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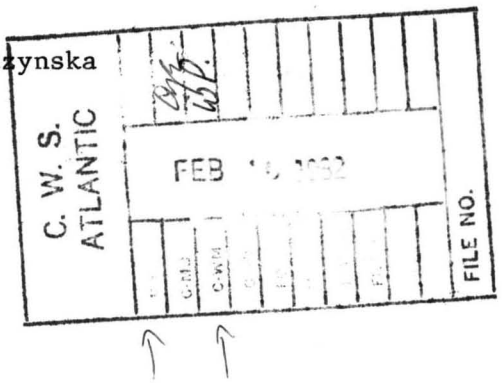
Please find attached a copy of the report prepared by D.J. Nieman entitled "Analysis of Saskatchewan Waterfowl for Endrin Contamination". Please retain for your information.

Dr. W.C. Pleszczynska



ANALYSIS OF SASKATCHEWAN WATERFOWL FOR ENDRIN CONTAMINATION

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Saskatoon, Saskatchewan

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These data are preliminary and not intended for publication.

Data contained herein are for information purposes only.

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INTRODUCTION

In September, 1981, the Canadian Wildlife Service (C.W.S.) and the provincial resource agencies in Alberta and Saskatchewan were notified of the possibility that some waterfowl in Western Canada may have been contaminated by the toxic pesticide endrin. The C.W.S., in consultation with the two provinces, immediately notified the public of a possible health hazard and began testing ducks and geese for pesticide residues. A sense of urgency accompanied these efforts because of the extreme toxicity of the chemical and the recognition that the waterfowl hunting season was in progress in both provinces. This situation did not allow an extensive literature review of the subject and hindered attempts by resource agencies to coordinate an efficient and well-planned approach to the problem. The hunting public, as individuals and through local wildlife federations and the media, were seeking an immediate response to concerns regarding the safety of consuming migratory game birds during the 1981 hunting season.

This report is not an exhaustive review of the endrin problem which occurred in Canada and the U.S. last fall. It presents some background information and describes the investigations of U.S. authorities in their attempts to determine the magnitude of endrin contamination in Montana. This paper also documents action taken by C.W.S. staff at the Prairie Migratory Bird Research Centre (P.M.B.R.C.) in co-operation with other C.W.S. offices, the Canada Department of Agriculture and the provinces of Alberta and Saskatchewan. Detailed information on the activities and findings of investigating teams in the U.S. are lacking

as P.M.B.R.C. staff received only occasional preliminary reports and highly qualified "off the record" comments. It is hoped that more information will be forthcoming in the form of reports compiled in that country by federal and state authorities.

This document represents a review of the P.M.B.R.C. 1981 endrin files and includes most of the information made available to C.W.S. staff during this investigation. Telephone conversations, correspondence, preliminary reports, and short literature reviews comprise most of the substance of this report. It is intended only as a record of C.W.S. involvement in the 1981 endrin studies and will hopefully serve as a guide in future situations of this nature.

BACKGROUND INFORMATION

A. The pesticide endrin

Endrin is an insoluble white crystalline solid used in insect control. It is a chlorinated hydrocarbon similar to DDT, dieldrin, aldrin, heptachlor and lindane. Endrin is practically insoluble in water and is very toxic and stable with a long half-life (10-15 years) in the environment. The LD_{50} for rats is less than 10 ppm and it is poisonous if inhaled, swallowed or in contact with the skin. Organochlorines are fat-soluble, and upon entering the body circulate in the blood and are deposited in lipid. In cases where lipid levels are lower, they may accumulate in internal organs, e.g.; liver, kidney and particularly the brain.

Ingestion of endrin by humans of progressively heavier doses causes mild headaches, fatigue, loss of appetite, nausea, vomiting, trembling, convulsions and coma. Pulmonary edemia and disorders of ion transfer occur in the central nervous system.. The group of chlorinated hydrocarbons to which endrin belongs can cause genetic mutations and birth defects, but is not on the carcinogen suspect list.

B. Registration

1. United States

The toxicity and stability of endrin in the environment has led to increased restrictions on use in Canada and the U.S. as potential environmental problems were identified and substitute pesticides became available. However, it is extremely

effective in dealing with a host of insect pests especially on small grains, cotton and sugar cane in addition to being used as a rodenticide to control mice on orchard floors. Therefore, it is still licensed for use in some parts of agricultural United States where serious insect pest outbreaks are imminent.

In the United States, endrin has been registered as an insecticide since 1951, although its use has declined since 1973, the peak year of production. Evidence of its acute and chronic effects on the environment and non-target species began to surface in the early 1960's with reports of massive fish kills and water contamination in the lower Mississippi River. Since those early reports, numerous episodes involving endrin-caused death or injury to fish, birds, other wildlife and domestic animals have been documented. The Environmental Protection Agency (E.P.A.) spent several years reviewing the uses of endrin. Although recognizing the teratogenicity (birth defects) and acute toxicity to wildlife, humans and domestic animals of this compound, the E.P.A. concluded that its use on cutworms would not generally cause unreasonable adverse effects in the environment if conditions prescribed on the label were followed. Endrin, therefore, is federally registered by the E.P.A. and can be legally used in the U.S. There are, however, very stringent restrictions on its rate and timing of application and the target crops and pests for which it is to be used, including distance of application from water bodies. These restrictions are on the label and it is the responsibility of the user to conform to those requirements.

2. Canada

In Canada, endrin is licensed by federal authority for cutworm control in western crops. The registration has a restricted qualification, however, which permits only commercial applicators to use the chemical. This

license expires at the end of 1981, having been extended two years, and is unlikely to be renewed. In Alberta, endrin use has been phased out and replaced by shorter-lived, safer insecticides. The last significant use of the chemical was 5-6 years ago. In Saskatchewan, the supply of endrin has dried up in spite of the fact that it can still legally be used. The Saskatchewan Department of Agriculture decided not to make its inventory available for use this year, and the Wheat Pool was not distributing endrin through its farm service centres. Lorasban (chloropyrifos) is used for cutworm control in this Province.

C. Application in the United States (1981)

A mild winter and warm spring conditions throughout eastern Montana in 1981 encouraged earlier than normal activity of some insect pests. Agricultural experts forecast an increase in army cutworms in winter wheat, alfalfa, pasture and native range in south central and southeastern Montana. They recommended the application of the pesticide endrin to control these pests and, because of the value of the crops, cereal grains received the majority of the treatments.

The scope of occurrence of the cutworm problem approached ten times that of an average year and the application of endrin was widespread. Only commercial applicators are required to report the application of pesticides such as endrin; hence there is no readily available means of determining the quantity used. The amount sold and the recommended application rates (¼pound/acre) provide the best indicators of the total area sprayed with endrin. Approximately 120,000 acres in Montana (Appendix A), 100,000 acres in Wyoming, 30,000 acres in South Dakota, 12,000 acres in each of Colorado and North Dakota, 1,200 acres in Nebraska and 800 acres in Kansas were treated with the pesticide by

private users. Commercial operators reported application of endrin to 80,000 acres in Montana during March and April, 1981 for a total of 356,000 acres in the mid-west U.S.

D. Endrin contamination

1. Concern regarding endrin residues

The severity of the 1981 cutworm outbreak on winter wheat crops in Montana and the resultant widespread application of endrin suggested a strong possibility of contamination of wildlife and water bodies due to misuse of the chemical, and the large amount applied. Wildlife managers recognized that stock watering ponds and natural wetlands could contain high concentrations of the pesticide in sediments deposited by run-off. The pesticide would also adhere to vegetation and other particulate matter. Wildlife could become contaminated through feeding on aquatic vegetation, on upland crops where spraying occurred, or on invertebrates which consume particulate matter in the sediment.

In April, 1981 the departments of Agriculture and Livestock, and Fish, Wildlife and Parks issued a situation statement to commercial and private pesticide applicators and dealers throughout the eastern two-thirds of Montana. It dealt with the extreme toxicity of endrin and toxaphene, the principal compounds applied, and suggested that lethal doses for some species are so small that even proper application of these chemicals could result in population reductions of fish and wildlife, possible harm to domestic pets, and restrictions against the marketing of dairy and meat products for as much as one year if livestock were grazed in treated areas. The abstract stated that misuse of endrin could result in its cancellation as a registered insecticide by the state or the E.P.A.

In early May, 1981 a major fish kill near Miles City, Montana was attributed to endrin poisoning. This misapplication of the pesticide resulted in a controversy about potential environmental effects within the rather substantial treatment area. Two of the major concerns of the Department of Fish, Wildlife and Parks were the effects of accumulated endrin residues on various wildlife species, and the potential danger to humans of consumption of game species.

2. Effects on migratory waterfowl

Waterfowl migrating north in the spring to breed are in a phase of hyperphagia, and deposit large amounts of lipids prior to the nesting cycle. Ducks and geese migrating through Montana could have incorporated substantial amounts of endrin into their fat reserves, depending upon the length of time spent feeding on staging areas in eastern Montana. Endrin is stored primarily in the fat and only becomes mobile once this reserve is depleted. This generally occurs during the nesting cycle which often completedly exhausts lipid reserves. When this occurs endrin may become concentrated in other tissues, such as the brain and may cause death. However, most of the pesticide would be eliminated by biliary excretion. Endrin may be transmitted from the female to her eggs via the egg lipids, but this would be in very minimal amounts. Therefore birds in Canada, which have gone through a nesting cycle, should be relatively free of endrin by September. (After lit. review by R. Bailey)

The dispersal of post-breeding ducks, particularly males, from breeding areas in Montana was also a source of concern. Such birds may travel several hundred miles to molt(sometimes northward) and could be present in Canada from mid to late May onward, having spent

from late March to May feeding in Montana, perhaps on contaminated areas. However, lipids are also depleted during the molt, and these birds supposedly would be feeding on a "clean" Canadian diet from June to August. By September endrin levels in these birds should be very low.

The post-molt dispersal of birds which have spent the entire spring and summer in Montana and may have accumulated high levels of endrin in body tissues was also considered. Young waterfowl, and older birds which have just completed the molt, may move considerable distances prior to the migration south. Overall, the number of post-molt birds dispersing from Montana into southern Alberta and Saskatchewan is believed to be small. Not all Montana birds would be contaminated, and the southern prairie provinces were not very attractive to migrating waterfowl this year because of the drought.

Much has been made of studies which have shown that endrin does not generally accumulate to very high levels in waterfowl tissues, and that mobilization and excretion of the pesticide is relatively rapid. However, laboratory studies may not be strictly applicable to wild birds if endrin continues to persist in their food in the wild. At least one analyst has suggested that some laboratory studies were not conducted over a long enough time period to put a heavy "load" into the fat. Hence, the excretion could have proceeded apace from the other tissues. Experimental birds have been given heavy doses of the pesticide over a short period of time, then put on a "clean" diet. The results would have been much different if the birds were either exposed to high levels over a longer period of time, or if small amounts of endrin persisted in their diet.

3. Health risk to humans

The potential risk to humans of consumption of waterfowl contaminated

with endrin was an important consideration in determining what restrictions, if any, should be placed on the 1981 hunting season. There were, however, conflicting opinions as to whether a health risk existed and controversey over the interpretation of "safety" levels for endrin.

The Montana Department of Health and Environmental Sciences recommended that game species with endrin fat concentrations of 0.3 p.p.m. or greater should not be consumed and that continuing surveillance of endrin in game continue for three years in the areas sprayed. The U.S. E.P.A. stated that there was no danger to public health posed by the consumption of affected game birds, however, hunters might consider skinning and discarding the fat and entrails of "potentially contaminated" birds. The U.S. Department of Agriculture (Food Safety and Quality Service) indicated that domestic fowl with 0.3 p.p.m. in fat (0.03 in muscle) would be considered illegal if the food was in legal commerce, but there are no standards for wild meat.

The World Health Organization (W.H.O.) established an allowable daily intake (A.D.I.) of 0.0002 mg./kg. endrin. This A.D.I. is based upon the chronic no-observable-effect levels (N.O.E.L.) divided by an arbitrary safety factor of 100 or more. The A.D.I. is the quantity of endrin that a human can ingest daily with some assurance that at least 100 times that amount would produce no observed effects on dogs or rats.

As previously mentioned, endrin is an acutely toxic organo-chlorine compound. Acute poisoning occurs in almost all species at very low doses and its lethal effects on small mammals and birds have been demonstrated in several "acute toxicity" experiments. Several endrin studies relating

to cancer have been performed. Tumors have not been produced in excess of levels seen in controls, and it is not on any W.H.O. suspect cancer list. A teratology study to determine the production of life threatening changes in the fetus has been performed in guinea pigs. This study showed a positive result at 5 mg./kg. and a N.E.L. (no effect level) at 1.5 mg./kg. and below.

The U.S. has a maximum allowable limit of endrin in domestic meat of 0.3 p.p.m. in fat and 0.03 p.p.m. in flesh. If above those levels, animals cannot be sold and must be quarantined until they are below those levels. Canada allows only 0.02 p.p.m. (on a lipid basis) in dairy products, but has no maximum acceptable limit in other domestic foods or animals. Neither country has a standard which applies for wild meat.

Although endrin is very toxic, analysts generally agreed that the infrequent consumption of contaminated birds did not pose a major health risk.

TESTING FOR ENDRIN RESIDUES

A. Montana

Because of the fish kill near Miles City, and the consequent controversy about potential environmental effects of endrin, a monitoring program was established in Montana. The departments of Agriculture and Livestock, and Fish, Wildlife and Parks began collecting and analyzing samples in April. Samples of water, stream and pond sediment, soil, vegetation, livestock, fish and wildlife were taken and analyzed for endrin residues. From April to September, 1981, over 500 samples were tested (see Appendix B), primarily at the Montana Department of Agriculture's Analytical Chemistry Laboratory, Patuxent Wildlife Research Center (Maryland), and the Raltec Laboratory in Madison (Wisconsin).

1. Vegetation

Samples of wheat (prior to harvest), range grass and alfalfa were tested for endrin. A total of 35 wheat samples were collected from 10 counties. Endrin levels ranged from highs of 39.5 p.p.m. in April, but subsequent testing of the same fields revealed significant declines in levels to late June and early July. For example, one field had levels of 3.2 (April), 0.05 (May) and 0.012 (July). Most samples were far below those levels cited here.

Range grass samples (17) were taken from 4 counties and although most samples were reported as "very low", one field had an endrin level of 18.9 p.p.m. in early April. However, this level also declined to

0.066 p.p.m. by July. Only one sample of alfalfa was tested (0.046 p.p.m. endrin).

2. Water

Twelve samples of water from 3 counties were tested for endrin. Two showed minute traces of the chemical (0.7 p.p.b. and 0.07 p.p.b.). The remaining samples had no detectable levels.

3. Soil

A total of 45 soil silt samples were collected from 10 counties. The maximum detectable level was 1.30 p.p.m., but, similar to the vegetation samples, the levels of endrin declined rapidly with time.

4. Livestock

The Montana Department of Livestock collected fat samples from six beef carcasses which had been fed on ranches where endrin had been applied. No detectable levels of endrin were found. During a pesticide fluid milk survey, no detectable levels of endrin were found in over 300 samples analyzed.

5. Wildlife

The Montana Department of Fish, Wildlife and Parks, following the fish kill attributed to endrin spraying, attempted to determine the effects of the pesticide application on wildlife. This analysis took two primary forms. The first was sampling various species of wildlife to determine the toxic levels, if any, in those species. The second form has been to share those sample results with various representatives of the medical profession in state and federal agencies as well as the private sector.

They reported this analysis to be a difficult and frustrating process. At the outset, difficulty was experienced in securing samples

due to the lack of accurate and comprehensive information on areas which were affected by endrin. In addition, an accurate historic record of endrin use was not available for comparison to this year's quantity which was applied. This information at the outset would have helped to put in perspective this year's usage with that of previous years.

Also, it was apparent that a consensus from the medical profession was not at hand. As a result they were faced with a decision for which they did not have an ideal set of circumstances.

Other states also expressed a desire to analyze samples of various waterfowl species. Only limited testing was completed in other areas due to three important considerations:

(a) The probable temporal and geographic distributions of ducks reared in Montana suggest that they will be a relatively small but variable proportion of the ducks in any given area at any given time. Subjective estimates suggest that the samples required to obtain reasonable information for individual hunters would be large and have to be taken throughout the season; in fact, the samples may well exceed the sport harvest.

(b) The number of laboratories that can conduct endrin analyses are few and their capacity is limited, e.g., it has been reported that the Colorado State University Laboratory can do six samples each 34 hours.

(c) Analyses are expensive, e.g., the U.S.F.W.S. contracted for expedited samples at $157/sample. Routine analyses reportedly cost about $80/sample in commercial labs.

Test results received from the State of Montana were as follows:

(a) Fish

A total of 18 fish from 4 counties were analyzed for endrin. The highest value detected was 0.043 p.p.m. Generally though, the values ranged from 0.012 p.p.m. to traces reported in parts per billion.

(b) Big Game

Fat samples from 13 antelope and 24 mule deer were tested. One fat sample taken from one antelope in late April yielded an endrin level of 0.53 p.p.m., exceeding the federal tolerance level of 0.3 p.p.m. for meat. Levels ranging from 0.06 p.p.m. to 0.07 p.p.m. were detect in 3 more animals (2 deer and 1 antelope). All others yielded no detectable levels.

(c) Wild Birds

(i) Upland Game

Ring-necked pheasant, sharp-tailed grouse, wild turkey and Hungarian partridge were collected from endrin treated areas of Montana. Sharp-tailed grouse had the highest levels (maximum of 0.53 p.p.m. in fat, and 0.002 p.p.m. in meat)

(ii) Migratory Birds

High levels of endrin were found in meat and fat samples of ducks and geese analyzed in Montana. High (maximum levels) for Canada geese ranged from 0.16 to 0.23 p.p.m. in fat and 0.13 to 0.19 p.p.m. in meat. Various species of ducks had maximum levels of from 0.69 to 1.20 p.p.m. in fat and 0.005 to 0.013 p.p.m. in meat.

The C.W.S. simply did not receive any more detailed information on the test results from the State of Montana or the U.S.F.W.S. other than periodic telephone conversations indicating that testing was on-going and that "dangerously high" levels of the pesticide were being found in migratory bird samples collected over a wide part of the State.

B. Alberta

The Alberta Fish and Wildlife Division became aware of the endrin problem in Montana, about September 9. There was some concern that contaminated birds may have moved into Alberta so Fish and Wildlife Officers collected approximately 40 waterfowl from a broad area in central and southern Alberta. Analysis by the Alberta Agriculture laboratory in Edmonton revealed no detectable levels of endrin in any of the samples. Further sampling was not conducted.

C. Saskatchewan

The Prairie Migratory Bird Research Centre was notified of the endrin contamination problem in Montana by officials of that state the week of September 7, 1981. At about the same time, hunters in Saskatchewan began to register their concern to the C.W.S. and Saskatchewan Department of Tourism and Renewable Resources (D.T.R.R.) about the safety of consuming waterfowl shot in this Province. The waterfowl hunting season opened in Saskatchewan on September 1 in the north and September 7 in the south. The media also became very persistent in obtaining information on the magnitude of the problem in Canada.

To determine the incidence of endrin contamination in Saskatchewan and provide guidance to a concerned hunting public, the C.W.S. decided to collect waterfowl from several areas in Saskatchewan and measure the levels of pesticide residues in fat and meat tissues. Ducks and geese

were collected by C.W.S. in the Last Mountain Lake, Perdue and Indi Lake regions. Saskatchewan D.T.R.R. personnel contributed birds from south-western Saskatchewan (Appendix C). A total of 171 ducks and 25 geese were collected over an 8 day period. The carcasses were frozen and stored at the P.M.B.R.C. facility. C.W.S. staff thawed the birds and dissected 5.0 gm. of pectoral muscle and 2 gm. of fat (abdominal) from each bird. In some instances, entire preen glands were taken. All tissue samples were carefully labelled in vials and refrozen. They were then packed in dry ice and sent for analysis.

Arrangements were made with 3 laboratories to conduct analysis of the samples. The Canada Department of Agriculture Research Station at the University of Saskatchewan, Saskatoon made their facilities available. C.W.S. hired a chemist on contract and provided two technicians to assist him with the analysis, as well as purchasing the required chemicals. This laboratory analyzed 36 individual fat samples at a cost of $45 per sample. No detectable levels of endrin were found with the exception of one adult female Ross' goose (CWS-110) which was subsequently re-tested twice with negative results (Appendix D) (Table 2). It was concluded that contamination occurred in the laboratory.

The C.W.S. National Wildlife Research Centre, Hull, Quebec agreed to analyze pooled samples of duck breast muscle and preen glands from each collection location. Dr. R. Norstrom, Head, Environmental Chemistry Section, outlined the analytical procedure as follows:

> The pooled samples were received in frozen condition, partially thawed, and immediately homogenized in a Waring blender. A sub-sample (10 grams) of this pool was ground with sodium sulfate, extracted with hexane and cleaned-up by Florisil chromatography.

Recoveries of endrin were determined by spiking three subsamples of Perdue duck muscle homogenate at the 20 ppb (10^{-9} g/g) level. The recoveries averaged 94 ± 6%.

The samples were analyzed by gas chromatography employing a 30 m fused silica column and an electron capture detector. The minimum detectable amount, determined by co-injecting endrin with duck muscle extract, was found to be 10^{-11} g, based on a response 2.7X higher than background peaks near the retention time of endrin. This minimum detectable amount translates to a minimum detectable concentration of 0.3 ppb on an "as received" or "wet weight" basis. As an added precaution against losses during analysis, this limit was increased to 1 ppb.

All samples were also analyzed by gas chromatography/mass spectometry employing a 30 m fused silica column, scanning over the mass range 260-268 m/z ($C_7Cl_5H_2^+$) characteristic of the most intense high mass fragment in the mass spectrum of endrin. The minimum detectable amount was 10^{-10} g, based on the baseline noise level. By concentration of the final extract to 0.2 ml, we were able to achieve roughly the same mimimum detectable concentration (0.7 ppb) as that found by electron capture gas chromatography.

In no case was endrin found by either method of determination at or above the detection limit. The results are summarized in Appendix D, Table 3 by detection limit based on net weight, dry weight and lipid weight. In pooled samples, of course, the given values represent an average concentration. The maximum concentration in an individual sample can be obtained by multiplying the minimum detectable concentration by the number of individuals in the pool.

The Alberta Department of Agriculture laboratory, in cooperation with the Alberta Fish and Wildlife Division, also conducted analysis of fat and muscle tissues for endrin for C.W.S. They analyzed pooled samples of 87 birds from the four different locations in Saskatchewan. No detectable levels of endrin were found in any sample.

RESPONSES TO THE PUBLIC

A. Probability of encountering contaminated waterfowl

Hunters in the U.S. and Canada, uneasy about the risk of consuming waterfowl contaminated with endrin, asked the various resource agencies what the odds were of encountering a bird containing endrin residues. In the U.S., federal authorities stated that no statistically reliable answer was possible in determining the probabilities of bagging an endrin-laden duck. The extent of contamination of waterfowl in Montana was difficult to determine because of the wide area sprayed and the logistical impossibilities of sampling each region extensively. However, they stated that if all Montana waterfowl were contaminated, then 2.3 per cent of the total U.S. fall flight would be affected. They were able to give a very approximate estimate of the number of these birds which may be encountered in any one state or flyway using direct band recoveries. Little confidence was placed on these estimates since the bandings did not reflect the specific areas where endrin was used.

The Alberta Fish and Wildlife Division calculated a risk of 1/100,000 that southern Alberta waterfowl may be "unsafe" for human consumption (Appendix E, Figure 1). Calculations by C.W.S. for Saskatchewan hunters indicated a much higher probability of encountering an infected bird in that Province (Figure 2). The calculations for Saskatchewan differed from the Alberta figures due, in part, to differences in the proportion of Montana banded birds recovered during the same season in Saskatchewan and the recognition that a much wider area in Montana was subjected to

spraying than the 120,000 acres initially reported. It became readily apparent that the large number of assumptions which had to be made, the lack of data on the proportion of Montana birds infected and the number of post-breeding and post-molting birds which would move north into Canada, made any such calculations very speculative. These estimates served no purpose other than to perhaps allay the public's fear that there were "millions of poison birds" flying around Alberta and Saskatchewan.

B. News Releases

Three joint news releases were prepared by the C.W.S. and Saskatchewan D.T.R.R. (see Appendix F). There was extremely high public interest in the problem, particularly since the hunting season was under way. The C.W.S. P.M.B.R.C. was inundated by telephone calls from the media and the public, in spite of the three releases, the first (September 14) to outline the problem, the second (September 25) as a progress report on the testing and the final (October 2). Staff at the P.M.B.R.C. conducted 65 interviews by the media (newspapers, radio, television) and handled over 200 telephone calls on the subject. The final news release appeared to satisfy most people that a serious endrin-related health hazard did not exist in Saskatchewan.

EFFECTS ON 1981 HUNTING SEASONS

A. Montana

Montana and 16 other states considered a complete closure of the waterfowl hunting season due to the risk of hunters consuming contaminated birds. However, following the analysis of various wildlife species for endrin residues, the Montana Department of Fish, Wildlife and Parks proceeded with all hunting seasons, as did other states in the Central Flyway. However, specific recommendations on hunt seasons and the consumption of game were made by the Department in an attempt to balance its responsibilities to fish and wildlife resources, to the provision of recreational opportunities, and to the health and safety of its residents. These recommendations were intended to give sportsmen a warning of the health risk and allowed them to make a choice on whether or not they hunted in 1981. This Department also noted that it was questionable if it could legally close a hunting season because of adverse potential health effects. Sportsmen were reminded of the law against waste of meat from wild game.

Montana hunters of Sharp-tailed Grouse were advised to skin and remove fat from their grouse, and to eat no more than one grouse every other day. The Sharp-tailed season was not closed. Grouse meat is not very fatty, and it was thought that the majority of the endrin can be removed in skinning and de-fatting.

The State of Montana recommended that the waterfowl season proceed as scheduled, except that the season for Canada geese was delayed until mid-November in 8 counties.

Considering comments received from toxicologists and health officials, it further recommended that the following precautions be taken for consumption of waterfowl east of the Continental Divide.

1. Trim all fat and discard the skin and internal organs. These items should be discarded in a manner which will ensure that they cannot be consumed by humans or domestic or wild animals.

2. Fully cook the skinned bird on a rack and discard the drippings in the same manner as fat, skin and organs.

3. Do not stuff birds.

4. Women who are pregnant or suspect they are pregnant, and nursing women should not consume waterfowl.

5. No more than one duck or one pound of goose meat per week nor more than six ducks per year or six pounds of goose meat per year should be consumed by adults. Children's consumption should be limited to a half pound or less of meat at same intervals as those for adults.

Because of the large population of ducks and the opportunity for dilution of the population of contaminated birds by incoming and outgoing migratory movement, Montana recommended that the duck season open as scheduled on a statewide basis. Hunters were advised that sampling has shown endrin residues of well over 1.0 ppm in the fat of ducks. Pothole areas associated with endrin treated fields may harbor concentrations of contaminated birds and hunters were not advised to hunt these areas.

Geese were considered a higher risk than ducks for the following reasons:

1. All the geese sampled in an eight county area had high levels of endrin.

2. Research data indicated that broodmates are more often taken by the same hunter than ducks, increasing the possibility of bagging several contaminated birds at one time.

3. Research also indicates that a small percentage of goose hunters take a large percentage of the harvest, averaging as many as 20 or more birds per hunter, concentrating the hazard in a relatively small number of people.

4. The potential for exceeding the Acceptable Daily Intake with geese is higher than for ducks because geese are larger birds and the potential for consuming a larger portion at one meal is greater; also, the meat is fatter than ducks and contains more endrin at the same level of endrin concentration in fat.

The goose hunt season was delayed in 8 counties in the hope that resident geese would be diluted by short grass Prairie Canada Geese which move through Montana in early November from Alberta and Saskatchewan staging areas. Also, migration of large-type (Hi-Line) Canada geese from Saskatchewan and northern Montana occurs in early November. The movement south of resident geese also happens in early November, coinciding with the freezing of small ponds. This would force the birds to use larger wetlands and mix with other, hopefully, uncontaminated birds.

B. Alberta and Saskatchewan

Waterfowl hunting seasons in Alberta and Saskatchewan proceeded on schedule since they were open for nearly two weeks in some areas prior to the issue being raised in this country. During the collection and analysis of waterfowl tissue samples in Alberta and Saskatchewan, hunters were not advised to stop hunting but to store their birds in a freezer until the tests were completed and the health risks better

identified (see press releases, Appendix F). Alberta completed its limited testing approximately two weeks earlier than Saskatchewan and advised that the birds were safe to eat, and the hunting season could proceed in a normal manner. The C.W.S., coordinating analysis of Saskatchewan birds, was more cautious, and the testing of nearly 200 birds post-poned any final announcement until early October, when hunters were advised that a minimal health risk existed and the birds were safe to eat (see October 2 press release, Appendix F).

It is doubtful, however, that the endrin situation affected Canadian hunting seasons only to the extent of delaying the consumption of birds harvested by hunters. The actual impact on hunter effort and use of birds taken to bag is largely unknown. It became readily apparent to field personnel that several things were happening:

(a) A large number of hunters simply did not hunt this year because of the fear of encountering a "poisoned" bird. The probabilities of shooting a contaminated bird meant nothing to a segment of the hunting population, who wanted to be assured that there was "no chance" of a health hazard whatsoever.

(b) Wastage of birds in the field was occurring. Conservation Officers of the Saskatchewan D.T.R.R. reported numerous instances of hunters leaving their birds in the field or disposing of them at rural landfill sites.

(c) A proportion of hunters did not go afield until after the final press release (October 2). This may have resulted in more hunting effort directed at late migrating species such as mallards. By this date many other species were poorly represented in the province. The same effect would result from some hunters waiting until late in

the hunt season so they would only shoot "northern" ducks which were less likely to be contaminated.

(d) Some hunters simply ignored the warning in the first press release and hunted and consumed their birds in a normal manner. It is expected that a large number heeded the caution, and stored birds they shot. After the final press release some of them consumed their birds, others discarded them anyway.

The magnitude of the effect of these various scenarios will be difficult to determine, but some indications of how the hunt season was affected by the endrin situation may be available by examining migratory game bird hunting permit sales and data from the national species composition and harvest surveys. Non-resident permit sales may indicate to what extent hunting trips to this Province were cancelled due to publicity on the endrin issue. Any evaluation of these effects will be complicated by the serious drought on the prairies which will also have affected permit sales and hunter effort.

SUMMARY

Although endrin is a very toxic pesticide, it appears that it poses little health hazard in Canada, due to the length of time the chemical is retained in wildlife tissues, and the amount of flesh and fat that would have to be consumed by individuals. Danger to humans was apparently over-stated due to misuse of the"allowable daily intake" (A.D.I.) figure for endrin by the press and some officials.

The issue of damage to wildlife may not be as alarming as had been made out. There is a possibility that some ducks and geese might become intoxicated as they begin to draw on fat stores over the winter months. Claims that eagles and endangered species of birds might be harmed are, at present speculative since the endrin residues have not been measured. Ducks and geese are among the fattier birds and appear to be the area of concern as opposed to grouse, eagles or other birds. In the U.S., the EPA believes that the present endrin situation poses little danger, if any, to someone who might unknowingly consume an affected bird and poses low probability of danger to endangered or protected species.

The Montana Department of Livestock agreed with the EPA assessment. The State will continue to monitor soil, forage livestock, and wildlife for endrin residue.

The U.S.F.W.S. will continue to monitor pesticides in wildlife in several ways, including the periodic analyses of mallard and black duck wings from the national parts collections. The available reports show

that no endrin was detected in the 1965-66 parts; however, endrin was detected in the 1976 analyses as follows: Pacific Flyway, 0 percent of the samples; Central, 2 percent of 56 samples (each sample was a "composite" of 25 wings); Mississippi Flyway, 4 percent of 69 samples; and the Atlantic Flyway, 5 percent of 20 samples.

There are some areas of serious concern. Endrin is known to degrade very rapidly in the environment, as demonstrated in the samples of soil, water and vegetation tested over a period of time. However, the agriculture, resources and health authorities in the U.S. are very concerned about the levels of endrin found during testing of various animal tissues. They expected, based on available literature and E.P.A.'s review, that the residue levels should have been minimal or nonexistent by late fall. That, however, was not the case. Since the majority of the endrin applications were made according to label directions, something is happening that is not clearly understood. The monitoring program is continuing and will continue until some answers are forthcoming. Just how long pesticide residues will continue to be found is simply not known. High endrin levels in waterfowl have been found in some Central Flyway states as recent as December, 1981.

Endrin is a very toxic poison and the use of it in Montana this year alarmed a great number of people. It affected the sport hunting season and denied many people recreation days in the field. It undoubtedly caused financial loss to guides and outfitters, particularly in Saskatchewan, when non-resident hunters cancelled trips. The effects of this pesticide on migratory bird populations may never be measured due to the subtle way in which endrin poisoning affects individuals. It is possible that residues from the 1981 spraying program may remain in the

environment until next year, and once again cause concern with regard to the hunting season.

RECOMMENDATIONS

1. The C.W.S. should attempt to evaluate the effects of the endrin issue on the Canadian hunter and the 1981 sport harvest. Permit sale, hunter effort and harvest data are available from Ottawa. Recognizing the impact that the 1981 drought and subsequent distribution of birds would have on the hunt season, it should be possible to estimate the effects of the endrin issue on the recreational use of our migratory bird resource.

2. Protests by the Government of Canada should be made to the appropriate authorities in the U.S. over the approved use of endrin in that country. If a formal protest is not possible, then C.W.S. representatives at the Central Flyway Technical Section meeting should register our concern. The use of this pesticide in the U.S. resulted in a considerable expenditure of finances and manpower by the C.W.S.

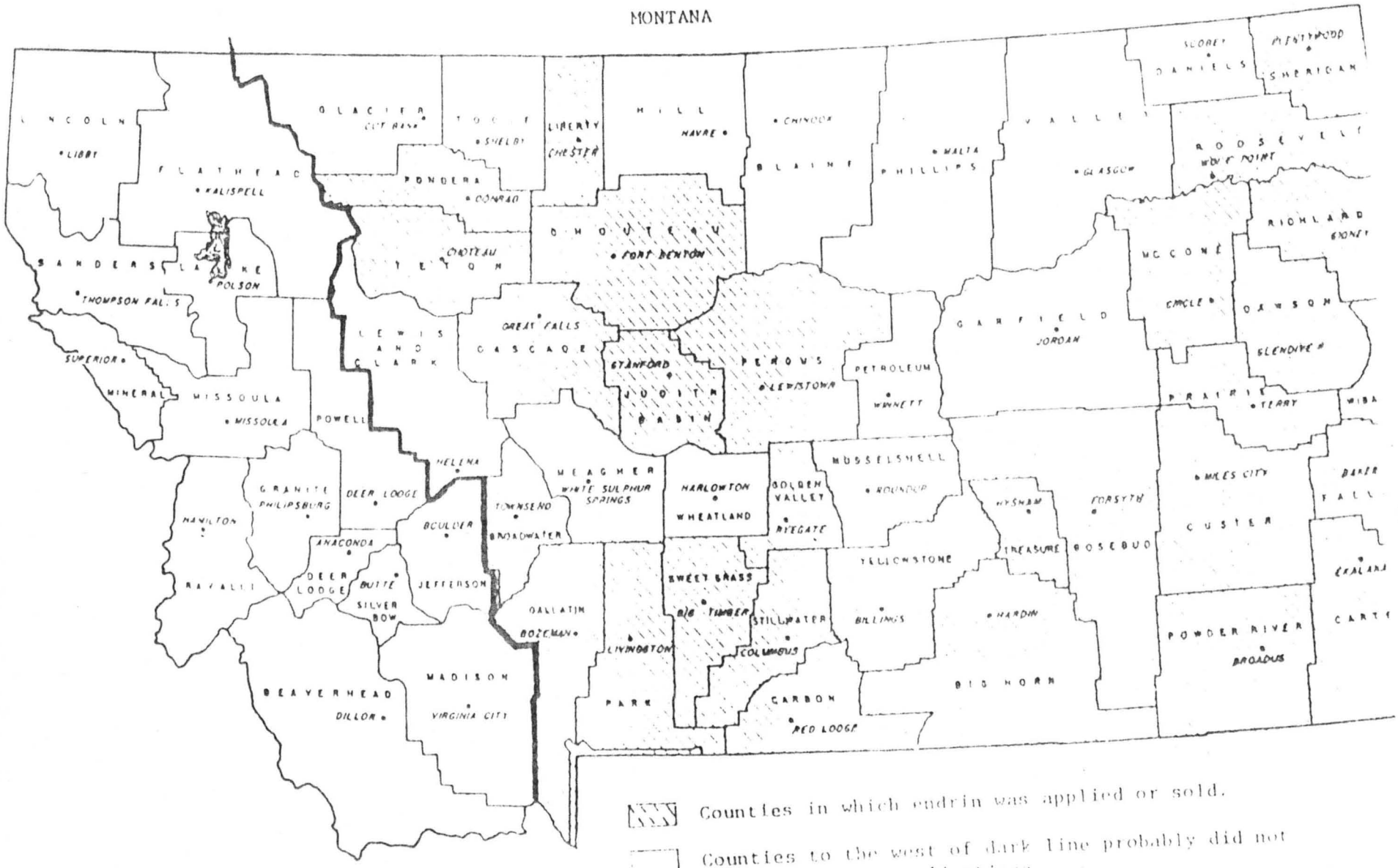
3. C.W.S. personnel should continue contact with the appropriate authorities in the U.S. regarding on-going studies of endrin residues, particularly in Montana. If this becomes a problem next year, perhaps we can be better prepared to deal with it.

4. The results of the test sampling, with particular reference to the individual samples completed at the Canada Agriculture laboratory in Saskatoon, should be published. Other chemicals found during these analyses are of interest.

5. Canadian authorities must be made aware of as many interim and completed reports on the endrin investigation in the U.S. as are available.

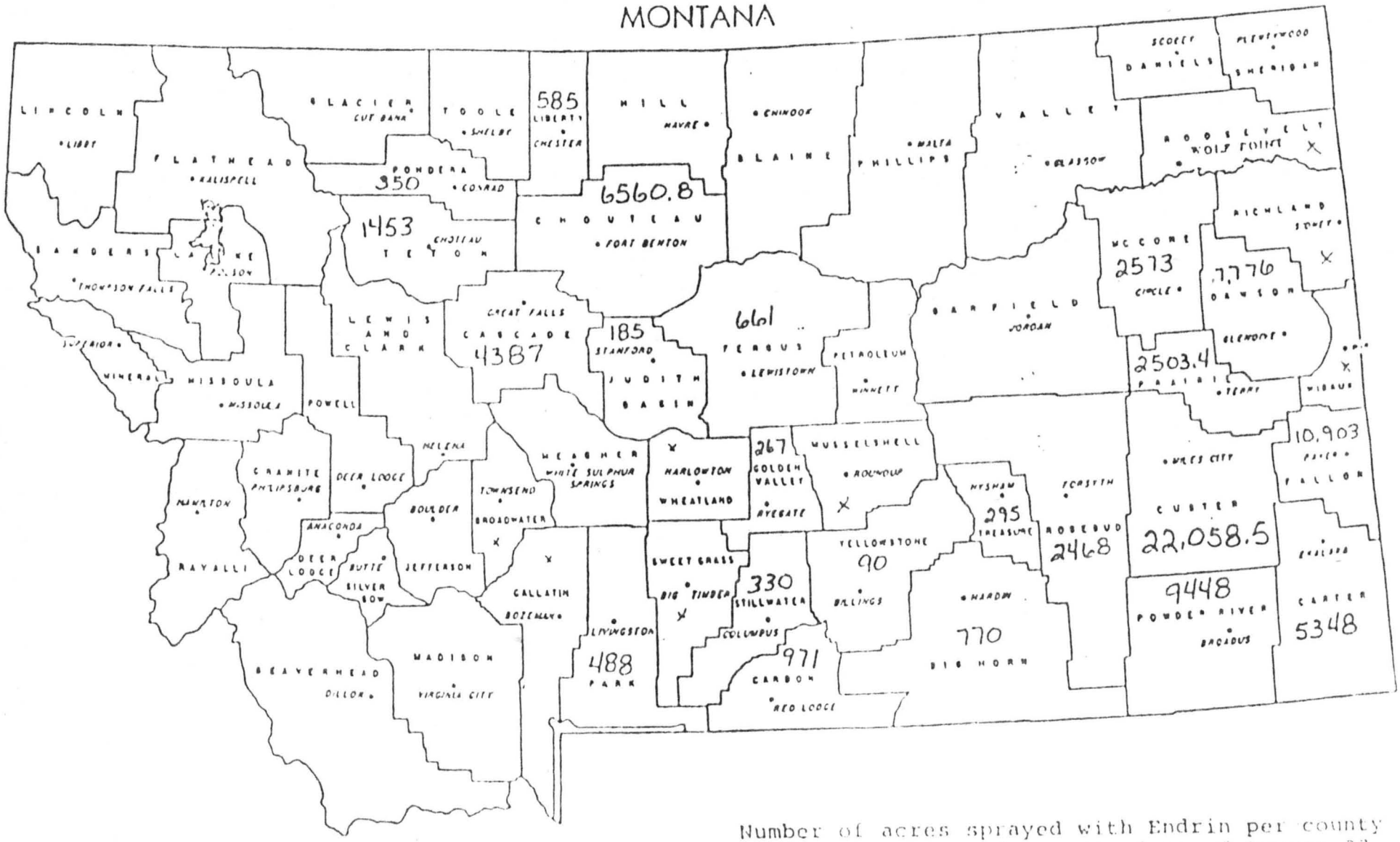
ACKNOWLEDGMENTS

The C.W.S. toxicology laboratory in Hull, Quebec (Dr. R. Norstrom, Head, Environmental Chemistry Section), the Alberta Agriculture laboratory (Edmonton), and the Canada Agriculture laboratory (Saskatoon - Dr. N. Westcott, Dr. Y. Lee) are recognized for the efficient and willing manner in which they received and analyzed tissue samples. Thanks are due to R. Bailey, G. Beyersbergen, R. Brace, G. Gentle, K. Godwin and J. Smith for the many long, uncomfortable hours spent collecting, dissecting, shipping and analyzing waterfowl tissue samples for this project.



NOTE: Those counties east of the dark line not shaded, may have had endrin applications by private applicators. We cannot document whether or not applications occurred.

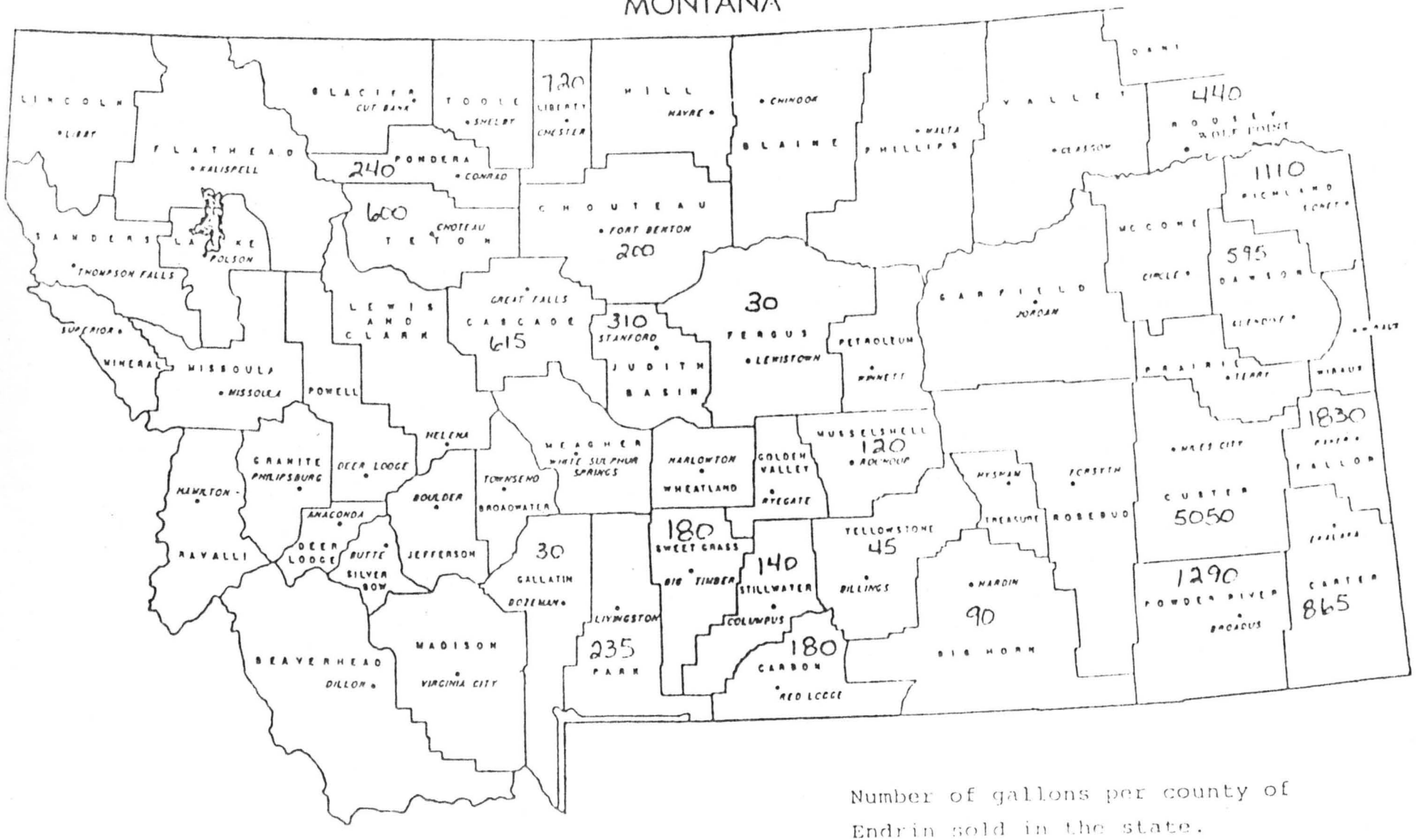
Appendix A Figure 1 Endrin applications and scales by commercial applicators and dealers.



Appendix A Figure 2

Number of acres sprayed with Endrin per county according to records received as of August 27, 1981.

MONTANA



Number of gallons per county of Endrin sold in the state.

State total - 15,445 gallons

Appendix A Figure 3

Appendix B. Table 1. Soil, vegetation and animal samples analyzed for endrin in Montana.

These values may change slightly depending upon quality of the sample.

Site and Location	CR#	Parameter	Sample Interval	Residue Levels	All Endrin unless otherwise noted
1 Custer County	2308	Wheat	2 weeks	2.8 ppm	
	3488	Wheat	9 weeks	0.03 ppm	
	2309	Range Grass	2 weeks	18.9 ppm	
	3491	Range Grass	9 weeks	0.65 ppm	
	2307	Soil	2 weeks	0.29 ppm	
	3490	Soil	9 weeks	0.10 ppm	
2 Custer County	2310	Wheat	2 weeks	3.2 ppm	
	3492	Wheat	9 weeks	0.05 ppm	
	3494	Range Grass	9 weeks	0.78 ppm	
	2302	Soil	2 weeks	0.35 ppm	
	3493	Soil	9 weeks	0.01 ppm	
	3451	Mule Deer	7 weeks	0.07 ppm	
	3452	Antelope	7 weeks	0.53 ppm	
3 Custer County	2304	Wheat	2 weeks	39.5 ppm	Toxaphene
	3495	Wheat	9 weeks	0.90 ppm	Toxaphene
	2303	Soil	2 weeks	6.6 ppm	Toxaphene
	3496	Soil	9 weeks	0.95 ppm	Toxaphene
4 Custer County	3412	Wheat	4 weeks	0.09 ppm	
	3527	Wheat	9 weeks	0.037ppm	
	3413	Grass	4 weeks	2.2 ppm	
	3529	Grass	9 weeks	0.01 ppm	
	3411	Soil	4 weeks	0.15 ppm	
	3528	Soil	9 weeks	0.03 ppm	
	3430	Mule Deer	5 weeks	0.00	
	3432	Mule Deer	5 weeks	0.00	
5 Custer County	3415	Wheat	4 weeks	0.45 ppm	
	3525	Wheat	9 weeks	0.001ppm	
	3414	Soil	4 weeks	0.35 ppm	
	3526	Soil	9 weeks	0.004ppm	
	3431	Antelope	5 weeks	0.00	
	3433	Mule Deer	5 weeks	0.00	
	3434	Mule Deer	5 weeks	0.12 ppm	
	3435	Antelope	5 weeks	0.06 ppm	
6 Custer County	3436	Fish	6-7 weeks	2.50 ppm	
(Yellowstone River mouth of tongue)	3437	Fish	6-7 weeks	2.1 ppb	
7 Custer County	3438	Fish	6-7 weeks	4.2 ppb	
(Yellowstone River	3439	Fish	6-7 weeks	5.3 ppb	
mouth of Powder River)	3447	Fish	6-7 weeks	4.2 ppb	
8 Custer County	3448	Fish	6-8 weeks	2.7 ppb	
(Yellowstone River	3449	Fish	6-8 weeks	1.8 ppb	
Mouth Sunday Ck)	3450	Fish	6-8 weeks	2.6 ppb	

Appendix B. Table 1. (Cont'd)

9 Powder River Co.	3417	Wheat	6 weeks	0.05 ppm
	3520	Wheat	9 weeks	0.020 ppm
	3418	Range Grass	6 weeks	0.24 ppm
	3522	Range Grass	9 weeks	0.005 ppm
	3416	Soil	6 weeks	0.045 ppm
	3521	Soil	9 weeks	0.04 ppm
	3516	Antelope	6 weeks	0.06 ppm
	3517	Antelope	6 weeks	0.00
	3518	Antelope	6 weeks	0.00
10 Powder River Co.	3420	Wheat	6 weeks	0.05 ppm
	3523	Wheat	9 weeks	0.006 ppm
	3419	Soil	6 weeks	0.28 ppm
	3524	Soil	9 weeks	< 1 ppb
	3519	Antelope	6 weeks	0.00
	3515	Mule Deer	6 weeks	0.00
	2840	Mule Deer	7 weeks	0.00
	2841	Mule Deer	7 weeks	0.00
11 Rosebud County	3427	Wheat	6 weeks	0.09 ppm
	3530	Wheat	10 weeks	0.015 ppm
	3428	Soil	6 weeks	0.06 ppm
	3531	Soil	10 weeks	0.04 ppm
	3456	Songbirds	7 weeks	0.00
	3458	Mule Deer	7 weeks	0.00
	3459	Mule Deer	7 weeks	0.00
12 Treasure County	2842	Wheat	7 weeks	0.013 ppm
	2844	Wheat	7 weeks	0.02 ppm
	2846	Wheat	7 weeks	0.03 ppm
	2843	Soil	7 weeks	0.03 ppm
	2845	Soil	7 weeks	0.06 ppm
	2847	Soil	7 weeks	0.02 ppm
13 Fallon County	3425	Wheat	5 weeks	0.07 ppm
	3534	Wheat	9 weeks	0.01 ppm
	3426	Soil	5 weeks	0.15 ppm
	3535	Soil	9 weeks	0.04 ppm
	3457	Mule Deer	6 weeks	0.00
14 Fallon County	3446	Wheat	6 weeks	0.04 ppm
	3532	Wheat	10 weeks	0.007 ppm
	3445	Soil	6 weeks	0.019 ppm
	3553	Soil	10 weeks	0.02 ppm
	3429	White tail	6 weeks	0.00
	3460	Pheasant	6 weeks	0.00
15 Fallon County	3421	Wheat	6 weeks	0.10 ppm
	3497	Wheat	9 weeks	0.019 ppm
	3501	Range Grass	9 weeks	0.03 ppm
	3422	Soil	6 weeks	0.16 ppm
	3498	Soil	9 weeks	0.04 ppm
16 Fallon County	3423	Wheat	6 weeks	0.01 ppm
	3502	Wheat	9 weeks	0.007 ppm
	3424	Soil	6 weeks	0.03 ppm
	3503	Soil	9 weeks	0.02 ppm

Appendix B. Table 1. (Cont'd)

17 Liberty County	3467	Wheat	2 days	17.7	ppm
	3466	Soil	2 days	0.94	ppm
18 Liberty County	3468	Wheat	2 days	24.0	ppm
	3465	Wheat	8 weeks	0.003	ppm
	3753	Soil	2 days	1.3	ppm
19 Fergus County	2652	Wheat	3 weeks	0.45	ppm
	2653	Soil	3 weeks	0.48	ppm
20 Fergus County	2650	Wheat	2 weeks	0.75	ppm
	2651	Soil	2 weeks	0.12	ppm
21 Fergus County	2654	Wheat	3 weeks	0.34	ppm
	2655	Soil	3 weeks	0.08	ppm
22 Dawson County	2668	Wheat	6 weeks	0.10	ppm
	2849	Wheat	9 weeks	0.003	ppm
	2667	Soil	6 weeks	0.26	ppm
	2850	Soil	9 weeks	0.001	ppm
23 Dawson County	3512	Antelope	approx.	0.00	
24 Prairie County	2618	Wheat	6 weeks	0.09	ppm
	2851	Wheat	9 weeks	0.05	ppm
	2617	Soil	6 weeks	0.17	ppm
	2852	Soil	9 weeks	0.11	ppm
	3518	Antelope	7 weeks	0.00	
	3509	Mule Deer	7 weeks	0.00	
	3511	Mule Deer	7 weeks	0.00	
25 Prairie County	2616	Wheat	6 weeks	0.12	ppm
	2853	Wheat	9 weeks	0.012	ppm
	2855	Range Grass	9 weeks	0.041	ppm
	2615	Soil	6 weeks	0.10	ppm
	2854	Soil	9 weeks	0.03	ppm
26 Chouteau County	2664	Wheat	2 weeks	8.6	ppm
	2819	Wheat	8 weeks	0.06	ppm
	2661	Soil	2 weeks	0.79	ppm
	2818	Soil	8 weeks	0.31	ppm
27 Chouteau County	2666	Wheat	2 weeks	7.40	ppm
	3752	Wheat	8 weeks	0.04	ppm
	2665	Soil	2 weeks	0.32	ppm
	3751	Soil	8 weeks	0.45	ppm
28 Chouteau County	2662	Wheat	2 weeks	4.6	ppm
	2817	Wheat	8 weeks	0.03	ppm
	2663	Soil	2 weeks	0.16	ppm
	2816	Soil	8 weeks	0.16	ppm
	2674	Water-Pond	2 weeks	0.00	ppm
	2675	Silt-Pond	2 weeks	0.07	ppm
	2676	Fish	2 weeks	0.05	ppm
	2814	Fish	8 weeks	0.09	ppm
	2815	Fish	8 weeks	0.14	ppm
29 Wibaux County	3536	Wheat	8 weeks	0.006	ppm
	3538	Range Grass	8 weeks	0.20	ppm
	3537	Soil	8 weeks	0.012	ppm
	3539	Soil	8 weeks	0.002	ppm
30 Fallon County	2848	Alfalfa-grass	8 weeks	0.046	ppm

Appendix B. Table 1. (Cont'd)

31	Custer County	3440	Beef fat	approx 4 wk	0.00		
32	Custer County	3442	Beef fat	approx 4 wk	0.00		
33	Custer County	3444	Beef fat	approx 4 wk	0.00		
34	Powder River Co	3443	Beef fat	approx 4 wk	0.00		
35	Rosebud County	3441	Beef fat	approx 4 wk	0.00		
36	Custer County	2867	Beef fat	approx 10 wk	0.00		
37	Yellowstone Co	3035	Deer	8 weeks	0.00		
38	Yellowstone Co	3036	Antelope	8 weeks	0.00		
39	Yellowstone Co	3037	Water-Pond	9 weeks	0.00		
		3038	Fish	9 weeks	0.00		
40	Dawson County (Intake Dam)	2856	Paddlefish eggs	10 weeks	0.005	ppm	Endrin
					0.02	ppm	Dieldrin
41	Custer County (Tongue River)	3461	Fresh Water mussels	9 weeks	0.00		
42	Custer County No. Fork Sunday Ck	3409	Water	95 weeks	0.7	ppb	
43	Custer County Sunday Creek	3507	Water	5 weeks	0.00		
44	Custer County Sunday Creek	3508	Water	5 weeks	0.00		
45	Custer County Sunday Creek	3506	Water	5 weeks	0.00		
46	Custer County Sunday Creek	3455	Water	5 weeks	0.00		
47	Custer County Powder River	3504	Water	5 weeks	0.00		
48	Custer County Powder River	3463	Water	5 weeks	0.00		
49	Custer County Powder River	3454	Water	5 weeks	0.00		
50	Custer County Yellowstone River	3453	Water	5 weeks	0.00		
51	Custer County Mizpah Creek	3505	Water	5 weeks	0.07	ppb	

Appendix B. Table 1. (Cont'd)

COUNTY	LOCATION	CR#	RELATED CR'S	SPECIES	RESULTS	DETECTION LIMIT
Fallon	T9N R57E NW¼ Sec. 6	2902		grouse-breast	N.D.	.001
			2898	grouse-fat	.06	
Fallon	T5N R57E NW¼ Sec. 6	2903		grouse-breast	.0018 ppm	.001
			2899	grouse-fat	.3	
Fallon	T5N R57E NW¼ Sec. 6	2904		grouse-breast	.0017 ppm	.001
			2897	grouse-fat	.3	
Prairie	T10N R52E NW¼ Sec. 1	2905		grouse-breast	N.A.	
			2900	grouse-fat	N.D.	
Prairie	T12N R53E SE¼ Sec. 6	2906		pheasant-breast	N.A.	
			2901	pheasant-fat		
Custer	T9N R45 Sec. 36	2907		goose-fat	.12	
				goose-meat	.010**	
				goose-liver	.039**	
Custer	T9N R45 Sec. 36	2908		goose-fat	.23 ppm	
				goose-meat	.008**	
				goose-liver	.069**	
Custer	T9N R45 Sec. 36	2909		goose-fat	.09 ppm	
				goose-meat	.012**	
				goose-liver	.03**	
Custer	T9N R45 Sec. 36	2910		goose-fat	.20 ppm	
				goose-meat	.011**	
				goose-liver	.026**	
Custer	T9N R45 Sec. 36	2911		goose-fat	.16 ppm	
				goose-meat	.013**	
				goose-liver	.058**	
Custer	T9N R45 Sec. 36	2912		goose-fat	.17 ppm	
				goose-meat	.019**	
				goose-liver	.084**	
Carter	T3N R59E SW¼ Sec. 24	2913		antelope-fat	N.D.	105
				antelope-meat	N.D.	.001 ppm
				antelope-liver	N.D.	.005 ppm

Appendix B. Table 1. (Cont'd)

Carter	T3N	R59E	SW¼	Sec. 19	2914	deer-fat	N.D.	. 05
						deer-meat	N.D.	.001 ppm
						deer-liver	N.D.	.005
Fallon	T10N	R61E	SE¼	Sec. 36	2915	deer-fat	N.D.	. 05
						deer-liver	N.D.	.005
Custer	T9N	R45E		Sec. 24	2916	antelope-fat	N.D.	. 05
						antelope-meat	N.D.	.001
						antelope-liver	N.D.	.005
Fallon	T9N	R56E	SW¼	Sec. 2	2917	grouse-fat	N.D.	. 05
						grouse-meat	N.A.	
Fallon	T9N	R56E		Sec. 6	2918	pheasant-fat	N.D.	. 05
						pheasand-meat	N.A.	
Fallon	T9N	R56E		Sec. 6	2919	pheasant-fat	N.D.	. 05
						pheasant-meat	N.A.	
Powder River	T6N	R51E	NW¼	Sec. 23	2920	grouse-fat	N.A.	
						grouse-meat	N.A.	
Fallon	T5N	R57E		Sec. 1	2921	deer-fat	N.D.*	. 05
Fallon	T5N	R57E		Sec. 1	2922	grouse-fat	.53 ppm*	
						grouse-meat		
						grouse-liver		
Fallon	T10W	R56E		Sec. 36	2923	grouse-fat	.059 ppm*	
						grouse-meat		
						grouse-liver		
Dawson	T17N	R53E	NW¼	Sec. 1	2924	pheasant-fat	N.D.*	. 05
						pheasant-meat		
						pheasant-liver		
Dawson	T19N	R55E		Sec. 29	2925	grouse-fat	N.D.*	. 05
						grouse-meat		
Dawson	T17N	R53E		Sec. 12	2926	grouse-fat	.17 ppm¢	
						grouse-meat		

Appendix C Figure 1 Location of collection of waterfowl for endrin analysis.

Appendix D Table 1 Location and species of waterfowl collected in Saskatchewan for endrin analysis.

Area of collection	Species and Numbers Collected												Total number collected
	Mallard		Non-Mallard		Small Canada		Whitefront		Snow		Ross'		
	Ad.	Imm.	Ad.	Imm.	Ad.	Imm.	Ad.	Imm.	Ad.	Imm.	Ad.	Imm.	
Indi Lake	1	5	17	17									40
L M L	19	6	12	7			3						47
So-Central Sask.	8		1	2			4	2					17
Perdue	37	5		5									47
Kindersley					2	2	5		1		3	3	16
Unity		3											3
Blaine Lake		2		1									3
St. Denis				2									2
Cypress Hills	1	3	2	3									9
Galloway Bay	9	2		1									12
Totals	75	26	32	38	2	2	12	2	1		3	3	196

Table . Area, species and numbers of waterfowl collected in Saskatchewan for endrin analysis during the fall of 1981.

Sample Y.W. Lee's no.	CWS no.	Date of Analysis	Type of Test	Results (Endrin P.P.M.)
Fats (Domestic Fowl)				
1		Sept. 21, 1981	Background	
2		Sept. 22, 1981	"	
3		Sept. 23, 1981	Cleanup	
4		"	Recovery	
5	CWS-7	Sept. 24, 1981	Background	
6	CWS-7	"	Cleanup	
7	CWS-6	"	"	
8	CWS-6	"	Recovery	
9	"	Sept. 25, 1981	Analysis	Nil*
10	CWS-7	"	"	"
11	CWS-119	"	"	"
12	CWS-112	"	"	"
13	CWS-12	Sept. 26, 1981 (Sat.)	"	"
14	CWS-109	Sept. 26, 1981	"	"
15	CWS-120	Sept. 29, 1981	"	"
16	CWS-7 (Repeat)	"	"	"
17	CWS-110	"	"	Contamination
18	CWS-42	Sept. 30, 1981	"	Nil
19	CWS-90	"	"	"
20	CWS-198	"	"	"
21	CWS-123	Oct. 1, 1981	"	"
22	CWS-61	"	"	"
23	CWS-199	"	"	"
24	CWS-84	"	"	"
25	CWS-7	Oct. 2, 1981	Recovery	
26	CWS-110 (Repeat)	"	Analysis	
27	CWS-201	"	"	
28	CWS-200	"	"	"
29	CWS-110 (Repeat)	Oct. 5, 1981	"	"
30	CWS-152	"	"	"
31	CWS-125	"	"	"
32	CWS-164	Oct. 6, 1981	"	"
33	CWS-187	"	"	"
34	CWS-91	"	"	"
35	CWS-191	"	"	"
36	CWS-153	Oct. 7, 1981	"	"
37	CWS-146	"	"	"
38	CWS-200	"	Recovery	
39	CWS-115	"	Analysis	Nil
40	CWS-75	Oct. 8, 1981	"	"
41	CWS-122	"	"	"
42	CWS-128	"	"	"
43	CWS-47	"	"	"
44	CWS-152 (Repeat)	Oct. 9, 1981	"	"
45	CWS-158	"	"	"
46	CWS-143	"	"	"
47	CWS-34	"	"	"

*Nil, not detectable or less than 0.004 p.p.m. (4 p.p.b.) of endrin.

Appendix D. Table 3. Levels of endrin in pooled samples of duck tissue from Saskatchewan, 1981, determined at the National Wildlife Research Centre, Hull, Quebec.

Location	Age	Tissue	No. in Pool	% Dry Matter	% Lipid	Endrin Concentration, ppb Wet Wt.	Dry Wt.	Lipid Wt.[2]
Last Mt. Lake	Adult	Breast muscle	17	28.9	1.50	<1.0	<3.5	<67
Perdue	Adult	Breast muscle	36	29.0	1.05	<1.0	<3.5	<95
SW Sask.	Immature	Breast muscle	9	28.6	1.75	<1.0	<3.5	<57
SW Sask.	Adult	Breast muscle	22	29.7	1.61	<1.0	<3.4	<62
Ind. Lake	Adult + Immat.	Breast muscle	40	29.1	2.08	<1.0	<3.4	<48
Ind. Lake	Adult + Immat.	Preen gland	40	56.7	39.75	<1.0	<1.8	< 2.5

[1]neutral lipids (triglycerides).

[2]Detection limits based on analysis by fused-silica capillary GC, using both electron capture and multiple-ion monitoring mass spectrometry.

Appendix E Figure 1

An estimation of the risk of endrin-contaminated waterfowl in Alberta (After Alberta Fish and Wildlife Division)

Assumption: By September, the small number of spring migrants exposed to endrin in contaminated areas in Montana should have rid themselves of most of the endrin they picked up. Potentially hazardous waterfowl are those which flew to Alberta after breeding and molting in contaminated areas in Montana.

Montana = 147,138 square miles.

Sprayed area = 120,000 acres = 187.5 square miles

= 0.0013 of the state.

1981 Montana waterfowl population = 1,792,000 birds.

Of summer-banded Mallards and Pintails in Montana, 1.5% are recovered in the following September - January in southern Alberta.

i.e. 1,792,000 x 0.015 = 26,880 Montana waterfowl fly to Alberta in late summer or fall.*

If waterfowl were evenly distributed and banding was done at random throughout Montana, Alberta would receive 35 contaminated waterfowl (0.0013 x 26,880 = 34.9) on the basis of the fraction of the state that was sprayed.

7.9 million waterfowl were present in the summer in the southern half of Alberta. The Montana-banded Mallards and Pintails recovered in Alberta in the same year are mainly from south of Red Deer. This area approximates 1/2 the Southern Alberta survey area and would contain roughly 3.95 million waterfowl.

35 potentially contaminated Montana waterfowl in 2.63 million waterfowl

= 0.000013 = 0.00001

Appendix E Figure 1 (cont'd)

Estimated Risk = $\frac{1}{100,000}$ southern Alberta waterfowl may be "unsafe for human consumption", i.e. may exceed legal limits for endrin concentration in domestic meat products.

*By assuming that all Montana waterfowl move about in the same way that the Mallards and Pintails do, probably we are over-estimating the number of birds which move into Alberta.

Appendix E Figure 2

Probability of encountering an endrin-laden duck in Saskatchewan

(Alex J. Smith & E. Woodsworth, C.W.S.)

Montana early fall population = 700,000

5 percent of direct recoveries of Montana bandings are found in Sask.

No. Mont birds in Sask. = 700,000 x .05 = 35,000

Local Sask pop. = 3,960,000

Total Sask. pop. = 3,995,000

If 25 percent of Mont. birds are infected, no. infected birds in Sask. = 35,000 x .25 - 8750

Proportion of Sask. birds infected = 8750 over 3995000 = 0.00219

If a hunter kills "x" birds, the probability of getting at least one infected one is P = 1 - (1-.00219)X which is approx. 0.00219X.

Table gives values of P and X

X	1	2	3	5	10	20
P	.0022	.0044	.0066	.0109	.0217	.0429

Assumptions:

1. All ducks either have endrin or do not
2. Probability of an event (capture of affected duck) is not affected by sampling i.e. samping with replacement from a stable population. This assumption is not completely satisfied, since hunting reduces the population, but is well enough satisfied for a large population and equal susceptibility to capture for the two kinds of ducks.
3. Random sampling can be assumed to be satisfied.

The estimate of proportion of Sask. birds infected also assumes that Montana and Sask. ducks have the same distribution in Saskatchewan.

Appendix F. Figure 1.

ATTENTION SPORTSMEN

There is a possibility that some ducks and geese may not be fit for human consumption this fall. This message has particular relevance in prairie Canada, as migratory game bird season is in progress. The problem is a result of spraying endrin on winter wheat in Montana last March. Endrin is a pesticide used for cutworm control in some states. It is not used in Canada.

High levels of endrin have been detected recently in several species of Montana wildlife including ducks and geese. It may not be safe to eat these birds and the State of Montana is considering not opening the waterfowl hunting season.

Some Saskatchewan ducks and geese migrating through Montana may have been exposed to this chemical. The Canadian Wildlife Service and Saskatchewan Department of Tourism and Renewable Resources are currently testing our ducks and geese for endrin and advise that waterfowl shot this fall should be stored and not eaten until the current testing has been completed.

Further information will be released upon the completion of testing.

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Regina, Saskatchewan

Appendix F. Figure 2.

PROGRESS REPORT ON ENDRIN ANALYSIS ON SASKATCHEWAN WATERFOWL

Endrin, a very toxic insecticide used for cutworm control was applied to a large area of Montana during March and April. Montana officials recently discovered high levels of endrin in ducks in the areas sprayed. However, the Montana waterfowl season will proceed on schedule. The only exception is with regard to Canada goose hunting, which will be delayed until November 15, 1981 in 9 countries. Montana officials have cautioned hunters with regard to the preparation and consumption of ducks and geese.

The waterfowl hunting season is presently underway in Saskatchewan. The Canadian Wildlife Service and Saskatchewan Department of Tourism and Renewable Resources recently issued a percaution to Saskatchewan hunters. Hunters are advised to freeze ducks and geese shot this fall and store them until the situation has been fully evaluated in Saskatchewan.

Staff of our two wildlife agencies have collected more than 200 waterfowl for analysis. Birds are presently being tested at the Canada Department of Agriculture laboratory in Saskatoon. In addition, materials have been sent to the Alberta Fish and Wildlife Division Laboratory in Edmonton and to the Canadian Wildlife Service Toxicology Laboratory in Ottawa. Very preliminary results from a pooled sample of 40 ducks indicate that they were not contaminated. However, we have not analysed sufficient numbers of ducks and geese to draw definitive conclusions. Additional testing is required before we can make final statements about the edibility of Saskatchewan waterfowl.

We expect to have sufficient information to make a final statement by September 30, 1981.

Appendix F. Figure 3.

NO ENDRIN FOUND IN SASKATCHEWAN DUCKS AND GEESE

Testing of 210 Saskatchewan waterfowl for the insecticide Endrin has been conducted and no trace of the chemical has been found, according to Saskatchewan Tourism and Renewable Resources Minister Reg Gross and Canadian Wildlife Service Regional Director Ward Stevens.

Officials of the Saskatchewan Department of Tourism and Renewable Resources (DTRR) and the Canadian Wildlife Service (CWS) collected waterfowl from central and southern parts of the Province during the third week of September and sent them to three different laboratories for analysis. The Canadian Department of Agriculture laboratory in Saskatoon, the Alberta Fish and Wildlife laboratory in Edmonton and the Canadian Wildlife Service Toxicology laboratory in Ottawa have now completed their tests.

CWS and DTRR officials tested the Saskatchewan waterfowl for Endrin after the pesticide was detected recently in birds in Montana. Endrin was sprayed on winter wheat crops there last March to combat cutworms, and the chemicals subsequently showed up in the fatty tissue and internal organs of Montana wildlife.

Endrin has not been used in Saskatchewan for some years and only a relative small number of waterfowl that migrate north to Saskatchewan pass through Montana. Even so provincial and federal wildlife specialists felt it wise to monitor the situation.

Previously the DTRR and CWS spokesman asked hunters to freeze and store any ducks and geese shot this fall until the analyses of waterfowl tissues were completed. From the testing conducted there is no evidence of any Endrin in Saskatchewan waterfowl and the birds are now considered safe to eat.

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