Chlorpyrifos Carbaryl Guthion	Bees	1.4 ppm 0.04 ppm nd nd
Two nearby orchards had been sprayed with Penncap-M (methyl parathion) and one with Lorsban (chlorpyrifos). Which orchard contributed to the bee kill is unknown. It should also be mentioned that one of the orchard owner says that he always mows before spraying.(NCDA)						
12/ 6/6/95	Not reported	Apple orchard	NC	Methyl parathion Chlorpyrifos Endosulfan Phosmet Guthion	Bees	0.90 and 1.4 ppm 0.02 and 0.08 ppm nd and nd nd and nd nd and nd
Bees show exposure to methyl parathion and chlorpyrifos. However, the source of the pesticide is unknown. The closest apple orchard had not been treated this year.(NCDA)						
13/ 6/18/95	Not reported	Apple orchard	NC	Methyl parathion Chlorpyrifos Endosulfan Phosmet Guthion Carbaryl	Bees	(Three samples) 0.80, 1.4 & 5.2 ppm 0.03, 0.05 & 0.06 ppm nd, nd & nd nd, nd & nd nd, nd & nd
The investigation did not mention any visits to nearby orchards and question them about recent pesticide applications. However, bee samples did show methyl parathion and chlorpyrifos concentrations. (NCDA)						

Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
14/ 6/20/95	Not reported	Apple Orchards	NC	Methyl parathion	Bees	1.5 ppm
				Chlorpyrifos		0.10 ppm
				Endosulfan		nd
				Phosmet		nd
				Guthion		nd
				Carbaryl		nd
				Methyl parathion	Bees	1.0 ppm
				Chlorpyrifos		0.06 ppm
				Endosulfan		nd
				Phosmet		nd
				Guthion		nd
				Carbaryl		nd
				Methyl parathion	Bees	3.0 ppm
				Chlorpyrifos		0.2 ppm
				Endosulfan		nd
				Phosmet		nd
				Guthion		2.2 ppm
				Carbaryl		nd
Three beekeepers reported bee kill on this day. The inspector visited nearby orchards both said they used chlorpyrifos but denied using Penncap-M.(NCDA)						

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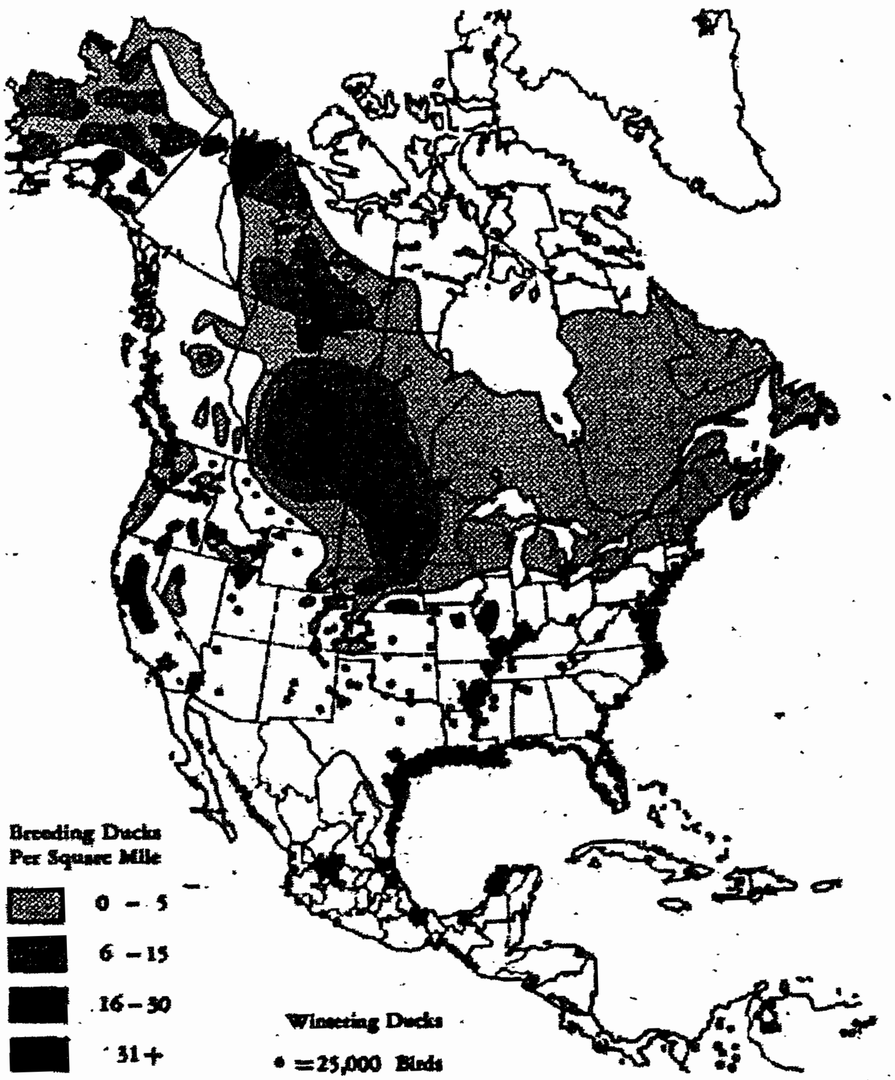
Table 1: Terrestrial Methyl Parathion Incidents -Bees						
					Residue Analysis	
No./ Date	Effect/#	Crop	St	Pesticides	Item	Conc. (ppm)
15/ 7/5/95	Not reported	Apple orchard	NC	Methyl parathion (Penncap-M)	Bees	4.8 ppm
				Chlorpyrifos (Lorban)		0.05
				Endosulfan		nd
				Phosmet		nd
				Guthion		nd
				Carbaryl		nd
The inspector could not determined the source of the methyl parathion and chlorpyrifos.(NCDA)						
1995-1996 11 incid-ents	Not Reported	Corn (corn adult root root worm beetles)	NB	Methyl parathion	Bees or pollen	Detected
Due bees forageing in treated fields.						
1997 4 incid-ents	Nor Reported	Corn (corn adult root root worm beetles)	NB	Methyl parathion	Bees or pollen	Detected
Due to direct drift over the hives.						

Appendix 3- Distribution of North American Breeding and Wintering Ducks

AVERAGE DISTRIBUTION OF NORTH AMERICAN BREEDING AND WINTERING DUCKS



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APPENDIX 4: Bird species observed in corn field studies

	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
1	American Avocet				X		
2	American Coot				X		
3	American Crow			X			
4	American Goldfinch		X	X		X	X
5	American Kestrel	X			X	X	
6	American Redstart					X	X
7	American Robin		X	X		X	X
8	American White Pelican	X					
9	Bald Eagle	X				X	X
10	Bank Swallow		X	X	X	X	
11	Barn Owl	X					
12	Barn Swallow	X			X	X	X
13	Black and White Warbler					X	
14	Black-bellied Plover	X					
15	Black-bellied Whistling-Duck				X		
16	Black-capped Chickadee		X				
17	Black-crown Night Heron	X			X		
18	Black-necked Stilt	X			X		
19	Black-shoulder Kite				X		
20	Black Tern	X					

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	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
21	Black-throated Green Warbler					X	X
22	Black Vulture					X	X
23	Blue-gray Gnatcather				X		
24	Blue Grosbeak				X	X	X
25	Blue Jay		X	X		X	X
26	Blue-winged Teal	X			X		
27	Blue-winged Warbler					X	X
28	Bobolink		X				
29	Bronzed Cowbird				X		
30	Brown-crested Flycatcher				X		
31	Brown-headed Cowbird		X	X	X	X	X
32	Brown Pelican	X					
33	Brown Thrasher		X	X	X	X	X
34	Buff-bellied Humming Bird				X		
35	Buff-breasted Sandpiper	X					
36	Canada Goose				X	X	X
37	Canada Warbler				X		
38	Cedar Waxwing		X			X	X
39	Carolina Wren		X			X	X
40	Caspian Tern	X					
41	Cattle Egret	X				X	X
42	Chickadee spp.					X	X
43	Chimney Swift					X	X

	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
44	Chipping Sparrow			X		X	X
45	Cliff Swallow		X		X	X	
46	Common Crow		X				
47	Common Flicker					X	X
48	Common Grackle		X	X		X	X
49	Common Ground-dove				X		
50	Common Loon	X					
51	Common Moorhen	X					
52	Common Nighthawk		X				
53	Common Snipe	X			X		
54	Common Yellowthroat		X	X	X	X	X
55	Couch's Kingbird				X		
56	Crow spp.					X	X
57	Curve-billed Thrasher				X		
58	Dickcissel		X	X	X		
59	Double-crested Cormorant						
60	Dowitcher spp.	X					
61	Downy Woodpecker		X			X	X
62	Eastern Kingbird		X	X	X	X	X
63	Eastern Bluebird		X			X	X
64	Eastern Meadowlark		X		X	X	X
65	Eastern Pewee					X	
66	Eastern Phoebe		X		X		
67	Eastern Screech Owl	X					

	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
68	Eastern Wood-pewee		X		X		X
69	Eurasian Tree Sparrow		X				
70	European Starling		X	X		X	X
71	Empidonax Flycatchers				X		
72	Field Sparrow		X	X		X	
73	Fish Crow	X					
74	Forster's Tern	X			X		
75	Fulvous Whistling-duck	X					
76	Glossy Ibis	X					
77	Grackle sp.					X	
78	Grasshopper Sparrow			X		X	
79	Gray Catbird		X	X		X	X
80	Gray Partridge			X			
81	Great Blue Heron	X			X	X	X
82	Great Crested Flycatcher		X	X		X	X
83	Great Egret	X			X	X	X
84	Green Heron		X		X	X	X
85	Green-back Heron	X					
86	Great-tailed Grackle				X		
87	Greater Yellowlegs	X			X		
88	Great Kiskadee		X		X		
89	Gull sp.						X

	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
90	Hairy Woodpecker					X	X
91	Herring Gull	X				X	
92	Hooded Warbler						X
93	Horned Lark		X	X	X	X	
94	House Sparrow		X	X	X	X	X
95	House Wren		X		X	X	
96	Inca Dove				X		
97	Indigo Bunting		X	X	X	X	X
98	Kentucky Warbler				X		
99	Killdeer	X	X	X	X	X	
100	Ladder-backed Woodpecker				X		
101	Lark Sparrow		X		X		
102	Lapland Longspur			X			
103	Laughing Gull	X			X	X	
104	Least Flycatcher					X	
105	Least Sandpiper	X			X		
106	Least Tern	X					
107	Lesser Golden Plover			X			
108	Lesser Yellowlegs	X			X		
109	Lincoln Sparrow				X		
110	Little Blue Heron	X				X	X
111	Long-billed Curlew				X		
112	Long-billed Dowitcher				X		

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	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
113	Long-billed Thrasher				X		
114	Loggerhead Shrike				X		
115	Magnolia Warbler					X	X
116	Mallard	X				X	X
117	Marsh Wren						X
118	Merlin				X		
119	Mottled Duck	X			X		
120	Mourning Dove				X	X	X
121	Mute Swan					X	X
122	Myiarchas Flycatcher				X		
123	Nashville Warbler				X		
124	Northern Bobwhite Quail		X		X	X	X
125	Northern Cardinal		X		X	X	X
126	Northern Dove		X	X			
127	Northern Flicker		X	X			
128	Northern Harrier	X			X		
129	Northern Oriole		X			X	X
130	Northern Mockingbird				X	X	X
131	Northern Parula Warbler					X	X
132	Northern Pintail	X			X		
133	Northern Rough-winged Swallow				X		
134	Olive Sparrow				X		

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	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
135	Orchard Oriole		X			X	X
136	Osprey	X				X	X
137	Ovenbird					X	
138	Peafowl					X	X
139	Pectoral Sandpiper	X					
140	Pine warbler					X	X
141	Pileated Woodpecker		X				
142	Prairie Warbler						X
143	Prothonotary Warbler					X	
144	Purple Martin					X	X
145	Ray-breasted Warbler					X	
146	Ring-billed Gull				X		
147	Red-eyed Vireo					X	X
148	Red-bellied Woodpecker					X	X
149	Red-breasted Grosbeak		X				
150	Red-headed Woodpecker		X			X	X
151	Red-shouldered Hawk	X					
152	Red-tailed Hawk	X	X			X	X
153	Red-winged Blackbird		X	X	X	X	X
154	Ring-billed Gull	X					
155	Ring-necked Pheasant		X				

	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
156	Rock Dove		X	X	X	X	X
157	Rose-breasted Grosbeak					X	
158	Ruby-crowned Kinglet			X	X		
159	Ruby-throated Hummingbird					X	X
160	Ruddy Duck	X					
161	Ruddy Turnstone	X					
162	Rufus-sided Towhee					X	X
163	Savannah Sparrow		X	X	X	X	
164	Sharp-shinned Hawk	X					
165	Scarlet Tanager					X	X
166	Scissor-tailed Flycatcher				X		
167	Sedge Wren			X		X	
168	Semipalmated Plover	X					
169	Semipalmated Sandpiper	X					
170	Solitary Sandpiper	X					
171	Snowy Egret	X			X	X	X
172	Song Sparrow		X	X		X	
173	Stilt Sandpiper	X					
174	Swainson's Hawk				X		
175	Tennessee Warbler		X				
176	Tree Swallow		X		X	X	X

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	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
177	Tricolor Heron	X			X		
178	Tropical Kingbird				X		
179	Tufted Titmouse		X		X	X	X
180	Turkey Vulture	X				X	X
181	Upland Sandpiper	X			X		
182	Vesper Sparrow		X	X			
183	Western Kingbird				X		
184	Western Meadowlark			X			
185	Western Sandpiper				X		
186	White Breasted Nuthatch		X				
187	White-crowned Sparrow		X				
188	White-eyed vireo					X	X
189	White-faced Ibis	X			X		
190	White-tipped Dove				X		
191	White-throated Sparrow					X	X
192	White-winged Dove				X		
193	Willet	X					
194	Willow Flycatcher		X				
195	Wilson's Phalarope	X					
196	Wilson's Warbler				X		
197	Wood Duck	X					

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	Birds Observed in Corn Field Studies						
Number	Bird	Carbofuran				Terbufos	Phorate
		FL	IL	IA	TX	MD	MD
198	Wood Stork	X			X		
199	Wood Thrush					X	X
200	Worm-eating warbler					X	
201	Yellow-billed cuckoo					X	X
202	Yellow-breasted Chat		X		X	X	X
203	Yellow-headed Blackbird				X		
204	Yellow-rumped warbler					X	
205	Yellow Warbler		X		X	X	X

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Appendix 5- Aquatic and Terrestrial Incidents with Methyl Parathion

<table>
<tr><th colspan="8">Aquatic Methyl Parathion Incidents</th></tr>
<tr><th rowspan="2">No./ Date</th><th rowspan="2">Species</th><th rowspan="2">Effect/#</th><th rowspan="2">Crop</th><th rowspan="2">St</th><th colspan="2">Residue Analyses</th><th rowspan="2">ChE</th></tr>
<tr><th>Item</th><th>Conc. (ppm)</th></tr>
<tr><td>1/ 8/20/73</td><td>Fish</td><td>17000</td><td>cotton</td><td>AL</td><td>None</td><td>None</td><td>None</td></tr>
<tr><td colspan="8">According to "summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a large fish kill in Alabama. Methyl and Guthion had been applied aerially to adjacent cotton fields the week of the kill and are considered to have been the cause of the incident.</td></tr>
<tr><td>2/ 8/14/72</td><td>Fish</td><td>unknown</td><td>cotton</td><td>AL</td><td>None</td><td>None</td><td>None</td></tr>
<tr><td colspan="8">According to "summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in Alabama. Following aerial application of methyl parathion and endrin to cotton, an unknown number of fish was killed. Residues of toxaphene and endrin in the fish were 14.0 and 0.15 ppm, respectively.</td></tr>
<tr><td>3/ 8/27/73</td><td>Fish</td><td>200,000</td><td>Cotton</td><td>AL</td><td>lake water</td><td>1.6 ppb</td><td>None</td></tr>
<tr><td colspan="8">According to "summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in Alabama. All of the water samples taken from the lake revealed the presence of endrin (0.58 ppb) and methyl parathion (1.6) ppb</td></tr>
<tr><td>4/ 7/22/74</td><td>Fish</td><td>6600</td><td>NR</td><td>AL</td><td>None</td><td>None</td><td>None</td></tr>
<tr><td colspan="8">According to "summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in Alabama. The information is that methyl parathion and endrin were involved in the fish kill. No confirmatory data were given.</td></tr>
<tr><td>5/ 8/9/74</td><td>Sunfish
Smallmouth buffalo
Carp
Bluegill</td><td>28,300</td><td>Cotton</td><td>AL</td><td>None</td><td>None</td><td>None</td></tr>
<tr><td colspan="8">According to "summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in Alabama. During the investigation, the investigators observed the aerial application of pesticide to cotton. It was reported that prior to the fish kill there had similar applications made while it was raining. Endrin was found in the water samples and also in the carp.</td></tr>
<tr><td>6/ 7/73</td><td>Minnow
Shiner</td><td>Unknown</td><td>Cotton</td><td>AR</td><td>None</td><td>None</td><td>None</td></tr>
<tr><td colspan="8">According to "summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in Arkansas in July 1973. Aerial application of pesticides (presumably one or more of those included in the title of this report) to a nearby cotton field was presumed to be the cause.</td></tr>
<tr><td>7/ 8/23/74</td><td>Shiner
Catfish
Minnow</td><td>Unknown</td><td>Cotton</td><td>AR</td><td>None</td><td>None</td><td>None</td></tr>
<tr><td colspan="8">According to "summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in Arkansas in on August 23, 1974. A commercial catfish farm suffered the death of fish in four of their ponds. Reportly, the nearby cotton fields had been treated during the same period.</td></tr>
<tr><td>8/ 8/5/91</td><td>Catfish</td><td>Unknown</td><td>Cotton</td><td>LA</td><td>Water</td><td>Negative</td><td>None</td></tr>
</table>

1298136

Aquatic Methyl Parathion Incidents							
No./ Date	Species	Effect/#	Crop	St	Residue Analyses		ChE
					Item	Conc. (ppm)	
The fish kill occurred in the private catfish pond. Investigation, made by DEQ and LAAF, revealed a cotton field, west of the pond, which had been treaed with pesticides 8-3-91. Water samples, taken at investigation 8/5/91, were negative for suspected insecticides Sulprofos and Methyl parathion. There were low DO readings in areas of the pond and algal bloom was evident by brilliant green coloring in areas of the pond, therefore the investigators felt trhat algal bloom caused the fishkill.							
9/ 7/25/94	Catfish shad, bowfin buffalo, gar drum,	2395	Cotton	LA	Water	All Positive for both chemicals	None
					Sediment		
					Fish		
Curacron and methyl parathion had been applied to a large acreage of cotton, but a heavy rain followed and the runoff exited into Crews Lake, then Little Lake Lafourche, and ultimately Lake Lafourche. Varying species of shad, bowfin buffalo, gar drum, and catfish were killed and the deaths were attributed to profenefos and methyl parathion (based on analyses of water, sediment, and fish by the LSU School of Veterinary medicine but no datat were included in the report on which but no data were included in the report on which this narrative is based.							
10/ 8/2/91	Various species	Unknown	Cotton	LA	water	Negative	None
					Cyanizine	5.33 ppb	
Fish kill on Crew Lake was investigated by DEQ and LDAF. Multiple types of dead fish were observed, DO levels were low, 1.7-2.8. Water samples were negative for methyl parathion and 5.33 ppb for cyanizine, a level insufficient to cause fish mortality. LDAF determined that low DO was responsible for the fish mortality.							
11/ 7/31/91	fish	Unknown	Cotton	LA	None	None	None
acertified applicator aerially treated cotton fields with methyl parathion and endosulfan on 7/27/91. ?these pesticides were applied according to its labeled concentration and recommendation. The application followed 1.39 inches rainfall, which caused runoff to Joe's Bayou as the fields treated are located on both sides of the Bayou. The Louisiana Department of Agriculture & Fishery (LDAF) jointly investigated this incident. The water samples taken from the Bayou were tested and detected the presence of methyl parathion among other pesticides. LDAF concluded that both of these pesticides. LDAF concluded that both of these pesticides are what killed the fish. Concentrations of profenofos in the water were only 0.62 and 1.08 ppb, but profenofos concentrations in shad muscle were 78.2 and							
12/ 8/6/96	Shad Carp	Thousands	Cotton	LA	methyl parathion	0.12 ppb	
					atrazine	2.07 ppb	
					prometryn	0.64 ppb	
					cyanazine	0.34	
					norflurazon	0.19	
					metolachlor	0.57	
					profenofos	1.08	

1308136

Aquatic Methyl Parathion Incidents							
No./ Date	Species	Effect/#	Crop	St	Residue Analyses		ChE
					Item	Conc. (ppm)	
An extensive fish kill took place in Crew Lake on August 6, 1996. A variety of pesticides) was found in the waer but the low dissolved oxygen content may also have been a factor in the deaths of the fish. Concentrations of profenofos in the water were only 0.62 and 1.08 ppb, but profenofos concentration in the shad muscle were 78.2 and 363 ppb, and conentrations in the lever were 1`00 and 1181 ppb. In the judgement of Dr. Jay Means, coordinator of the fish kill investigation team at LSU, profenofos was responsible for the fish kill. Another factor, however, was the low dissolved oxygen content (0.8 to 3.0) which also be toxic.							
13/ 4/29/81	Bluegill	hundreds	Unknown	MO	None	None	None
Misuse- No mention of weather conditions was made in the report. Evidently it was a case of an aerial spray entering the water. Methyl parathion was sprayed, and there was a fish kill in a neighboring pond near the town of Rosendale, Mo. No residue analysis was provided. The owner may even have been the one doing the spraying, and the concern was the status of the home water supply.							
14/ 8/1/95	Fish	240,000	Cotton	AL	None	None	None
More than 240,000 fish were killed along a 16 mile stretch of the Big Nance Creek that flows into the Tessesee River. A pesticide product (made by FWC Corp. of Philadelphia), containing methyl parathion and endosulfan, was sprayed by airplnes and tractor-type applicators on about 10 farms in early August. Shortly thereafter, heavy rains washed the pesticide product into the creek. Reports indicate that the spraying was done within the guidelines on the label but the results show that the provisions on the label should be revised. The product contains both endosulfan and methyl parathion, but only the results of the endosulfan analyses were cited in assessing the cause of the fish kill. The endosulfan concentration was high enough to kill fish. Methyl parathion concentration is known. The Alabama Dept.of Environmental Management, the Departments of Agriculture and Industry, Public Health and Conservation and Natural Resources investigated the fish kill. They concluded that some of the fields where the pesticides were applied may be slightly closer to the Creek than the 300 feet specified. A warning to this effect is carried ont he leaflets distributed with the product but no mention of it is made on the label.							
15/ 4/5/80	Mullet Minnow Blue crab Oyster Mussel	Tomato	Not Reported	SC	Methyl parathion Hoaulover creek -Water	0.29 ppm	
					Endosulfan I and II Leadenwah Creek -Water	0.166 and 0.34 ppb, respectively	
					-Fish	0.140 ppb	
					Haulover Creek -Fish	0.5 and 0.16 ppb, respectively	

Aquatic Methyl Parathion Incidents

No./ Date	Species	Effect/#	Crop	St	Residue Analyses: Item	Residue Analyses: Conc. (ppm)	ChE
					Toxaphene Haulover creek -Water	3.5 to 1040 ppb	None
					-Mussels	0.44 to 2.64 ppm	
					-Oyster flesh	0.44 ppm	

This fish and oyster kill took place in Leadenwah Creek (Wadmalaw Island) and Haulover Creek (Hwy 20) (both near Charleston,SC) over an extended period. Spraying took place on April 3, followed by rain on April4, and reported fish kills April 5; then spraying took place on April 12, followed by rain on April 13, and fishkills reported the same day. Because of the tidal nature of the creek, apparently there were situations in which carcasses were washed out to open water and, later, washed back. For these and other reasons it would be difficult to establish quantitative estimates of the numbers involved. All applications were aerial. The reported was issued by SC Wildlife and Marine Resources Dept.

No./ Date	Species	Effect/#	Crop	St	Item	Conc. (ppm)	ChE
16/ 11/11/73	Fish	200,000	Ag Area	TX	None	None	None

According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a very large fish kill in Texas on November 11, 1973. There were 200,000 fish killed but particulars about the event were not available. For the purposes of this report it is assumed that DDT, endrin, or methyl parathion may have been responsible.

No./ Date	Species	Effect/#	Crop	St	Item	Conc. (ppm)	ChE
17/ 8/17/74	Fish 90% Trout	500	Ag area	PA	Water	0.17 ppb	None

According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in Pennsylvania on August 17, 1974. Of the 500 fish killed. approximately 90% were trout. A factor in the fish kill was that there were heavy rains following the application of pesticide to a field adjacent to a pond. Parathion was found in a water sample taken below the pond, at a concentration of 0.17 ppb. There was no analysis of the ish flesh included in the report.

No./ Date	Species	Effect/#	Crop	St	Item	Conc. (ppm)	ChE
18/ 8/27/70	Mullet Perch Eel Shad	33,600	Soybeans	NC	None	Non	None

According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in North Carolina on August 27, 1970. While spraying a soybean field with methyl parathion, an aerial applicator overflew a drainage canal causing the death of a wide variety and great number of fish.

1328136

Aquatic Methyl Parathion Incidents							
No./ Date	Species	Effect/#	Crop	St	Residue Analyses		ChE
					Item	Conc. (ppm)	
19/ 8/12/74	Goldfish	450	Not Reported	NC	Methyl paration Grass and leaves surrounding the pond Toxaphene Grass and leaves surrounding the pond	 180 ppm 8.5 ppm	None
According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a fish kill in North Carolina on August 12, 1974. The victims were 450 goldfish, and toxaphene and methyl parathion were found in the grass and leaves near the fish pond.							
20/ 8/13/73	Fish	6400	Unknown	MO	Methyl parathion Endrin	25.0 ppb 2.3 ppb	None
According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a large fish kill in Missouri on August 13, 1973. The source of the contamination was unknown but, of four water samples, one contained 2.3 ppb endrin and 25.0 ppb methyl parathion.							
21/ 8/7/71	Non-game fish	15,000	Cranberries	MA	Methyl parathion -Fish and water Lindane -Fish and water	Detected Detected	None
According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a large fish kill in massachusetts on August 7, 1971. Cranberries nearby had been sprayed, and methyl parathion and lindane had been detected in both the water and the fish.							
22/ 8/5/71	Non-game fish	18,000	Not Reported	MA	None	None	None
According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a large fish kill Massachusetts on August 5. 1971. Methyl parathion had been sprayed upstream 2 days before the kill and was suspected to be the cause of the incident; however, the reported indicates that low dissolved oxygen may have contributed to the problem.							
23/ 8/12/74	Golden Shiner	1,000,000	Cotton	LA	Methyl parathion Toxaphene -Fish Endrin -Fish	None 6.91 ppm 0.74 ppm	None

1338136

Aquatic Methyl Parathion Incidents							
No./ Date	Species	Effect/#	Crop	St	Residue Analyses		ChE
					Item	Conc. (ppm)	
According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a large fish kill at a minnow farm in Louisiana on August 12, 1974. An adjacent cotton field had been sprayed with a mixture of endrin and methyl parathion. The aerial applicator would not admit using toxaphene but the fish samples contained 6.91 toxaphene and 0.74 ppm endrin.This was allegedly accidental misuse.							
24/ 9/12/74	Golden shiner	1,250,000	Cotton	LA	None	None	None
According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was a large fish kill in Louisiana on September 12, 1974. The report stated that 1,250, 000 golden were killed when there was a drift of methyl parathion into a minnow farm.							
25/ 8/4/73	Catfish Bream Trout	6,000	Known	GA	None	None	None
According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was fish kill in Georgia on August 4, 1973. Methyl parathion and endrin were thought to be the cause of the death.							
26/ 8/4/73	Fish 90% game, 10% other	8,900	Cotton	LA	None	None	None
According to "Summary of Reported DDT, Endrin, and Methyl Parathion Episodes Involing Fish from 1967 to February, 1975" there was fish kill in Louisiana on August 4, 1973. Aerial application of pesticides to adjacent cotton fields was the cause of the incident. The species of fish were not listed in the report but the breakdown was 90% game fish and 10% non-game.OPP EPA							

References:

(CDFG) California Department of Fish and Game
(DEDA) Delaware Department of Agriculture, Division of Consumer Protection
(ODWC) Oklahoma Department of Wildlife Conservation
(NYSDEC) New York State Department of Environmental Conservation
(USFWS) United States Fish and Wildlife Service
(USFWS-P) United States Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, Maryland
(VADGIF) Virginia Department of Game and Inland Fisheries

Terrestrial Methyl Parathion Incidents						
					Residue Analysis	
No./ Date	Species	Effect/#	Crop	St	Item	Conc. (ppm)
1/ 1967	Ring-necked Pheasant	decline of population	Alfalfa	NV	None	None

1348136

<table>
<tr><td colspan="7">In 1967 there was a noticeable decline in the pheasant population in west-central Nevada. The decline was so severe that it resulted in a closed hunting season in Nevada's major pheasant areas of Lyon county (Smith and Mason Valleys). A breeding population peak was reached in 1966 which was followed by a sharp decline in the 1967 to 1968 and a slight recovery in 1969. It is indicated that from 1966 to 1969 the most notable difference in the 1966 hunting season bag and the additional and concentrated emphasis upon spraying alfalfa fields, which in Nevada are primary pheasant nesting areas, with ethyl and methyl parathion.
Methyl parathion is used, through aerial application, for control of alfalfa pests and is generally applied between mid-May and mid-June. This correlates closely with the peak of the pheasant hatch in Nevada. Field and laboratory studies conducted in 1969 showed that the use of methyl parathion as a pesticide in alfalfa fields can result in substantial mortality (29%) of the 1-120 day old pheasants chicks under minimum exposure conditions (NDFG)MRID No.:44342001</td></tr>
<tr><td>2/
1982</td><td>Canada geese,
other geese,
ducks</td><td>2,050

37
100</td><td>winter wheat</td><td>TX</td><td>None</td><td>None</td></tr>
<tr><td colspan="7">In four incidents, 2110 wintering Canada geese (2,050 at playa lakes), 37 other geese and , in one incident, 100 ducks, were killed by parathion or parathion/methyl parathion ir were suspected to have been killed by parathion. Wintering bald eagles (<u>Haliaeetus leucocephalus</u>) have been observed feeding on geese thought to have been died from parathion poisoning. Two golden eagles (<u>Aquila chrysaetos</u>) were observed feeding on carcasses of geese killed in Swisher County. (Flickinger et al. 1991)(MRID No.: 44342002)</td></tr>
<tr><td rowspan="6">2/
5/15/90</td><td rowspan="6">Peregrine falcon (endangered species)</td><td rowspan="6">1</td><td rowspan="6">Unknown</td><td rowspan="6">VA</td><td rowspan="2">Methyl parathion</td><td>gizzard
0.072
ppm</td></tr>
<tr><td>crop
1.18
ppm</td></tr>
<tr><td rowspan="2">Dieldrin</td><td>gizzard
0.395</td></tr>
<tr><td>crop
0.355</td></tr>
<tr><td rowspan="2">Chlordane</td><td>crop and gizzard
0.038</td></tr>
<tr><td>intestine
0.032</td></tr>
<tr><td colspan="7">A sub-adult male peregrine falcon was found in a debilitated condition and died. A necropsy showed that the bird had a broken neck but the analysis of crop, gizzard, and intestine showed the presence of methyl parathion, dieldrin, and degradates of DDT and chlordane the probably contributed to its death.(VDGIF)</td></tr>
<tr><td rowspan="2">3/
7/11/90</td><td rowspan="2">Swallows</td><td rowspan="2">6</td><td rowspan="2">Barley</td><td rowspan="2">ND</td><td>Methyl parathion</td><td>0.043</td></tr>
<tr><td>Ethyl parathion</td><td>0.65</td></tr>
<tr><td colspan="7">Aerial application Clean Crop 6-3 (ethyl and methyl parathion) to barley went awry in that fog drifted towards a neighboring farmstead, killing swallows nesting over a doorway and possibly endangering the health of residents living there (strong odor/strange taste in mouth). Recorded temperature was 72 degrees F.

The commercial applicator was found liable to a finding of misdemeanor spraying 960 acres out of 1110 total for control of armyworms.

Product used was Clean-Crop 6-3 a flowable formulation applied a 0.75 to 1.0 lbs a.i./A. (NDDAPD)</td></tr>
<tr><td>1/
5-30-92</td><td>Praire chickens</td><td>3</td><td>Winter Wheat</td><td>MO</td><td>bird brain</td><td>N/A</td></tr>
</table>

1358136

The three dead praire chickens were found in connection with research on their habitats and movements. The radioed birds were in or near recently (may 22, 1992) treated winter wheat. The wheat was treated for armyworms with Paraspray 6-3 which contains a mixture of methyl and ethyl parathion.(NDDA)

References:
(NDDAPD) North Dakota Department of Agriculture, Pesticide Division
(NDFG) Nevada Department of Fish and Game
(VADGIF) Virginia Department of Game and Inland Fisheries

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