Endrin: Position Document 2/3

Special Pesticide Review Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

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ENDRIN

I. Introduction

Endrin belongs to the cyclodiene class of chlorinated hydrocarbon pesticides, and is classed as an insecticide/rodenticide. It is used mainly in the form of a concentrated solution which is mixed with water for application primarily to control insects on cotton and wheat and to control mice in orchards. Currently, approximately 400,000 pounds are used on less than 2 million acres per year. Endrin is the most acutely toxic of all of the chlorinated hydrocarbons. Because of endrin's acute toxicity, in 1978, the Agency classified it as a restricted use pesticide (43 FR 5782). As a restricted pesticide endrin is available only to certified applicators.

A. Background

1. The Statute

The Federal Insecticide, Fungicide, and Rodenticide Act, as amended ("FIFRA") (7 U.S.C. 136 et seq.) regulates all pesticide products. Section 12(a)(1)(A) of FIFRA requires all pesticide products to be registered by the Administrator before they may be sold or distributed. Before the Administrator may register a pesticide, however, he must determine that its use will not result in "unreasonable adverse effects on the environment," which is defined by 2(bb) of FIFRA to mean "any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide."

In other words, any decision concerning registration must take into account both the risks and the benefits from the use of the pesticide.

Section 6(b) of FIFRA authorizes the Administrator to issue a notice of intent to cancel the registration of a pesticide or to change its classification if it appears to him that the pesticide or its labeling "does not comply with the provisions of [FIFRA] or, when used in accordance with widespread and commonly recognized practice, generally causes unreasonable adverse effects on the environment." Thus the administrator must cancel the registration of a pesticide whenever he determines that it no longer satisfies the statutory standard for registration which requires among other things that the pesticide not cause "unreasonable adverse effects on the environment" (Section 3(c)(5). He may also cancel the registration of a pesticide if its labeling does not comply with the misbranding provisions of FIFRA which require the labeling to contain language "adequate to protect health and the environment" (FIFRA 2(q)).

2. <u>The "RPAR" Process</u>

The Agency has designed a process to gather risk and benefit information about a problem pesticide and to make a balanced decision concerning it in an open manner allowing maximum participation by all interested groups. This process is known as the Rebuttable Presumption Against Registration (RPAR) process; it is set out in 40 CFR Section 162.11.

In broad summary, these regulations describe the various criteria for determining that a risk exists, and provide that a RPAR shall arise if the Agency determines that any of these criteria have been met. Once the Agency issues such a rebuttable presumption, the regulations provide an opportunity for registrants, applicants, and interested persons to submit evidence to rebut the presumption. These persons may also submit evidence relating to the economic, social and environmental benefits of any use of the pesticide. If the presumptions of risk are not rebutted, the evidence on the benefits of the pesticide which is submitted to or gathered by the Agency is then evaluated and considered along with the information on the risks from the pesticide. The Agency then analyzes various methods of reducing the amount of risk from the pesticide together with their costs and determines whether it can regulate the pesticide in such a manner so as to strike the balance between risks and benefits. Striking the balance may necessitate cancelling certain uses of the pesticide.

3. Organization of This Position Document 2/3

This Position Document 2/3 contains six parts. Part I is this introductory section. Part II is an evaluation of the risks associated with endrin on which the RPAR action was based. It includes descriptions of relevant experiments and field observations, Agency responses to RPAR rebuttal comments, and the Agency's assessment of those

risks. Part III is a description of the process which the Agency employed to gather and to analyze information about the economic benefits associated with endrin, on a use-by-use basis. Part IV describes the range of regulatory options available to the Agency for the reduction of unreasonable risks, and explains the basis of the Agency's selection of alternative courses of action for each registered use of endrin. Part V is the Agency's evaluation of the risks and benefits associated with endrin on a use-by-use basis, including an evaluation of the risks associated with substitute chemicals for endrin, and the Agency's evaluation of each available regulatory option. The beneficial and adverse impacts for each alternative course of action are evaluated, and the rationale for the decision on each use is set forth. Finally, Part VI summarizes the regulatory action which the Agency proposes to take, in the aggregate, concerning the registrations of pesticide products containing endrin.

B. Chemical and Physical Characteristics, Registered Uses, Production, and Tolerances

1. Chemical and Physical Characteristics

Endrin (Hexachloroepoxy-octahydro-endo-endo-dimethanonaphthalene) belongs to the cyclodiene class of chlorinated chemical pesticides. Endrin is a stereoisomer of dieldrin. Much like its chemical relatives, it is a nonpolar compound, slightly soluble in water (230 ug/l at $25^{\circ}C$), highly soluble in lipids, and it is strongly adsorbed by organic particulate matter.

2. Registered Uses

Currently there are a total of 115 EPA-registered products containing endrin as the active ingredient. They are used primarily for the control of insects on cotton, small grain crops, sugarcane and ornamentals. In addition, endrin is registered for use as a ground spray to control orchard mice, as a perch treatment to control birds around buildings, and as a conifer seed treatment to repel mice. There are thirty-six applications for the federal registration of state-registered products. The state products are registered for a variety of similar and additional uses including vegetable and watermelon seed treatments, alfalfa and clover seed crops and tree paint.

3. Production

The Agency's estimates of the amounts of endrin used during the past three years on the three crops on which endrin is most often and most heavily used, differ substantially from what Velsicol, the major marketer of endrin, is able to establish from its records. Because the discrepancies between the two sets of figures are substantial, the Agency requested Velsicol to disclose its estimates of the amounts of endrin which were sold for use on these crops during the years 1975-1978. These amounts are in thousands of pounds of endrin as active ingredient (a.i.) (Ebner, 1978).

	1975	1976	1977	1978 (est.)
Cotton	1,200	355	360	280
Small grains	140	201	25	31
Orchards	61	90	64	81

All other uses of endrin combined probably amount to less than 10,000 lbs. endrin a.i.

4. Tolerances

In 1966, the FDA established tolerances of zero for residues of endrin in or on the following raw agricultural commodities: broccoli, brussels sprouts, cabbage, cauliflower, cottonseed, cucumbers, eggplant, peppers, potatoes, sugar beets, sugarbeet tops, summer squash, and tomatoes (31 FR 13210; 10-13-66). Current Agency policy requires that tolerances higher than zero be established for the pesticide residues which result from the use of the pesticide in or on current food and feed commodities. If, as a result of the RPAR process, EPA registers endrin for use on certain food and feed commodities, the Registration Division will establish the actual tolerances when the Agency has completed the RPAR review.

C. Regulatory History

The history of the federal regulation of the pesticide, endrin, is composed of a series of official notices of actions which the federal government has taken in its efforts to restrict the use of the pesticide, as well as the response to those actions by interested members of the public.

Endrin has been used as a pesticide in the United States since 1951. Serious concern over the impacts on the environment from endrin can be traced to the massive fish kills which occurred in the lower Mississippi River during the early 1960's. In 1969, the Report of the Secretary of Health, Education, and Welfare's Commission on Pesticides and Their Relationship to Environmental Health (Mrak, 1969) listed endrin among several pesticides which "are persistent and cause or can cause contamination of the environment and damage to various life forms within it." The Commission recommended that the use of these persistent pesticides be restricted "to specific essential uses which create no known hazard to human health or to the quality of the environment." (Recommendation 4, p. 9.) Before the formation of EPA, the USDA cancelled the use of endrin on alfalfa, eggplant, lettuce, peppers, tomatoes and strawberries in February 1968 (Pesticide and Registration Notice 68-6). EPA cancelled its use on corn, potatoes, sorghum and sugar beets in March 1971 (Pesticide Registration Notice 71-3).

Public comment on the risks and benefits of the use of endrin was solicited by the Agency in a March 18, 1971, Federal Register Notice. After completing an internal review, Agency scientists recommended that the Agency cancel the registration of endrin for use on all commodities except for the use on conifer seeds, use on small grains to control

pale western cutworms, the use of bird perches to control nuisance bird and the use in orchards to control orchard mice, because of the concerns these scientists had about the adverse effects of endrin on fish and wildlife.

On July 31, 1975, the Environmental Defense Fund and the National Audubon Society petitioned the Agency to suspend or cancel all uses of endrin. Velsicol Chemical Corporation responded to this petition on November 10, 1975. On April 30, 1976, the Environmental Defense Fund renewed its petition.

In 1975, EPA initiated an update of the ecological hazards of endrin. The Agency received reports that the deaths of brown pelicans in Louisiana were linked to the use of endrin. The Agency consulted with the Louisiana State University, the Louisiana State Wildlife and Fisheries Commission, and the Patuxent Wildlife Research Center concerning the deaths of the brown pelicans and obtained copies of autopsy and residue analyses.

In accordance with Section 7 of the Endangered Species Act of 1973 (50 CFR 402, 43 FR 870), the Agency requested formal consultation with the U.S. Fish and Wildlife Service (Dreer, October 17, 1977) regarding the potential threat of endrin to endangered species. Their response was received on June 8, 1978 (Greenwalt, 1978). The U.S. Fish and Wildlife Service has also supplied

the Agency with reports of recent tests which were conducted in collaboration with the U.S. Forest Service in order to evaluate the hazards of endrin-treated conifer seeds to birds.

On May 19, 1977, the Agency held public hearings under FIFRA Section 21(b) in New Paltz, New York and received verbal and/or written testimony from 37 witnesses representing 8 states regarding the use of endrin to control orchard mice (EPA, 1977). This hearing was preceded by field trips to inspect damage caused by pine voles in several orchards and to discuss the problem with growers. Immediately following this hearing, a group of state officials, extension workers and researchers met informally with representatives of the Agency to discuss possible ways of reducing the risks associated with the use of endrin to control orchard mice. Agency personnel have also participated in both the First and the Second Eastern Pine and Meadow Vole Symposia (Byers 1977, 1978). These opportunities to discuss the orchard mouse problem with a wide variety of knowledgeable and concerned people have been supplemented by many phone calls and a large amount of correspondence between the Agency and experts on the subject.

On May 26, 1977, the Agency held public hearings under 21(b) of FIFRA in Kansas City specifically for the purpose of soliciting suggestions and recommendations from users, state extension workers, and others on steps that

could be taken to reduce the risks associated with the use of endrin to control the pale western and army cutworms on wheat and other small grains. Testimony was received from 26 witnesses representing 4 states (EPA, 1978).

On December 8 and 9, 1977, Velsicol convened a panel consisting of experts on the aerial application of pesticides and on the use of endrin on cotton and wheat, to develop recommendations for reducing the risk associated with the application of endrin (Akesson, 1977). The Agency was invited to participate as observers in the proceedings.

II. Risk Analysis

The Agency presumed in endrin Position Document #1 that pesticide products containing endrin meet or exceed the following six criteria for risk which are delineated in 40 CFR 162.11: 1) oncogenicity, 2) fetotoxic and teratogenic effects, 3) fatalities to an endangered species, 4) significant population reductions in nontarget organisms, 5) acute toxicity to wildlife, and 6) acute hazards to humans and domestic animals through dermal exposure and published a notice of these findings in a Notice of Rebuttable Presumption Against Registration (41 FR 31316, July 27, 1976). In the notice, registrants and other concerned parties were advised of the opportunity to submit information or comments either in rebuttal of, or in support of, the presumption, as well as information concerning the benefits of endrin. The Agency has received submissions from 70 parties in response to the RPAR notice.

A. General Risks and Rebuttals

1. The Presumption Based on Acute Dermal Toxicity

a. Basis of the Presumption

While conducting the review of the literature on endrin, an Agency scientist discovered an unpublished dissertation which reported the existence of two formulations which exceeded the criterion for the risk of dermal toxicity

as stated in 40 CFR Sec. 162.11(a)(3)(i)(A). Because the existence of the formulations was reported in two unpublished reports, the Agency did not find it possible to identify the producer of the two formulations. The Agency therefore directed all registrants to certify whether or not their particular formulations met or exceeded this criterion for risk. Velsicol Chemical Corporation (Calo, 1976) and Rid-a-Bird Corporation (Bosch, 1976) submitted the only responses to this directive.

b. Rebuttals

(1) Velsicol's Rebuttal

Velsicol submitted test data for three (3) formulations: an emulsifiable concentrate (EC) containing 1.6 pounds of endrin per gallon, an EC containing 1.6 pounds each endrin and methyl parathion per gallon, and an EC containing 2.4 pounds endrin per gallon (Calo, 1976). The Agency evaluated the test results and determined that the test protocols met acceptable testing standards, and that the results indicated that all the formulations fell below the criteria for risk for both inhalation and dermal toxicity (Butler, 1977).

(2) Rid-A-Bird's Rebuttal

The data submitted by Rid-a-Bird on its 9.6% EC formulation were consistent with those which Velsicol submitted, and the Agency judged the results to be adequate evidence that this formulation did not exceed these criteria for risk (Burnam, 1977).

c. EPA's Response to the Rebuttals

The Agency has accepted the rebuttals by Velsicol and Rid-a-Bird. Since no other registrants submitted rebuttals, and since many formulations of endrin may contain toxic and/or inert ingredients which are not present in the formulations tested by Velsicol and Rid-a-Bird, the Agency will deny the applications of other registrants for the registration and reregistration of endrin products unless they can demonstrate that their formulations do not meet or exceed the criteria for risk of dermal toxicity.

2. The Presumption Based on Acute Toxicity to Wildlife

a. Basis of the Presumption

The Agency's presumption was based on theoretical calculations of the endrin residues that could be expected to occur on wheat (0.25 lb/acre) and on forage and seeds in orchards treated with a ground spray (1.2 lb/acre) to control meadow mice. The amounts of endrin residues which EPA scientists estimated would occur in orchards (290 ppm on short grass, 145 ppm on forage) greatly exceeded the LD_{50} (7 mg/kg) for rabbits that consume contaminated feed while residues on seeds approximated the LC_{50} for pheasants (14 ppm). Their estimate of the amount of endrin residues which they expected to find on wheat exceeded the amount that would produce an LD_{50} in rabbits (EPA, 1976).

b. Velsicol's Rebuttal

(1) Hazards from Cotton Use

Velsicol (1976) argued that the use of endrin probably poses little risk to rabbits, quail, and pheasants because quail would probably feed on the cotton plants only when the plants are young, before endrin is applied, and the dense upper foliage of mature plants would reduce the amounts that would be found at ground level where rabbits would feed. Velsicol stated that pheasants are not found in the regions of the United States where cotton is grown.

(2) Hazards from Small Grain Use

In reviewing its files on the residues of endrin which are found on small grains, Velsicol found that the highest residue after one day's treatment with 0.25 lb/acre (the maximum rate of use registered) was 13 ppm. Most values were lower. Velsicol calculated that if a rabbit ate about 20% of its body weight in fresh forage it would ingest 2.6 mg/kg/day, an amount well below the LD_{50} for rabbits.

(3) Hazards from Orchard Use

(a) Rabbits

Velsicol (1976) submitted data in which the actual residues of endrin (1.2 lb/acre) which had been sprayed in apple orchards were measured. Velsicol determined the mean of the reported residues as 131 ppm, a value of roughly

the same magnitude as the theoretical amount estimated by the Agency. In addition Velsicol cited a report by Treon in which the LD_{50} for rabbits was found to be 7 to 10 mg/kg and a report by Pimentel that gives the LD_{50} as 5 to 10 mg/kg. Velsicol assumed, therefore that the LD_{50} could be 8 mg/kg. It calculated that if a 2 kg rabbit ate nothing but treated grasses (60 g food per day) containing the mean residue of 131 ppm, it would ingest endrin at a rate of 3.94 mg/kg/day and thus consume the LD_{50} after 2 days. However, Velsicol stated that the rabbits' diet is unlikely to consist of only grasses and that endrin is rapidly metabolized and excreted. On the basis of these assumptions, Velsicol concluded that the rabbit would not ingest the total amount calculated and, because "sequential doses are not additive", it would be unlikely that concentrations of endrin in the tissues would approach the range of the LD_{50}.

(b) Quail and Pheasants

Velsicol noted that the subacute dietary LC_{50} value cited in the RPAR for quail and pheasants (14 ppm) was calculated for young birds and that the LC_{50} for mature birds would be much higher. Furthermore, Velsicol assumed that because endrin is not applied to orchards from late spring to early fall when these birds reproduce, it is likely that the birds actually exposed to endrin are mature birds. Velsicol further assumed that the diets of quail and pheasants would include other untreated foods.

c. EPA's Response to Velsicol's Rebuttal

(1) Hazards from Cotton Use

Velsicol states that "endrin is normally applied when the cotton plant is nearing maturity". However, endrin is used to control many insect pests on cotton, and many registrations specify early, mid-season, and later use. Cotton may be treated as many as 15 times over a 3-month period, and Velsicol's data indicates that residues on cotton foliage treated with 0.5 or 1.0 pounds of active ingredient per acre are 40 to 98 ppm and 100 to 160 ppm, respectively. By extrapolation, residues from the usual rate of treatment of 0.4 lb/acre would range from 30 to 80 ppm. Such residues exceed the LC_{50} for quail (14 ppm), therefore, the Agency cannot accept Velsicol's rebuttal.

(2) Hazards from Small Grain Use

Velsicol's analysis of the possible effects on rabbits appears to present a valid argument that the potential hazard to this species will be low. While some mortality of rabbits and other wildlife species has been observed in association with the use of endrin to control cutworms on wheat (Bushong, 1978a; McEwen, 1978), this observation alone does not satisfy the criterion for risk. Thus, the Agency concludes that Velsicol has adequately rebutted the presumption for this criterion of risk in so far as the Agency's concern in Position Document 1 focussed

on residues on the wheat plant. As is discussed below, the Agency has additional concerns in regard to the residues of endrin which occur on the insects inhabiting grain fields which wildlife might eat.

(3) Hazards from Orchard Use

(a) Rabbits

Velsicol's rebuttal is rejected because they used incorrect values and assumptions. Velsicol (1976) assumed that a 2 kg. rabbit would consume approximately 60 g of food per day but this value represents the amount of dry laboratory chow a rabbit would eat, not the amount of grass and forage. Velsicol also assumed that the rabbit would consume a high percentage of materials other than grass, but Velsicol failed to account for the fact that other materials which may be fed upon in the treated orchard would also be contaminated with endrin residues. Moreover, Velsicol's calculations focus on an application rate of 1.2 lb/acre (primarily in Washington State), whereas the normal application rate for pine voles in the Eastern U.S. is 2.4 lb/acre. Velsicol's contention that endrin is rapidly metabolized and excreted by animals and that, therefore, doses are not cumulative is not supported by the results of an Agency study in which the acute oral LD_{50} for endrin in hamsters was found to be 18 mg/kg, whereas that for multiple dosing was below 1.5 mg/kg (Chernoff, 1978).

(b) Quail and Pheasants

Velsicol's rebuttal is rejected because it presents no evidence to support its assumption that the LC_{50} of endrin for mature birds is substantially higher than that for young birds. Furthermore, although Velsicol states that the birds will eat foods other than treated grasses, they do not specify what foods these are, nor do they show why these foods from a treated orchard would not be similarly contaminated with endrin.

3. The Presumption Based on Significant Reduction of Nontarget Populations

a. Basis of the Presumption

The basis for the presumption against endrin for the reduction of nontarget populations was information on fish kills derived from the Pesticide Episode Reporting System (PERS) which implicated endrin in 52 fish and wildlife kills. Analyses of the residues of endrin which were found in 33 of these kills supported this body of data.

b. Velsicol's Rebuttal

Velsicol's rebuttal (1976) contended that the Agency's evaluation of PERS records dealing with fish were numercially inaccurate, the evidence was too sketchy, other toxicants were involved, and that whatever kills may be attributed to endrin were a result of misuse.

c. The Agency's Reply to the Rebuttal

Velsicol has responded to the Agency's concerns about reductions in the populations of non-target organisms which are a result of the use of endrin, by contending that the information contained in the PERS is inadequate, and by asserting that the Agency had substantially overstated the number of dead fish involved in the incidents reported.

The Agency is aware that the body of data in the PERS reports is incomplete. The body of data is sufficient, however, to indicate endrin's role in causing fish kills. The Agency does not allocate a significant amount of resources for monitoring the applications of pesticides in order to ascertain their potential impacts on fish and wildlife kills nor for the investigation of all of the reported incidents of fish or wildlife kills. Rather, the Agency relies on voluntary reporting by private parties to either state agencies or to the EPA concerning observed pesticide-related kills. Under such a system, only a nominal amount of the total number of incidents could be expected to be both observed and reported to either state or federal athorities. Moreover, even when incidents are reported, resources are not always available at either the state or federal level to measure the concentrations of the toxicants in water, or to determine the concentrations of

the residues of the pesticide in the dead fish. Finally, the PERS system does not include all of the incidents which are reported at the state level. A rebuttal comment acknowledged that in the State of Mississippi alone at least twenty endrin-related fish kills had occurred in five years. (Young, 1976); none of these incidents were included in the Agency's PERS files. In light of the acknowledged incomplete nature of the PERS system, even a few reports of substantial fish kills are of serious concern to the Agency.

Velsicol's rebuttal disputed the accuracy of the number of dead fish (31 million) which Position Document 1 attributed to endrin-related fish kills. The Agency is not as concerned with the overall body count of dead fish as it is with the water concentrations of endrin which are associated with the reported kills. Thus, while Velsicol is correct in its assertion that the total of 31 million dead fish reported in Position Document 1 was arithmetically inaccurate, the Agency's position that endrin causes signficant reductions in nontarget populations remains unrebutted. The Agency realistically can never expect to get an accurate count of the number of fish killed by any or all pesticides; body counts are often inaccurate, especially when they range into the millions. Other factors may also complicate these counts, such as dead fish not surfacing immediately, or fish dying over a period of several days or even weeks from a single pesticide episode.

The relevant focus for assessing the hazards to non-target organisms associated with the use of endrin is the occurrence of toxic and lethal concentrations of endrin in bodies of water where fish kills have been observed. In order to sustain the criterion for risk set forth in 40 CFR 162.11(a)(3)(ii)(C), the Agency need only establish a data base where concentrations of the pesticide in the water associated with fish kills exceed the toxic level for the sensitive species. To the extent that these concentrations result from practices of application which are typical, the Agency may then generalize to the broader picture of the pesticide's overall use in a given region, and can reasonably anticipate that the use will result in significant local or regional reductions in the populations of non-target organisms.

Velsicol also attempted to rebut the criterion of risk by contending that in several of the reported episodes, other pesticides were present in varying concentrations, and may have been a substantial contributing factor to the fatalities. Indeed, Velsicol attaches considerable significance to the fact that the concentrations of other materials may have been sufficient to cause mortality by their presence alone, so that it would not be possible to say with any certainty that endrin alone caused the resulting kill. Once again, Velsicol's emphasis has been misplaced. The presence

of lethal concentrations of endrin, which could have caused the reported kills, is a sufficient basis for the Agency's concerns about endrin; the presence of lethal concentrations of other pesticides does not mitigate that concern, but gives rise to similar concerns about the other chemicals. To argue that the presence of lethal concentrations of two pesticides tends to exonerate both rather than to condemn either is cynical at best.

The Agency has evidence that lethal concentrations of endrin in water have been associated with reported fish kills. For example, in the Lake Bartholomew Bayou area of Louisiana (Incident #1, Table 1) fish (9 samples) sampled for 21 days contained concentrations of endrin ranging from 42-445 ug/kg, which clearly demonstrates that they were exposed to endrin. Water (6 samples) sampled in the area for 19 days had concentrations of 0.1-2 ug/l. All of these water samples exceeded the 96-hour LC_{50}'s of 0.037 ug/l for pink shrimp (Penaeus duorarum) and 0.094 ug/l for striped bass (Morone saxatilis), and two exceeded the 96-hour LC_{50} for bluegill (Lepomis macrochirus) of 0.6 ug/l. These concentrations may also be toxic to many other indigenous species for which a body of toxicity data is not available. The fish kills in the Lake Bartholomew Bayou area, which are reported to exceed 7 million fish, occurred during and following rainfall totalling 7.64 inches over a one-month period on the cotton field watershed of the area.

TABLE 1 ENDRIN RELATED FISH KILLS WHERE WATER CONCENTRATIONS EXCEEDED LETHAL LEVELS

Incident number	Estimated # fish killed	Date	Location	Type of incident	Endrin in water (µg/l)	Endrin in fish (µg/kg)	Data source
No. 1	Greater than 7,000,000	9/1/74 9/21/74	Lake Bartholomew Bayou area, Ouachita-Morehouse Parrish line, Louisiana	Cottonfield watershed runoff from 7.64 inches rain 9/5/74-9/15/74	Bartholomew Bayou 9/5/74		PERS # A0084
					0.2	147	
					Adjacent ditch 9/13/74		
					2.0	277	
					La Fouche Canal 9/1/74		Louisiana Wildlife and Fisheries Commission Report on Fish Kills, NE LA, Fall 1974, by L.R.C. Johnson
					0.6	299	
					Sandy Bayou 9/16/74		
					———	445	
					Joe Bayou 9/17/74		
					0.5	351	
					Beouf River 9/17/74	353	
					———	336	
					Bayou Barthol. Cutoff 9/19/74		
					0.1	———	
					Tensas River 9/19/74		
					0.2	———	
					9/21/74	42	
					———		
					Little Lake La Fouche 9/19/74	49	
					———		
No. 2	Greater than 48,000 of 20 species	7/24/75	Donnegan Slough, Colbert Co., Alabama	Cottonfield watershed runoff from more than 8 inch rain over 20 days	Eight samples less than 0.1-2.7	———	PERS # 00245

TABLE 1 (Continued)

No. 3	Largemouth bass 368 Bluegill 7500 White crappie 350 Channel catfish 900 Yellow bullhead 150 Drum 380 Carp 18 Blacktail redhourse 600 Spotted gar 2 Gizzard shad 3312	9/12/74	Slough of Black Warrior River, Old Lock #7, Hale Co., Alabama	Cottonfield watershed 1 mile from field	0.22 Upstream: less than 0.01 Midslough: 3.73 Rearslough: 3.36	——	PERS #00243
No. 4	Yellow bullhead 25 Channel catfish 450 Gizzard shad 550 Minnows 1869 Bream 1147 Suckers 150 Largemouth bass 25	9/15/74	Mulberry Fork, Black Warrior River, Cullman Co., Alabama	Cottonfield watershed runoff from daily showers for 1 week	0.18 and 0.224	——	PERS # A0237

TABLE 1 (Continued)

Incident #	Estimated # Fish killed	Date	Location	Type of Incident	Endrin in Water (µg/l)	Endrin in Fish (µg/kg)	Data Source
No. 5	31 Largemouth bass Bluegill Crappie Channel catfish Suckers	9/3/74	North River, Tuscaloosa Co., Alabama	Cottonfield watershed runoff	0.06 and 0.37	—	PERS #A0244
No. 6	Not given	8/72	Morgan Co., Alabama	Cottonfield watershed runoff	0.24	—	PERS #93016
No. 7	Largemouth bass Bluegill 17 other fish species with total of 858 killed	8/17/74	McKernan Creek, Colbert Co., Alabama	Cottonfield watershed runoff	0.74	90 in Carp	PERS # A0293
No. 8	Largemouth bass 6 Bluegill 506 Yellow bass 198 White crappie 88 Blue catfish 88 Drum 6204 Skipjack 110 Spotted redhorse 44 Smallmouth buffalo 22 Carp 88 Threadfin shad 10472 Minnows 2046	8/9/74	Limestone Creek, Limestone Co., Alabama	Cottonfield watershed runoff	0.3	6 in Buffalofish 150 in Carp 8 in Bluefin 40 in Blue catfish	PERS # A0240
No. 9	47 includes Largemouth bass Bluegill Yellow bullhead Carp Suckers Minnows	8/20/74	Big German Creek, Hale Co. Alabama	Cottonfield watershed runoff	Trace-0.168 in 3 samples	210 in Carp	PERS #A0242

TABLE I (Continued)

No. 10	30,000	8/3/74	Alabama	Stream adjacent to cottonfield watershed with frequent rain during week of kill; 10 miles of stream observed affected	Two samples 0.22	—	PIMS Summary
No. 11	70,000	8/20/74	Alabama	Runoff from cottonfield into stream	Two samples 0.022 and 0.65	Catfish 110	PIMS Summary

TABLE I (Continued)

Incident number	Estimated # fish killed	Date	Location	Type of Incident	Endrin in water (µg/l)	Endrin in fish (µg/kg)	Source of Data
No. 12	Unknown No. Bluegill Carp Golden shiner Goldfish Hogchoker White sucker Channel catfish Bullhead	11/21/70-3/2071 (minimum)	North Carolina, Haywood Co.,	Apple orchard watershed in Lake Junaluska area, received "heavy rain" 11/20/70	Racoon Creek 11/21/70 0.12 Richland Creek 11/21/70 0.45 11/22/70 0.85 12/3/70 0.5 12/15/70 0.16-0.45 Lake Junaluska 12/23/70 0.39-0.7 (20-666 µg/kg in mud 12/15/70)	12/15/70 Kidney 1,100 Liver 3,300 Flesh 1,162	Water Quality Division, Dept. of Water and Air Resources, Raleigh, N.C.
No. 13	9,300	12/71	Pennsylvania	Tributary draining orchard watershed into river where fish died	550	—	PIMS Summary

The occurrence of the heavy rainall following the application of endrin, and the resultant concentrations of endrin in water together with the observed fish kills, leads the Agency to reasonably conclude that run-off from the treated cotton fields was the source of the contamination by endrin.

Incident Number 2 (Table 1) in Donnegan Slough, Alabama followed 8 inches of rain over a 20 day period in an area where endrin had been applied to cotton. The concentrations of endrin in 8 samples of water ranged from less than 0.1 to 2.7 ug/l. The higher concentrations exceed the LC_{50} values for the above species and it was estimated that 48,300 fish of 20 species died. Again, the Agency has concluded that the kills and the associated concentration of endrin in water were the result of run-off from treated cotton fields.

Incident Number 3 (Table 1) occurred in a slough of the Black Warrior River, Alabama, which was one mile from a cotton field where endrin had been applied. The concentrations of endrin in water ranged up to 3.73 ug/l, which is far in excess of the LC_{50} of the above aquatic species, and dead fish of at least 10 species were estimated to number in the thousands. Further, incident Number 4 (Table 1) in a fork of the Black Warrior River, Alabama was associated with run-off from cotton fields treated with endrin following daily rainfall for one week. Concentrations of endrin in water were reported as 0.18 and 0.224 ug/l which exceeds the LC_{50} values for shrimp and striped bass.

In addition to the above incidents, seven other incidents (Incident nubmers 5-11, Table 2) were associated with run-off of endrin from cotton fields where concentrations of endrin in the water exceeded LC_{50} values for aquatic organisms. Maximum concentrations of endrin in ug/l reported in water were 0.168, 0.22, 0.24, 0.3, 0.37, 0.65 and 0.74, all of which exceeded the LC_{50} for some aquatic species.

Velsicol contends that the PERS-reported kills "apparently arose from aerial spraying" and that "overspray and wind drift were apparently the major causes of the aerial problems"; its expert, Mr. Odom, acknowledges in a footnote that "run-off may have been a contributing factor." Although the Agency agrees that drift and overspray are potential sources of endrin contamination, the Agency's analysis of the available data leads it to conclude that run-off is a major factor--not merely a "contributing factor" -- in contamination of water at concentrations lethal to aquatic life.

This interpretation of the available data is further supported by models of run-off potential for endrin. The EPA Environmental Research Laboratory, Athens, Georgia (Bailey 1975) has modeled or simulated run-off of endrin on a Piedmont watershed under a number of different expected rainfall conditions. For example, at the lowest assumed rainfall rate of 1.44 inches per hour occurring once in a

year, and assuming a single application of endrin to cotton of 0.7 lbs/A, run-off was predicted to contain endrin in amounts of 30 ug/l (far in excess of LC_{50} values for aquatic organisms even after many-fold dilution). An additional 0.02 lb/A of endrin was predicted to be carried off on sediment for a total loss to waterways of 3.77% of the endrin applied. Although the application was made at a rate in excess of the rate specified on the label, the Agency believes that the model provides a sound basis for its conclusion concerning the high run-off potential of endrin.

Additional support for the conclusion that concentrations of endrin lethal to aquatic organisms are likely to occur from run-off may be found in a study of experimental sugarcane plots. Run-off was measured for endrin (formulated as 2% active ingredient on 40/60 mesh montmorillonite granules) after application to the surface of experimental plots of sugarcane in Louisiana at a rate of 0.337 kg a.i./hectare. There were 14 run-off events during 10 months following application with amounts of rainfall varying from 0.53 to 11.43 cm. per rainfall. Runoff waters had maximum endrin concentrations ranging from 0.12-2.73 ug/l following a single application and concentrations in run-off as great as 1.12 ug/l occurred as long as two months after

application. A separate part of the study involved four run-off events in one month (rainfall was 3.15-9.32 cm) and showed maximum concentrations of endrin per run-off to be 2.88-5.02 ug/l. Concentrations as great as 4.09 ug/l occurred as long as one month after application (Willis and Hamilton, 1973).

Because of land configurations and precipitation patterns, the area where endrin is applied to cotton exists among the areas with the highest direct run-off potential in the United States (Stewart, 1975). Many of the reported fish kills detailed above occurred after period of rainfall, and heavy rainfall may be expected to occur throughout the season when endrin is applied to cotton. The Agency concludes that, wholly apart from drift considerations, the use of endrin on cotton can reasonably be anticipated to result in concentrations of endrin in water that exceed the LC_{50} of aquatic organisms and can reasonably be anticipated to result in significant local or regional reductions in the populations of non-target organisms.

Velsicol contends that fish kills which are the result of the run-off of endrin from treated fields must be characterized as the result of pesticide misuse, since Velsicol's endrin lables include the prohibition: "Do not apply where run-off is likely to occur." The Agency concludes that the typical application of endrin for use on cotton cannot be

made in accordance with the directions on the label because the run-off of endrin from cotton fields always is likely to occur under the geographic and climatic conditions of current usage. Moreover, since the run-off has been demonstrated to result in concentrations of endrin in water which are lethal to aquatic organisms, the Agency concludes that application of endrin to cotton in accordance with widespread and commonly recognized practice can reasonably be anticipated to result in significant local or regional reductions in the populations of non-target organisms.

The Agency also has evidence that lethal concentrations of endrin associated with fish kills occurred as the result of run-off from apple orchards treated with endrin to control voles. Several such incidents are summarized in Table 3. With respect to the Lake Junaluska incident, the North Carolina Department of Water and Air Resources (1971) concluded that:

> "the Lake Junaluska Fish Kill, which was reported on November 21, 1970, was caused by a chlorinated hydrocarbon insecticide known as Endrin. Endrin, used for rodent control by some of the apple growers in the Lake Junaluska drainage basin just a few days before the kill, was washed into Richland Creek by a heavy rain early on the morning of November 20, 1970. The

Endrin entering Lake Junaluska from Richland Creek was reponsible for the initial and continued fish mortalities that occurred from November 21, 1970, to the latter part of March 1971."

That incident resulted in lethal concentrations of endrin in the orchard drainage waters for a period of at least 33 days, and fish kills continued to be reported over an even longer period.

The Agency therefore concludes that the use of endrin on apple orchards also has the potential for causing significant local or regional reductions in the populations of non-target organisms. However, because of significant variations in rainfall patterns and terrain among the apple growing regions where endrin is used, the Agency is not presently able to make any generalizations concerning reductions in the populations of non-target organisms resulting from use of endrin on apple orchards.

4. Presumption Based on Fatality to Endangered Species

a. Basis of the Presumption

The brown pelican is classified as an endangered species by the Office of Endangered Species, U.S. Fish and Wildlife Service (FWS). For several years, the State of Louisiana has been attempting to re-establish the species in that state by transplanting pelicans from Florida to Barataria Bay, Louisiana. In 1975, scientists observed a substantial

decrease in the new population and found several dead brown pelicans. The Feed and Fertilizer Laboratory at Louisiana State University and the Patuxent Wildlife Research Center conducted analyses for residues of endrin; both identified endrin in the brains of these pelicans in concentrations ranging from 0.18 ppm to 0.70 ppm. Because the range of the concentrations of endrin found in the brains of these pelicans overlapped the range which the Patuxent Wildlife Research Center found to be lethal in small numbers of a variety of other birds which they tested, the Agency concluded that contamination by endrin was the major cause of the decline in the population of the brown pelican.

b. Velsicol's Rebuttal

In its rebuttal, Velsicol characterized the incident as "small, isolated, and one-time." It argued that the analyses had not directly established the concentration of endrin which is lethal in brown pelicans, and that the Patuxent data on residues was gathered from too small a number of birds to be a reliable basis for prediction. Velsicol further argued that the brown pelican mortality was associated with environmental factors such as the presence of parasites in the birds, and muddy water, which would have impaired their fishing ability. Velsicol says that these factors pointed to causes other than poisoning by endrin for the deaths of the pelicans.

c. EPA's Reply to the Rebuttal

With respect to Velsicol's contention that the incident was "small, isolated and one-time," the Agency (Markley 1977) determined that this characterization was both inaccurate and irrelevant, for several reasons. First, although some media accounts of total brown pelican mortality were exaggerated due to conflicting reports, a substantial loss did occur, and was not necessarily limited to the actual numbers of birds found dead. Moreover, any contention that the mortality was "isolated" or a "one-time" event is pure speculation. The odds of finding a dead pelican in the wild are remote and, simply because no major mortality has been observed since 1975, these are no grounds to conclude that no other deaths have occurred and that there is no potential for further death.

Velsicol is correct in its contention that the lethal concentration of endrin in the brains of brown pelicans has not been established. However, as with humans, it is necessary to extrapolate the probable risks from a pesticide from the effects which are observed on less valuable species. When the RPAR Notice was issued, the

only available experimental evidence concerning lethal concentrations of residues of endrin had been derived primarily from a small study of secondary poisoning in raptors conducted at the Patuxent Wildlife Research Center (PWRC). The raptors were fed mice which had been treated with endrin. Since rats metabolize endrin into a more toxic product, 12-ketoendrin (Bedford, 1975), it is probable that the mice which the raptors ate contained the metabolite. To the extent that 12-ketoendrin was present, it could have caused the amount of endrin in the brains of the raptors at the time of death to be lower than it would have been from exposure to endrin alone. The raptors were not analyzed for 12-ketoendrin. Thus, the standard which the Agency employed to assess lethal brain concentration was probably faulty.

Velsicol correctly contends that the death of the brown pelicans in Louisiana was associated both with the presence of parasites and with muddy water. However, it also contends that the presence of little or no stored fat in the bodies of two autopsied pelicans, the fact that their stomachs were empty, and the presence of parasites all support the conclusion that "there is considerable evidence that the deaths were caused by environmental stress or other factors not related to endrin" (Velsicol, 1976). The Agency rejects any conclusion that evidence of environmental

stress is sufficient to exonerate the potential role of a pesticide in the cause of death. In the laboratory, birds killed by cyclodienes die with very low lipid reserves, so that one cannot conclude that the absence of fat in a bird found dead in the wild was caused by starvation or parasitemia independent of pesticide residues. Moreover, the accumulation of lipid reserves by birds presumably is an adaptation to counteract the effect of various environmental stresses. If depletion of these reserves occurs as a consequence of normal stresses, an increase in the amounts of pesticides in the brain is to be expected (Barbehenn, 1976). If these levels reach toxic concentrations, it begs the question to argue that the bird would not have died from pesticides had it not been for the stresses.

However, the Agency has revised its original position on the role of endrin in the death of the brown pelicans based on the pesticide residues in the white pelicans which were found dead near Tulelake, California. The concentrations of endrin in the brains of the 9 white pelicans that probably died from pesticide poisoning in 1975 ranged from 1.3 ppm to 2.7 ppm (PD#1, App. MM). Three of four pelicans which were analyzed after their deaths in 1976 (Stickel, 1976) showed concentrations of endrin ranging from 0.74 ppm to 1.2 ppm. The fact that this range of concentrations of endrin (0.74 ppm to 2.7 ppm) exceeds that found in

the brown pelicans (0.18 ppm to 0.70 ppm) forms the major basis for the revised conclusion that the concentrations of endrin found in the brown pelicans were not sufficient to have killed the pelicans (Markley, 1977). The Agency concludes that the risk to endangered species has been rebutted for the brown pelican.

The Agency also received a very lengthy and detailed rebuttal from Dr. Gordon Edwards (1976). Dr. Edwards' relevant points have been adequately addressed in the Agencys response to Velsicol's rebuttal on fatality to the brown pelican.

After the RPAR notice, the PWRC analyzed a bald eagle (PR 1164 from Wisconsin) that contained 0.61 ppm endrin in the brain (Stickel, 1976). Following this lead, the Agency requested that six additional eagles be analyzed specifically for endrin. These individual eagles were selected because they had symptoms of pesticide poisoning but the original analysis which the PWRC had performed had not revealed levels of pesticides adequate to have been the cause of death. This analysis had not included endrin. Of the six birds, one (PR 730 from Minnesota) was found to have 2.1 ppm dieldrin in the carcass and 1.5 ppm in the brain, plus 1.1 ppm endrin in the carcass (Reichel, 1977). From a knowledge of the relationship between the concentrations of endrin residue in the lipids of the carcass and

those in the brain, the concentrations of endrin in the brain (which was not available for reanalysis) were estimated to be 0.8 ppm (Barbehenn, 1977).

The PWRC now has the results of a large study based on tests with several kinds of birds. The study indicates that death is almost always indicated by a level of 0.8 ppm or more endrin in the brain and that birds usually survive at 0.6 ppm or less in the brain (Coppage, 1978). Thus, it appears that the two bald eagles discussed above span the grey area of uncertainty regarding the probable role of endrin as the primary cause of death. The Agency concludes that a substantial risk to individual bald eagles has been established. As indicated in the hearings in Kansas City (EPA, 1977c), these two eagles most likely acquired the residues of endrin from their wintering grounds, where endrin is used on wheat.

In accordance with regulations implementing Section 7 of the Endangered Species Act of 1973 (43 FR 870, January 4, 1978), the Agency requested formal consultation with the U.S. Fish and Wildlife Service (FWS) in regard to the potential impact of the use of endrin on Endangered or Threatened species (Dreer, Oct. 17, 1977). On June 8, 1978, the FWS submitted its biological opinion on the subject

(Greenwalt 1978). The endangered species considered most likely to be exposed to endrin included six birds, 11 fish and 23 mussels. The Conclusion and Recommendation of the FWS was: "Based on my consultation team's review of the above information and other information and data available to the Service, it is my biological opinion, subject to the conditions identified herein, that the use of pesticide products containing endrin under present use restrictions is not likely to jeopardize the continued existence of the listed species considered herein or result in destruction or adverse modification of their Critical Habitats. However, since there is a potential that listed species could be directly exposed to toxic amounts of endrin, I reiterate the need for EPA to reinitiate Section 7 Consultation prior to final actions including new label restrictions."

In compliance with this finding and request, therefore, the Agency is submitting a copy of Position Document 2/3 to the FWS so that it can determine whether the proposed regulatory actions on endrin adequately address the FWS's requirements.

5. The Presumption Based on Oncogenic Effects

a. Basis of the Presumption

The Agency's original conclusion that endrin induces oncogenic effects in test animals was based on reanalyses of two unpublished studies: a Food and Drug Administration (FDA) study on the rat and a study on two strains of mice by the Kettering Laboratory. Five other

studies bearing on the issue were considered to be either inconclusive as definitely positive or negative studies in light of design deficiencies (Albert, 1976). Histological results from the FDA rat study were reexamined by an EPA consultant, Dr. Melvin Reuber. His tabulations of hyperplastic nodules, carcinomas and sarcomas in the livers of both sexes as well as malignant tumors at all sites, indicated a statistically significant increase over the controls, especially at the lower doses. In the Kettering mouse study, a statistically significant increase in hepatomas was found for females only in one of the two strains tested.

b. Velsicol's Rebuttal

Velsicol (1976) reiterated the conclusions originally drawn by FDA in their study of the oncogenic effects of endrin in rats. Those conclusions were (1) that the data did not show a dose-response relationship, (2) that the tumors found were not site-specific, (3) that the animals did not exhibit the characteristic liver involvement caused by chlorinated hydrocarbons, and (4) that the liver weights of the test animals did not increase.

In addition, Velsicol attacked Dr. Reuber's re-evaluation and diagnoses of the slides from that study on three principal grounds: (1) that Reuber did not record the diagnoses, slide by slide, thus preventing independent confirmation of his diagnoses, (2) that there was a disparity

between the numbers of tumors in the controls which he reported and the number which the FDA reported in the original study; and (3) that it was not clear whether he reported the total number of tumors or the number of animals with tumors. With respect to the Kettering mouse study, Velsicol contended that the excess incidence of hepatomas in the C302F1-J mice was insignificant because the lesions in the treated females occurred later than in the controls.

c. EPA's Response to Velsicol's Rebuttal

The Carcinogen Assessment Group (CAG) rejected Velsicol's rebuttal (Albert, 1977) by indicating that the criteria used by Velsicol in evaluating the FDA study, such as dose-related increases in tumor induction and site specificity, are not now considered to be essential elements for assessing carcinogens, although they are common characteristics of carcinogens. In the case of the Kettering study, the CAG indicated that the response was dose related and that the time-to-tumor relationship could not be fully evaluated with the information at hand.

Dr. Reuber examined the FDA material in detail, and his tabular presentation of the incidence of tumors by treatment group was considered ample grounds for initiating an assessment of endrin's oncogenic potential in humans (Albert, 1976) However, because there were differences between Dr. Reuber's interpretations of the lesions and those which the FDA reported in the original study, CAG

submitted the material to Dr. Frith of National Center for Toxicological Research (NCTR) for another review of the slides. For female rats, Dr. Frith reported 88% of the total number of tumors (all sites, benign and malignant) which Dr. Reuber had reported. However, the number reported as malignant by Dr. Reuber was twice the number which Dr. Frith reported. In the male controls, Dr. Frith reported two with tumors; Dr. Reuber reported none. In males treated with 1 ppm, 5 ppm or 25 ppm, the findings of the two scientists agreed. For those treated with 0.1 or 10 ppm, Dr. Frith reported one-third of the total number of tumors in 40 rats which Dr. Reuber had reported in 36 rats, and only one-half of the number of malignant tumors. Dr. Frith reported no significant increase in the incidence of tumors in male or female rats which were exposed to endrin.

In an effort to resolve the differences between Dr. Reuber's and Dr. Frith's reports, CAG set up a review at the FDA of the liver slides for male and female rats treated with 0.1 ppm and for males treated with 10 ppm. The review was conducted by Dr. Frith and Dr. Dubin (CAG). It was found in the slide review that there were 5 cancers involving the liver, as reported by Dr. Reuber, but only 1 was a primary cancer of the liver, the other 4 being metastatic. Later, Dr. Dubin independently reviewed the liver sections of the following groups in the FDA study: controls (both sexes), 0.1 ppm (both sexes) and 10 ppm (males). Dr. Dubin's findings substantiated both Dr. Frith's findings and those findings originally reported in the FDA study.

Dr. Reuber's original diagnosis of the FDA slides provided the major basis for the Agency's issuance of an RPAR based on oncogenic effects in laboratory animals. Dr. Reuber did not submit a slide-by-slide diagnosis and declined to participate in the group review of slides. The group review did not confirm Dr. Reuber's findings. Consequently, the weight of the evidence with respect to the oncogenicity of endrin has shifted since the RPAR was issued. The CAG having reviewed four bioassays on rats and three on mice, has concluded that the weight of the evidence therefore, is that endrin is "unlikely to be a human carcinogen" (Albert, 1978).

6. The Presumption Based on Fetotoxic and Teratogenic Effects

a. Basis of the Presumption

The Agency presumed against endrin on the basis of a study by Ottolenghi et al. (1974) in which hamsters were given a single dose of endrin (5 mg/kg), on either day 7, 8, or 9 of gestation and mice were given 2.5 mg/kg on a comparable regimen. In the hamster, defects such as open eye, web foot, and cleft palate tended to be associated with each other. The first two defects were associated with low fetal weight. Fused ribs, however, occurred independently and were indicative of a teratogenic effect. In the mouse there was a statistically significant increase in open eye and total abnormalities. Since no other dosages had been

used in the study and the Agency could not determine what risks to humans might occur from exposure to endrin, the Agency directed registrants to conduct studies to identify the no-observed-effect level.

b. Velsicol's Rebuttal

Velsicol's rebuttal contended that the Ottolenghi study did not comply with EPA's criterion for teratological studies--specifically, that three dosages must be utilized in order to establish a no-effect level. In the Ottolenghi study, two species were each given one massive dose. Velsicol illustrated the "exaggeration" of extrapolating risk from a single massive dose by asking Mr. Reo Duggan to compare the dose with the "average daily intake of endrin." Mr. Duggan's calculations illustrate that the dose rates used in the Ottolenghi study were from 12,500 to 25,000 times higher than the Food and Agriculture Organization/ World Health Organization Acceptable Daily Intake (ADI) and from 250,000 to 500,000 times higher than the highest average daily dietary intake found in FDA's Total Diet Studies.

Additionally, Velsicol cited testimony by Dr. Ernest Thorpe who characterized the study as "unconventional," pointing out that the vehicle, corn oil, alone caused adverse effects on the hamster fetuses, thus casting uncertainty on the contribution of the corn oil to the experimental results with the pesticides.

After consulting with the Agency, Velsicol commissioned the International Research and Development Corporation (IRDC) to conduct teratological studies in the rat and the hamster. The IRDC study (1978) tested the effects of administering endrin by gavage daily during organogenesis to hamsters (days 4-13) and rats (days 6-15). Rats were sacrificied on day 20 and hamsters on day 14 of gestation. Vitamin A was used as a positive control. The endrin was administered as a suspension in 0.5% Methocel.

A preliminary range finding study in pregnant hamsters was interpreted by the investigators as indicating a 10% reduction in weight gain during gestation in the high dose group (2.0 mg/kg/day) as compared to controls. In the definitive study, doses of 0.1, 0.75, and 2.5 mg/kg/day failed to induce any statistically significant effects on the dams or the fetuses.

In the rat, a similar range finding study was interpreted by the authors as indicating that behavioral toxicity (increased irritability, salivation, and tremors) occurred in the 1.0 and 2.0 mg/kg/day dose groups. Animals in the 2.0 mg/kg/day group were reported to have a reduced weight gain when compared to controls. With the exception of one female in the high dose group, no maternal behavioral effects were noted in the definitive study although a

reduction in maternal body weight gain occurred at the high dose level (2.0 mg/kg/day). With the exception of reduced fetal weight at the high dose level, there were no fetal effects attributable to endrin.

c. EPA's Reply to the Rebuttal

Since Velsicol used a test protocol that followed EPA's proposed Guidelines for teratology testing in which they gave daily doses to the animals throughout the critical period of organogenesis rather than the single dose which Ottolenghi used, the Agency conducted a study of teratogenesis in hamsters using tests based on each of the Ottolenghi and IRDC protocols (Chernoff, 1978). The original rationale for this approach was that the treatment of an animal before the critical period could induce the production of enzymes or other physiological changes that could alter the effect of subsequent treatment (Barbehenn, 1977). The Agency's studies produced results which are at variance with both those of Ottolenghi et al and the IRDC studies and which lead the Agency to conclude that endrin is teratogenic in the hamster.

Chernoff administered endrin to pregnant hamsters by gastric intubation. Initially he used dosages chosen to duplicate those used in the Ottolenghi study or to bracket the highest dose used in the IRDC study. However, he found, in the first case, no evidence of retarded fetal growth and,

in the second, a high incidence of maternal death. Therefore, he repeated the studies using single oral doses of 0, 0.5, 1.5, 5.0, 7.5 or 10.0 mg/kg administered on day 8 of pregnancy for the acute study and dosages of 0, 0.75, 1.5, 2.5 or 3.5 mg/kg/day administered on days 5 through 14 for the multiple dose study.

In addition, he treated a second group of females with single oral doses of 10, 13.3, 16.7 or 20.0 mg/kg, and determined the acute LD_{50}. He treated a third group with endrin (0, 0.75 or 1.5 mg/kg) during days 5 through 14, and observed the effects of treatment on rearing behavior and ambulation 4 hours after the last treatment. On day 38, postpartum he retested the mothers and observed open field behavior and exploratory activity in 20 and 70-day old pups, respectively.

When Chernoff administered single doses of endrin on day 8 of gestation, the numbers of maternal deaths, the pregnancy rate, the maternal weights during pregnancy, the ratios of liver and body weights, the numbers of fetal deaths, fetal weights, and the maternal behavior were not statistically different from the controls. In the absence of any overt embryolethal or maternotoxic effects, a single dose of endrin administered on day 8 produced meningoencephaloceles at doses above 1.5 mg/kg and fused ribs at

doses above 5.0 mg/kg. The effective dose for the production of fused ribs was higher in the Chernoff study in comparison to that of the Ottolenghi study. This is consistent with a higher LD_{50} in the Chernoff study (18 mg/kg was opposed to 10 mg/kg in the Ottolenghi study).

The administration of multiple doses of endrin produced significant maternal lethality at doses of 1.5 mg/kg/day or greater. With increasing doses of endrin, there was a dose-related increase in fetal mortality ($p<0.05$) and decrease in fetal weight ($p<0.001$). Two of twenty litters in the 1.5 mg/kg/day multiple dose groups had a total of 4 fetuses with meningoencephaloceles suggesting that this effect is producible in this regimen at a lower dose than in the acute study. The relationship between maternal lethality and the production of this defect is unknown at this time. The reason for the difference in teratogenic effects between single and multiple dosing has not been established.

A low incidence of fused ribs was noted in the low and high dose hamster groups of the IRDC study. Although the results are not statistically significant, they are suggestive of a dose related effect since they are consistent with both the Ottolenghi and Chernoff studies. The IRDC study has failed to evaluate the potential of endrin to induce teratogenic effects in hamsters since it did not

include a dose level high enough to elicit either maternal or fetal toxicity, i.e. the dose-response curve is incomplete. Finally, Velsicol's contention that corn oil is an inappropriate vehicle, as demonstrated by Ottolenghi's results, is invalid. In order to conclude that corn oil, per se, can produce adverse fetal effects, it would be necessary to compare corn oil treated hamsters, with sham treated hamsters. As Chernoff indicated, Ottolenghi's control hamsters were not sham treated, making that part of the study invalid.

Since the Agency now has the results of additional studies, Velsicol's rebuttal regarding the impropriety of extrapolating risk from a single, massive dose is irrelevant. The no-observed-effect level in hamsters was established by Chernoff to be 1.5 mg/kg for a single exposure during organogenesis and teratogenic effects were observed in the absence of maternal and fetotoxic effects. Whether or not an adverse chronic effect (other than oncogenicity or mutagenicity) observed in laboratory animals is a cause for concern over human risks depends on the calculated margin of safety.

The margin of safety (MOS) is the ratio of the highest dosage from which no adverse effects are observed in test animals and that level of exposure which can reasonably be expected for humans. While the Agency has not established

official guidelines for determining the adequacy of the MOS for teratogens in general, Agency toxicologists believe that an MOS below 100 would be a matter of serious concern. Interpreting these values, however, requires a judgement based on other factors associated with characteristics of the chemical, routes of exposure, and the probability of various levels of exposure. Thus, the above value should not be construed as an established Agency policy but only as a toxicological guideline for risk assessment against which benefits must be balanced and additional safety requirements imposed.

In the case of endrin, the Agency has additional information that requires a substantial deviation from the above MOS guideline. Specifically, limited epidemiological evidence indicates that humans may experience convulsions from exposure to endrin at a dose 50 times lower than that at which this effect was observed in hamsters (Burnam, 1978d). For endrin, therefore, differences in sensitivity between species are five times greater than the conventional factor of 10 used in evaluating the MOS when comparative information is not available. One can not necessarily conclude from this that humans are 50 times more sensitive than hamsters to teratogenic effects. However, since the mechanism(s) of action of teratogens are generally unknown, since sensitivities to teratogenic effects may vary

by more than a factor of 10 between species and since the teratogenic mechanism of action for endrin is unknown, the comparative data on convulsions must be taken as a warning to employ a more conservative interpretation to the MOS. The Agency must conclude, therefore that an MOS of 500 or less is a basis for serious concern. As indicated by the exposure analyses associated with the various uses of endrin (below), margins of safety of less than 500 can reasonably be anticipated and the Agency concludes that the margin of safety is inadequate to rebut the trigger.

B. Other Agency Concerns Relative to Risk from Endrin

1. Effects of chronic exposure

Endrin is currently registered for use in the U.S. on cotton, small grains, sugar cane, and in orchards (ground cover for mouse control). These registrations are designated as "extended no-residue registrations". Under existing Agency policy, no-residue registrations were to have been converted in registrations covered by tolerances established under the Federal Food, Drug and Cosmetic Act.

No tolerances for endrin have ever been established because it had not heretofore been possible to establish a "no-effect level" or acceptable daily intake (ADI). The Agency has recently determined a tentative ADI for endrin (Engler, 1978).

In long term animal feeding studies, a no observable effect level was determined at 0.025 mg/kg/day. At higher levels, liver, kidney and heart were affected by Endrin. Based on this result we can determine an exposure level for humans which would represent an acceptable risk. This acceptable daily intake would be 0.0002 mg/kg body weight/day, or 0.012 mg/day for an average 60 kg person.

The Agency's earlier review (EPA, 1973) calculated that the average dietary intake for the period of 1964-1970 was 2.5 percent of the ADI, and endrin residues in the diet appear to have declined since that base period (Ebner, 1978). Thus, the Agency has had no basis for concluding that the observed adverse effects in rats and dogs from chronic exposure to endrin, when considered in relation to estimated human dietary exposure, were indicative of risk to humans. However, the Agency has not concluded that the available chronic tests satisfy the needs for establishing an official ADI and additional testing may be required for setting finite tolerances.

2. Mutagenicity

It its review of the oncogenic potential of endrin, the CAG reviewed several papers dealing with the possible mutagenic effects of endrin and concluded from this

review that the results were "equivocally positive" (Albert, 1978). The Agency is unwilling to issue an RPAR on the basis of such evidence but it will require that the issue be resolved by compliance with the Pesticide Registration Guidelines prior to both reregistration and to the setting of tolerances.

3. Metabolic Fate in Man

Unlike its stereoisomer, dieldrin, residues of endrin have never been reported in samples of human adipose tissue (Mississippi, Epidemiologic Studies Programs, 1978). While there may be various reasons for this observation, one possibility is that endrin is rapidly metabolized to hydrophilic compounds and excreted. However, in a study with the rat (Hutson, 1975), it was found that a highly toxic metabolite, 12-ketoendrin, was produced and that this metabolite was lipophylic. This lead the authors to observe that, "This metabolite could be very significant for use in monitoring suspected acute exposure to endrin".

On September 8, 1976, the Agency formally requested Shell Chemical Company to provide information on, "Results of any attempts to determine the presence of 12-ketoendrin in human and other organisms" (Dreer, 1976). On December 14, 1976, Dr. E. L. Hobson submitted to the Agency an undated report by Michael K. Baldwin entitled, "A Brief Guide to the Metabolism of Endrin..." Relying on a 1973 paper by Baldwin and Milner, Baldwin concluded that

"12-ketoendrin is thus unlikely to occur as a residue in man's tissue." When the discrepancy between this conclusion and that of Hutson, Baldwin and Hoadley cited above was brought to Dr. Hobson's attention by a letter (Barbehenn, Feb. 17, 1977), Dr. Hobson replied that Shell had no data on 12-keto endrin in adipose tissues of Pernis workers (Hobson, July 1, 1977).

The Agency still does not know whether or not 12-ketoendrin may be expected to occur in the adipose tissues of individuals which are exposed to endrin. This critical question remains unresolved.

C. Risk Assessment of the Major Uses of Endrin

The RPAR criteria for risk reflect a concern with the potential which the use of a pesticide has for adverse effects on man and on the environment. The anticipated adverse effects from the use of a pesticide, however, vary with the extent of exposure to the pesticide which may be different for each of its uses. In order to assess the risks from the use of endrin, the Agency concentrated primarily on its three major uses: cotton, small grains, and orchards. The Chemistry Branch, Hazard Evaluation Division (HED), OPP) conducted the analyses which estimated the amount of exposure to endrin from each of its uses. In

conducting the analyses, the Chemistry Branch used information both from labels and from field studies. Using toxicity data and field evidence, the Metabolic Effects Branch and the Ecological Effects Branch then utilized the exposure data to determine the risks and their extent from the amounts of endrin exposure to humans and the amount of endrin contamination in the environment associated with each major use of the pesticide.

1. Cotton

From the standpoint of risk to humans, the Agency's concern is with the teratogenic potential of endrin. The Agency agrees with the position adopted by Velsicol and discussed in Section 6(b) that the average amount of exposure to endrin which the general population has from food, air and drinking water contaminated by endrin provides an ample margin of safety (greater than 10,000). However, the Agency is concerned about women who may consume large quantities of fish containing endrin and those who may on occasion be exposed to concentrations of endrin from drift.

The use of endrin on cotton is normally at the rate of 0.4 lbs a.i./acre, and the Agency's Benefit Analysis indicates that cotton growers who used endrin applied it an average of five times per season. Human habitations are common on the periphery of many cotton fields, thus providing

many opportunities for exposure to drift. Should a normally clad bystander be caught 80-85 feet down wind from aerial application, a reasonable estimate of dermal exposure would be 1 mg (EPA, 1978b). If the bystander absorbs 10% of the endrin per day, the dose would be 0.0017 mg/kg for a 60 kg person. The absorption value of 10% is based on an analogy with studies of aldrin, dieldrin and lindane (Burnam, 1978c).

For aerial applicators, inhalation exposure was estimated at 0.011 mg/hr and dermal exposure at 0.16 mg/hr. If 10 % of the dermal exposure is absorbed, the total daily dosage for a 60 kg female pilot actually applying endrin for ten hours a day would be approximately 0.005 mg/kg. The Agency estimated that approximately 100 pilots were involved in aerial application of endrin to cotton (EPA, 1978b). The number of female pilots among this group is probably very small (Barbehenn, 1978h). Inhalation exposure to mixers/loaders is estimated at 6.8 ug/hr. Dermal exposure due to accidents would be very sporadic and the level of exposure can not be estimated.

In the cotton areas of the lower Mississippi River, rainfall is frequent during the growing season and the proximity of streams and ponds to cotton fields makes contamination by runoff common. FDA surveillance of residues from commercial catfish ponds has disclosed endrin residues

as high as 0.5 ppm. Considering the frequency of reported fish kills, concentrations of endrin residues in excess of 1.0 ppm in living fish would not be rare. The consumption of 250 g of fish containing 1.0 ppm endrin would produce a dose of 0.25 mg or 0.004 mg/kg for a 60 kg woman.

In comparison with the no-observed-effect-level of 1.5 mg/kg which Chernoff observed in the hamster for encephloceles, exposure to applicators (0.005 mg/kg) provides a margin of safety of 300. For the local population, the dermal exposure of 0.0017 mg/kg and the food exposure of 0.004 mg/kg provide margins of safety (MOS) of 880 and 375, respectively (Burnam, 1978c). It is not possible to estimate the probability of obtaining teratogenic exposure and the frequency of such incidents can not be accurately estimated. However, the frequency is a function of the number of treatments per acre, topographic and climatic conditions, application techniques, the rate of application, and the precautions which the applicator takes to avoid contaminating people and water. The Agency concludes that the use of endrin on cotton presents a teratogenic risk to female applicators and women who consume large amounts of fish contaminated with endrin.

The risk of endrin to local fish populations from its use on cotton has been established in the Agency's rebuttal analysis and this adverse effect has been known for

many years by cotton growers (Sears 1978). Risks to terrestrial wildlife associated with cotton fields are possible (Markely 1977) but the reality of the risk is uncertain. Risks to endangered species, in terms of jeopardizing their continued existence, have not been demonstrated (Greenwalt 1978). The potential risks to the brown pelican have been established and would seem to be proportional to the total number of acres of cotton treated with endrin in the regions that drain into the Gulf of Mexico and perhaps into the Atlantic coast from South Carolina to Florida as well. The Agency has established above (Section II) a qualitative record that the past use of endrin on cotton has adverse effects on fish and wildlife.

2. Small Grains

The margins of safety for teratogenic risks from the use of endrin on small grains are in the same range as those for cotton, i.e. from 300 for applicators to near 1000 for bystanders. However, many circumstances combine to reduce the probability of exposure occurring. Single applications at the rate of 0.25 pounds a.i./acre may be made in the late winter or early spring. Outbreaks of the cutworms are sporadic and any given acre may require treatment only once every several years with the mean frequency of treatment depending on the geographic location of the acre. In general, the density of humans living in close proximity to

wheat fields is lower than the density of humans living in close proximity to cottonfields. The time of year (late winter or early spring) and lower dose of endrin used on wheat further reduce the potential for dermal exposure. It is less likely that humans will be exposed to endrin from eating contaminated fish from wheat-growing areas than from the areas where cotton is grown. In the wheat areas, there are fewer fish-bearing waters, runoff is less frequent, applications are less frequent, and the general amount of fish in the diet is lower. As is the case with cotton, the Agency can not reliably estimate the probable frequency of exposure from concentrations of endrin which have a potential for causing teratogenic effects.

As indicated in the rebuttal analysis, the risks to local populations of fish from the use of endrin on small grains in general, are substantially less than those which the Agency expects from the use of endrin on cotton. Nevertheless, drift (and run off) poses some risk, especially during outbreaks of pests that require emergency treatment. The extent of this risk depends on the distance of the water from the point where endrin is applied on wheat, as well as on other factors. There is some risk to bald eagles which may be poisoned by consuming moribund and dead fish associated with the use of endrin on small grains. However, in the opinion of the FWS (Greenwalt, 1978), the use of

endrin has not jeopardized the continued existence of either the bald eagle or of other endangered species. Risks associated with the use of endrin to control other pests of small grains will be discussed in Section V.

3. Orchards

Endrin is applied as a post-harvest ground spray in orchards primarily to control pine voles (mice) in the Eastern United States and meadow voles in the Northwest. Rates may vary from 0.6 to 2.4 lbs. a.i./acre. High nozzle pressures (500 psi) are recommended on the label to achieve penetration of the ground vegetation but practices and equipment vary widely, resulting in the generation of everything from a solid stream to a relatively fine spray during application. Field estimates of exposure to normally clad applicators were 0.01 mg/hr by inhalation and 3 mg/hr dermal (EPA, 1978b). The number of women among the estimated 2200 orchard applicators is unknown, but, assuming four hours of actual spraying per day, the margin of safety for this amount of exposure would be about 75 in the absence of protective clothing and this MOS indicates a high level of teratogenic risk. The amount of exposure to bystanders can not be estimated from the available data. The State of New York conducted a monitoring program in endrin-treated orchards in the Lower Hudson Valley in 1977. A report

citing the concentration of endrin residues found in specimens of dead and living fish and wildlife, and in a dead cow, is not yet available. Fish kills resulting from runoff of endrin from orchards have been verified from North Carolina and Pennsylvania (Coppage, 1978).

III. Benefit Analysis

A. Introduction

The Agency has prepared analyses of the economic consequences which would occur if the Agency were to cancel the use of endrin, or if endrin were to be used under more stringent restrictions. In the preparation of these analyses, the Agency's personnel used, among other sources, an assessment prepared by the U.S. Department of Agriculture (USDA) in cooperation with various state agencies, the records of several hearings conducted under Section 21(b) of the FIFRA, prior Agency reports and reviews of endrin, and pesticide registration documents. This section summarizes the major conclusions of the economic analysis, and provides a background for the specific dollar figures and the other qualitative effects.

The Agency performed an analysis of the impacts of cancelling endrin in 1973 (EPA, 1973). This document, plus the review of any new data and the review of early studies formed the basis for USDA's report which was submitted to the Agency on November 4, 1976. The individuals reponsible for the USDA assessment developed an estimate of the economic consequences which would occur if the Agency were to cancel certain uses of endrin. They used yield and efficacy data, information on the ways farmers and others actually use endrin, and other relevant published data.

EPA's analysis centered on those sites where endrin is used which earlier studies (including the USDA report) indicated might be of economic importance, namely cotton, sugarcane, wheat and other small grains, conifer seeds and apple orchards. The following sections present a summary of the major findings for the use of endrin on these sites. These uses were analyzed in depth in the Preliminary Benefit Analysis of Endrin which was conducted during 1975 to 1977 by the Economic Analysis Branch of the Office of Pesticide Programs, EPA (EPA, 1977a). The following discussion is based on information in this analysis unless identified otherwise.

B. Cotton[1/]

Introduction

The discussion of benefit issues to follow relates to the use of endrin in the effort to control *Heliothis spp.*, which are *Heliothis zea* (cotton bollworm) and *Heliothis*

1/ The original Benefit Analysis for cotton was completed in 1977 (EPA, 1977a). This analysis made the assumption that if toxaphene were available it would be "... the most likely alternative..." to replace endrin (EPA, 1977a, p. 98). Several reasons, valid at the time, were provided to support this assumption. More recently data on declining use of toxaphene in Mississippi has been made available (Mississippi). This data supports informal reports from several sources that use of toxaphene is declining. As a result, the original assumption that toxaphene would be the major replacement was reassessed. In addition, Velsicol has provided updated usage of endrin on cotton (Velsicol). This Section provides new information on the usage of endrin and its alternatives and the modifications to the economic impact estimate.

virescens (tobacco budworm). The term "bollworm complex" refers to both the cotton bollworm and the tobacco budworm. Bollworms have the status of secondary pests on cotton. Chemical treatment to control bollweevils (methyl parathion is the pesticide most often used for bollweevils which occur early in the season) frees the bollworms from attack by predators and parasites and promotes the expansion of their populations. When the damage from these increased bollworm populations exceeds economic threshold levels, the bollworms are raised to the status of primary pests on cotton.

Various Integrated Pest Management (IPM) techniques are available to ameliorate the damage caused by bollworms. One example is the use of economic thresholds in order to delay for as long as possible the first insecticide application. This is important because the pesticides currently used are non-selective in terms of the pests which they kill. Once the first pesticide treatment is administered, the predator population is substantially reduced but many problem pests remain. For many growers the only tool of control, after beneficial insects are destroyed, is the use of insecticides. Once the first spray has been applied, many growers adopt a regular schedule, spraying every third to seventh day throughout much of the growing season. (In rare cases the number of insecticide treatments can exceed twenty or more in cotton growing areas). Other

IPM technologies include early maturing and pest resistant and determinant varieties of cotton and other practicies such as scouting and numerous cultural practices.

IPM technology is in varying stages of development throughout the Cotton Belt. IPM techniques are basically preventive measures to control pests and thus to decrease the use of chemical pesticides. Nevertheless, they cannot totally prevent the outbreak of pests in all situations. When outbreaks of pests occur at economically damaging levels, chemical pesticides are the only curative measure available. One thing is clear from usage data of insecticides on cotton: at present, cotton growing areas identified in the benefits study (Georgia, Florida, Alabama, Mississippi and Arkansas) remain heavily dependent upon chemical pesticides. These cotton growing areas coincide with areas where there are heavy infestations of the bollworm and the budworm and where endrin is and has been used.

The issue of how beneficial endrin is, is the extent to which it is useful for the control of the Heliothis pests. The discussion to follow will focus on the contribution endrin makes to the control of Heliothis in the way in which it is generally used; i.e. endrin is almost always used in formulation with methyl parathion. The Benefit Analysis reported the use of specific insecticides (i.e. actual mixtures or formulations) and use of endrin by itself

was not found in that particular survey (EPA, 1977, p. 65). Endrin was used alone in the 1950's and early 1960's. Due to the fact that cotton pests rapidly developed resistance to endrin alone, most of the endrin which has been used since the early 1960's to control the insects which damage cotton has been used in a formulation with methyl parathion. Thus, the productivity provided by endrin is the added insect control it provides when combined with methyl parathion. Although endrin is currently registered for the control of numerous other insects, many alternatives are available which are economical to use and which also control these insects. The states which recommend using endrin do so only for the control of the Heliothis complex.

Usage

The amount of endrin which is used as an insecticide on cotton has been small in relation to other cotton insecticides. In 1972, it was reported that less than 400,000 pounds were used on cotton (EPA, 1977a, p.67). During the succeeding two years the use of endrin increased by a factor of almost five. This temporary increase can be explained by several factors including the shortage of organophosphate pesticides, the cancellation of DDT in 1972, the significant increase in the number of acres of cotton grown during 1973 and 1974, and the relatively large infestations of the tobacco budworm at that time. From 1975 to the present, the number

of pounds of endrin which has been used on cotton has declined significantly. Velsicol has recently estimated that approximately 285,000 pounds of endrin has been used on cotton during 1978 (Velsicol 1978). At the time the Benefit Analysis was conducted (1976) the economic impact of the use of endrin was based upon an estimate of 500,000 lbs. of endrin which had been used that year. This amount translates into less than 3% of the total number of acres planted in cotton which are treated with insecticides. The amount of endrin now used for the control of pests on cotton would represent less than 2% of the total number of acres which are treated with insecticides. The use of endrin has been concentrated in Alabama, Arkansas, Florida, Georgia and Mississippi.

Federal Registrations

Endrin is registered for numerous pests on cotton. Table 1 lists the various pests.

Recommendations

Recommendations for the use of insecticides are formally made each year by the states. The Benefit Study reported that two states, Arkansas and Mississippi, were recommending endrin. Those two states were recently contacted by Agency personnel (Ludvik). Arkansas reports that endrin is not recommended for 1978 and that use of endrin is down sharply.

Mississippi continues to recommend endrin but reports that use has dropped off significantly. The only other state recommending endrin at the current time is Alabama. The state recommendations are for the bollworm and budworm only.

Table 1

Cotton Insects for Which Endrin is a Registered Control

Aphids[1/]	Cotton fleahoppers
Army cutworms[1/]	Cotton leafperforator
Armyworm[1/]	Cotton leafworm
Boll weevil	Cutworms
Bollworm	Desert Spider Mite[1/]
Brown Cotton leafworm	Fall Armyworm
Cabbage looper	Fleahoppers
Celery leaftier	Garden webworm
Climbing Cutworms[1/]	Tobacco budworm
Cotton aphid[1/]	

1/ Pests identified on labels on products containing 2 or more active ingredients. The pests in question may or may not be controlled with endrin alone.

Source: EPA listings from Microfiche (Input January 1975).

Page 41 of the report from the 1978 Annual Conference on Cotton Insect Research and Control mentions endrin along with 18 other insecticides as a possible control for insects which prey on cotton (National Cotton Council of America, 1978). The mention of a pesticide in this report does not consistute a recommendation; the purpose of the list is simply to provide information on which insecticides have controlled cotton pests in the past.

Resistance

The Benefit Analysis reported that since 1956 the cotton pests against which endrin was used exhibited resistance to it at low levels over widespread areas in Arkansas and Louisiana. Due to the development of resistance in Louisiana it had become uneconomical by 1962 to use endrin to control the Heliothis complex on cotton (EPA, 1977). Table 2 shows the amount of increase in the tobacco budworm's resistance to endrin between 1961 and 1965 in the state of Texas (2.3-491.7). The amount of this increse in resistance is greater than that for all other comparisons, and this helps to explain why endrin is no longer used in Texas. The Agency recently contacted the states of Arkansas and Mississippi to find out how much endrin was being used for the control of cotton pests. These states reported a decline in the use of endrin on cotton and explained that this delcine was due to the resistance of the cotton pests to endrin.

Alternative Insecticides

Only a limited number of the federally registered alternatives have been shown to provide control of the resistant Heliothis populations (USDA, 1977). Endrin is believed to be used in those areas where the bollworms exhibit resistance to the use of methyl parathion by itself. The RPAR alternatives include toxaphene-methyl

Table 2.—Relative toxicity of insecticides applied topically to the tobacco budworm.

Insecticide and location	LD_{50} (m/g larva)						
	1961	1964	1965	1967	1969	1970	1972
Texas							
DDT	4.9		627.4				
Endrin	2.3		491.7				
Carbaryl	11.4		2069.9				
Strobane-DDT	27.7		422.6				
Toxaphene-DDT	17.9		133.8				
Methyl parathion							
College Station		0.4	1.1	0.8	2.3	5.3	
Weslaco					4.2	17.5	
Monocroptophos							
College Station		4.9	3.8	5.3	14.4	9.1	
Weslaco					7.6	5.3	
Louisiana							
Methyl parathion							4.2
Natchitoches							3.4
Curtis							
ssissippi							
Methyl parathion					0.6		
Jefferson-Davis Co.					0.2		
Monroe Co.							5.7
Lawrence							35.8
Quitman							4.4
Sharkey							4.0
Bolivar							

Source: USDA. The Bollworm and the Budworm on Cotton. Status of Insecticides and other Methods of Control of 1977. USDA, Washington, January, 1977.

parathion and EPN-methyl parathion (EPN is on the Pre-RPAR List). Several non-RPAR chemicals are available and include monocrotophos, methomyl, acephate and several others. Although methyl parathion is registered for use on the bollworms it is not effective for controlling resistant populations. Most of the methyl parathion used is for bollweevil control (O'Mara,1978a). Several new pesticides are not currently registered but they have been available under Section 18 of FIFRA to farmers who have experienced difficulty in controlling the bollworm and budworm. These new insecticides include sulprofos, profenofos, permethrin and fenvalerate. Collectively these insecticides are being used on an area which is substantically greater than the number of acres of cotton on which endrin was used in the 1970's (O'Mara, 1978b). These new insecticides are providing good control of the budworm and bollworm complex in many areas because resistance to them has not developed (USDA, 1977b).

Economic Impact Analysis

To address the benefit endrin provides for Heliothis control on cotton it is necessary to project the pest control practices farmers would most likely use to replace endrin if it were not available. The benefit which endrin provides is measured by changes in both costs of production and income associated with the change to alternative pest control practices. The changes in costs can be due to

different application rates, prices per pound of active ingredient, application costs and number of treatments. Changes in income can be due to different yields and varying grades of cotton quality. It is first necessary to identify those practices and second to allocate them over the amount of acreage currently treated with endrin.

The choice of insecticides to replace endrin and the proportion of total acreage to be treated by each could be determined by a survey of farmers currently using endrin. Available resources do not permit the costly and time consuming exercise to identify the subject farmers and to survey their expected alternative pest control practices.

The four most viable alternatives among those registered federally for bollworm control are toxaphene, EPN, monocrotophos and methomyl. In addition, several new insecticides were made available in 1977 and 1978 under Section 18 of FIFRA. These insecticides include sulprofos, profenofos, fenvalerate and permethrin. Since these chemicals are currently being used much more extensively than endrin, it is appropriate to consider them in assessing the impact of the loss of endrin.

There are several factors which farmers consider in making choices. Farmers are motivated by the possibility of decreasing their production costs and by increasing their income. Farmers make choices among pesticides based

upon their costs and upon their ability to control insects. Table 3 lists the alternatives, the application rates and material costs per acre for the insecticides which are identified as alternatives to endrin. Toxaphene and EPN are the least expensive of the alternatives. If they were to consider costs alone, farmers would have an incentive to choose these. However, other factors such as the effect of the pesticide on the yield from the crop are important in the selection of an insecticide. (The performance of the insecticides which are alternatives to endrin is discussed in a separate Section).

A major factor in assigning the acreage distribution of alternatives should be current practices of farmers. A recent study on usage of pesticides in Mississippi provides a good data base for distributing the most popular bollworm insecticides over the endrin acreage (Mississippi State University, 1977). This data helps to indicate what practices are being followed at the current time and to show trends in practices from recent years.

Other sources of information are available including previous studies and knowledge of experts in EPA, USDA, the States and elsewhere. These sources of information are helpful to assign a level of confidence in the data used as a basis for impact analysis.

Table 3. Application rate and material cost per acre for single application of endrin and alternative insecticides for budworm-bollworm control

Insecticides	Application rate per acre1/	Material cost per application2/
Present insecticides	lbs. a.i.	dollars
toxaphene + methyl parathion	2.0 + 1.0	2.75[4/]
EPN + methyl parathion	0.5 + 0.5	2.80[5/]
monocrotophos	1.0	4.60[5/]
methomyl	0.45	4.00[6]
endrin - MP	0.4	2.18
New insecticides[3/]		
permethrin	0.1	6.40[6/]
fenvalerate	0.1	6.00[6/]
sulprofos	1.0	6.00[6/]

1/ Taken from 1976 Biological Survey for Toxaphene Assessment. USDA
2/ In addition, the application cost per acre is estimated at: Southeast - $1.25; Delta - $1.60; Southern Plains - $2.50; and Southwest - $1.75.
3/ All but sulprofos are synthetic pyrethroids.
4/ Average of data provided by Hercules ($2.60), Fred Cooke ($2.70). Art Gruhe ($3.00), and Gold Kist Corporation ($2.75).
5/ Southern States Cooperative
6/ Based on discussion with pesticide manufacturers, October 1977.

The method used to allocate the identified federally registered alternatives over the endrin acreage was to use data on pesticides from 1971 to 1976 from Mississippi (Mississippi State University, 1977). The justification for using this data base is:

1. It is a consistent time series data base for the viable bollworm insecticides, and

2. Mississippi is well suited to address the endrin issue because,

   a. the total usage of endrin recently provided by Velsicol indicated that 335,984 pounds of endrin were sold for cotton in 1976 (Ebner, 1978c and e). The Mississippi data indicate that 329,288 pounds of endrin were used in 1976. If these figures are reasonally representative then most of the endrin used on cotton, at least for this year, was in Mississippi.

   b. Mississippi has climatic conditions and pest complex problems similar to other cotton states using endrin.

The Mississippi data show a significant decline in poundage of toxaphene in Mississippi and the subsequent increase in EPN (Mississippi State University, 1977). Since EPN is applied at 1/2 pound per acre, the relative increase in acreage treated with EPN is even more dramatic.

The distribution of the selected viable alternatives to endrin over the endrin treated acreage was determined by using the poundage figures from the Mississippi data for the selected alternatives and the derivation of the total number of treated acres by dividing the number of pounds of endrin used by the application rates in order to get the total number of acres treated. The total number of acres derived for the selected endrin alternatives was used as the basis for determining percent distribution. Table 4 presents this information. Additionally, the data on the usage of new insecticides from Mississippi is also included, although this comprised only 3 percent of the total treated acres. For purposes of this study the acreage distribution as listed in the far right column of Table 4 is used for the current assessment of the economic impact which would occur if endrin were to be cancelled.

Estimate of Economic Impact of Cancelling Endrin

As mentioned above there are three factors which could alter the net returns to growers who use endrin if it were cancelled. These factors are changes in costs, changes in yield and changes in quality of crop. As with any economic analysis it is imperative that assumptions be made. The assumptions to be made for the endrin analysis are discussed below.

Table 4. Usage of Selected Insecticides to Substitute for Endrin from Mississippi in 1976[1/]

Insecticide/ Class	Total Pounds Applied (lbs.)	Application Rate (#/ac.)	Total Treated Acres (ac.)	Proportion of Total Acres (%)
RPAR				
Toxaphene	4,421,638	2.0	2,210,819	25
EPN	2,469,759	0.5	4,939,518	56
Non-RPAR				
Monocrotophos	971,805	1.0	971,805	11
Methamyl	227,381	0.45	505,291	6
Special Use Exemption[2/]			230,073	3

1. Source: Mississippi State University. Mississippi Epidemiologic Studies Program: Annual Report #9. Mississippi State Univ. under Contract to HEMB, TSD, OPP, EPA #68-01-1944.

2. The insecticides available under Section 18 of FIFRA and which were used in Mississippi in 1977 are sulprofos, permethrin, and fenvalerate. The treated acreage was reported from: Mississippi Department of Agriculture and Commerce or Emergency Exemption Report - 1977, Mississippi State, Mississippi.

To conduct the comparative cost analysis for addressing an endrin cancellation, the alternative pesticides and their proportional use over the endrin acreage must be specified. Table 5 lists the insecticides and the acreage. The top row of Table 5 lists the case for endrin. In the rows below, the case is presented for an endrin cancellation. The impact assessment is based upon 1978 use of endrin as supplied by Velsicol, which is 285,000 pounds (Ebner, 1978c and e). This would allow 712,500 total treatment acres (this includes multiple treatments). The original 1974 Benefit Analysis derived the average number of treatment per year with endrin which is 4.7 sprays per season, and this will be used herein. The assumption is made that the alternatives would be used an equal number of times. There is no way to verify this assumption without extensive and costly investigation. An enormous variability exists in treatment patterns across regions and seasons due to numerous factors such as pest density and composition, weather throughout the season and so on.

This assumption could overstate the cost of replacing endrin simply because more effective control obtained by the alternatives could reduce frequency of treatment. However, the estimate of costs based on this assumption would not differ significantly if another assumption were made, i.e. that some alternative pesticides were used fewer times per season than others. Therefore, it is not necessary to

Table 5. Comparative Cost Analysis

Insecticide	Bases Acres Treated ac.	Total Treatment Acres	No. of Treatments per Season	Material Cost[1/] Total	Material Cost[1/] Change	Total Cost All Acres
Endrin PMP [2/]	151,596	712,500	4.7	2.18		$1,553,250
Alternatives						
RPAR						
Toxaphene - M.P.	37,899	78,125	4.7	2.75	.57	489,844
EPN - M.P.	84,894	399,000	4.7	2.80	.62	1,117,200
Non-RPAR						
Monocrotophos	16,676	78,375	4.7	4.60	2.42	360,525
Methomyl	9,096	42,750	4.7	4.00	1.82	171,000
New Insecticide[3/]	4,548	21,375	4.7	6.20	4.00	132,525
Net Change in Cost if Endrin is Cancelled						717,844

1/ The total cost is the total chemical cost per acre. The change is the difference in cost compared with endrin.

2/ This implied poundage figure for endrin was obtained from Velsicol and represents 1978 usage or 285,000 pounds of endrin.

3/ The new insecticides include sulprofos, permethrin, fenvalerate and profenofos which represented use in Mississippi during 1977.

generate actual information from field experience because that information would be of little importance for the outcome of the analysis. Thus, this assumption will be used in the budget analysis. However, the reader should be aware that this assumption represents the worst case for this particular variable.

The cost of shifting to the alternatives is a function of the chemical cost per acre of the alternatives only since the number of treatments is assumed to be the same and since application costs are identical for all the pesticides listed in Table 5.

In the far right column of Table 5, the total chemical cost for each insecticide is listed. The change in cost due to replacing endrin is therefore the difference between the total endrin cost and the sum of the total cost of the alternatives. If the Agency were to cancel the use of endrin on cotton the total cost of using the alternatives to endrin per year would be $717,850 (based on the amount of endrin used in 1978).

The breakdown of this total amount is as follows:

- Average increase per acre in cost per treatment = $1.00
- Acreage increase per acre per year for all treatment = $4.70, or less than 3% of total per acre production costs
- Average increase per year per farm - $815 or less than 2% of the total revenue received from the cotton which would be sold.

The second factor to consider is the potential change in yield per acre which might occur if endrin were unavailable. The 1976 Benefit Study investigated the effects on yield and decided that there was no basis for assuming that the effects on yield would be greater or lesser than those which the use of alternatives pesticides might produce. Thus, the assumption was made that the effects on yield would be the same. The Agency investigated what the effects of the use of alternative pesticides to endrin would be on yield and found that no experimental trials have been conducted since the original Benefit Study was completed (O'Mara, 1978a).

Yield effects of endrin can be inferred from certain other available information. Endrin appears to have experienced a significant downward trend in use during the 1970's. This has happened in spite of the fact that endrin is the least costly of all pesticide materials commonly used for bollworm control. A decline in relative efficacy could be a significant factor for explaining this trend. Alternative insecticides are apparently providing relatively greater economic control than endrin on that acreage being replaced by its alternatives.

However, on the existing endrin treated acreage, there are no recent yield data from experimental testing to serve as a basis for choosing a non-zero estimate to represent relative yield effects of endrin. For those growers using endrin it is reasonable to assume they are achieving econo-

mic control for they are most closely associated with endrin use and its results. Since endrin is used on a small scale (in terms of pounds, acres and users) the assumption for relative yield is not critical for estimating economic impacts. Therefore, in this study it was assumed that yield effects were zero.

The final factor is the effect of endrin on quality of cotton. However, there is no evidence of quality effects associated with alternative insecticides on cotton.

In summary, the economic impact of the cancellation of the use of endrin on cotton would be limited to increases only in the cost of production. Endrin is the least costly of the pesticides commonly used for the control of bollworms. The increases in costs which would be due to the use of more costly pesticides would have a relatively minor effect on the growers. Nevertheless, the growers' average gross income would be reduced by approximately $800.00 per year. In the cotton market the economic impact of the cancellation of the use of endrin on cotton would affect only the user of endrin. There would be no change in the national supply of cotton or in its price. Hence, if the Agency were to cancel the registration for the use of endrin on cotton, no effect from this action would be felt by the members of the marketing chain or by the consumers of products which are made of cotton.

In addition to the fact that there are small benefits for cotton farmers who use endrin its use also poses some disadvantages. These are disadvantages for the cotton farmer himself. These disadvantages arise from the accumulation of endrin residues in the soil which translocate to oil crops such as peanuts and soybeans. These crops are commonly grown in rotation with cotton. The use of endrin is thus a constraint for the farmers who wish to use certain crop rotation schemes. Since oil crops are often exported, there is a definite possibility of a loss in export sales from countries which will not accept oil crops containing residues of endrin. There are other disadvantages from the use of endrin on cotton which have not been quantified. For example, there is a loss in recreational value which occurs when the run-off of endrin from cotton fields kills game fish and there is a loss in income for commercial catfish operators when the run-off of endrin kills catfish. These disadvantages are real and they offset to some extend the small benefits endrin provides as an insecticide on cotton.

C. Wheat and Other Small Grains

Annual endrin use varies between 222,000 to 277,000 pounds active ingredient for small grains.. Application is made at 0.25 pounds active ingredient per acre (Table 6 and Table 7). Current USDA estimates are that

SUMMARY OF PRELIMINARY BENEFIT ANALYSIS - GRAIN/ARMY CUTWORMS

A. USE: Small grains/endrin

B. MAJOR PESTS CONTROLLED: Army cutworms

C. ALTERNATIVES:

Major registered chemicals: Endosulfan, Toxaphene (RPAR)

State/Federal recommendations: 7 states recommend controls for army cutworms on wheat. 4 recommend endrin, 1 endosulfan, 6 toxaphene, and 6 trichlorfon.

Non-chemical controls: None

Efficacy of alternatives: Available data shows endosulfan (0.5 lbs a.i./acre) delivers comparable control of army cutworms.

Comparative performance: No yield or quality difference anticipated.

Comparative costs: The endosulfan control program costs $1.66 to $1.94 more per treated acre.

Conclusion: FMC anticipates no supply problem in the future. Production can be increased should demand shift.

D. EXTENT OF USE:

Active ingredient basis: (pounds a.i.)

(a) Endrin

State	lbs (1,000)
Co	45 - 56
Ks	40 - 50
Mt	1
Ok	45 - 57
SD	7 - 9
Total	138 - 173

(b) Alternatives: Negligible

Units treated basis:

(a) Endrin

State	Acres (1,000)
Co	225.0
Ks	200.0
Mt	3.7
Ok	226.7
SD	36.0
Total	691.4

(b) Alternatives: Negligible

(c) Not treated: Unknown

E. ECONOMIC IMPACTS:

User: Assuming equivalent control, aggregate impacts of adoption of endosulfan (0.5 lbs a.i./per acre) as an alternative will total $1.1 million to $1.3 million due to increased chemical costs. The average annual farm impact in the five affected states is 10-11 dollars.

Projected Annual Increased Costs of Control on an Average Size Wheat Farms on Which All Acres Have Continual Levels of Economic Infestations

State	Per Acre Loss (dollars)	Per Farm Loss (dollars)
Co	1.66 - 1.94	524 - 612
Ks	1.66 - 1.94	324 - 379
Mt	1.66 - 1.94	668 - 780
Ok	1.66 - 1.94	366 - 428
SD	1.66 - 1.94	300 - 350

Market: The resultant increased costs of production are expected to be negligible on a national scale.

Consumer: Negligible

Macroeconomic: Negligible

F. SOCIAL/COMMUNITY IMPACTS:

G. LIMITATIONS OF ANALYSIS: Analysis assumes comparable level of army cutworm control using the alternative at the specified application rates; control data, however, is available in only three of the five affected states. Distribution of use of endrin by farm and frequency are unavailable.

H. PRINCIPAL ANALYST AND DATE: Donna E. Tegelman, Economist
January, 1977

Table 7

SUMMARY OF PRELIMINARY BENEFIT ANALYSIS - GRAINS/PALE WESTERN CUTWORMS

A. USE: Small grains/endrin

B. MAJOR PESTS CONTROLLED: Pale western cutworms

C. ALTERNATIVES:

Major registered chemicals: None

State/Federal recommendations: 7 states recommend controls for pale western cutworms. All recommend endrin; no alternatives cited.

Non-chemical controls: None

Efficacy of alternatives: -

Comparative performance: During years of non-extensive (low) infestation and extensive (high) infestation losses, are estimated to be 2.4 to 4.2 bushels and 14.6 bushels per untreated acre respectively.

Comparative costs: -

Conclusion: Alternative controls are not registered; losses will be incurred on non-treated acres.

D. EXTENT OF USE:

Active ingredient basis: (pounds a.i.)

(a) Endrin

State	lbs (1,000)	State	lbs (1,000)
Co	11.9	Ok	5.8
Id	0.3	S.D.	5.0
Ks	30.0	Wy	6.7
Mt	8.4	Total	104.2
Nb	16.1		

(b) Alternatives: Negligible

Units treated basis:

(a) Endrin

State	acres (1,000)	State	acres (1,000)
Co	127.5	Ok	23.3
Id	1.0	S.D.	20.0
Ks	120.0	Wy	26.8
Mt	33.5	Total	116.3
Nb	64.2		

(b) Alternatives: Negligible

(c) Non treated: Unknown

E. ECONOMIC IMPACTS:

User: Net aggregate annual impact range between 13.5 million and 14.2 million dollars at the farm level. Total estimated annual average wheat losses varies from 4.6 million to 4.8 million bushels of wheat (equivalent to 0.28 to 0.29 percent of the total recent (1972-1974) U.S. production).

Projected Annual Value of Wheat Losses on An Average Size Farm on Which All Acres Have Continual Levels of Economic Infestations

State	Per Acre Loss (dollars)	Per Farm Loss (1,000 dollars)
Co	26.0	8.2
Id	-	-
Ks	37.2	7.3
Mt	38.6	15.5
Nb	43.5	4.4
Ok	37.1	8.2
S.D.	34.1	6.2
Wy	29.3	6.3

Consumer: Negligible.

Macroeconomic: Negligible.

F. SOCIAL/COMMUNITY IMPACTS:

G. LIMITATIONS OF ANALYSIS: Analysis assumes yield effects are represented by test data results generated in two states. No data is available concerning a) distribution of use of endrin other than on a state basis and b) number of farm units affected.

H. PRINCIPAL ANALYSTS AND DATE:

416,000 acres and 691,000 acres are treated for pale western cutworm and army cutworm each year, respectively.

According to the Benefit Studies, there are no registered alternatives to endrin for pale western cutworm control. Yield losses valued at about $33/acre could occur on endrin treated acres (1976 Prices). Aggregate losses of 4.7 million bushels (0.28% of total U.S. production) with a value of $14.9 million could occur annually without effective control of the pale western cutworm. Colorado, Kansas, and Nebraska would be the states most heavily affected.

Endosulfan is the primary non-RPAR registered alternative to endrin for controlling army cutworms. As indicated in Table 6, available data shows endosulfan delivers comparable control of army cutworms. Since no yield differences were anticipated, yields were assumed to be the same for endrin and endosulfan in the benefit analysis. Additional chemical costs would be $1.66 - 1.94/acre. Total impacts would be 1.2 million dollars on the affected acreage. Colorado, Kansas, and Oklahoma would absorb 90% of the total impacts.

Market and consumer impacts are expected to be negligible if endrin is cancelled for use on wheat.

D. Orchards

Endrin is applied as a postharvest ground spray to control pine and meadow voles in many apple-producing areas of the East and Northwest (Table 8). Current endrin usage on domestic apple orchards is estimated at 84,000 pounds active ingredient per year applied to about 58,100 acres (11.2% of total U.S. apple acreage). In the nine states in which endrin is used for orchard vole control (Georgia, South Carolina, North Carolina, Virginia, West Virginia, Maryland, Pennsylvania, Washington, Idaho), the acreage treated with endrin represents 26.5% of total apple orchard acreage in those states.

The State and USDA Assessment Team considered pine and meadow voles to be the most important threat to growing apple trees and maintaining economic levels of production in both the Eastern and Western apple-producing areas of the U.S. During periods of environmental stress (generally during summer drought and/or the winter months) voles feed on the tree trunk and roots at or below the soil surface. The voles gnaw phloem tissue from the trunk and roots. Depending upon the severity of the damage, apple yield and quality are reduced and tree growth is stunted. If 25% or more of the trunk circumference is "girdled" the tree may die within three years unless restored by grafting, an uncertain and expensive process. Trees less than three

A. USE: Endrin use as postharvest spray on apple orchards.

B. MAJOR PESTS CONTROLLED: Pine voles, meadow voles.

C. ALTERNATIVES:

Major registered chemicals:

RPAR: none
Non-RPAR: Federal registrations: zinc phosphide
State registrations: chlorophacinone (CPN), diphacinone (DPN)

State/Federal recommendations:

Number of apple states (out of 20) recommending: endrin-6; zinc phosphide-13; CPN-2; DPN-3; strychnine-2; herbicides-6; trunk guards-5; mowing/cultivation-11.

Non-chemical controls:

Cultural practices (mowing, cultivation, trunk guards) and non-rodenticide chemicals (herbicides) are used to destroy the food sources and habitat of voles and to directly protect the trees.

Efficacy of alternatives:

In areas where endrin is still used (probably due to lack of development of resistant vole populations) it is the most effective material available.

Comparative performance:

According to state contacts, use of zinc phosphide on acreage now treated with endrin will lead to a 6.66% weighted average loss in production per year on the affected acreage. An analysis was also completed under the assumption that the use of CPN, DPN, herbicides and cultural practices would result in 50% of the losses in production expected under a zinc phosphide program (3.33% annual weighted loss).

Comparative costs:

Control measure	Treatment cost/acre
endrin 1.6 EC ground spray	$16.40
CPN 0.4 conc. ground spray	37.40
CPN 0.005% pellets	17.45
DPN 0.005% pellets	16.95
Zn_2P_3 corn-oat bait	14.55
cultivation + herbicide (paraquat)	35.84
cultivation	26.84
herbicide (paraquat)	15.65
herbicides (simazine + paraquat)	24.40

Seasonal control programs generally include two or more of the methods listed. Trapping and trunk guards are also used. Current endrin users face a maximum seasonal control cost increase of $93 per acre (an 8.6% increase in per acre nonharvest production costs). The average Zn_2P_3 and average CPN-DPN-herbicides-cultural methods programs would increase per acre seasonal control costs (relative to the average cost of endrin control programs) by $18 (1.67% of nonharvest production costs) and $21 (1.95% of nonharvest production costs), respectively.

Conclusion:

Loss of endrin for orchard vole control will increase production costs and reduce apple production on the acreage currently treated with endrin. Available alternatives do not provide adequate control in areas subject to consistently high levels of infestation and damage.

D. EXTENT OF USE:

Active ingredient applied and acres treated:

State	Acres treated/year	Pounds a.i. applied/year
Georgia	500	1,200
South Carolina	900	2,200
North Carolina	5,000	12,000
Virginia	4,000	9,600
West Virginia	5,500	13,200
Maryland	900	2,200
Pennsylvania	10,400	25,000
Washington	30,200	18,100
Idaho	700	400
Total	58,100	84,000

E. ECONOMIC IMPACTS: Analysis limited to initial three years following an endrin cancellation.

User:

		Estimated Change in Net Returns	
		per acre	total
Assuming current endrin users adopt Zn_2P_3 programs:	User	-$246	-$19,110,000
	Non-user	+$113	+$51,323,000
Assuming current endrin users adopt CPN-DPN-herbicides-cultural methods programs:	User	-$123	-$ 9,479,000
	Non-user	+$ 57	+$25,773,000

Market:

		Estimated Change in Value of U.S. Production	
		farm level	retail level
Assuming current endrin users adopt Zn_2P_3 programs:	Fresh apples	+$ 4,965,000	-$7,815,000
	Process apples	+$12,868,000	——
Assuming current endrin users adopt CPN-DPN-herbicides-cultural methods programs:	Fresh apples	+$ 1,575,000	-$3,962,000
	Process apples	+$ 6,555,000	——

F. SOCIAL/COMMUNITY IMPACTS: Not investigated in depth. However, loss in grower income and reduced marketings in affected areas likely to have an adverse effect on economy in localized areas.

G. LIMITATIONS OF ANALYSIS:

1. Apple production assumed to remain constant in non-endrin use areas.
2. To minimize effects of diverse orchard situations and management practices, a composite acre approach was used.
3. No quantitatively-based estimates of loss under the alternative programs were available. The crop loss estimate under the Zn_2P_3 program provided state personnel. Losses under the CPN-DPN-herbicides-cultural methods programs represent an assumption by the analyst based on limited field test data.
4. Long-term grower and industry economic impacts could not be developed due to a lack of supply-price response data. Analysis limited to three years following cancellation.
5. No data available to quantify effects of endrin withdrawal upon fruit grades in affected and unaffected areas.

H. PRINCIPAL ANALYST AND DATE:

Mark A. Luttner, Economist
Economic Analysis Branch
Criteria and Evaluation Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

years old cannot be saved by any method if girdling exceeds 33%.

Very few alternative rodenticides would be available for use by apple growers in affected areas if the use of endrin were to be cancelled. Zinc phosphide is the sole EPA registered rodenticide of sufficient efficacy to be of any use against orchard voles. Several states have obtained registrations for two anticoagulant rodenticides--chlorophacinone (CPN) and diphacinone (DPN)(EPA, 1977a). Herbicides and certain cultural practices (trunk guards, cultivation, mowing) can also be used to reduce the risk of vole damage by destroying or disrupting the voles' habitat and/or primary food sources (grasses and forbs).

State extension and research personnel have estimated that the loss of endrin and subsequent adoption of zinc phosphide bait (the sole federal registered material of sufficient effectiveness to be considered an alternative) would result in a 6.66% annual loss in apple production on the acreage currently treated with endrin. This represents a 1.0% reduction in total national apple production.

If the cancellation of the use of a pesticide results in losses in total national output of a product of sufficient magnitude to cause a measureable change in the price of the final product then several distinct groups in addition to the group which uses the pesticide are affected. The groups

which are affected are the producers of the product, including both the users and the non-users of the pesticide, the groups which market the product, and the consumers of the final product. At the production level, a redistribution of income occurs whereby the nonusers of the pesticide gain and the users of the pesticide lose money. Whenever the volume of production decreases, consumers normally lose, because they pay higher unit prices for a smaller total annual crop. In the case of apples, some peculiar and paradoxical impacts occur which are not immediately obvious to the casual observer. One effect of the cancellation of the use of a pesticide on apples would be that the total expenditures which are made for apples at the consumer or retail level are smaller. Even though this would occur, there would be a substantial gain in the total expenditures for apples at the production level. This gain in revenue at the production level is explained by an additional redistribution of income which occurs between the marketing and production levels whereby the producers of the apples gain at the expense of the marketing firms. Although this may seem unusual, this phenomenon occurs when the elasticity of demand is elastic for the product at the retail level while at the same time the elasticity of demand is inelastic at the production level. This is the case for apple markets.

Current endrin users adopting the Zn_2P_3 programs would experience a reduction in per acre net income of $69

per year during the first three years after cancellation. Total reductions in user net income are estimated at $5,336,000 per year for the initial three year period.

An analysis was also conducted based on the assumption that endrin users would adopt control programs combining CPN, DPN, herbicides, and expanded use of cultural control techniques. This assumption indicated losses equivalent to 50% of those projected to occur under the Zn_2P_3 programs (a 3.33% annual weighted average loss in production) on the affected acreage. Endrin users adopting the CPN-DPN-herbicides-cultural methods programs would experience (based on the efficacy assumption) reductions in per acre net income of $34 per year during the initial three years following cancellation. Total reductions in user net income under this program are estimated at $2,645,000 per year for the three year period.

E. Sugarcane

The use of endrin use on sugarcane, once widespread in the U.S., is now limited to Puerto Rico and to small acreages in Florida (Table 9). Current annual usage levels in Florida are estimated at 1,000 pounds endrin active ingredient applied to approxiamtely 500 acres of sugarcane (representing less than 0.2% of Florida cane acreage). This usage level indicates that endrin is applied to cane on very

few (possibly only one) Florida farms. Endrin is reportedly used in Puerto Rico for sugarcane pest control. However, an evaluation of the impact upon Puerto Rican sugarcane production resulting from the potential cancellation of endrin is not included due to a lack of data regarding current endrin usage levels.

Several alternative insecticides including azinphos-methyl, carbofuran, and monocrotophos are registered and recommended for control of the major cane pest (sugarcane borer) for which endrin is used. These alternatives have already replaced endrin in most areas where pesticide treatments for the sugarcane borer are required. The adoption of these alternatives on the remaining acreage on which endrin is used would increase pesticide chemical costs by $9.20/acre, which represents an increase in production costs of 2.8% on these acres affected. The total increase in Florida would total $4,600 per year. Farm level and aggregate impacts are not available for Puerto Rico; however, the increase in per acre production costs shoud be similar to those projected in Florida. The economic impact of cancelling this use would be minor.

Table 9

SUMMARY OF PRELIMINARY BENEFIT ANALYSIS
ENDRIN USE ON SUGARCANE

A. USE: Sugarcane

B. MAJOR PESTS CONTROLLED: Sugarcane borer

C. ALTERNATIVES:

Major Registered Chemicals: RPAR Compounds: None
Non-RPAR: Azinphosmethyl, carbofuran, monocrotophos

State/Federal Recommendations: Endrin recommended in Florida and Puerto Rico. Number of recommended alternatives: Florida, 5; Louisiana, 1; Puerto Rico, 3; USDA, 3. Hawaii and Texas do not have state recommendations for sugarcane pests.

Non-Chemical Controls: Biological control of sugarcane borers and other pests encouraged in all areas, particularly in Florida, Louisiana, and Hawaii.

Efficacy of Alternatives: Alternatives provide good control of sugarcane borers when an insecticide is required.

Comparative Performance: Available test data indicate comparable levels of control using endrin and alternatives.

Comparative Costs:

Pesticide	Pesticide Cost Per Acre
endrin	$1.91
azinphosmethyl	4.14
carbofuran	5.31
monocrotophos	3.12

Conclusion: Several non-RPAR insecticides are both registered and recommended for use on sugarcane to control sugarcane borers. Alternatives provide acceptable levels of control at reasonable cost. No problems of alternative availability are anticipated given the small increase in demand for alternatives associated with the cancellation of endrin.

D. EXTENT OF USE:

Active Ingredient Basis: Approximately 1,000 pounds active ingredient applied in Florida; some endrin is used in Puerto Rico but quantity involved is undetermined.

Units Treated Basis: Five hundred acres in Florida (less than 0.2% of Florida acreage), an undetermined number of acres treated in Puerto Rico.

E. ECONOMIC IMPACTS:

User: Cost increases for insecticides in Florida estimated at $4,600 per year, or $9.20 per acre now treated with endrin. No change in yield indicated on acres now treated with endrin following adoption of alternatives. Production cost increase of 2.6% per acre per year on affected acres. Total user impacts in Puerto Rico undetermined; however, per acre cost impact may be similar to that projected for Florida.

Market, Consumer: No impact indicated due to minor pattern of endrin use on sugarcane. No change in domestic sugar production.

Macroeconomic: No effects of importance on a macroeconomic level.

F. SOCIAL/COMMUNITY IMPACTS: Not evaluated.

G. LIMITATIONS OF ANALYSIS: Precise data regarding the quantity of endrin currently in use on U.S. sugarcane is not available; no use data is available for Puerto Rico.

H. PRINCIPAL ANALYST AND DATE: Mark A. Luttner, Economist
March 1977

F. Conifer Seeds

Endrin is widely used as a rodent repellent when conifer tree seeds are applied to prepared forest sites in the southeastern and western United States (Table 10). It is the only chemical repellent registered for this use and the USDA Assessment Team considered it essential for success in direct seeding on approximately 90 percent of the 160,000 acres direct seeded in a typical year. Until recently direct seeding has contributed 15 - 17 percent of all artificial reforestation, the remainder being reforested by planting nursery grown seedlings. The amount of endrin reaching the environment ranges from .002 - .015 lbs (a.i.) per acre, when applied at labeled rates. Most direct seeded acres receive less than .005 lbs (a.i.) per acre. The total use of endrin on direct seeding in a typical year ranges from 500-850 lbs. (a.i.).

Endrin is the only federally registered rodent repellent presently available. A petition for registration has been received to apply Mestranol on Douglas Fir Seed, commonly used in the west. The cost of treating seed with endrin is less than 10 cents per acre and the cost of Mestranol, if registered, will be from $5-10 per acre.

The impact of reforesting without the use of endrin would be approximately $20 per acre for a total estimated impact of approximately $3 million for a typical year. (See Table 10 for additional detail).

Table 10

SUMMARY OF PRELIMINARY BENEFIT ANALYSIS - CONIFER SEED TREATMENT

USE:	For direct seeding of several conifer tree species by coating seeds with endrin and other chemicals to prevent consumption by rodents.
b. MAJOR PESTS CONTROLLED:	Deer and harvest mice, wood and harvest rats.
C. ALTERNATIVES:	
Major registered chemicals:	None. Petition to register mestranol by USDI for protection of Douglas Fir seed pending.
State/Federal recommendations:	Apply coating of mixture of endrin (.5% a.i. by weight of seed) with thriam (as bird repellent) plus latex sticker (USDA - FS; Cal. Div. Of Forestry).
Non-chemical controls:	None for seed protection. Planting seedlings is only alternative reforestation method.
Efficacy of alternatives:	Mestranol slightly less effective for Douglas Fir. Tests on Southern Pine show losses with mestranol twice that with endrin.
Comparative performance:	Planting of seedlings gives greater assurance of established stand, better control of stocking and spacing, and husbands costly seed, especially from limited production of genetically controlled seed sources.
Comparative costs:	Use of mestranol increases costs of treated seed by about $6-$10 per acre and total direct seeding cost by 20-50%.
Conclusion:	Direct seeding for reforestation will practically cease until effective substitutes are registered. If mestranol registration is granted, direct seeding will continue at 30-40% of current rates. Planted seedlings will provide some substitute reforestation.
D. EXTENT OF USE:	
Active ingredient basis: (pounds a.i.)	
(a) Endrin	1973 =815 pounds, a.i.; 1975 = 485 pounds, a.i.
(b) Alternatives	None.
Units treated basis:	
(a) Endrin	1973 = 181,000 acres; 1975 = 100,000 acres (USDA, 1976).
(b) Alternatives	None.
E. ECONOMIC IMPACTS:	
User:	Direct seeding is a widely used supplement to tree planting, particularly by large corporations for their own lands and lands managed for others. State agencies and federal agencies also direct seed but federal agencies are restricted from the use of endrin by policy. Planting will be substituted for direct seeding on many of the acres presently seeded at a cost increase of 12-35 dollars per acre. For a typical recent year this cost increase for planting an estimated 145,000 acres will be approximately 3 million dollars. For many of these acres, where direct seeding is the only technically feasible method, direct seeding may be done at a much higher cost using larger quantities of seed.
Market:	No immediate impact. Failure to reforest lands for several years will eventually cause increased wood products supply problems - 30-40 years in the future. Erosion on steep sites may become an increasing problem is not revegetated.
Consumer:	None for immediate future.
F. SOCIAL/COMMUNITY IMPACTS:	Will require increased local labor (in short supply) for reforestation by planting seedlings in areas affected.
G. LIMITATIONS OF ANALYSIS:	No information is available to predict (1) revegetation of sites not reforested after harvest or burning, (2) the extent of substitution of planting for direct seeding.
H. PRINCIPAL ANALYST, DATE:	C. Dudley Mattson, Economist March 1977

IV. Development and Selection of Regulatory Options

A. Introduction

In Sections II and III above, the Agency identified the human and environmental risks associated with the use of endrin and identified the benefits associated with each of its uses. As explained in Section I, FIFRA mandates the Agency to achieve a balance between these competing considerations. In order to accomplish that goal, the Agency has identified various regulatory options and has evaluated each option for its impact on both sides of the risk/benefit equation.

This section of Position Document 2/3 describes the process which the Agency used to develop potential courses of action for evaluation and identifies the options wihch were ultimately selected for in-depth evaluation. In Section V, each optin is evaluated for each registered use of endrin, and the rationale for the final selection of an option for each use is set forth.

B. Rationale For Development of Options

In its simplest terms, FIFRA contemplates two basic options concerning the regulation of pesticides -- namely, to grant or to deny registration. For new pesticide products, these options are presently in terms of the approval or the denial of an application for registration; for previously

registered pesticide products, they are framed in terms of a decision to either cancel the registration or to allow the continued registration of the product. Both the denial and the cancellation of registration represent absolute regulatory responses insofar as they unqualifiedly prohibit the sale or the distribution of the pesticide for the use(s) at issue.

Registration, on the other hand, represents a range of regulatory options, since the Administrator may specify the terms and conditions of the registration. He may, for example, require the label and the labeling of a pesticide product to contain certain language -- such as warning and cautionary statements or directions for use -- which he considers necessary for the adequate protection of health and of the environment. He may also classify the use of a pesticide product for restricted use, and limit its application to certified applicators or to persons under their direct supervision.

Cancellation and unrestricted registration fall at opposite ends of the regulatory spectrum. The development of intermediate regulatory options involves the formulation (and/or modification) of the terms and conditions of registration which are intended to reduce the risks attendant to the use(s) of the pesticide. Each option is then evaluated on a use-by-use basis to determine whether it achieves an

adequate reduction in risk without causing unacceptable economic consequences, so that the remaining benefits of the use exceed the remaining risks of that use.

C. Velsicol Risk Reduction Proposals

Velsicol Chemical Corporation ("Velsicol"), the sole domestic manufacturer of technical grade endrin, submitted a lengthy response to the RPAR on November 4, 1976, and has been in frequent communication with the Agency concerning the progress of the RPAR. In July, 1977, representatives of Velsicol and the Agency met to discuss the possible resolution of the RPAR process. At the meeting, it was indicated that classification of endrin for restricted use, together with the imposition of appropriate label modifications, might be a feasible disposition of the endrin RPAR. It was suggested that Velsicol could assist the Agency in its consideration of this option by collecting and submitting to the Agency expert technical advice concerning revisions of label directions and the development of limitations which would enhance the safety of the application of endrin.

Velsicol subsequently submitted three documents to the Agency concerning proposed label modifications. On November 11, 1977, it submitted a package containing certain proposed revisions to the endrin label, which focused on the use of endrin in apple

orchards for control of the pine vole and the meadow vole. The package also contained a compilation of expert opinions on which the proposed revisions were based, together with an explanatory summary of the rationale underlying the proposed changes.

On January 30, 1978, Velsicol submitted a second document, entitled "Report from the Technical Advisory Committee on Label Instructions For Endrin-Methyl Parathion 1.6 EC and Endrin 1.6 EC", which contained proposed revisions of the endrin labels relating to the cotton and small grain uses of endrin, designed to enhance the environmental and applicator safety of those uses. The "Technical Advisory Committee" referred to in the document's title consisted of a panel of cotton and small grain entomologists and experts on aerial application of pesticides who participated in a two-day round table discussion at Velsicol's invitation. The report itself also contained technical background material which was considered by the panel in formulating its final recommendations for label revisions.

Finally, on April 11, 1978, Velsicol submitted to the Agency a formal application for amended registration for two of its registered endrin products (EPA Registration Nos. 876-153 and 876-127). The applications for amended registration were accompanied by proposed labeling which synthesized the proposals previously submitted into a comprehensive package incorporating

what Velsicol considered to be the consensus of expert advice about the specific limitations which would enhance the safety of endrin while maintaining the major benefits of its use.

The Agency has considered Velsicol's proposed label modifications in its development of regulatory options for all registrations of endrin products. To the extent that the Agency determines that modifications to the terms and conditions of endrin registrations are necessary to prevent unreasonable adverse effects on the environment, it will develop specific label language for incorporation into all endrin labels; Velsicol's particular application for amended registration will then be evaluated for compliance with the required changes. The Registration Division will also determine the acceptability of any other additional changes to the label which Velsicol may propose in its application.

D. Risk-Reduction Methods

The process of developing the regulatory options designed to reduce the risks accompanying the use of endrin focused on the routes of human exposure to endrin and on the routes of environmental contamination from the use of endrin.

Because of the demonstrated teratogenicity of endrin, the human population of concern to the Agency consists primarily of women of child-bearing age. Women of child-bearing age may be exposed to endrin in situations which arise prior

to, during or after application. Prior to application, mixers and loaders may be exposed both dermally and via inhalation as the result of splashing, vaporization or accidential spills; during application, pilots and flag persons involved in aerial application, as well as ground applicators, may all be exposed both dermally and via inhalation, primarily as the result of drift of the endrin spray. Finally, both during and after application, bystanders (i.e., persons other than those directly involved in the application process) may be exposed both dermally and via inhalation as the result of spray drift, and via ingestion as the result of consumption of food -- principally fish -- which contains residues of endrin.

From an environmental point of view, a major problem is the contamination of fish-bearing waters with toxic amounts of endrin. Such contamination may occur as the result of either or both of two processes: drift of the endrin spray onto water bodies; and run-off of endrin from soil or foliage into the water bodies, either directly or via drainage channels. A second problem relating to environmental contamination is the existence of residues of endrin on plant parts and target species which form part of the diet of non-target species.

The Agency has considered each of these exposure situations, and has identified several methods of reducing the

potential exposures. Each method is generally discussed immediately below.

(1) Classification for Restricted Use; Limitation of Use to Certified Applicators

Under FIFRA, pesticides may be classified for restricted use and limited to use only by or under the direct supervision of certified applicators who have been determined to be competent with respect to the use and handling of hazardous pesticide products. Certification programs are, for the most part, administered by the States. These programs use various methods to determine that applicators are certifiable as competent to use restricted use pesticides.

On January 31, 1978, the Administrator classified all uses of endrin for restricted use, and limited them to use by or under the direct supervision of a certified applicator (40 CFR §162.31; 43 FR 5788, February 9, 1978). The uses were classified under the Agency's Optional Procedures for Classification of Pesticide Uses by Regulation (40 CFR §162.30; 42 FR 44170, September 1, 1977) (the "Optional Procedures"). As explained in the preamble to the Optional Procedures, the decision to classify endrin under those procedures was based on an "incremental" risk/benefit analysis established by 40 CFR §162.11(c), which requires the Administrator to compare

the incremental benefits of unrestricted use (those over and above the benefits of restricted use) with the incremental risks of unrestricted use (those over and above the risks of restricted use). In other words, the Optional Procedures focused on the risks which could be reduced by restriction as compared with the benefits which could be lost as the result of restriction. With respect to endrin in particular, the criteria of risk influencing the Agency's risk/benefit analysis were the acute dermal toxicity of endrin and the hazard it presents to non-target organisms. The predominant factor on the benefits side was the determination that the classification of endrin for restricted use would not unduly limit access to, or the availability of, endrin products.

Decisions made in the context of the Optional Procedures must be distinguished from decisions made in the RPAR process. The latter decisions require an evaluation of the overall, as distinguished from incremental, risks and benefits associated with the use of any pesticide. In the RPAR context, classification is appropriate as a regulatory response if it will avoid the need to cancel a use of a pesticide in a situation where the overall risks of the use otherwise would exceed the overall benefits of the use. (42 FR at 44170, September 1, 1977). The preamble to the Optional Procedures stated:

"Since this optional procedure only involves an incremental, and not an overall risk/benefit analysis, a decision under the optional procedure to restrict (or not to restrict) a use of a product will not in any way imply that the product will (or will not) ultimately satisfy the statutory standards governing registration or reregistration." (Id.)

Thus, the Administrator must reevaluate the adequacy of the reduction in risk achieved by the classification of endrin for restricted use in the context of the overall risk/benefit analysis undertaken during the RPAR process.

(2) Reduction of Dermal Exposure By Use of Protective Clothing

The populations with the greatest potential dermal exposures to endrin consist of persons who are directly involved in the ground application of endrin, and persons who are involved in the mixing, loading and transfer operations related to both aerial and ground application. The Agency has noted that one drop of endrin (1.6 EC) on the skin, if totally absorbed, is equivalent to an exposure of 10 milligrams of endrin (EPA, 1978b). Since such an exposure would result in a margin of safety of approximately 10 for teratogenic effects, the Agency believes that it is both necessary and prudent to explore means for reducing or eliminating the possibility of direct dermal contact with endrin.

Such reduction can best be accomplished by a requirement that women involved in these operations wear appropriate protective clothing. Such clothing is described in Section V.

(3) Reduction of Inhalation Exposure By Use of Respirators

Women involved in mixing, loading and transfer operations and women involved in the actual application of endrin -- including pilots, flag persons in the field, and other ground personnel -- are faced with an additive risk of teratogenicity from inhalation exposure to endrin.

The Agency believes that significant reductions in inhalation exposure will be achieved if all such persons comply with the current requirement to wear full-face air-purifying pesticide respirators of the type jointly approved by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration.

(4) Reduction of Exposure By Minimization of Drift

As discussed above, drift of endrin spray may result in human exposure (of by-standers as well as those involved in application or related operations) and in significant environmental contamination. With respect to the latter, drift of endrin spray may result in deposition of toxic amounts of endrin onto water bodies containing fish, and may

also result in deposition of endrin on plants and other organisms which constitute part of the diet of a non-target species.

The principal factor controlling drift is particle or droplet size. Any spray technique will ordinarily produce a range of droplet sizes; drift is the airborne component of the spray, and may generally be defined as that portion of the spray distribution which is released in droplets initially below 100 microns in diameter (EPA, 1978b; Akesson, 1977). Since the number of droplets below 100 microns in diameter decreases as the overall average droplet size increases (e.g., by using a coarse spray with relatively large average droplet size instead of a fine spray with smaller average droplet size), one method for reducing the drift component of endrin spray applications would be to utilize engineering controls to increase average droplet size. However, droplet size is also a parameter of the efficacy of the application, and a larger droplet size may result in reductions in target coverage. Accordingly, to the extent that engineering controls are considered as a feasible method of reducing the airborne drift component of endrin spray applications, an optimum droplet size distribution would have to be achieved.

A second factor which affects potential exposure from the drift of endrin spray is the distance from the point of application, since the amount of drift which is deposited decreases as the distance from the point of application increases (EPA, 1978b). Accordingly, another method of reducing the potential exposure from drift of endrin spray would be to prohibit the application of endrin -- depending on droplet size distribution -- within certain distances from specified areas.

Finally, other factors are relevant to the dispersal of drift, such as the climatic conditions prevailing at the time of application (e.g., wind velocity), and the height at which the spray is released. General limitations and instructions concerning these factors would also be appropriate in order to minimize the potential exposure from drift.

(5) Reduction of Environmental Contamination By Minimization of Run-Off

The second, and perhaps more significant, source of environmental contamination is the run-off of endrin from treated areas into water bodies. Some run-off may go directly into the affected water body (e.g., from a treated field immmediately adjacent to the water body); other run-off may be more indirect, going first into drainage channels that may normally be dry.

Unlike the situation with drift, engineering controls on application equipment can not reduce the potential for run-off. For some uses the potential for run-off may be reduced by prohibiting application of endrin when rainfall is imminent and by a prohibition against the application of endrin within a specified distance from water bodies. In addition, a distance restriction would reduce the total number of acres treated with endrin, thus reducing the total amount of endrin susceptible to run-off.

(6) Reduction of Ingestion Exposure

Although the total dietary burden of endrin residues is not of concern to the general population, a high potential for exposure to endrin via ingestion exists for women or non-target organisms eating fish which have accumulated either sublethal or lethal amounts of endrin. The best means of reducing such potential exposure obviously would be to reduce the occurrence of such residues in the fish; this in turn would best be accomplished by the minimization of environmental contamination from run-off and drift.

With respect to other potential food chain exposures, an additional precaution may be taken -- namely, to require the clean-up of certain endrin-related kills of vertebrates, both intentional (as in bird control) and accidental, in order to prevent exposure to predatory animals which might feed upon the victims.

E. Regulatory Options Selected

The Agency has selected three general options for the ultimate registration decision, to be considered and evaluated in Part V on a use-by-use basis. In selecting these options, the Agency first chose both the least restrictive option -- continued registration as a restricted use pesticide -- and the most restrictive option -- cancellation of each use of endrin. The Agency then fashioned an intermediate option between these regulatory extremes, which focused on modification of the terms and conditions of registration of each endrin use. In developing this third option, the Agency necessarily exercised its discretion in its choice and consolidation of terms and conditions of registration. The Agency believes that these three options adequately address all of the relevant concerns relating to the use of endrin.

The alternatives selected are as follows:

(1) Continue Registrations as Restricted Use Pesticides

Under this option, a use of endrin would be registered in the same manner and with the same restrictions that are currently in effect, and no additional regulatory action would be taken to reduce any risk which accompanies that use endrin. The use of endrin would continue to be limited to certified applicators (or persons under their direct supervision) who have been demonstrated to be competent in the use and handling of pesticides.

(2) Modify Terms and Conditions of Registrations

Under this option, the terms and conditions of registration would be modified for each use in order to reduce the risks which accompany that use. Generally, the modifications fall into four major categories.

The first set of modifications are intended to reduce the risks to the certified applicators involved in the application process and to women involved in related operations such as mixing, loading and transfer. Specifically, protective clothing covering essentially all of the body surface would be required for women during application and during all phases of mixing, loading and other transfer operations. The protective clothing would consist of impermeable gloves, boots or boot covers, long sleeved shirt and pants, and would significantly reduce the high potential for dermal exposure during these operations.

The second set of modifications focus on the cautions and warning statements and other language designed to educate the user in the hazards associated with the use of endrin. First, a specific warning to women is necessary to reduce teratogenic risk. Second, a statement warning against prophylactic use of endrin should be included for uses for which unnecessary prophylactic application is a

common practice. Prophylactic use of endrin may not only result in unnecessary environmental damage, but may also reduce future endrin efficacy by increasing target pest resistance to endrin. Third, appropriate labels should contain warnings and directions concerning the disposal of certain vertebrate animals (whether or not they are target species) which are killed as the result of exposure to endrin. Such modifications would help prevent the secondary poisoning of non-target species. Moreover, the label should contain warnings designed to prevent consumption of fish contaminated by endrin.

The third set of modifications are specifically formulated to reduce the risks associated with endrin by focusing on application techniques and the conditions of application. In particular, in order to reduce the environmental contamination and human exposures which are associated with the drift of endrin from target areas, this option would reduce the airborne drift component of endrin spray applications by increasing the average droplet size produced by application equipment. Label directions for use would, whenever possible, prescribe ranges of nozzle sizes and nozzle presures on specific types of application equipment

(both aircraft and ground); otherwise, they would describe other conditions which would achieve the desired range of droplet sizes. Further, aerial applications would be prohibited when wind speeds do not fall within a specified range, and a maximum height for release of the spray would be prescribed.

Finally, the fourth set of modifications would impose, whenever feasible, prohibitions against the use of endrin within specified distances from designated bodies of water, human habitations, or other areas requiring protection.

(3) Cancel Registrations

Under this option a specific use (i.e., site/pest combination) of endrin would be prohibited. Where a crop is grown under a relatively wide range of environmental conditions, however, the risk/benefit picture may vary accordingly. In such circumstances the Agency may conclude that cancellation is an appropriate option in some areas while continued registration is appropriate elsewhere. Where feasible, therefore the Agency may determine that a partial cancellation of a use on a geographical basis is a viable option.

V. Impact of the Major Options

A. Introduction

This section presents and evaluates the regulatory options for each use of endrin and determines which option produces the most favorable balancing of the risks and the benefits of its use.

B. Investigation of the Impacts of Regulatory Options for Each Use of Endrin

1. Cotton

a. General Information

More endrin is used for cotton than for any other use. Recent information from Velsicol (Sec. I) indicates that the use of endrin on cotton declined substantially in 1976, but that usage has remained relatively constant since then. The information on current use was used to update the impact analysis.

The importance of endrin as a cotton insecticide is relatively minor, since the 150,000 acres on which endrin is used represent less than 1% of the total number of acres planted with cotton which are treated with insecticides. The use of endrin as an insecticide on cotton is not a common practice throughout the Cotton Belt. Instead, its use is concentrated in the States of Alabama, Arkansas, Florida, Georgia, and Mississippi (EPA, 1977a). Although EPA currently registers endrin for use on numerous insects (see

Sec. III), its primary use has been to treat the tobacco budworm (Heliothis virescens) and the cotton bollworm (Heliothis zea). Only two states, Mississippi and Alabama recommended the use of endrin on cotton in 1978, specifically for the control of Heliothis. EPA currently registers a total of 18 pesticides for the control of bollworms (Thomas, 1978). Five new pesticides, including synthetic pyrethroids, have pending registrations.

b. Comparative Risks of Current Use

(1) Human.

The risks to humans from the use of endrin on cotton are limited essentially to the potential teratogenic effects which may be caused by exposure to drift from nearby fields during treatment and from eating fish which are contaminated with endrin (Sec. II). The margins of safety associated with such exposure (880 and 375, respectively) indicate that some teratogenic risks to humans could reasonably be anticipated.

The major alternative to endrin, EPN, is under RPAR review because the Agency has reason to believe it causes neurotoxic effects and may cause irreversible eye problems in humans. EPA has issued a RPAR of the second most likely alternative, toxaphene, because it appears to cause oncogenic effects in rats and mice. The assessment

of the risks for these effects is not yet available The other most likely substitutes for use on bollworms, acephate, monocrotophos, and methomyl, do not appear to have toxicological properties that meet or exceed RPAR criteria for risks to humans (Burnam 1978a). The use of these alternatives could reduce risks.

(2) Fish and Wildlife

As indicated in Section II, endrin is highly toxic to fish and other aquatic organisms. The predictable relationship between the use of endrin on cotton and fish kills is verified by PERS reports. This adverse effect is recognized by users (Sears, 1978). However, the information which is available does not permit an accurate quantification of the frequency and the magnitude of the fish kills in relation to the use of endrin. Although the Agency concurs in the assessment of the FWS (Greenwalt, 1978) that the use of endrin has not jeopardized the continued existence of the brown pelican, it concludes that a substantial potential for risk to this endangered species nevertheless does exist, since the concentrations of the residues of endrin which were found in the dead brown pelicans (up to 0.7 ppm in the brain) are so close to the concentrations which are known to be lethal for other species of birds (0.8 ppm and greater).

EPN, the most likely alternative to endrin for use on cotton, poses less of an acute risk to aquatic organisms then does endrin. However, EPN has a relatively

high potential for causing chronic effects in aquatic invertebrates. The Agency has found that these chronic effects are not readily assessed (Bushong, 1978). The Agency judges EPN to be less hazardous than endrin for terrestrial organisms (Bushong, 1978).

The Agency has issued a RPAR of toxaphene, the next most likely alternative, because its use causes reductions in the populations of nontarget aquatic, avian, and mammalian species. Compared to endrin, the use of toxaphene on cotton has less potential for causing acute effects in aquatic organisms, but its greater persistence in the environment and the fact that it causes chronic effects in fish appear to make the total risks from toxaphene equal to or greater than those of endrin (Bushong, 1978). Similarly, while limited field evidence suggests that endrin may be more acutely hazardous than toxaphene to terrestrial organisms, more bird deaths are anticipated to occur from toxaphene-laden fish than from endrin-laden fish based on incident records and accumulated data (Bushong, 1978). Hence toxaphene is not a desireable substitute for endrin from an environmental point of view.

The information on other alternative pesticides which is necessary to assess comparative risks is generally less adequate than that for toxaphene. Using laboratory data as a basis, EPA scientists have judged that acephate, monocrotophos, and methomyl pose less of an acute risk to

fish and to aquatic invertebrates than endrin. The risk of chronic effects occurring in aquatic invertebrates from the use of methomyl is relatively low. The Agency has not yet found it possible to assess the risk of of chronic effects from the use of acephate (Bushong, 1978). The Agency expects that the use of monocrotophos on cotton would cause a significant increase in avian mortality and that the use of both methomyl and EPN would be safer materials for terrestrial verebrates than endrin. The Agency has not yet found it possible to assess the risks to terrestrial vertebrates from the use of acephate (Bushong, 1978). In summary, the Agency believes that the information which is currently available indicates that substituting toxaphene for endrin for use on cotton would not reduce the risks to fish and wildlife, but that a substitution of a mixture of the other alternative pesticides would do so.

c. Benefits of Current Use

In order to assess the benefit which endrin provides for controlling the cotton pest, Heliothis it is necessary to predict which practices of pest control farmers would most likely use to replace endrin if it were not availble. The Agency measures the benefit which endrin provides by comparing the costs of using endrin with the costs of using its alternatives.

First, it is necessary to identify those practices and second, they must be allocated over the current endrin treated acreage. Several insecticides are available if endrin were cancelled. Of the RPAR choices, toxaphene and EPN are the most commonly used. The most likely candidates from the non-RPAR group include monocrotophos and methomyl.

The acreage distribution of these alternatives was obtained from their proportional use based upon data from Mississippi (See Section III B). To summarize, the alternative insecticides and the treatment acres used to estimate benefits are as follows:

Insecticide	Treatment Acreage Replacing Endrin AC.	% of Endrin Acreage
Toxaphene	178,125	25
EPN	399,000	56
Monocrotophos	78,375	11
Methomyl	42,750	6
New Insecticides available under Sec. 18	21,375	3

The benefits of endrin can be estimated by analyzing changes in the costs and yields associated with the use of the alternatives. The investigation of cost and yield changes are presented in Section III.

(1) The average increase in cost per each treatment is $1.00.

(2) The average increase in cost per acre which includes all treatments in the season is $4.75 or less than 3% of total production costs.

(3) The average increase in cost per farm per year is $815.00.

(4) The total increase in cost to all cotton growers is $717,850 per year.

(5) No improvement in yields can be expected from endrin compared with the alternatives.

In summary, due to the combined effect of small savings in cost and the few number of farms and acres so affected, the following can be concluded about endrin's benefit in cotton production:

1. There will be no change in cotton prices or supply due to the presence or absence of endrin. Therefore, no adverse effects would occur in overall agricultural production and no adverse effects would occur to consumers of the final products made of cotton if endrin's use were cancelled.

2. There are small savings in costs to cotton farmers who use endrin. Since the national supply and the price of cotton will remain unaffected, the costs of a cancellation will accrue only to the users of endrin.

In conclusion, the use of endrin as an insecticide on cotton is minor. Its absence would alter neither the national supply nor the price of cotton. The affected persons would be limited to a few users and the manufacturer.

d. Impacts of Alternative Regulatory Options

1. Option 1: Continued Registration with No Further Restrictions

The Agency classified endrin for restricted use in 1978. Any possible impact of this classification must be considered in the risk/benefit analysis. Endrin has not been readily available for use on cotton except to those users who seek certification. The Agency generally expects the certification program to encourage greater responsibility on the part of applicators, which would thereby reduce the occurence of adverse effects. However no substantial reduction in run-off potential can be expected from this classification alone. Since run-off is the major route of exposure to fish, this option is not sufficient to adequately address the concerns for the risks to aquatic populations, the subsequent teratogenic risks to humans and the teratogenic risks to female applicators.

Under this option, the benefits of endrin would not be changed because no real restrictions which are likely to reduce its allowed uses or the acreage treated have been imposed.

2. Option 2: Continued Registration with New Restrictions

To assess this option, the Agency evaluated the impact of each of the sets of label modifications described in Part IV of this document. The types of restrictions assessed included worker safety requirements, applica-

tion directions, distance restrictions from bodies of water and human habitation, and warnings with respect to the risk of teratogenicity.

(a) Protective Clothing and Respirators

The Agency determined that requiring female mixers, loaders, flagpersons, and applicators to wear more specifically defined protective clothing and respirators than the current labels require would reduce dermal and inhalation exposures (EPA, 1978b). The following additional clothing and respirator requirements were assessed for their impact on mixers and loaders, flagpersons, and ground applicators as appropriate: closely woven clothing with long sleeves and long pants, impermeable boots and aprons, full-face respirators of the type jointly approved for pesticide spray applications by the Mining and Safety Administration (formerly the U.S. Bureau of Mines) and by the National Institute for Occupational Safety and Health and wide-brimmed hats.

The economic impact of the above requirements is likely to be insubstantial. The clothing and respirators are inexpensive and since current label restrictions impose restrictions upon method of application, it is likely that many applicators already own the equipment and clothing evaluated here.

(b) Cautionary and Warning Statements

The Agency assessed the impact of additional cautionary and warning statements of the following types: warnings with respect to excessive use of endrin and warning with respect to the teratogenic effects of endrin. The teratogenicity warning would state:

Warning to Female Workers

> Excessive exposure to endrin may cause birth defects. Female workers must be sure to wear all protective clothing and equipment specified on this label. In case of accidental spills or other unusual exposure, cease work immediately and follow directions for contact with endrin.

The Agency believes that some reduction in risk will be achieved by the education of the user about the potential effects of unnecessary use of endrin and about the possibility of secondary poisoning of humans and non-target speciies. The cost associated with these risk-reduction measures would be negligible.

The warning with respect to teratogenic effects would reduce risks to female applicators who may be pregnant by requiring the use of more specific protective clothing and respirators. The cost of this restriction, too, would be minimal.

(c) Equipment and Application Directions

The Agency considered the impact of directing that application be made only when wind velocity is between 2 and 10 mph and containing the following instructions:.

> Aircraft Applications: Do not apply at less than 2 gallons total mixture of water and chemical per acre. Do not operate nozzle liquid pressure over 40 psi (pounds per square inch) with no fan nozzle smaller than 0.4 gallons per minute (gpm) or fan angle greater than 65 degrees such as type 6504. Do not use any cone type nozzles smaller than 0.4 gpm nor whirl plate smaller than #46 such as type D4-46 or no other atomizer or nozzle giving smaller drop size. Do not release this material at greater than 10 ft. height above the crop.
>
> Ground Applications: For use with boom-nozzle ground equipment. Apply at not less than 5 gallons total mixture, water and chemical, per acre. Do not use nozzle liquid pressure at greater than 40

psi (pounds per square inch). Do not use cone nozzle size smaller than 0.16 gpm at 40 psi such as type D2-25 or TX-10, or no other atomizer or nozzle giving smaller drop size.

d. Distance Restrictions. The Agency considered prohibiting application of endrin within areas adjacent to water bodies and human habitation as a possible regulatory option. The questions raised in any consideration of distance restrictons are: "How much acreage will be excluded from treatment by various distance restrictions? To what extent can risks from drift and run-off be reduced by a distance restriction from bodies of water? To what extent would benefits be reduced by a distance restriction?

The Agency attempted to evaluate the impact that a distance restriction would have on treatable acreage by the following methods. The Agency asked extension

personnel from the States of Alabama, Arkansas and Mississippi (the major areas of endrin use on cotton) to identify two areas within their respective states where the restriction on distance from water would have the most and the least influence on treatable acreage. U.S. Geological Survey 7.5 min. topographic maps were then used to locate 25 sq. mi. plots covered by aerial photographs on file at the Environmental Photographic Interpretation Center (Holtorf, 1978). The proportions of the total cropland located within 1/8 and 1/4 miles of water bodies were then measured.

The results of the above procedures indicated that, even in areas judged to be least affected by the restriction, about 65% of the acreage would be eliminated at 1/8 mile and more than 90% at 1/4 mile. Under the criteria employed to define water, which included intermittent streams, it is clear that a 1/4 mile restriction in these cotton states would be tantamount to a cancellation since the restriction effectively eliminates virtually all treatable acreage.

On learning of the Agency's results, Velsicol engaged Dr. Norman B. Akesson to reassess the Agency's results employing a more conservative definition of "any

body of water" and included "only perennial bodies of water and not intermittent streams, ponds or drainage systems" (Ebner, 1978). Thus, in five of the areas previously analyzed by the Agency, Akesson (1978) estimated that from 30 to 90 percent of the total land area could be treated while maintaining a 1/4 mile distance from bodies of water as defined. The average treatable acreage was 62 percent and this deviates substantially from the Agency's estimate of less than 10 percent. Velsicol's estimate, however, is probably too low because, among other reasons, ponds were not included in the analysis.

In order to reach the conclusion that a 1/4 mile distance restriction would reduce substantially the risk of endrin to aquatic organisms, information would be required on the extent of past and current application practices in the 1/4 mile zone and on the extent to which transport by drift and by run-off would be reduced. Available data permits realistic approximations of the impact of a distance restriction on drift reduction to be calculated, and this data indicates that a distance

restriction can substantially reduce contamination of water from drift. (EPA, 1978b). Further, a distance of about 150 yards from the point of application would increase the MOS to approximately 5500, and this provides an ample margin of safety from the teratogenic risk associated with drift.

For the cotton use, run-off, rather than drift, is the principal source of contamination. The Agency does not have information showing the impact of a distance restriction on runoff reduction. The Agency has information indicating that to bring endrin concentrations in water to below lethal concentrations for the most sensitive species of aquatic organisms, a distance restriction would have to reduce concentrations of endrin in water 1000-fold (EPA, 1975). In the absence of data to the contrary, the Agency must assume that a 1/4 mile distance restriction would not reduce significantly the risk to aquatic organisms associated with run-off of endrin in areas of high rainfall.

3. Option 3: Cancellation

If the registration of endrin for use on cotton were to be cancelled, the risks and benefits associated with this use would be eliminated. EPN and toxaphene are the most likely substitutes for endrin and several potential risks attributed to these compounds have been identified. The Agency is currently assessing these risks but their significance is not now known. EPN may cause nerve damage, eye problems and adverse effects on aquatic organisms. The Toxaphene RPAR Notice cited oncogenic effects in rats and mice, other chronic effects and reductions in nontarget populations of aquatic, avian and mammalian species. Non-RPAR alternatives (methomyl, acephate, and monocroptophos) do not appear to meet the RPAR criteria for risk for health effects, although some environmental risks could be expected (Bushong, 1978). On balance, the cancellation of the registration of endrin for use on cotton is likely to result in a net reduction of risks.

4. Selected Options: (a) Option 3: Cancellation of Registration for Use in Areas with High Potential for Aquatic Contamination; (b) Option 2: Continued Registration with New Label Restrictions for Areas with Low Potential for Aquatic Contamination

Cotton is grown under a wide range of climatic conditions, and the potential for contaminating bodies of water from the use of endrin is not uniform. While the Agency's major analysis focused on the use of endrin in Alabama, Arkansas and Mississippi, where risks from runoff are high, some endrin is used in areas such as Oklahoma (Sears, 1978) where this risk would be lower.

The potential for aquatic contamination is a function of both run-off potential and the relative abundance of fish-bearing waters. In delineating this area of concern, the Agency took several factors into account: run-off potential (Stewart, 1975); the existence of fish-bearing waters; the geographic distribution of cotton-growing areas; and the feasibility of establishing enforceable demarcation lines. In general, the Agency determined that the potential for aquatic contamination is greatest in the southeastern United States and least in the southwestern United States.

(a) Cancellation of Registration for Use in Areas with High Potential for Aquatic Contamination

The Agency reviewed the option to continue registration without further restrictions on the label and rejected it. Current use practices result in large numbers of fish kills. The presence of fish kills implies a probable teratogenic risk to women of child-bearing age who eat fish contaminated with endrin. The benefits of continued use were found to be quite small and to accrue only to users. However, these users have several viable alternatives. To some unknown amount, the benefits of use are offset by residues of endrin in the soil translocating to oil crops, by adverse effects to commercial catfish, and by any decline in recreational fishing associated with endrin contamination. In view of the relatively small benefits, the risks were found to be unreasonable under this option.

The Agency considered numerous restrictions short of cancellation to reduce the risk from the use of endrin. The Agency's major risk concern is the contamination of water from the run-off of endrin and the subsequent impact on aquatic life and on women of child-bearing age who may eat fish contaminated with endrin. The Agency considered various restrictions on the distance from the point of application to bodies of water.

The Agency has concluded that there is no factual basis for determining that a reduction in risk from run-off associated with the distance restrictions considered would significantly reduce the risk to fish and other aquatic species. The Agency estimates that a 1/4 mile distance restriction would preclude the use of endrin on a high percentage of acreage treated with endrin (Holtorf 1978). The Agency finds that a distance restriction would take away a substantial portion of the present low benefits from the use of endrin on cotton.

The Agency has decided to cancel the registration of endrin for use on cotton areas with high potential for aquatic contamination. The Agency believes that the use of endrin in these areas will result in substantial reductions in populations of fish and other aquatic organisms and carries with it a risk to pregnant women from eating endrin-contaminated fish. The Agency has concluded that no feasible regulatory option less severe than cancellation will result in reductions of these risks to acceptable levels.

Accordingly, use of endrin on cotton is cancelled in the following areas: all states east of the Mississippi River, Arkansas, Louisiana, Missouri, and east of Interstate Highway #35 in Oklahoma and Texas. Interstate Highway #35 was selected as a demarcation line because it approximately separates the regions of high and low risks, and because it is an enforceable and recognizable boundary line.

(b) Continued Registration with New Label Restrictions for Areas with Low Potential for Aquatic Contamination

In areas of low potential for aquatic contamination there is some risk to aquatic organisms from drift and runoff to pregnant women from drift, and from ingestion of contaminated fish. The current level of benefits is relatively low. The Agency proposes that registration for use on cotton west of Interstate Highway # 35 be continued with new restrictions. The Agency has determined that the benefits of use will exceed the risks only if new restrictions are proposed.

Because the use of endrin on cotton in areas with low potential for aquatic contamination and its use on wheat pose similar risks, the same restrictions should apply to both uses. These restrictions will be discussed below in greater detail (pp. 144-148).

2. Small Grains

a. General Information

Historically, wheat and other small grains have ranked second to cotton in terms of pounds of endrin applied annually. The most recent estimates indicated that up to 250,000 pounds of endrin are applied to treat 1.1 million acres of wheat each year (EPA, 1977a). The application rate for wheat is approximately two-thirds that of cotton or 0.25 pounds of active ingredient per acre. Outbreaks of the major target pests (army cutworm, Euxoa auxiliaris and the pale western cutworm, Agrotis orthogonia) at economic thresholds are not yearly occurrences on all acreage subject to infestation and endrin is generally applied only in response to imminent damage by pests (EPA, 1977c).

The use of endrin on wheat appears to be limited primarily to the major wheat-growing states of the mid-west. The states identified in the Benefit Analysis are Colorado, Idaho, Kansas, Montana, Nebraska, Oklahoma, South Dakota and Wyoming. For control of the army cutworm, two additional insecticides are registered. These insecticides are toxaphene, currently under RPAR review, and endosulfan. Although the army cutworm infests more acreage than the pale western cutworm (690,000 acres and 415,000 acres, respectively), the latter pest is of greater concern because no federally registered alternative pesticides currently exist for its control.

b. Relative Risks of Current Use

(1) Cutworms. The main basis for the Agency's concern, as indicated above (Sec. II), resulted from emergency control for an outbreak of army cutworms in Kansas and Oklahoma in 1976 and alleged misuse by aerial applicators not familiar with the region. Additionally, residues of endrin found in

certain bald eagles (Section II) suggest that local fish kills from the use of endrin on winter wheat are probably not rare. To the extent that humans may consume fish bearing high concentrations of endrin residues, some teratogenic risk (MOS=360) is to be expected (Burnam, 1978c). Excessive exposure from drift is unlikely from this use for reasons cited previously in Section II.

There are no registered alternatives for control of the pale western cutworm. For the army cutworm, toxaphene is the alternative in most widespread use, and, in addition to being a possible oncogen, its risks to fish and wildlife may equal or exceed those of endrin. Endosulfan is judged to be a safer alternative (Burnam, 1978a, Bushong, 1978) but this compound has not been used extensively on wheat (EPA, 1977c).

(2) Chinch bugs. The use of endrin to control chinch bugs in barrier strips poses no special exposure problems for applicators or bystanders. The use of protective clothing is sufficient to reduce the teratogenic risks to acceptable levels. Contamination of water by drift is essentially precluded since the strips lie between two areas

of cropland and application is by low pressure ground equipment. However, a fish kill associated with this use occurred in 1978, following a 3-inch rain (J. Stewart, Velsicol, pers. comm.). Some risk to wildlife is probable (Bushong, 1978) especially since the timing of the application in early summer coincides with the presence of young birds that feed mainly on insects.

Alternatives to endrin for controlling chinch bugs on wheat include methyl parathion, parathion, and toxaphene whose risks to wildlife might approximate those of endrin. The purpose of the barrier strip is to reduce the migration of chinch bugs from wheat to other crops, especially sorghum. Since endrin is not registered for use on sorghum, pesticides registered only for use on sorghum are not alternatives for endrin on wheat.

(3) Grasshoppers. A single state registration (Montana) for this use existed at the time the RPAR Notice was issued. Velsicol has defended this use (Ebner, 1977). Under Section 24(c), several State registrations for grasshopper control on wheat and non-crop land were received by the Agency in

1978. Velsicol's labels for these new registrations impose 1/4 mile distance restrictions from bodies of water and habitation for humans and domestic animals. Such restrictions virtually preclude excessive human exposure, but the Agency is concerned with possible hazards to wildlife that may consume contaminated insects and with residue levels that may exist in game birds consumed by humans. No firm basis for this concern is available. The Agency is assessing the possibility of monitoring wildlife species associated with grasshopper control (Kutz, 1978) and will use any such information in a future assessment of risks from this use.

Alternatives for grasshoppers are malathion, parathion, phorate, and toxaphene.

(4) Undefended Pests. Endrin 1.6 EC labels also include armyworms, fall armyworms and cutworms. The use of endrin to control these pests was not defended by any response to the RPAR notice. Risks from these uses appear to be similar to other uses on wheat.

Alternatives for armyworms are malathion, methyl parathion, parathion, toxaphene, and trichlorfon. Trichlorfon is RPAR candidate under review for possible oncogenicity in mice, teratogenicity in rats, mutagenicity in microorganisms, and possible bone marrow effects.

Alternatives for fall armyworm are methyl parathion, and toxaphene. Alternatives for "cutworms" include endosulfan (army cutworm), methyl parathion, parathion, (including climbing cutworms), toxaphene (including climbing and surface feeding) and trichlorfon (variegated and surface feeding). With the exceptions of toxaphene and trichlorfon, which are under review, the other alternatives appear to pose less chronic risk to humans than endrin.

(5) Pests Listed on Endrin-methyl parathion formulations. Pests included on various endrin-methyl parathion labels and controllable by methyl parathion alone include aphids, greenbugs, winter grain mites, brown wheat mites, barley thrips, false chinch bugs, Say plant bugs and leafhoppers. The Agency is not aware that the presence of endrin contributes significantly to the efficacy of methyl parathion for the control of these pests (Ludvik, 1978i) and the use of endrin to conrol these pests was not defended in any response to the RPAR notice. Methyl parathion alone is not known to have a teratogenic potential (Burnam, 1978a) and thus has a lower risk potential than endrin. Risks to fish and wildlife from methyl parathion are generally less than for endrin.

c. Benefits of Current Use

In the Benefit Analysis, investigations of economic impacts were conducted separately for the army cutworm and the pale western cutworm (EPA, 1977a). The comparative cost analysis for control of the army cutworm provided the following estimates for replacing endrin with alternatives (1976 costs):

1. Total increase in cost per treated acre per year - $1.66-1.94 (only one treatment per season is applied)
2. annual increase in cost per farm during years of army cutworm infestation $332-388
3. total increase in costs per year $1.1-1.3 million

The unavailability of endrin to control the pale western cutworm would result in no pesticide treatment since there are no other federally registered pesticides for this pest.

The effects of a cancellation of endrin on wheat yields and quality were investigated. For control of the army cutworm no yield or quality effects were expected with the switch to alternative controls. Since there are no alternatives for the pale western cutworm, yield loss would be expected. During years of low infestation yield losses were estimated to be between 2.4 to 4.2 bushels per acre on the infested acreage. In years of high infestation,

which occur relatively infrequently, yield losses could be 15 bushels per acre. No effect on quality of wheat would be expected. The added cost per acre per year would range from $26 to $44. On a per farm basis added costs would vary from $7000 to $16,000 per year.

In summary, the total increased costs due to the increased cost of pest control and to lower yield would be about $15 million on an average annual basis. The loss in total wheat production, 0.28 percent of the national crop, would have an inperceptible impact upon the price of wheat as would the maximum annual loss of 1.5 percent. As a result there would be no effect on consumer prices of products made from wheat. In summary, the impact of a cancellation accrues to the user of endrin.

The function of a barrier strip is to reduce the movement of chinch bugs from maturing wheat into other crops, especially sorghum. The merits of this use rest solely on the extent to which such treatment reduces the need for treating the crops to be protected. The Agency has no basis for concluding that a single application of endrin in a barrier strip reduces the movement of chinch bugs so effectively as to substantially reduce the need for treating the protected crop and therefore believes that the benefits from this use of endrin are very small. The use

was defended only by Dr. Leroy Brooks (1976) of Kansas and the absence of more widespread support suggests that this use is not considered to be generally important (Ludvik, 1978 g and k).

The use of endrin to control grasshoppers in Montana was defended by Velsicol (Ebner 1978) and by users (Ludvik, 1978 d and f). The widespread eruption of grasshoppers in 1978 has elicited additional concerns for this use of endrin. The Agency has no data which can be used to evaluate the benefits conferred by this use of endrin.

The use of endrin to control armyworms, fall armyworms, cutworms, and the several pests listed on certain endrin-methyl parathion formulations were not defended. In the absence of relevant information, the Agency assumes that the benefits from these uses if endrin are negligible.

d. Impacts of Alternative Regulatory Options

(1) Option 1: Continued Registration with No Further Restrictions

Risks to fish and consequent risks to wildlife and humans from control of army and pale western cutworms on wheat are mainly associated with drift. It is expected that restricted use classification will help to reduce risk due to drift by informing the applicators of the concerns. However, winds of 10 mph or greater are common in the Great Plains where endrin is used. Growers apply economic thres-

hold techniques as a guide to timing endrin applications, waiting until damage is apparent from these cutworms before treating (EPA, 1977c). As a consequence, endrin may need to be applied when wind conditions are unfavorable.

The benefits of continued registration are as outlined above. Briefly, the benefit is primarily to the user in terms of both savings in total production costs and gains in income from higher yields. In summary, a principal use of endrin would be maintained but exposure to endrin, primarily from drift, remains.

Continued registration for use on chinch bugs would expose wildlife along crop borders to large numbers of dead and dying insects and occasional run-off from summer storms is possible. The benefits from this use appear to be negligible.

Lack of information on the risks and benefits of continued registration for grasshopper control has prevented a final assessment. Risks to man and to the environment from the use of endrin to control other pests have not been balanced by demonstrable benefits.

(2) Option 2: Continued Registration with New Restrictions

Improved requirements for protective clothing and the addition of a warning statement can reduce teratogenic risks to workers. These requirements are at pages 122-124. Improvements in equipment and application directions indicated on pages 124-125 can help to

control drift. Restricting application to within 150 yards of human habitation will limit dermal exposure and therefore teratogenic risks to bystanders to an ample margin of safety. In the Great Plains, drift rather than run-off is the major factor contributing to water contamination (Coppage, 1978). A 1/4 mile restriction would limit risk to all but sensitive species in shallow ponds or marshes (EPA, 1978b, Coppage, 1978). It is the Agency's opinion that this distance restriction should be applied to permanent streams, lakes, public waterways and commercial fish ponds. Private ponds are intentionally excluded from the restriction but are to be protected by the label precaution, "Application within 200 yards of ponds may result in fish kills."

The rationale for exempting private ponds from any distance restriction is that most such ponds are owned by the grower (Coppock, 1976). In general, the value of the wheat protected within 1/4 mile of a pond may greatly exceed the value of the potential fish loss and the Agency believes that the grower should have the option of choosing between fish and wheat when these are both owned by the same individual.

However, fish kills pose a potential for causing additional adverse effects to bald eagles and to such other forms of wildlife which may be attracted to the dead fish. In addition, surviving fish may bear residue levels that pose teratogenic risks to humans. Accordingly, the Agency believes that the following statements should be

included on the label, "In case of accidental fish kill, fish must be collected promptly and disposed of by burial." and "If ponds have been contaminated by drift or runoff, post No Fishing, Contaminated signs for a one-year period." A period of one year provisionally is based on the fact that endrin is absorbed by particulate matter and deposited in sediments, and contaminated fish lose endrin residues rather rapidly when placed in clear water in the laboratory (Argyle et al, 1973). The rate of residue elimination in the field is unknown but three or four months after the 1976 Kansas episode, some fish still contained up to 0.3 ppm endrin (Kloepfer, 1976).

Under this option, the benefits are largely maintained as presented in continued registration. It is anticipated that most of the restrictions can be achieved at little or no cost. Since the purpose of the restrictions is to protect applicators, mixers and loaders, adequate compliance is expected if a teratogenic warning is present. The only restriction which would impose increased costs is the 1/4 mile distance limitation. A preliminary study assessed the impact of this restriction on wheat (Zygadlo, 1978) and concluded that, at the very most, less than 10% of

the current endrin treated acreage would be affected. The expected amount of acreage affected is about 2 to 3% and the cost associated with this amount of acreage is small although not quantified. Thus, this restriction is feasible for the majority of wheat farmers and is a viable choice of options for the Agency.

Where endrin is the pesticide of choice, alternate compounds are not likely to be used on most of the wheat acreage if the use of endrin were to be prohibited. The reasons for this conclusion are that no other pesticides are registered for the pale western cutworm and, on army cutworm, toxaphene is less efficacious in cold conditions (EPA, 1977c). Additionally, the 1/4 mile distance restriction does not impose a total reduction of treatable acreage within that distance but rather an incremental reduction. Present labeling precludes use within a distance from water judged by the applicator as sufficient to avoid adverse effects. Thus, it seems likely where endrin is the chemical of choice that some acreage will simply go untreated rather than having endrin replaced by toxaphene. A net reduction of risks will be obtained in this situation.

In summary, this option allows use of endrin for army and pale western cutworms at a small increase in costs. But these additional restrictions would be expected to reduce risk. Special label restriction that

would reduce risks from the control of chinch bugs and undefended pests are not apparent. Contaminating insects that may be fed upon by wildlife is an inevitable consequence of treatment. Intense summer storms are not predictable and it seems unlikely that any distance restriction will slow the runoff from a cloud burst.

(3) Option 3: Cancellation

The risks to humans and to the environment due to endrin would be eliminated for all pests. About 40% of the acreage currently treated is infested by the pale western cutworm and no pesticides would be used. On the remaining 60% of the acreage, toxaphene is the likely alternative and risks from the use of this pesticide may equal or exceed those of endrin. The loss in benefits due to a cancellation on pale western and army cutworms would be significant to the user group. Cancellation of chinch bug control would result in a very low loss of benefits since this use is little practiced and is of questionable value in areas where it is employed. Cancellation of undefended pests would have no known effect on benefits.

(4) Selected Options: (a) Option 2: Continued Registration With Label Restrictions for Pale Western and Army Cutworms and for Grasshoppers;(b) Option 3: Cancel Registration for Chinch Bugs and All Undefended Pests

Option 2 is selected because the use of endrin is important to those farms which experience outbreaks of the target pests. The savings in costs and

gains in revenue are significant to these individual farms. The most important benefit of endrin is its effectiveness is controlling the pale western cutworm. It was estimated that the overall risk associated with the use of endrin is relatively low under current use practices. With the additional restrictions, that risk is even lower.

Option 3 is selected because the risks to humans and to the environment are not balanced by any demonstrable benefits.

3. Apple Orchards

a. General Information

Apple orchards rank third in total yearly usage of endrin; approximately 85,000 pounds are applied to 58,000 acres. Endrin is used to control the pine vole (Microtus pinetorum) and the meadow vole (Microtus pennsylvanicus in the east and primarily M. montanus in the West). Endrin may be applied once annually, post-harvest. The major states using endrin are Georgia, South Carolina, North Carolina, Virginia, Maryland, West Virginia and Pennsylvania in the East and Washington and Idaho in the West.

b. Risks of Continued Use

(1) Human

Judging by measures of applicator exposure to endrin in the orchards of Washington State (EPA, 1978b) unprotected female applicators of child bearing age may be

subject to a high level of teratogenic risk (MOS of 75, Burnam, 1978c). Current use by certified applicators in conformance with label directions for protective clothing, however, should reduce that risk by a factor of five to an MOS of 375 (EPA, 1978b) but this is still cause for concern. Except for applicators, exposure from this use appears to be below the level of concern, assuming compliance with label precautions.

(2) Fish and Wildlife

Endrin residues designed to kill mice are intuitively hazardous to other forms of wildlife that feed on the ground vegetation in orchards. Theoretical calculations support this conclusion (Barbehenn, 1976; Bushong 1978). Apparently the only systematic monitoring to detect effects on wildlife was conducted in the fall of 1977 in New York State. A report of the results is not yet available. The high rate of application (up to 2.4 lbs/acre) provides a potential for fish kills when runoff conditions are present. This potential has been verified in reports from North Carolina and Pennslvania (Sec. II).

The major federally registered alternative to endrin is zinc phosphide baits. These baits pose some demonstrable hazard to pheasants and rabbits but potential

effects on aquatic systems cannot be assessed with available data (Bushong, 1978). Information on DPN and CPN is generally inadequate to assess comparative risks.

c. Benefits of Continued Use

Endrin provides the most economical means of rodent control in orchards that are subject to consistently high levels of infestation and damage. The cost of using endrin is lower and its performance as measured by apple production is higher compared with other methods of control. In the Benefit Analysis it was estimated that yield losses if endrin were unavailable would be of a magnitude sufficient to alter apple prices. In such a situation, the impacts extend beyond users of endrin. Other affected groups include non-users, marketing firms and consumers. Because of the differential effect of changes in price, supply and total consumer income spent on apple products, some affected groups gain while the others lose. The losers include the users of endrin who are faced with higher costs and decreased production and consumers who pay higher unit prices for a smaller total crop. To evaluate redistributional effects of losses and gains between users and non-users budgeting techniques and partial economic equilibrium models were used. The results of this analysis are as follows:

Range in loss to endrin users, per acre per year - $34-$69.

Range in loss to all users, total per year - $2.6 - $5.3 million.

Range in gain to non-users, per acre per year - $16 - $31.

Range in gain to non-users per year, total - $7.2 - $14.3 million

National reduction in apple production without endrin was established to be between 1/2 to 1 percent.

(d) Impacts of Alternative Regulatory Options

1. Option 1: Continued Registration with No Further Restrictions

The risk from continued registration of endrin used for apple production must take into consideration the "Restricted Use" classification. Certification of applicators would have no anticipated effect of altering the composition of the applicators treating orchards but the certification process should lead to some reduction in risk through greater care in application. Risks to fish and wildlife would be unaffected.

The benefits of continued registration of endrin are savings in cost and improvement in yields. Endrin also contributes to a significantly larger apple crop which reduces price of apple products to the consumer.

(2) Option 2: Continued Registration with New Restrictions

Label changes that the Agency considered for reducing risks to humans and the environment included protective clothing, methods of application, rates of

application, the species to be controlled, evidence of economic infestation and distance restriction. Improved requirements for protective clothing and respirator and the addition of a warning statement can reduce teratogenic risks to workers. These requirements are at pages 123-124.

The rate of application has been confused, historically concerning the distinction between an orchard acre and a treated acre. The Agency agrees with the opinions of Drs. Don Hayne and Ross Byers (Hayne, 1977) that the application rate for pine voles should be 3 pints of endrin EC per 100 gallons with 600 gallons applied to each treated acre. This assumes, as is the usual practice, that the one-third of the orchard that lies between the rows of trees is not treated. The Agency believes that if the use of endrin is necessary, it should be used at a rate efficaceous for non-resistant pine voles.

The major use of endrin for meadow voles occurs in the Pacific Northwest and recommendations on rates for the State of Washington indicate that 2 pints per 100 gallons of water with 300 to 350 gallons of spray per acre of ground treated is appropriate (Hunter and Tukey 1977).

The State of Washington further recommends that the area actually treated can be substantially reduced without a loss in efficacy (Tukey 1978). While no experimental data have been submitted to support this rate of application, the Agency must rely on the collective experience of the users and will require that labels for western meadow vole control reflect the recommendations of the State of Washington.

Four basic types of equipment are in general use for applying endrin to orchards: power hand guns, horizontal and vertical boom sprayers, and air blast equipment (speed sprayers). All of these types of equipment can be either adjusted or adapted to produce a wide range of droplet sizes, depending mainly on nozzle orifice and pressure. From both the standpoint of efficacy as judged by Drs. Byers, Hayne and Young (Barbehenn 1978) and risk reduction (EPA, 1978b) a coarse or very coarse spray (as judged by a layman relying on visible droplet size) is desired. Pressure considerations alone are thus inadequate. Therefore, label directions dealing with equipment should state "Use a very coarse spray with minimum pressure necessary to penetrate ground cover. Do not apply as a fine spray. Power air blast equipment must be modified to meet the above application restriction. Consult with State recommendations for acceptable methods of adapting equipment." The Agency relies on

the opinion of Dr. Hayne (1978) in both the need for and the successful methods of adapting speed sprayers for orchard mouse control. In his words, the cost of adapting speed sprayers by methods used in North Carolina is "a few dollars worth of hardware and a half hour of time."

The established record (including Velsicol's rebuttal, 1976; EPA, 1977b; and Byers 1977, 1978) clearly indicates that the need for endrin in orchards of the Eastern United States is to control the pine vole. This subterranean species is very difficult to control, even by laborious hand placement of baits. Users agree that the surface-feeding meadow vole can be controlled effectively with zinc phosphide baits. Zinc phosphide baits placed above ground present some hazards to rabbits and pheasants but it is generally a safer pesticide than endrin for use in orchards.

The eastern states in general have not requested the Agency to retain endrin on the eastern meadow vole; western states think endrin is a necessary rodenticide. Moreover, application rates and runoff potential are lower in the West than in the East.

While Velsicol's proposed label indicates, "Apply only when infestation is present...", "infestation" could be defined as evidence of one vole in the orchard. On the other hand, levels of economic infestation are difficult to define (EPA, 1977b). The Agency wishes to discourage prophylatic use of endrin for orchard mouse control, since such practice has little benefit and may generate resistance. A remedy to this situation is to add the following precautionary statement, "Unnecessary use of this product can lead to resistance in the mouse population and subsequent lack of efficacy." Such loss of efficacy has been well demonstrated in large orchards in Virginia where endrin was used for 12 years (Webb, 1967).

The requirement for full protective clothing reduces teratogenic risks to any female applicators to a MOS of 375 and the elimination of fine sprays renders exposure negligible (EPA, 1978b). A 50 foot distance restriction should include bodies of water and areas occupied by unprotected humans. With a coarse spray, this distance effectively eliminates risk potential from drift (EPA, 1978b) and has an inconsequential economic impact (Luttner, 1978). Additionally, to reduce the probability of run-off, the label should indicate, "Do not apply when rainfall is imminent."

In summary, this option can reduce risks by protective clothing, equipment restrictions, a distance restriction, a warning on resistance, and cancelling

use on the eastern meadow vole--none of which have a major economic effect. Additionally, this option increases the benefits by warning against prophylatic use. Major risks to fish and wildlife would remain because of the high application rate to the terrestial habitat and because the potential for runoff would be little affected by a distance restriction of 50 feet.

3. Option 3. Cancellation

The effect of a cancellation on risks is to eliminate those associated with endrin and to substitute lesser risks from zinc phosphide baits. However, the loss in benefits of endrin use on apple production are significant. The only federally registered alternative pesticide, zinc phosphide, is more costly and is less efficacious for the pine vole. The absence of endrin would cause significant impact to users and contribute to an important decline in apple production.

4. Selected Options: (a) Option 2: Continued Registration With Label Restrictions for the Pine Vole and Western Meadow Vole; (b) Option 3: Cancellation for Control of the Eastern Meadow Vole

Currently, many apple producers would not have an effective means of rodent control without endrin and the Agency views the continued registration of endrin as necessary to prevent major economic impacts on many individual users. While the Agency feels that the risks to fish and wildlife will continue with but minor reduction, human

risks can be reduced greatly at little cost to the user. The Agency believes that the continued use of endrin to control orchard mice is an undesirable situation and encourages users to increase efforts to develop viable alternatives.

Option 3 is chosen because some risks can be reduced with no loss in benefits. In the case of the Western meadow vole, benefits appear to be higher and risks are lower because of the lower application rate and lower run-off potential.

4. Sugarcane

a. General Information

Sugarcane represents a small and relatively unimportant use of endrin. The most recent estimates (EPA 1977a) indicate that approximately 1000 pounds of endrin are applied to 500 acres to control the sugarcane borer. Endrin is applied foliarly at a rate 0.5 lbs. A.I. four times a year. The 500 acres represents less than 0.2% of sugar production in Florida. Apparently some endrin is used in Puerto Rico but the amount is unknown. Several alternative chemicals are available in addition to biological controls which are encouraged, particularly in Florida, Louisiana and Hawaii (EPA, 1977a). Endrin is also registered to control the sugarcane beetle by treating seed pieces in furrow but the Agency's investigation indicated that little, if any, endrin was used for this purpose (EPA, 1977a).

b. Relative Risks of Continued Use

Because of similarities in application rates and environmental conditions (especially high rainfall), risks associated with aquatic contamination from each application of endrin for borer control should approximate those from use on cotton. The major chemical alternatives are monocrotophos, carbofuran and azinphosmethyl. For aquatic organisms, monocrotophos is judged to pose less of an acute hazard but data on environmental transport, persistence, accumulation and chronic effects are inadequate to estimate accumulation and chronic effects on aquatic organisms. Available data indicate that endrin is clearly more hazardous to aquatic organisms than either carbofuran or azinphosmethyl (Coppage, 1978b).

For terrestrial wildlife, monocrotophos has a potential for causing a significant increase in avian mortality in comparision with endrin but this effect could be minimized by keeping the alternative away from cover adjacent to cane fields. The acute toxicity of carbofuran to birds and mammals is similar to that of endrin. Azinphosmethyl is probably equally hazardous to mammals but less hazardous to birds (Markley, 1978).

An assessment of potential chronic effects on humans from the three substitutes has disclosed no probable effects (Burnam 1978b). Thus, these compounds appear to pose less risk than endrin.

On balance, assuming the three alternative pesticides are used in about equal amounts to replace endrin, use of endrin to control sugarcane borer poses greater risks for humans and to the environment.

For control of the sugarcane beetle, endrin is applied to seed pieces in the furrow. Apparently this would involve ground application with low pressure equipment followed by covering the material with soil. Assuming compliance with the worker safety precautions on existing labels, very low exposure to humans and the environment would be anticipated.

c. Benefits of Continued Use

The Benefit Study (EPA, 1977a) included an examination of the importance of endrin in sugarcane production. It was found that several non-RPAR insecticides are available including azinphosmethyl, carbofuran, and monocrotophos. In addition, biological methods for controlling the sugarcane borer are available and are used.

It was estimated in the Benefit Study that chemical cost per acre would be increased if endrin were unavailable. The cost increase would average about $9.20 per acre or an increase in production cost of 2.6% on those acres affected (about 0.2% of total acres). It was reported that alternative pesticides provide good control of the sugarcane borers and that no change in yield was expected. The total economic impact was estimated at $4,600. In summary, the impact of a cancellation of endrin on sugarcane would be a small cost increase (2.6%) to a small amount of

acreage (0.2%) where endrin is used for borer control. Because of disuse, no economic benefits are associated with endrin for beetle control.

d. Regulatory Options

(1) Option 1: Continued Registration with No Further Restrictions

The risks of continued use of endrin for borer control are associated mainly with the contamination of water by drift and runoff. Some mortality to aquatic organisms is to be expected and consumption of highly contaminated fish by women of child-bearing age is a possibility that leads to some degree (MOS=360, Burnam, 1978c) of teratogenic risk. Risks from beetle control appear to be negligible.

The benefits from use of endrin on sugarcane are negligible. A few growers benefit from lower production costs associated with borer control. Apparent lack of use for beetle control implies that there are no current benefits from that use.

(2) Option 2. Continued Registration with New Restrictions

Improved requirements for protective clothing and respirators and the addition of a warning statement can reduce teratogenic risks to workers. These requirements are at pages 123-124. Improvements in equipment and application direction indicated on pages 124-125 can help to control drift.

Because the economic analysis indicated a marginal value associated with the use of endrin to control sugarcane borers and because this use was not

defended in any response to the RPAR Notice, the Agency has not invested resources in pursuing methods that might be taken to reduce environmental risks from borer control. Standard label changes for worker protection would further reduce the negligible risk associated with potential use for sugarcane beetle.

(3) Option 3: Cancellation

Cancellation of endrin for borer control would result in a net reduction of risks because alternatives, as a group, are less hazardous to humans and to the environment. Use of endrin for beetle control does not appear to pose a potential for unreasonable adverse effects on man or the environment and a cancellation would achieve no perceptible reduction in risk were endrin to be used.

The loss in benefits due to a cancellation for borer control is minimal and affects only a few growers. Since endrin is used on small total acreage and since there are no yield effects expected in its absence, no adverse impacts would accrue to the agricultural sector or to consumers. Cancellation for beetle control might delay availability should a need for endrin arise, since there are no registered alternatives.

(4) Selected Options: (a) Cancel Use for Sugarcane Borer; (b) Option 2: Continued Registration for Use on Sugarcane Beetle with New Restrictions

The risks to nontarget aquatic organisms is relatively high for that acreage which is treated. Use of alternative pesticides, as a group, would result in reduced risk.

The benefits from the use for sugarcane borer are extremely small. For these reasons the Agency considers the risks to offset the marginal benefits to a few users and therefore proposes to cancel this use of endrin.

The expected environmental risks from the use on sugarcane beetle are negligible. Teratogenic risks to applicators can be reduced to an acceptable level by use of basic safety requirements for clothing and equipment.

While there is no evidence indicating that endrin is used for beetle control, there is no registered alternative. Were a need to arise for this use of endrin benefits would materialize and, since benefits would then exceed risks, there is some merit in maintaining registrations for this use.

5. Conifer Seed Treatment

a. General Information

When direct seeding is used as a method to re-establish conifer forests in the western and southeastern U.S., destruction of the seed by rodents and birds may hamper the success of the operation. A coating of endrin on the seed provides protection. The most recent estimate indicates that 500 pounds of endrin are used for this purpose each year (EPA, 1977a). The application rate results in from 0.002-0.015 pounds A.I. per acre. Approximately 100,000 acres are planted with treated conifer seed annually.

b. Risks of Continued Use

In issuing the RPAR, the Agency did not specifically address the issue of risk criteria for conifer seed treatment although it indicated an awareness of several studies conducted jointly by the Fish and Wildlife Service and the U.S. Forest Service regarding the potential risks associated with this use. Additionally, the Agency's 1973 review (EPA, 1973) described instances of bird mortality associated with conifer seed treatment as did the submission by the USFS (USDA, 1976). That some adverse effects from this use are to be expected then, is clearly established. However, in consideration of the rather lengthy growing cycle of forest trees and consequent infrequency of seeding on a particular site, effects on local populations of birds are likely to be transient. Some secondary poisoning of raptors is possible but of relatively low probability (Markley, 1977).

Exposure to people who treat the conifer seed is estimated to be negligible (EPA, 1978b). No other potential for human exposure is likely.

c. Benefits of Continued Use

Endrin is the only chemical repellent registered for this use. It is used on approximately 90 percent of direct-seeded-forest plantings. Without endrin the only alternative is hand planting nursery-grown seedlings, which would increase per acre costs by $12-$35. Some acres can

not be hand planted readily because of terrain. Total costs were estimated to be $3 million. The impact of a cancellation would fall entirely on the user group in the immediate future.

d. Regulatory Options

(1) Option 1: Continued Registration with No Further Restrictions

The risk of continued use in conifer seed treatment is expected to be at insignificant levels because of the low frequency of use (less than or equal to once per 20-40 years), the low rate of application (0.002-0.015 lbs. A.I. per acre), and no chance for human exposure except to the applicator who is well trained in its use. Some bird kills and secondary poisonings would be expected but at insignificant levels. For these reasons the risks of endrin so used are considered to be minimal.

Endrin contributes to the success of direct conifer seeding. This is the most economical method of planting. Without endrin, per acre and total costs would be increased for the user, who must bear the brunt of the cost. Endrin also has an indirect benefit in that direct seeding can take place in relatively inaccessible areas with significant run-off potential. By contributing to the successful seeding of such areas, endrin indirectly helps to reduce erosion.

(2) Option 2: Continued Registration with New Restrictions

The Agency sees little that can be done to substantially reduce the relatively low risks associated with this use. Where feasible however, adverse effects could be minimized by constraints on timing to avoid exposure

to large numbers of migrant birds and to sites where benefits are relatively high. The Agency understands that this use of endrin by the U.S. Forest Service has been limited to sites where hand planting is difficult and the Agency encourages a continuation of such a policy. The label should include the statement, "Avoid use at times when large numbers of migrant birds are anticipated".

(3) Option 3: Cancellation

The minimal risk of endrin is eliminated. On the other hand, no chemical pesticide will replace it; thus these treated areas would be free of chemical pesticides.

The benefits of endrin would be eliminated. As suggested above, these benefits are substantial to users in relation to the minimal cost of endrin. The timely use of endrin treated seed is a factor in reducing erosion on deforested slopes.

(3) Option Chosen: Continued Registration With New Restrictions

In consideration of the negligible risk associated with the endrin use, the benefits are substantial. Endrin helps to protect the seeds in a cost efficient manner. The Agency judges that the benefits of this use outweigh the risk, and that this use should be retained with label warnings to minimize exposure to large numbers of birds.

6. Watermelon Seed Treatment (Florida Registrations)

a. General Information

Endrin is used as a prophylatic treatment for protecting watermelon seeds against deer mice and cotton rats in Florida. No defense of this use was provided to the Agency until May 1978 (Weaver 1978, Conner 1978 Gillespie 1978). Kits containing endrin and either thiram or arasan as active ingredients are sold to users who treat essentially all of the watermelon seed planted on 65,000 acres in Florida. No alternative pesticides are registered for this use.

b. Risks of Continued Use

Some concern was expressed by Dr. James N. Layne (Barbehenn 1978) over the potential for secondary poisoning of burrowing owls and caracaras which may feed on sick or dying rodents on field edges. The Agency's opinion (Bushong 1978) is that the risk to nontarget wildlife, either direct or indirect, is relatively minor. While this is a prophylactic use, planted seeds offer essentially no wildlife exposure and most rodents apparently learn to avoid the treated seed by ingesting sublethal doses. Since methods of treating seeds are similar to those for conifer seeds, human exposure is probably negligible, posing no expected teratogenic risk to certified applicators.

c. Benefits of Continued Use

Very little information is available concerning the extent of benefits of this endrin use. Most or all of the commercial watermelon crop in Florida is said to be treated (Barbehenn 1978). The amount of crop damage averted by this prophylactic use is unknown. To the extent that crop loss is avoided, endrin would provide a positive benefit to the user. Florida grown watermelons are the first melons to reach the fresh produce market. As such, these growers benefit by selling their product at the period of peak price. As the season advances, additional watermelons enter the market from other producing areas and prices decline. One explanation for the use of endrin by Florida growers is that they want the maximum protection of their crop to benefit from that period of high price. In summary, the economic importance is unknown; to the extent that it exists it would appear to be a benefit to the Florida producer group. To the extent that uncontrolled rodent damage might substantially decrease production, the consumer may benefit from lower prices.

d. Regulatory Options

(1) Option 1: Continued Registration with No Further Restrictions

The risks of continued use for watermelon seed treatment appear to be minimal. Minimal risk to humans is expected and the potential risk to raptors from secondary poisoning is viewed as low.

The benefits of continued use are unknown. The wide spread use in Florida suggests that this could be an important use. The beneficiaries are primarily the user group although consumers might gain from increased production and lower prices of watermelons.

(2) Option 2: Continued Registration with New Restrictions

Since this is a prophylactic use, the Agency considered possible procedures to reduce unnecessary usage. Restricting treatment to edges of fields might be adequate for protection against cotton rats (Sigmodon hispidus) but deer mice (Peromyscus polionotus) may live in the field centers, thus, such a restriction would not be viable. Since the only perceived potential risk is from secondary poisoning, the absence of target species would eliminate that risk. Label precautions for certified applicators are considered to be adequate.

(3) Option 3: Cancellation

The minimal risk from endrin is eliminated. Significant benefits to Florida watermelon growers would be lost.

(4) Option Chosen: Option 1 - Continued Registration with No Further Restrictions

The risks of endrin in this use appear to be minimal and thus at acceptable levels. The benefits are judged to be greater than the small degree of risk and endrin should be maintained for this use.

7. Vegetable and Melon Seed Treatment (California)

a. General Information

This minor use was defended by the registrant (Scott 1976) and one user (Iverson 1976). Endrin is used prophylactically on several kinds of vegetable seeds in California to protect the sprouting seeds from birds. The actual annual poundage of endrin used is confidential, but it is of the same order of magnitude as that used for conifer and watermelon seed treatments. The application rate is about 3 grams per acre.

b. Risks of Continued Use

The registrant affirmed that the function of the treatment was to act as a repellent. Label directions caution against exposing seed on the soil surface and also direct users to clean up any spills. Adverse effects on wildlife have not been reported to the Agency and the Agency has no basis to expect that such unreasonable adverse effects will occur from this use of endrin (Bushong, 1978). Label precautions appear adequate to protect certified applicators.

c. Benefits of Continued Use

The only information regarding the economic importance of the use is provided by the registrant and a user group. They report that the use of endrin is important to protect seeds but supporting data are lacking (Ludvik, 1978e).

d. Regulatory Options

(1) Option 1: Continued Registration with No Further Restrictions

No unreasonable adverse effects are anticipated from the continued registration of endrin to treat vegetable seeds in California. There are no registered substitutes. The benefits of this use have not been quantified but presumably justify the cost of treatment.

(2) Option 2. Continued Registration With New Restrictions

Label changes that would reduce risks associated with this use of endrin are not apparent.

(3) Option 3: Cancellation

Cancellation of this use would eliminate risks from endrin that are judged to be negligible. Benefits claimed by users would also be eliminated. Since no alternative pesticide is registered, some economic loss to the users could occur.

(4) Option Selected: Option 1

As with watermelon and conifer seed treatments, these uses poses a minimal yet acceptable level of hazard. Although no actual estimates of economic importance are available, it is judged that the benefits offset the risk and the Agency proposes continued registration of this use.

8. Alfalfa and Clover Seed Crops (Colorado)

a. General Information

While endrin is registered to control a wide variety of insect pests on alfalfa and clover seed crops in Colorado, it is not recommended and little or none is believed to be used (Ludvik, 1978c and d).

b. Comparative Risks of Continued Registration

The apparent low level or lack of present use must be put in the perspective of its potential application relative to current alternatives. Recommended alternatives, each of which is registered for some, but not all of the insects on the endrin label, include toxaphene, dimethoate and carbofuran. Considering risks to aquatic organisms, the four compounds have been ranked from least to most hazardous as follows: carbofuran, dimethoate, and toxaphene equal to endrin. For wildlife, the relative acute risk is: dimethoate, toxaphene equal to endrin, and carbofuran (Bushong, 1978b).

Human risks from this use of endrin appear to be confined essentially to female applicators but this teratogenic risk potential has not been assessed and is assumed to be similar to that for wheat. Toxaphene and dimethoate are both RPAR compounds; the concerns with dimethoate include oncogenicity, mutagenicity, and feto-toxicity. Carbofuran is not known to pose chronic risks (Burnam 1978a).

c. Benefits of Continued Registration

Since it appears that little or no endrin is currently used to protect alfalfa and clover seed crops, benefits are essentially nil.

d. Options Considered

(1) Option 1: Continued Registration with No Further Restrictions

Apparent lack of present usage indicates that no risks from endrin are now present. If endrin were to be used, it is not clear at this time that its risks to man and the environment would differ substantially from some of the recommended alternatives. The benefits from use of endrin presumably would be similar to those of the alternatives although lack of use suggests that the benefits of endrin may be lower.

(2) Option 2: Continued Registration with New Restrictions

Were registration to continue, general improvements in safety requirements would reduce risks but no changes specific to this use have been considered by the Agency. The current label prohibits use of the treated crop for feed.

(3) Option 3: Cancellation

Since endrin is not now in use, cancellation would eliminate a potential rather than an active risk. Alternatives that pose some risk to man and the environment would continue to be used. The present picture of benefits would remain unchanged.

(4) Option Selected: Continued Registration with New Restrictions

The Agency can not now conclude that the overall risks of endrin for use on alfalfa and clover seed crops would exceed any of the presently recommended alternatives. To the extent that endrin may be used either currently or in the future, the Agency can not conclude that the benefits of endrin would be any less than those of the alternatives. The Agency concludes that the registered use of enrin should be retained with appropriate label modifications.

9. Ornamentals

a. General Information

Several federal and state registrations include use of endrin on ornamentals to control cyclamen mites and spittle bugs. One label (1202-75) includes thrips, cutworms, armyworms and corn earworm on flowers (asters, daisies, gladiolus, mums, iris, stock). The Agency's investigation (Ludvik, 1978a and h) indicated that endrin was neither recommended nor used by commercial nurseries and endrin is not now available to non-certified applicators.

b. Relative Risks of Continued Registration

Assuming endrin were to be used under current label restrictions and classification, the Agency perceives little potential for unreasonable adverse effects on the environment (Bushong, 1978). The Agency's exposure analysis estimated that the exposure from the use of endrin on ornamentals was 3 mg/hr dermal and 0.01 mg/hr inhalation. This

results in a dose of 0.005 mg/kg/hr. It would require an extremely large operation to require as much as two hours for treatment, thus, exposure from use on ornamentals should not exceed 0.01 mg/kg, providing a MOS of 150. The use of protective clothing would raise the MOS to 750. Exposure to workers who harvest plants treated with endrin can not be estimated from the information which is available.

The major alternatives for cyclamen mites are endosulfan and dicofol (Ludvik, 1978h). Dicofol is a suspect carcinogen (Burnam, 1978a). Alternatives for spittlebugs are chlorpyrifos and resmethrin (non-RPAR), lindane and rotenone (RPAR compounds). Registered alternatives for other insects vary with the site and include additional RPAR compounds (carbaryl, trichlorfon, toxaphene) and additional non-RPAR compounds (acephate, azinphosmethyl, chlorpyrifos, disulfoton, malathion, oxydemeton-methyl, and sulfur) (Thomas 1978).

c. Benefits of Continued Registration

In view of the reported absence of use and availability of numerous alternatives, the Agency has no basis for concluding that benefits from this registered use are either present or might develop.

d. Options Considered

(1) Option 1: Continued Registration with No Further Restrictions

With classification for restricted use, the Agency perceives little potential for unreasonable adverse environmental effects from this use of endrin. Some terato-

genic risks are possible especially since current labels do not preclude reentry by unprotected workers and no pre-harvest interval has been established. Lack of use indicates that no current benefits are associated with the registration and any predictions concerning potential future benefits would be speculative.

(2) Option 2: Continued Registration with New Restrictions

Teratogenic risks can be reduced greatly for applicators by general safety precautions and a label warning. Since women are commonly employed in nurseries, it is essential that a re-entry period and a pre-harvest interval be established. The label should specify, "Not for use in greenhouses." These restrictions should have little economic impact.

(3) Option 3: Cancellation

Cancellation would eliminate a low potential for environmental risk and an unknown level of teratogenic risk from this use of endrin. In the absence of current use and the availability of preferred alternatives, there would be no economic impact.

(4) Selected Option: Cancellation

In the absence of established re-entry and pre-harvest intervals, teratogenic risks must be presumed to be present. No economic impact would result from cancellation.

10. Tree Paint (Texas)

a. General Information

A formulation containing 1.0% endrin plus captan and copper is mixed with water for use as a 0.33% endrin dilution. This material is applied to the trunks of young citrus trees by spray or brush to control ants, termites and rodents (Ludvik, 1978b). It may also be applied to hardwoods such as hackberry and ash to control borers. The amount of endrin employed for this use is confidential but the use can be characterized as very minor.

b. Risks of Continued Use

Use by certified applicators according to label directions poses no perceptible hazard to the environment (Bushong, 1978) and negligible exposure to certified applicators who follow current label precaution would be expected. There are no registered alternatives for treating citrus. The alternative for borers is an RPAR compound -- lindane.

c. Benefits of Continued Use

The registrant (Klement, 1976) alleged that the product provided ant and rodent control to the citrus grower when used as a banking compound and was thus important.

d. Impacts of Alternatives Regulatory Options

(1) Option 1: Continued Registration with No Further Restrictions

Negligible risks are associated with some probable local benefits.

(2) Option 2: Continued Registration with New Restrictions

Improvement of general safety precautions and a teratogenic warning for applicators should further reduce potential teratogenic risks with no effect on benefits.

(3) Option 3: Cancellation

Cancellation would eliminate local benefits from this use and the negligible risks associated therewith.

(4) Selected Option: Continued Registration With New Restrictions

The local benefits from the minor use appear to outweigh the negligible risks.

11. Perch Treatments for Nuisance Birds

a. General Information

Two endrin products are registered to control pigeons, starlings and sparrows that roost in commercial areas: Rid-A-Bird Perch Solution and Sorbikil Bird Pesticide (Texas). These two products have much in common but have significant differences.

Rid-A-Bird is a 9.6% endrin solution used in conjunction with artificial perches placed around agricultural premises (indoor and rooftops), bridges, commercial, industrial and public premises (indoor, outdoor and rooftops), domestic dwellings (outdoor, rooftops), loading docks and pipe yards where nuisance birds may roost or breed. The tubular metal

perches contain a wick, the edge of which protrudes along the length of the perch surface. The perches are filled with about 2 ounces of the endrin formulation through a small hole by use of a plastic squeeze bottle. Birds landing on the perch absorb endrin through the feet from the saturated wick and may be killed. Use is restricted to professional pest control operators (PCO's). Annual production is about 3000 pounds of endrin (Barbehenn 1978).

Sorbikil contains 3.5% endrin and 2.5% paradichlorobenzene to act as a repellent. Its use was not defended in response to the RPAR notice. It is used "For control of pigeons, sparrows and starlings, only" ....." on roosting areas of commercial buildings. Product not to be used around food processing plants, restaurants, or residence buildings. Products [sic] to be used on perches only...." "Used by Licensed PCO only. Limited to buildings only where pest birds may become a health hazard." Annual usage is unknown.

The only registered substitute for this use of endrin is fenthion, a product registered by Rid-A-Bird and designed for use in the same perches. Fenthion is judged to be less efficacious than endrin, especially under cold conditions. The registrant reported that the amount of this product currently in use for bird control is only a small fraction of the endrin so used (Barbehenn, 1978).

b. Risks of Continued Use

(1) Human Risk

The Rid-A-Bird product is confined by the wicks in the tubular perches, each of which bears a conspicuous warning label. Human exposure is likely only by accidental spillage. For the Sorbikil product, "perches" are undefined and the Agency was unable to contact by phone either the registrant or potential users of the product to clarify the use practices. The wording of the label permits the product to be applied directly to ledges, girders or other structures on which birds may perch around buildings and the Agency's risk evaluation assumes such practices to be in effect. The label gives no directions as to the application rate. Use of this product according to label directions can lead to gross contamination of target species which would pose an acute hazard to people handling dead and dying birds. In addition, there is no provision for the protection of persons who may be involved in building maintenance and thus exposed to open puddles of endrin. The potential risks to humans from use of this product are relatively high in comparison to those from Rid-A-Bird.

(2) Risk to Non-Target Organisms

Cats and dogs that eat birds killed by endrin may die from secondary poisoning and both registered products direct the user to collect and bury dead birds. In general, PCO's that use endrin are aware of this risk and

Dr. W. B. Jackson advised the Agency that provision for collecting dead birds is often specified in the contract between the PCO and his customer (Barbehenn 1978). For birds that are found by a pet before they have been found by a responsible human, it is expected that those killed by the Sorbikil product may be more heavily contaminated externally and thus more hazardous than those killed by the Rid-A-Bird product. Limited data (Nichols, 1977) suggest that while fenthion is much less toxic than endrin for laboratory rats, it may be somewhat more toxic than endrin to the Kestrel.

While the theoretical potential for secondary poisoning of raptors has been demonstrated, the Agency's opinion (Markley, 1977) was that circumstances leading to such results are generally unlikely. However, subsequent to that opinion, the Agency learned that one of the peregrine falcons released in an attempt to reestablish that endangered species in the Eastern United States had established a roost in the city of Baltimore. The Agency's position is that peregrines that adapt to man-made cliffs should be rigorously protected from potential exposure to endrin. A direct hazard to barn owls is present (Bushong, 1978), where the use of endrin for controlling nuisance birds is not confined to specially designed perches.

c. Benefits of Continued Registration

While target birds present some theoretical potential for transmitting various diseases to human and livestock (Bosch, 1976) and use of the Sorbikil product is

restricted by the label to such situations, the health benefits from use of these products can not be determined. Most usage is to alleviate the esthetic nuisance provided by unsightly excrement. The benefits from the use of endrin to control nuisance birds can best be measured by the extent to which the public is willing to pay for the services of PCO's to achieve such control. The Agency has no basis for comparing the benefits of the Rid-A-Bird and Sorbikil products.

d. Impacts of Alternative Regulatory Option

(1) Option 1: Continued Registration

This option retains the current benefits from the use of endrin to control nuisance birds around buildings and other structures but does nothing to reduce associated risks. Since this use is already restricted to PCO's, classification for restricted use will have little impact on risk reduction.

(2) Option 2: Label Modifications

Secondary hazards to non-target species can generally be reduced by a more rigorous effort to collect and dispose of dead birds. Existing labels are vague about this responsibility and this situation should be clarified by the registrant in consultation with the Registration Division. Label must carry the warning, "Do not use in areas identified as roosting or nesting sites for peregrine falcons". The Agency recommends that the FWS inform the registrant

of areas to be protected as they become known and that the registrant immediately inform all users in the region surrounding the area. While the FWS may set standards it deems appropriate, Dr. Tom Cade (Barbehenn, 1978) agrees that a restrictive distance of at least one mile from established roosts and two miles from active nests would substantially reduce potentials for secondary poisoning.

The Agency perceives no realistic way to bring risks associated with the unconfined use of endrin on "perches" down to the level of risk provided by use in confined, artificial perches.

(3) Option 3: Cancellation

Cancellation of endrin would eliminate both the relatively low risks and the relatively high benefits associated with the control of nuisance birds. The replacement for endrin would be fenthion, a compound posing similar but lower risks from secondary poisoning but having lower efficacy. However, fenthion has no known chronic risks from acute exposure to humans. On balance, cancelling endrin would substantially reduce benefits with some further reduction in the low level of existing risks to humans and nontarget organisms.

(4) Options Chosen

(a) Reregister Rid-A-Bird with Label Changes. The relatively low risks of present use can be further reduced by label changes without affecting the benefits of current use.

(b) Deny Registration for Sorbikil. The high risks relative to the Rid-A-Bird product can not be substantially reduced by any label changes known to the Agency.

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VI. Summary of Proposed Courses of Action

In summary, the Agency proposes to continue registration of the uses of endrin for which the benefits outweigh the risks to humans and to the environment and for which appropriate label changes will make the benefits outweigh the risks. EPA will cancel the uses of endrin for which the risks to humans and to the environment outweigh the benefits and where the risks cannot be adequately reduced so that they are exceeded by the benefits.

A. Cotton

1. Cancel uses east of Interstate Route 35.
2. Continue registration for use west of Interstate Route 35 with appropriate label changes.

B. Small Grains

1. Cancel use for the control of all pests other than pale western cutworm, army cutworm and grasshoppers.
2. Continue the registration of endrin for pale western and army cutworms and grasshoppers with appropriate label changes.

The required label changes include specifications for protective clothing and equipment for workers, a teratogenic warning on the label, limitations on equipment to be used and conditions associated with application, a 150 yard distance restriction from human habitation, a 1/4 mile distance

restriction from permanent bodies of water other than privately owned, recreational ponds, a warning regarding private ponds and a requirement to collect and bury any accidentally killed fish, and to post contaminated ponds.

C. Orchard Mice

1. Cancel the use on meadow voles in the Eastern U.S.
2. Continue registration for pine voles and western meadow voles with appropriate label changes.

The required label changes include protective clothing for users, a teratogenic warning, restriction to equipment capable of ground application in the form of a very coarse spray, a restriction against application when rainfall is imminent, a distance restriction of 50 feet from water bodies and areas occupied by unprotected people or livestock, a requirement to collect and bury any accidentally killed fish and to post contaminated ponds, a warning on the development of resistance from prophylactic use, and reduced treatment rates for the western meadow voles.

D. Sugarcane

Cancel use for the sugarcane borer.

Continue registration for the sugarcane beetle with appropriate label changes.

E. Conifer Seed Treatment

Continue registration with appropriate label changes and a caution on migratory birds.

F. Watermelon Seed Treatment (Florida)

Continue registration.

G. Vegetable and Melon Seed Treatment (California)

Continue registration.

H. Alfalfa and Clover Seed Crops (Colorado)

Continue registration with appropriate label changes.

I. Ornamentals

Cancel.

J. Citrus Tree Paint (Texas)

Continue registration with appropriate label changes.

K. Perch Treatments for Nuisance Birds

1. Deny Registration for Sorbikil (Texas).
2. Continue registration for Rid-A-Bird with appropriate label changes and distance restraints for Peregrine Falcons.