THE EFFECT OF ORCHARD SPRAYING ON PHEASANTS IN THE OKANAGAN VALLEY WITH OBSERVATIONS ON BIRD-LIFE IN ORCHARD AREAS

by

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ABSTRACT

A review of the current literature on DDT and reports from sportsmen and growers indicated that the concentrations of DDT used in the Okanagan Valley were greater than those experimented with previously. Further, that many other insecticides possibly detrimental to wildlife were in use in the Okanagan. A recent decline in pheasant populations was attributed to orchard spraying by many interested persons.

The present investigation is of a preliminary nature and set out to determine:

1. The effect of orchard spraying on pheasants. This was done by means of controlled experiments wherein pheasants were placed in orchards during the normal course of orchard spraying.
2. The residual effect of toxic spray materials. This was done by subjecting pheasants to a period of starvation some time after they had been sprayed.
3. The effect of orchard spraying on wild-life other

than pheasants. This was done mainly by field observations.

4. Whether or not the recent pheasant decline was due to orchard spraying. This was also done mainly by field observations.

It was found that Parathion with DDT, Parathion, DDT, Hexafoss and Lindane were toxic to pheasants while Mono DN was apparently non-toxic. Inhalation exposures are probably more toxic than ingestion exposures and older birds are apparently more susceptible to both exposure types than are young birds. This is thought to be a reflection of the feeding habits of the two age groups. A residual effect was not observed for any of the insecticides tested but the data was not conclusive.

Robins, bluebirds and song sparrows are the avian species most affected by orchard spraying. Which sprays are the most toxic is not known at present although Parathion apparently does not harm robins. The mourning dove and California quail are apparently not affected by orchard spraying.

Chemical analyses by the total chlorine method do not furnish adequate evidence of death from toxic sprays at the present time. Too many variables are evident that possibly alter the toxic effect of the spray material.

The recent pheasant decline did not result from orchard spraying although this practice may have aided decline. The reason for the decline is not known, many theories have been

advanced but they are not wholly valid. The conclusion reached is that the pheasant population characteristic is not flat but shows fluctuations which may later prove to be cyclic when more information is available.

Several suggestions for future studies, concerning orchard spraying, are made. It is hoped that the biologists will keep pace with insecticide development.

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INTRODUCTION

The literature dealing with the effect of DDT on birds is fairly large and extremely variable. Mitchell (18) sprayed DDT on bird nests with a hand atomizer. He sprayed the equivalent of 5 lbs./acre and found that there was no apparent effect upon the hatching of the eggs or development of the young. Similar results were obtained by Hope (11) who sprayed DDT mixed with mentor oil and cyclohexanone on the eggs and nests of several birds. He found also that adult birds were not affected by the residue on the eggs. Several birds were dusted with DDT mixtures and no effects were found except for one olive-backed thrush which, it is believed, died as a result of undernourishment. Erickson (9) reports no significant effect on bird populations after applying DDT at the rate of 0.1 lbs./acre. Stewart et al (25) sprayed 2 lbs. of DDT per acre and found little or no effect on birds, with the possible exception of the redstart (Setophaga ruticilla). Couch (6) used a 5% solution of DDT in #2 fuel oil, applied

at the rate of 0.2 - 0.5 lb. of DDT per acre and found that insects were greatly affected as were some cold-blooded vertebrates. An accompanying shift in the bird populations to areas where more food was available was noted. He points out that while no obvious harm is caused to birds and mammals, with the concentrations used, there may be serious indirect effects resulting from the upset of the food chains in the area sprayed. Kendeigh (13) applied DDT at the rate of 1 lb. per acre and found a negligible immediate mortality of birds. This concentration did not affect the size of the total breeding population nor success in raising young. Nelson and Surber (20) bring up an anomalous situation when they show that mortality of birds and mammals was not evident when DDT was applied in concentrations up to 3 lbs./acre yet a mortality of at least 25% occurred in a group of nestlings when fed with insects killed by a 1 lb./acre concentration of DDT applied as spray. The work of Hotchkiss and Pough (12) shows a conspicuous reduction in the breeding population of birds when DDT is applied at the rate of 5 lbs./acre. Robbins and Stewart (21) and Adams et al (1) show results similar to those of Hotchkiss and Pough. Adams and his co-workers also applied spray at the rate of 7½ lbs./acre and found several dead birds and dying birds with tremors and incoordination. When they applied DDT at the rate of 5 lbs./acre, affected birds were found but two families of ruffed grouse survived two sprayings. Spiers (24) found that spraying 4 lbs. of DDT per acre had no signifi-

cant effect on the bird populstion of the forest but that repeated sprayings amounting to 10 lbs. of DDT per acre had a marked effect in reducing the bird population. Myrtle and bay-breasted warblers, chipping and white-throated sparrows were most affected.

This brief review of the literature revealed that the concentrations used in other studies were much smaller than those used in the Okanagan Valley. Considering this and the fact that many reports from the Okanagan told of pheasants dying as a result of spraying, it was decided to conduct an investigation into the effects of orchard spraying on pheasants.

As it is impossible to ignore wild species in the orchards, it was also decided to include field observations on these species.

The present paper is the result of a preliminary study to provide a basis for future research, the ultimate aim of which should be to advance parallel with insecticide development.

The purpose of this investigation was first, to determine the effect of orchard spraying. This was to be done by designing controlled experiments whereby various insecticides would be tested during the normal course of orchard spraying. Second, to test the residual effect of the insecticides in common use by subjecting birds which had been sprayed to adverse conditions. Third, to supplement experimental evidence with field observations on orchard wildlife. Fourhh,

to determine whether or not the slump in the pheasant population of the Okanagan could be due to the effect of orchard spraying. The pheasant decline first became evident in 1944 and reached its low ebb in 1947 and 1948 when a closed season was enforced.

Equipment, Methods and Sprays:

The spray machines used in the Okanagan Valley fall into four main categories:

(1) Conventional sprayers - These machines cover three to five acres per day and careful operators achieve almost perfect coverage. Coverage by the average grower is 30 to 50% as high a deposit at the top of the tree as at the bottom. Two men operate the handguns and one man drives the tractor. The pressure used is 350 - 650 p.s.i., H.P. is 5 - 25 and output is from 5 - 20 gallons per minute. The machine with the oscillating spray platform, used in many of the experiments, is a modified conventional machine. Although it is slightly faster than handguns and may distribute finer particles, it still uses conventional rather than concentrate mixtures. Concentrate machines use more spray material in a smaller tank than do conventional machines but cover a larger acreage in the same time, hence the amount of insecticide per acre is approximately the same. (2) Speed sprayers - Coverage in this case is equivalent to fair handgun spraying. Speed is about 15 acres per day or double this when a "nurse" truck is used. The crew consists of one man or two if the

"nurse" truck is used. Pump pressure for these machines is about 20 p.s.i. and H.P. required is 100 - 110. These machines operate by discharging insecticide at conventional dilution into a high volume air stream which sprays to both sides simultaneously. (3) Concentrate sprayers - Coverage in tree tops is better with these machines but they are otherwise similar to the speed sprayers. Their speed is about 15 acres per day and they spray to one side only. The crew consists of one man. Pressure runs from 200 - 400 p.s.i., H.P. is 10 - 20 and output per minute is 2 - 5 gallons. (4) Steam sprayers - These are actually concentrate sprayers that atomize the liquid insecticide by means of a high velocity steam blast. These machines utilize a flash boiler operated by fuel oil and are equipped with two gasoline engines in addition. One of the gasoline engines operates a high volume, low velocity fan. Steam pressure is of the order of 100 p.s.i. and steam temperature is 275 - 300 degrees (F°).

The number of sprays per summer and the amount of insecticide used per spray varies from orchard to orchard. From three to five sprays are usually applied during a summer depending largely upon the grower in question and the abundance of the orchard pests. Certain concentrations are recommended for each district by the Provincial and Dominion Agriculture Departments. Some growers adhere to these recommendations closely but others, reasoning from a dubious mathematical basis, believe that if the calendar recommendations are good then twice the

amount will be twice as good. Evidence of this is sometimes observed when one passes an orchard in which the trees are virtually leafless in the middle of the summer. Other growers simply do not know what concentrations they are using per acre of orchard. Thus in work of this sort it is imperative that one watch closely the poundage of insecticide used per spray tank and the number of tanks per acre as growers are often reluctant to admit that they have deviated from the calendar specifications.

The most common insecticides which were used in this investigation were DDT (dichloro-diphenyl-trichlorethane), Parathion (o,o-diethyl-o-p-nitrophenyl thiophosphate), Mono DN (1 oz. Monoethanolamine mixed with 5 oz. dinitrocyclohexylphenol), Hexafoss (Hexaethyl-tetraphosphate) and Lindane which is the trade name for benzene hexachloride with a 99% gamma rating.

DDT was first synthesized in 1874 by a German chemist named Zeidler and was not patented until 1939. During the war years it was used on a large scale for mosquitoes, flies, body lice and bedbugs. In 1947, the insecticide was used by fruit growers for the first time. It is used in the Okanagan primarily to combat codling moth and for this purpose it is formulated as a wettable powder containing 50% of actual DDT. Spraying of this substance alone often leads to an increase in the numbers of woolly aphis and orchard mites, the latter probably increasing when DDT kills off its natural and efficient enemy, the black beetle (Stethorus). Parathion is usually used

along with DDT or shortly afterwards as it effectively controls orchard mites and woolly aphis. Parathion is also used fairly extensively against pear psylla.

Benzene hexachloride is used for pear psylla and the use of the high gamma isomer will probably become more widespread due to its decreased odour and greater toxicity. Mono DN is used mainly, in conjunction with DDT, to combat orchard mites. The dinitrocyclohexylphenol is the poisonous element in Mono DN. Hexafoss was used fairly extensively in 1947 and 1948 to control woolly aphis but its popularity declined considerably in 1949 due to the belief that it was dangerous to handle – which may or may not be true.

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METHODS

Pens:

Light, movable pens were constructed to contain the birds used in experimental and control groups. These pens were 10 ft. long, 3 ft. wide and 3 ft. high. They were made of 1x3 lumber and 1 inch mesh stucco wire.

A rearing coop, which later served as a shelter, was constructed on a plan similar to that used by the Wisconsin Conservation Department (28). The coops used in the present study were rectangular rather than triangular.

Spraying and care of birds:

Experimental pens were placed in the orchards between the trees. Spraying crews were told to give no special attention to either the pens or the mixtures but to carry on as usual. Notes were then taken on mixtures used per tank and the number of acres sprayed with each tank. These data were then converted to pounds per acre.

The control pens were placed at the edge of a little used pasture where vegetation was nearly conparable to that found in the orchards. The control area had hawthorns for shade rather than fruit trees and there was a greater amount of Chenepodium album with a correspondingly lesser amount of red clover than in the orchard areas.

Birds sprayed with steam mist and then moved to a clear area were brought to the control area.

All pens were moved whenever natural food became depleted. Natural food was supplemented by wheat and mash in both the control and the experimental groups. Wheat was put in the pens throughout the life of the birds although it was eaten mainly by the mother hen while the pheasants were very young. Turkey starting mash was replaced by poultry mash when the birds were seven weeks old.

General:

Birds were diagnosed as having died from the effects of spray if they showed characteristic symptoms or if no other cause of death could be found. Post-mortems were done painstakingly on all dead birds regardless of their source, the only exceptions being some passerines which were much too decayed.

During the study as close a check as possible was kept on the wild populations of pheasants both in and outside of orchard areas. Observations in non-orchard areas were always carried out from 6 A.M. to 8 A.M. or from 6 P.M. to 9 P.M. as these hours constituted the most active periods for pheasants. Observations in orchard areas were done throughout most of every day but only the hours spent during the times shown above were tabulated. Thus, many more hours were spent in observing in orchard areas than is shown. It was thought

that this method was the best in that other hours could not be compared with those of the active periods. Two spaniels were used for all census work and to find dead birds.

For purposes of this investigation, birds found one-half mile or more from the nearest orchards were considered as being in non-orchard areas. This criterion seems to agree with Buss (3) who found little or no movement beyond a quarter of a mile for wild birds. Leopold (15) lists the daily cruising radius as one-eighth to one-half mile and the yearly radius as one-half to one mile.

Stock:

Nine chicks hatched under a bantam hen on May 30 were sprayed with Parathion and DDT on June 4. The eggs had been obtained from wild nests and two of them were from a dump nest containing seventeen quail and three pheasant eggs.

The three chicks in Control #1, hatched June 14, were the survivors of 13 chicks hatched from eggs obtained at a pheasant farm in the lower Fraser Valley. The weather was very cold at the time of hatching and for a week thereafter; however, no birds were sprayed in this week and the control served for sprays begun on July 4.

Birds hatched on June 19 were sprayed on July 4 with DDT in the one instance and with Parathion and DDT in the other. They came from a pheasant farm in Kelowna where thay had been hatched in an incubator. The general prognosis of this group

was poor. Many of the chicks could not be used because of abnormalities at hatching. Thirty percent of the birds were eliminated early due to twisted feet, fused leg joints and general frailty. The birds used, then, were the survivors and best of the group.

Pheasants hatched on July 10 made up control #2 as well as the groups sprayed with Mono DN, Parathion and DDT on July 14 and came from the Summerland Rod and Gun Club. Those hatched on July 14 came from the same source and formed control #3, the group sprayed with Parathion on August 8 and the group sprayed with DDT on the same date. All birds were hatched in incubators and their prognosis was good.

The birds sprayed on August 11 and August 18, were obtained through the Game Department from a pheasant farm in the lower Fraser Valley. These birds were 14 weeks old and hatched on or about May 5. The birds forming control #4 and those sprayed with Hexafoss and Lindane were obtained from the same source and hatched on June 13.

Bantam and New Hampshire hens were used to mother the chicks until they grew too large to be covered by the hen or until they left her. This interval usually lasted until the chicks were about five weeks old. The hen and chicks were kept free of ectoparasites by dusting with commercial preparations which did not contain any of the spray material to be tested.

All birds used in the study were of mixed stock composed of Phasianus colchicus torquatus and P.c. mongolicus in varying

degrees. The torquatus strain was most prevalent in the group. Thus the strains of the experimental birds were similar to the wild birds in the area as described by Gowan (7).

EXPERIMENTS

In all but one case, the experimental birds were sprayed during the course of normal orchard routine or shortly thereafter. That is, the growers would have sprayed the same insecticide in the same concentration whether experimental pens were in the orchard or not. Experiment VIII was the only exception and in this case part of the orchard was sprayed for the sole benefit of the experiment. No pests, requiring Mono DN for their control, were present in the orchard at this time. The trees were sprayed as if to control an orchard pest. Spray was not directed at the pens containing the experimental birds.

For each spray material two types of exposure exist:

1. Inhalation - spray material taken into the body by breathing contaminated air.
2. Ingestion - spray material taken into the body with contaminated food or water.

The original plan was to subject pheasants to a spray involving both exposure types to determine whether or not the spray was toxic. If the material proved toxic it was proposed that each exposure type be tested separately to determine which had the most toxic effect. Spray machines which discharge a very fine mist, suitable for inhalation exposures, were seldom available at the right time however and this type of exposure was tried

for DDT and for Parathion only. Other machines, which discharged a limited amount of fine mist and a great deal of coarse fog (droplets) were readily available at most times. Consequently the following experiments are predominantly of the ingestion type or a combination of both exposure types.

Experiment I - Inhalation and Ingestion (Table I):

Nine chicks, five days old, were exposed to contaminated food, water and air on June 4. Three of these chicks survived the first exposure and were sprayed again on July 4 in exactly the same manner. Spraying was accomplished with a modified conventional machine with six nozzles set on an oscillating table which was manipulated automatically. The spray applied was 15% Parathion at 9 lbs./acre and 50% DDT at 18 lbs./acre.

The symptoms observed in this experiment follow in detail for they display, remarkably well, the characteristics which subsequently proved to be typical for DDT poisoning.

June 4 - 7:55 A.M. - trees and pen sprayed on one side

8:15 A.M. - trees and pen sprayed on the other side

8:26 A.M. - bantam mother closing eyes and head is drooping

8:32 A.M. - one chick with head back, opening mouth and falling; also jerking head spasmodically, bubbles appearing when mouth is open

8:43 A.M. - all chicks under hen but two - these two show spasmodic jerking of the head and opening of mouth together with staggering almost to the point of falling

8:45 A.M. - two chicks above close eyes and throw heads backwards, much like a robin drinking

8:57 A.M. - all chicks under hen and hen is preening excessively

9:03 A.M. - one chick sitting on ground with very dumpy appearance and gasping (chick A) - another with tremors is convulsing and foaming at the mouth (chick B) - others apparently normal but preening excessively chick A is now foaming

9:05 A.M. - chick B with extreme tremors and convulsions is now dead

9:15 A.M. - chick A with violent tremors and occasional convulsions can no longer stand, a great effort to get onto its feet again only to fall

9:20 A.M. - chick A has even more violent tremors, gaping and convulsions - wings are at odd angles and appar-

ently out of control

9:25 A.M. - chick A with long spasms and now dead

9:35 A.M. - chick C with slight tremors and gaping

10:05 A.M. - chick C much the same and Chick D with slight tremors

10:25 A.M. - chick C losing balance intermittently while chick D is much the same or may have picked up slightly

11:10 A. M. -chick E with tremors and floppy wings, chick C has hard time standing and has increased tremors

11:20 A.M. - chick E with violent tremors and floppy wings

1:00 P.M. - chick C is unable to stand, mouth gapes intermittently and severe tremors - all others in poor shape

1:15 P.M. - chick C with a violent burst of energy got to its feet, ran about four feet and then fell down, lay there with severe tremors and convulsions

4:30 P.M. - all chicks except C and D appear to be improving but still show disinterest - bantam mother clucks

excitedly but chicks do not respond

June 5 - chicks C and D are dead - all others appear normal

June 7 - chick E had slight tremors all day

June 9 - two other chicks and chick E all have slight tremors

June 10 - 8:00 A.M. -chick E is now dead - another has violent tremors and the remainder have slight to moderate tremors

8:20 A.M. -chick which had violent tremors is now dead

July 4 - -sprayed again with the same concentration as before

July 19 - -another chick with tremors, gaping and convulsions

July 20 - -above chick is dead

July 23 - -one chick with extreme tremors and convulsions while the smallest chick has slight tremors - one of these chicks was the largest of the whole group and the other was the smallest

July 24 - -smallest chick with severe tremors and occasional light convulsions - other chick dead

August 3 - - smallest and sole remaining chick has had violent tremors all day

August 4 - - the above (last) chick is dead

TABLE I

15% Parathion at 9 lbs./acre and 50% DDT at 18 lbs./acre on pheasants and food

Conventional machine with oscillating spray table - spray in droplets (fine fog)

Chicks nos.	Age	When sprayed	Date of death	Cause of death	
1	5 days	June 4	June 4	spray	(A)*
2	"	"	"	"	(B)*
3	"	"	June 5	"	(C)*
4	"	"	" 5	"	
5	"	"	June 10	"	
6	"	"	June 10	"	
7	5&36 days	June 4 & July 4	July 20	"	
8	"	"	July 24	"	
9	"	"	August 4	"	

*Letters refer to chemical analyses, see Table XXII

TABLE II

15% Parathion at 7½ lbs./acre and 50% DDT at 15 lbs./acre on pheasants and food

Conventional machine with oscillating spray table - spray in droplets (fine fog)

Chicks nos.	Age	When sprayed	Date of death	Cause of death	
1	15 days	July 4	July 5	spray	(L)*
2	"	"	"	"	(M)*
3	"	"	"	"	(N)*
4	"	"	"	"	(O)*
5	"	"	"	"	(P)*
6	"	"	July 6	"	
7	"	"	"	"	
8	"	"	"	"	
9	"	"	"	"	

*Letters refer to chemical analyses, see Table XXII

The last three chicks were 36 days old when they were exposed for the second time. They were moved several times, when food was depleted, to other areas in the original orchard, contaminated by the same sprays.

There are two possible explanations for the death (after the second spraying) of these three birds which withstood one spraying. (1) That the birds were older and more susceptible to toxic materials. Possibly their food habits had changed sufficiently to cause death from a concentration they had withstood when they were younger and ate more animal material. (2) Possibly the late death of these three birds shows a residual or cumulative effect. It took a period of 16, 20 and 31 days respectively for the birds to die after the second spray. Presumably each bird retained a certain amount of the toxic material from the first spray and obtained a sufficient additional amount from the second spray to exceed the individual threshold of tolerance. If they had not stored some of the first spray it seems unlikely that they would succumb to the same concentration at a later date unless, of course, greater age and/or food habits had changed sufficiently to alter the toxic effect of the spray material. Further work will probably throw light on the correct solution.

Experiment II - Inhalation and Ingestion (Table II).

Nine chicks, 15 days old, were exposed to contaminated food, water and air on July 4. The same machine as that used

in Experiment I was used here. Fifteen percent Parathion at 7½ lbs./acre and 50% DDT at 15 lbs./acre were applied. A group of three chicks from the same stock and of the same age were not sprayed and served as a control (Table XIV).

Despite the lighter concentration in this experiment, the birds died more rapidly than did those of Experiment I. This discrepancy is believed to be due to the fact that these birds were older and ate more vegetable matter than the pheasants of Experiment I.

Experiment III - Inhalation and Ingestion (Table III).

Nine chick, 15 days old; their food, water and to some extent their air, were sprayed with 50% DDT at the rate of 18 lbs./acre an July 4. There was less opportunity for inhalation in this experiment as handguns were used to discharge spray and the material was in coarse droplets. Very little fine mist is associated with this spray method. The same control group as that of Experiment II was used (Table XIV).

Seven chicks died during the first two days while two were apparently unaffected.

These chicks died more rapidly than did the chicks of Experiment IV although concentrations were the same. The birds were older in this experiment and the type of exposure was different in that birds could inhale some spray material.

TABLE III

50% DDT at 18 lbs./acre on Pheasants and food

Conventional machine with handguns spray in droplets (coarse fog)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	15 days	July 4	July 4	spray (Q)'
2	"	"	"	" (R)'
3	"	"	July 5	" (S)'
4	"	"	"	" (T)'
5	"	"	"	" (U)'
6	"	"	"	" (V)'
7	"	"	"	" (W)'
8	"	"	Aug. 23	pecking
9	"	"	"	"

'Letters refer to chemical analyses, see Table XXII.

Experiment IV - Ingestion (Table IV).

Food and water were sprayed with DDT on July 13 and nine chicks, four days old, were placed in a pen on this sprayed area on July 14. Nine chicks served as a control and were of the same age and stock (Table XV).

Eight chicks were dead at the end of five days and the remaining chicks died nine days after exposure.

In general, chicks in this experiment took longer to die than the majority of birds in Experiment III. This discrepancy is believed to be due to the fact that birds of Experiment III were older and were subjected to the inhalation type of exposure.

TABLE IV

50% DDT at 18 lbs./acre on food only

Conventional machine with handguns spray in droplets (coarse fog)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	4 days	July 14	July 15	spray (1)*
2	"	"	"	" (2)*
3	"	"	July 16	"
4	"	"	"	"
5	"	"	July 17	"
6	"	"	"	"
7	"	"	July 19	"
8	"	"	"	"
9	"	"	July 23	"

*Numbers refer to chemical analyses, see Table XXII.

Experiment V - Inhalation and Ingestion (Table V).

Ten pheasant chicks, 14 weeks old, were exposed to food, water and air contaminated with 50% DDT at the rate of 15 lbs. per acre. Spraying was carried out on August 11 with the modified conventional machine. Seven chicks from the same stock served as a control (Table XVII).

Fifty percent of these birds died as a result of spraying, with typical tremors, convulsions and gaping outlined in Experiment I. Ten percent (one bird) died as a result of pecking and 40% survived. These birds were older than those of Experiments III and IV but judging from field observations and other experiments it is thought unlikely that this factor was the cause of reduced mortality. Rather, the older birds in general, die more quickly than the younger birds. This differential mortality with respect to age is probably related

to differences in food habits of old and young birds. The concentration of DDT used in this experiment was lower than for Experiments III or IV and this is thought to be the factor causing a lower mortality. It is probable that 15 lbs./acre of 50% DDT is close to the threshold of tolerance for pheasants (i.e. 7½ lbs./acre of actual DDT) when exposure is mainly of the ingestion type.

TABLE V

50% DDT at 15 lbs./acre on pheasants and food

Conventional machine with oscillating spray table - spray in droplets (fine fog)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	14 weeks	Aug. 11	Aug. 13	pecking
2	"	"	Aug. 15	spray
3	"	"	Aug. 17	"
4	"	"	"	"
5	"	"	"	"
6	"	"	Aug. 25	"
7	"	"	survived	------
8	"	"	"	------
9	"	"	"	------
10	"	"	"	------

Experiment VI - Inhalation (Table VI).

Ten chicks were exposed to a very fine DDT steam mist, 50% at 10 lbs./acre, on August 8. These birds were removed to a "clear" area as soon as the mist cleared and none of them ingested contaminated food or water. Ten control chicks, (Table XVI) of the same age and source were used in conjunction with this experiment.

All ten chicks subjected to this inhalation exposure of DDT succumbed within 24 hours. They exhibited the symptoms outlined in Experiment I. Tremors were probably more severe in this case than in any of the other DDT experiments.

These ten birds were younger than those of Experiment V and older than those of Experiments III and IV. It seems unlikely therefore that age difference was responsible for the sudden, high mortality in this group. The concentration used in this experiment was even less than the concentration in Experiment V which was believed to be close to the threshold of tolerance. The logical conclusion then, is that inhalation exposures are probably more toxic than ingestion exposures.

TABLE VI

50% DDT at 10 lbs./acre on pheasants only

Steam sprayer, spray in very fine particles (steam mist)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	25 days	Aug. 8	Aug. 8	spray
2	"	"	"	"
3	"	"	Aug. 9	"
4	"	"	"	"
5	"	"	"	"
6	"	"	"	"
7	"	"	"	"
8	"	"	"	"
9	"	"	"	"
10	"	"	"	"

Experiment VII - Ingestion (Table VII).

Ten chicks, four days old, were exposed to contaminated food and water on July 14. The food and water had been sprayed on July 13 with Mono DN at the rate of 60 oz./acre. The original intention of this experiment was to test Mono DN alone but it was found afterwards that the area, (hence natural food also), had been sprayed on July 10 with DDT in an unknown concentration. The men who applied the spray thought the concentration to be more than 15 lbs./acre. Nine chicks of the same age and stock served as a control (Table XV).

All birds died with typical tremors, gaping and convulsions. Time for total death was approximately four days longer than for Experiment IV where the chicks were the same age and the exposure type was the same.

DDT is known to be toxic and it is thought that mortality was due mainly to the unknown concentration of DDT. The difference in time for total death shown for Experiment IV and this experiment is attributable to two things:

1. DDT had been sprayed four days prior to the experiment, thus allowing time for dissipation.
2. DDT sprayed in this experiment may have been applied at a lighter concentration than that of Experiment IV.

TABLE VII

Mono DN at 60 oz./acre and 50% DDT

in an unknown amount on food only

Conventional machine with handguns, spray in droplets (coarse fog)

Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	4 days	July 14	July 15	spray
2	"	"	"	"
3	"	"	July 16	"
4	"	"	"	"
5	"	"	"	"
6	"	"	July 20	"
7	"	"	July 23	"
8	"	"	July 24	"
9	"	"	July 26	"
10	"	"	July 27	"

Experiment VIII - Inhalation and Ingestion (Table VIII).

Ten chicks, 15 weeks old, were exposed to contaminated food, water and air on August 18. A control group of seven chicks was not sprayed (Table XVII). Handguns were used to apply Mono DN at the rate of 60 oz./acre. This experiment was designed to obtain more conclusive evidence on Mono DN than was obtained in Experiment VII.

All chicks survived the spraying for although two died, the cause of death was definitely not spray (see Table VIII).

This experiment bears out the assumption made in Experiment VII, that DDT and not Mono DN was the toxic substance.

TABLE VIII

Mono DN at 60 oz./acre on pheasants and food

Conventional machine with handguns, spray in droplets (coarse fog)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	15 weeks	Aug. 18	Aug. 26	pecking
2	"	"	Aug. 28	broken neck
3	"	"	survived	----
4	"	"	"	----
5	"	"	"	----
6	"	"	"	----
7	"	"	"	----
8	"	"	"	----
9	"	"	"	----
10	"	"	"	----

Experiment IX - Ingestion (Table IX).

Ten chicks, four days old, were exposed to contaminated food and water on July 14. The nine chicks of Control #2 (Table XV) were of the same age and stock. Handguns were used to spray 15% Parathion at the rate of 16 lbs./acre on food and water on July 13.

Five chicks died from the effects of the insecticide over a period of 13 days. The other five birds died from mechanical causes, none of which could be attributed to effects of spray. All birds, including the mother hen, preened excessively during the experiment. Convulsions and gaping were observed before death but tremors were not seen at any time.

From this experiment, it may be stated that Parathion in some concentrations is toxic to pheasants. From the symptoms

observed, it seems possible that the toxic substance is in some way carried by the blood (excessive preening) and that the central nervous system is secondarily affected (convulsions).

TABLE IX

15% Parathion at 16 lbs./acre on food only

Conventional machine with hangguns, spray in droplets (coarse fog)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	4 days	July 14	July 16	crushed
2	"	"	July 17	spray
3	"	"	July 19	"
4	"	"	July 25	"
5	"	"	July 26	broken neck
6	"	"	July 27	spray
7	"	"	"	"
8	"	"	July 30	choked
9	"	"	Aug. 2	crushed
10	"	"	Aug. 13	pecking

Experiment X - Inhalation (Table X).

Ten chicks, 25 days old, were exposed to a steam mist of 15% Parathion at the rate of 12 lbs./acre, on August 8. The mist was very fine and as soon as the air cleared the birds were moved to an uncontaminated area. The control group was comprised of ten birds of the same age and stock (Table XVI). None of the birds in this experiment ingested contaminated material.

Fifty percent of the birds in this experiment died as a result of spraying. Time for death of this percentage was shorter than for the same percentage in Experiment IX, despite

the lower concentration.

It is thought that the inhalation exposure and the greater age of the chicks in this experiment were the factors causing the increased rate of death. Excessive preening was most noticeable in this experiment as well as in the former. It is significant that this excessive preening was not due to direct contact with the skin but was an inherent effect of the toxic material.

TABLE X

15% Parathion at 12 lbs./acre on pheasants only

Steam sprayer, spray in very fine particles (steam mist)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	25 days	Aug. 8	Aug. 8	spray
2	"	"	"	"
3	"	"	Aug. 11	"
4	"	"	"	"
5	"	"	Aug. 17	"
6	"	"	Sept. 20	bruised head
7	"	"	Sept. 27	pecking
8	"	"	Sept. 28	"
9	"	"	survived	----
10	"	"	"	----

Experiment XI - Inhalation and Ingestion (Table XI).

Ten birds, 15 weeks old, were exposed to food, water and air contaminated with 15% Parathion on August 18. The modified conventional machine was used in this experiment and spray was applied at the rate of 7½ lbs./acre. Seven chicks of the same stock and age were used as a control (Table XVII).

TABLE XI

15% Parathion at 7½ lbs./acre on pheasants and food

Conventional machine with oscillating spray table, spray in droplets (fine fog)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	15 weeks	Aug. 18	Aug. 25	pecking
2	"	"	survived	---"
3	"	"	"	---"
4	"	"	"	---"
5	"	"	"	---"
6	"	"	"	---"
7	"	"	"	---"
8	"	"	"	---"
9	"	"	"	---"
10	"	"	"	---"

No deaths attributable to the effects of spraying occurred in this experiment. The birds preened excessively fpr approximately 24 hours, aside from this no symptoms of toxic effects were evident.

While increased age apparently decreased tolerance for DDT it is possible that the same situation does not hold for Parathion. Perhaps older birds, feeding more on vegetable matter, have a greater tolerance for Parathion than the younger birds whose diet contains more animal matter. On the other hand it is very probable that 7½ lbs./acre of 15% Parathion approximates the threshold of tolerance for this substance, with respect to the ring-neck pheasant.

Experiment XII - Inhalation and Ingestion (Table XII).

Nine birds, ten weeks old, were exposed to contaminated food, water and air. Handguns were used to apply Hexafoss at the rate of 10 pts./acre on August 22. Seven chicks of the same age and stock were used as controls (Table XVII).

TABLE XII

Hexafoss at 10 pts./acre on pheasants and food

Conventional machine with handguns, spray in droplets (coarse fog)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	10 weeks	Aug. 22	Aug. 23	spray
2	"	"	"	"
3	"	"	Aug. 24	"
4	"	"	survived	----
5	"	"	"	----
6	"	"	"	----
7	"	"	"	----
8	"	"	"	----
9	"	"	"	----

Three of the birds in this experiment died as a result of spraying. These birds looked "dumpy" immediately after spraying and closely resembled a bird during the molting period. All birds shook their heads vigorously, from side to side, at the time spray was applied. Periodically the "dumpy" birds straightened up, shook their heads vigorously and returned to the "dumpy" position. The day after spraying, two birds lay on their sides convulsing intermittently. Convulsions terminated in an odd position with the head lying

directly over the back. One of these affected birds took extreme convulsions, exhibited "circus" movements, resulting from a wild kicking of the legs, flopped its free wing violently and lay dead. All this took place in the space of 31 minutes and the final outbreak of convulsions with "circus" movements took about five minutes. The second bird exhibited the same symptoms, without the flopping wing, and died two hours later. The third chick to die did so on August 24 with actions similar to those already described.

Hexafoss is obviously toxic at some concentrations. Whether inhalation exposure is more deadly than ingestion exposure is not known. The toxic material evidently affects the central nervous system resulting in convulsions and an odd position of the head. This material is not widely used at present but may have increased use in the near future depending on experiments for the control of orchard pests still being conducted.

Experiment XIII - Inhalation and Ingestion (Table XIII).

Nine birds, ten weeks old, were exposed to contaminated food, water and air on August 22. Handguns were used to apply Lindane at the rate of 5 lbs./acre. The control group used was the same as for Experiment XII (Table XVII).

Six of the birds in this experiment died as a result of spraying, one died from pecking and two survived. All birds humped up, with heads drooping and eyes closed, immediately

after spraying. Four hours later all birds had their heads thrown directly over their backs in the same position as that observed for Hexafoss. On August 23, the day after spraying, three birds died. Two were dead upon arrival at the pen in the morning. The third chick was observed, standing humped up, with its head directly over its back - with no warning of any sort it fell over on its side and was found to be dead. Two birds the following day were observed to die in the same manner with no symptoms other than general apathy and head thrown directly over the back.

TABLE XIII

Lindane at 5 lbs./acre on pheasants and food

Conventional machine with handguns, spray in droplets (coarse fog)				
Chicks nos.	Age	When sprayed	Date of death	Cause of death
1	10 weeks	Aug. 22	Aug. 23	spray
2	"	"	"	"
3	"	"	"	"
4	"	"	Aug. 24	"
5	"	"	"	"
6	"	"	"	pecking
7	"	"	Aug. 27	spray
8	"	"	survived	----
9	"	"	"	----

It is evident that Lindane is toxic to pheasants even in small concentrations. The symptoms exhibited by the birds indicate a nervous disorder of some sort but of a vastly different nature than that observed in other experiments. This insecticide has not been extensively used to date as it

is comparatively new. Its predecessor, benzene hexachloride with a low gamma rating, had an unpleasant odour which persisted on the apples and restricted its use. Lindane, the modern benzene hexachloride, has less odour and possibly will not taint fruit. Lindane is also a more successful pest killer than its predecessor. In consequence it may become a widely used insecticide in the near future.

Controls (Tables XIV, XV, XVI, and XVII).

The birds of the control groups were not sprayed at any time and were, in almost every other way, similar to the experimental groups. The matter of shade trees and slight food differences has been shown previously. Another difference is that some of the experimental birds became quite wet during spraying operations while the corresponding control birds were not wetted. It was felt that in this preliminary study, the wetting of sprayed birds was actually an effect of orchard spraying. In future work it would be well to set up control groups and throw water on them at the time their corresponding experimental groups are sprayed. In this way the effect of the toxic material itself will be tested. In the present investigation, all birds were soaked by sudden rainshowers with apparently no ill effect.

Fifty percent of the control birds died during the study but none showed any of the symptoms described for the various spray materials. When the experimental birds died from spray

there was no doubt as to the cause, inasmuch as symptoms were so very marked. Cause of death of control birds was always obvious and explainable by mechanical means.

TABLE XIV

Control # 1

NOT SPRAYED			
Chicks nos.	Served as control for Tables - -	Date of death	Cause of death
1	II and III	Oct. 13	pecking
2	"	survived	----
3	"	"	----

TABLE XV

Control # 2

NOT SPRAYED			
Chicks nos.	Served as control for Tables - -	Date of death	Cause of death
1	IV, VII and IX	July 16	trampled
2	"	"	"
3	"	July 17	broken neck
4	"	July 23	"
5	"	July 28	trampled
6	"	Aug. 30	shipment
7	"	Oct. 5	pecking
8	"	Oct. 17	"
9	"	"	"

TABLE XVI

Control # 3

NOT SPRAYED			
Chicks nos.	Served as control for Tables	Date of death	Cause of death
1	VI and X	Aug. 14	trampled
2	"	"	"
3	"	Sept. 27	bruised head
4	"	Oct. 3	pecking
5	"	survived	----
6	"	"	----
7	"	"	----
8	"	"	----
9	"	"	----
10	"	"	----

TABLE XVII

Control # 4

NOT SPRAYED			
Chicks nos.	Served as control for Tables	Date of death	Cause of death
1	V, VIII, XI XII and XIII	Aug. 20	choked
2	"	Oct. 13	broken neck
3	"	survived	----
4	"	"	----
5	"	"	----
6	"	"	----
7	"	"	----

Experiment XIV - Residual Effect.

There is some experimental evidence that DDT at least may be accumulated in the body fat of vertebrates. Small quantities not sufficient to cause death themselves, are stored and the total of these small additions is sufficient to cause death if it is released into active body processes. If this is the

case, a bird, apparently healthy, may succumb to the toxic material when an amount of the substance exceeding the threshold of tolerance is reached or when a stored amount exceeding the threshold of tolerance is released to the body in an available form.

In an attempt to test the residual effect of the various insecticides, the survivors of Experiments I - XIII inclusive and the unsprayed survivors of the control groups, were subjected to a period of starvation. It was believed that birds with a stored overdose of spray, when starved, would use up their body fats and thus liberate the stored material.

The birds to be used in this experiment were crated at Kelowna and shipped to the Department of Poultry Husbandry at the University of British Columbia where they were placed in a clean chicken-house and fed wheat and poultry mash. Some birds died from various causes such as pecking, trampling and concussion. The result was that only 29 birds were available for this experiment. These 29 birds were in groups as follows:

DDT from Experiment V ----------4

Mono DN from Experiment VIII----------2

Parathion steam mist from Experiment X--2

Parathion from Experiment XI----------5

Hexafoss from Experiment XII----------6

Lindane from Experiment XIII----------2

Control #1 (Table XIV)----------1

Control # 3 (Table XVI)--------3

Control # 4 (Table XVII)-------4

Total ---------- 29

The pheasants were fed regularly and weighed once a week until they attained a relatively constant body weight. On November 7 all food was removed and the birds were weighed every day until November 17 when food was returned. In actual fact, the birds were able to get some food from the earthen floor of the chicken-house but this source was almost completely exhausted on November 9, two days after food was removed.

The birds lost an average of 25% of their body weight during the starvation period. There was no significant difference in rate of loss of body weight among the nine groups. One of the birds exposed to Parathion steam mist (Experiment X) and one exposed to Parathion (Experiment XI) died during the starvation period. One of these died as a result of pecking and the other died from a broken neck when it somehow managed to get its head through the finely meshed stucco wire fronting the chicken-house. A bird from Control # 4 and a bird from the Hexafoss experiment died as a result of pecking after the starvation period was over. None of the birds exhibited symptoms characteristic of the spray materials used. In short, no evidence of a residual effect was observed for any of the materials tested in this experiment.

The results are not conclusive when one examines the time

birds were exposed to their particular spray material:

DDT (Experiment V)----------Aug. 11 - 29

Mono DN (Experiment VIII)--------Aug. 18 - 29

Parathion steam mist (Expt. X)----25 minutes

Parathion (Experiment XI)---------Aug. 18 - 29

Hexafoss (Experiment XII)---------Aug. 22 - 29

Lindane (Experiment XIII)---------Aug. 22 - 29

It is possible that the birds were not exposed for a sufficient time to accumulate more toxic material than they could tolerate.

FIELD OBSERVATIONS ON THE EFFECTS OF ORCHARD SPRAYING ON WILDLIFE OTHER THAN PHEASANTS

Effect of Parathion on Mourning Dove (Zenaidura macroura):

On June 9, Parathion was sprayed on a hen mourning dove sitting on two eggs. Spray was applied at the rate of 7½ lbs. (15% wettable powder) per acre using the conventional machine equipped with the oscillating table. A good deal of the spray fell directly on the bird and she was quite wet. The bird and nest were watched constantly for three hours and she behaved like any other wet bird.

On July 6, the mourning dove mentioned above had two young and in the meantime another nest had been built two trees away. This new nest was occupied by a hen sitting on two eggs. Both nests were again sprayed with Parathion at the rate of 9½ lbs./acre (15% wettable). Spraying was carried on with the same equipment as before.

The young of the first nest flew hesitatingly the next day keeping to the ground for the most part. On July 14, the hen was brooding two more eggs which hatched and the young flew successfully on August 13. The second mourning dove hatched her two eggs on July 20 and the young flew on August 3.

Both mothers had been heavily wetted during this second spray and neither showed any unusual action. During the whole

study neither dead nor ailing doves were found.

Cedar Waxwings (Bombycilla cedrorum):

On July 19, a nest containing five young cedar waxwings was sprayed with 9 lbs. of DDT (50%) and 3½ lbs. of Parathion (15%) per acre. The two adults were perched in the tree but not on the nest at the time of spraying. All birds became quite wet. Spraying was done with a concentrate machine and a great deal of fine mist and vapour was involved. The young were only partly feathered on this date and left the nest on August 3. The family group remained in the orchard until August 6 and were not seen thereafter.

Effect of Spray on Domestic Chickens:

On June 26, concentrations of 6 lbs. of DDT (50%) and 2 lbs. of Parathion (15%) per acre were sprayed on pear trees surrounding a chicken-house. The house contained 67 cockerels, seven weeks old; two geese, six weeks old and 38 turkeys, nine weeks old.

Spraying ceased at 3:00 P.M. and the poultry were let out of the chicken-house at 3:30 P.M. By 5:00 P.M. nine cockerels had died with convulsions and tremors; one was in severe spasms while seven others were groggy and showed occasional tremors. These seven birds were revived by forcing epsom salts and milk. The rest of the poultry were not affected.

The bantam and New Hampshire hens used to mother pheasant chicks in spraying experiments were exposed along with their chicks. All hens survived and only in the trials using Parathion and DDT and those using Parathion did they show any noticeable effect. In both instances the birds exhibited excessive preening.

Effect of Spray on Bluebirds (Sialia currucoides):

Following is an account of observations on a family of mountain bluebirds which were nesting in a packing shed in the centre of an orchard. These birds had access, within their cruising radius to areas sprayed with Parathion, Mono DN, DDT, Soap and Cryolite. Further, a large pool of water, containing some of all the above sprays, lay within 50 ft. of the nest. This pool was formed by the overflowing of the spray tank and after partial evaporation of the water it was presumably a potent mixture.

June 17 - 7:00 A.M. - one pair of mountain bluebirds perching on the edge of the water tank - the male has tremors and occasional convulsions - he flies poorly and flops to the ground to rest at frequent intervals - he apparently cannot stay perched on anything for any

length of time.

7:20 A.M. - female exhibiting slight tremors while male is sitting under the eaves of the packing shed with severe tremors and convulsions, apparently unable to fly.

7:30 A.M. - male is dead but no sign of cause can be found - crop contained two small grasshoppers.

7:36 A.M. - female flew into hole at side of packing shed to the accompaniment of much cheeping from young.

June 19 - 8:30 A.M. - three young bluebirds found dead on ground below nesthole and English sparrows seem to have taken over - search for adult female was made and she was found, badly mutilated under the loading platform - she had apparently been mouthed a great deal by a dog.

In another instance, two bluebirds had a nest in a Robinia tree at the edge of an apple orchard. The male

disappeared on the day of spraying and the female showed convulsions and tremors toward the end of the day. The next morning the female was dead and one of the young had severe tremors. The chicks were brought into the house by the owner of the orchard. One of the young died in two days with severe tremors and convulsions. The other chick suffered minor tremors but these soon disappeared; the bird was released and not seen again. DDT was the only insecticide used within a mile and one half radius of the nest.

Two other mountain bluebirds, a hen and a cock, died in the writer's hands. Both birds had severe tremors and convulsions, were unable to stand and could not support their heads. These two birds had been sprayed the day before with DDT at the rate of 25 lbs. (50%) per acre.

In addition to the former accounts, four mountain bluebirds (two hens and two cocks) were found dead in the orchards. No cause of death was evident at post mortem and it is assumed that these birds died as a result of spraying. All four birds were adults.

Effect of Spray on Robins (Turdus migratorius):

The majority of work on robins was done on one orchard which covered 116 acres. A count was kept of the number of observation hours spent in the orchard and of the number of birds seen. One observation hour is here defined as an hour spent cruising the orchard and used solely to observe and

count birds. This method was adopted because one cannot "position" a bird while working with pens, spray machines, etc. and there is a greater chance of counting the same bird more than once.

Figure 1 shows the result of orchard observations by months. It is significant that the number of robins per observation hour gradually decreases from June to August. This period should show an increased population resulting from the addition of the young of the year. It seems evident that some cause of mortality was reducing the robin population.

During the study, it was found that robins congregated on the roof of the packing house in the base orchard (116 acres). These congregations occurred between eight and nine o'clock in the evening. When time permitted a count was made between these hours. Table XIX shows the result of these counts and it is evident that a decrease in population made itself felt here as well.

Table XVIII shows the sex ratios of dead robins by months. Those birds which were unidentified were those too decomposed for study and four nestlings found in June. Apparently both sexes are equally affected by toxic spray materials although the sample is small.

It was difficult to determine which sprays had been used on any particular robin because of the movements of the large numbers involved. In one instance however, Parathion was sprayed on a nest containing four young robins and the

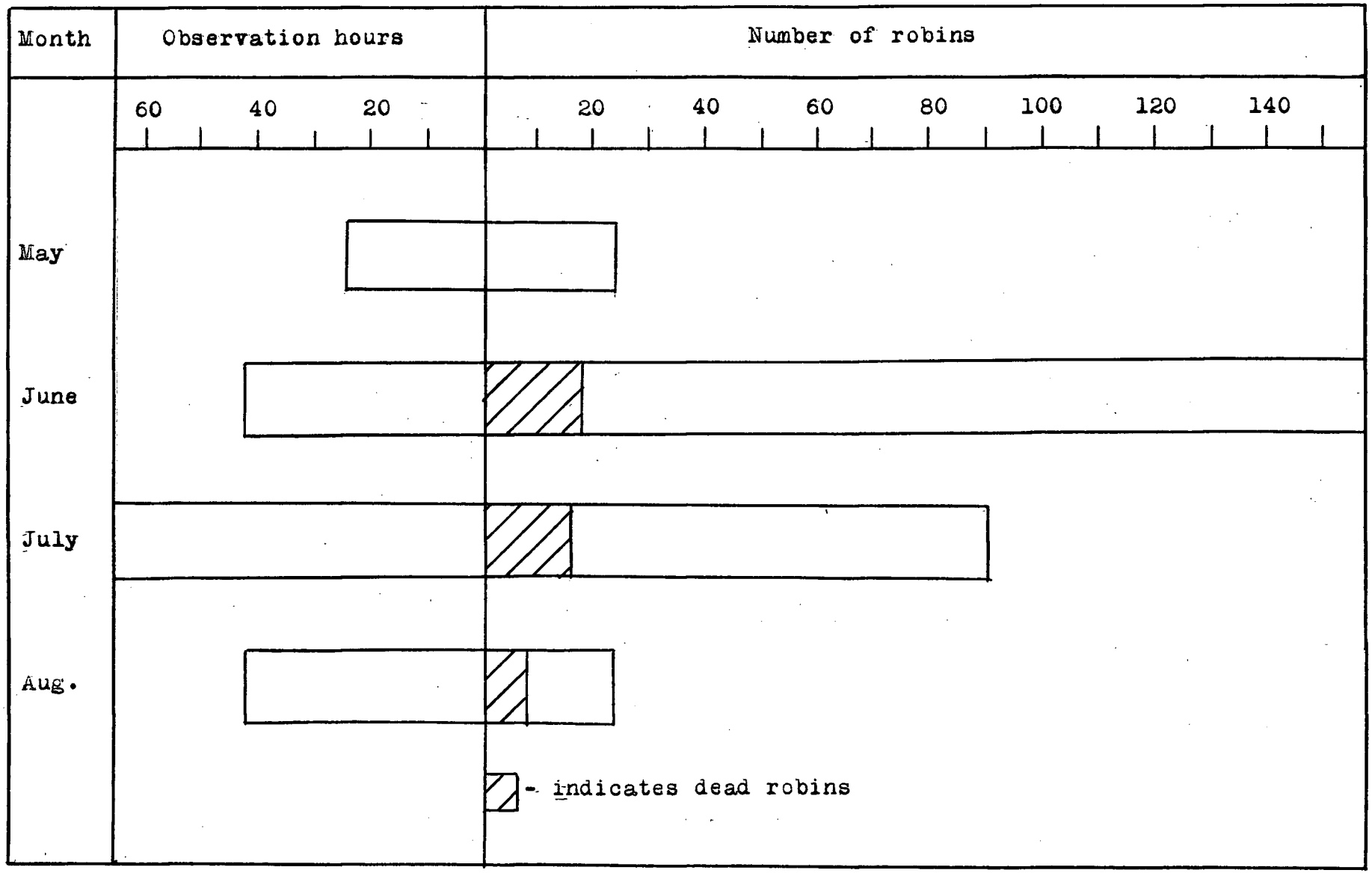

Fig. 1. Number of robins and hours spent in observation by months.

adult hen on a nearby branch. Spray was applied at the rate of 11 lbs. (15%) per acre and no effect was noticed. The young flew three days later, apparently normal.

TABLE XVIII

Sex ratios of dead robins

by months

Month	Total dead	Males	Females	Unknown
May	0	0	0	0
June	18	9	4	5
July	16	4	7	5
August	8	4	4	0
Total	42	17	15	10

TABLE XIX

Evening counts of robins

Date	Count on packing shed roof
June 19	40
" 21	39
" 25	29
July 9	15
" 10	18
" 17	24
" 23	13
Aug. 13	8
" 19	7

In another case four young robins were sprayed with DDT on June 15 by one of the local ranchers. He reports that these birds showed severe quaking motions, that one died the day after spraying and the other three died on the next

morning. These birds had left the nest but could not fly too well and he reports that they did not move outside a thirty foot circle during the whole three days. Spray had been applied at the rate of 13 lbs. (50%) DDT per acre.

Effect of Spray on Sparrows:

During the study four song sparrows, three chipping sparrows and one white-crowned sparrow were found dead. No cause of death was found and all birds were in good condition. The white-crowned sparrow had been feeding on seeds and flowers of Polygonum convulvulus while the others had fed entirely on insects. One of the chipping sparrows and one of the song sparrows were seen before they died. Both birds had tremors, convulsions, and the wings were out of control.

Effect of Spray on Quail (Lophortyx californica):

Quail were extremely abundant throughout the study period. They apparently suffered no harm from orchard practices and generally flushed a good distance ahead of any disturbance.

One pair was outstanding in its parental behaviour. The hen had a stump foot which made her easy to distinguish and the pair could always be found in an area of not more than three acres. The pair were seen with fifteen very young chicks on June 12, 16 and 17, but on June 19, only the cock and fifteen young were seen. A search was made for the

hen and she was found very much alive, sitting on ten eggs. On July 17, the pair were together again and now had two distinct broods, one of fifteen and the other of ten. On July 23, the cock and his two broods were seen while the hen was not in evidence until August 16. On this date both adults were found with a brood comprised of fifteen, ten and eight young of three different ages. Probably this is a case of brood transferal and/or of nest robbery as it is a little difficult to visualize a bird overcoming so quickly the psychological and physiological changes involved in ceasing to incubate and to begin laying.

From June 12 to the termination of the study on August 30, no adults were seen without young. In the last two weeks of August, large coveys were seen of mixed age groups.

During the whole summer only one quail was found dead. This bird was a cock and had been shot with a .22 calibre rifle. No symptoms indicating toxic spray effects were seen.

General Discussion:

DDT then, is noticeably harmful to some birds when applied at concentrations of 5 lbs./acre or more. Other substances are also harmful to a lesser extent on avian populations. However, any substance which significantly affects any animal population is apt to have a damaging effect on other populations, in the long run, by breaking the food chain. This will apply equally well to sprays such as

arsenic, black leaf "40", and others that significantly affect insect populations.

Indeed, after the first spray is applied, sometime in June or late May, the whole ecology of much of the Okanagan Valley is changed. Thus the western flycatcher (Empidonax difficilis difficilis), the western wood pewee (Myiochanes richardsoni richardsoni), and Trail's flycatcher (Empionax traillii), which were abundant in the orchards during May, were not seen in the orchards after the first spray in June but remained outside the orchards altogether or were seen occasionally on the very edge.

English sparrows (Passer domesticus domesticus) were found in greater numbers in the orchards after the first spray than before. Few of these birds nested in the orchards (three nests in the packing shed of one orchard) and no nests were found in fruit trees.

Evening grosbeaks (Hesperiphona vespertina) were found in the orchards, and the area surrounding them at Kelowna, until the end of May when they seemed to leave the region entirely. These birds returned in August but did not go into the orchards at this time.

House finches (Carpodacus mexicanus) were found in the orchards until the end of May but after this they remained in the surrounding area and did not venture into the orchard.

Mourning doves occurred in many orchards and often nested in prune-plum trees. They did not appear to be affected by

any spraying practice. They are surely not affected by Parathion applied at the rate of 7½ to 9½ lbs. (15%) per acre.

Cedar waxwings were found in only one orchard although they were abundant in the surrounding area. The family sprayed with DDT and Parathion was certainly not affected.

Mountain bluebirds are found in many orchards and their population is reduced by DDT in these orchards. Whether or not other sprays harm thses birds is not known as yet.

Robins are also common birds in the orchards and are probably affected by DDT more than is any other species. Parathion up to 11 lbs. (15%) per acre does not have any apparent effect on robins.

Of the sparrows, the song sparrow (Melospiza melodia) is most affected by toxic materials and is the most common in orchards. The chipping sparrow (Spizella passerina arizonae) is the next most common sparrow and is also affected to quite an extent. The white-crowned sparrow (Zonotrichia leucophrys) was plentiful in the orchards until the last week in May and only one specimen found dead on June 21, was seen from May until August 28 when eight were seen on a ponderosa pine about 200 yards from the edge of an orchard.

Quail, although in the orchards off and on throughout each day, were apparently not affected by insecticides.

Granted that many birds are severely affected by the use of insecticides, it does not follow that orchard spraying is the cause of an overall population decline in those species.

The present study indicates that an overall effect is possible for two members of the thrush family, the robin and the mountain bluebird, because of their susceptibility to the toxic sprays and their habit of frequenting orchards. No census of these populations was carried out in non-orchard areas however. Hence no real idea of the reduction in the avian population as a whole is indicated.

DISCUSSION OF CHEMICAL ANALYSES AS A RELIABLE SOURCE OF EVIDENCE OF DEATH FROM TOXIC SPRAYS

During the study period, several birds were taken to the Dominion Entomological Laboratory at Summerland, B.C. where they were analyzed for DDT by the total chlorine method. Table XX shows the result of these determinations.

Birds A, B, C, D and E were stored temporarily in wide-mouthed containers because of a shortage of narrow-mouthed sample bottles. Some evaporation took place and for this reason these birds were not analyzed quantitatively. Qualitative tests were run on all samples, using the material salvaged from the quantitative tests. Relative response to the qualitative tests is indicated by (') signs. These responses cannot be used to compare the relative amounts present in the birds.

DDT contains 50.10% chlorine, therefore the column headed "DDT (p.p.m.)" has been obtained by multiplying organic chlorine by two. Birds contain a certain amount of natural organic chlorine as is shown by bird G, an unsprayed control chick.

It will be noted upon examination of Table XX that if the chlorine present in the control chick is subtracted from all other birds (a necessary subtraction in that chick G really

contained no DDT but merely the normal amount of organic chlorine), these birds will have a negative chlorine hence a negative DDT value in most cases. It is further noted that birds Q to W inclusive were exposed to 50% DDT at 18 lbs. per acre and show a lower value than chicks H to K inclusive which were sprayed with 50% DDT at only 13 lbs./acre.

The conclusion to be drawn from the chemical analyses is that they do not suffice as a means of determining death from toxic sprays. These birds did die as a result of orchard spraying regardless of analyses.

Histopathological studies are apparently in the same category as chemical analyses as a reliable source of evidence of death from toxic spray materials. Work of histopathological nature has been done by Lillie and Smith (16), Woodward et al (29) and others. The general results are neatly expressed by Neal (19) when he says, "The principal histopathological findings in animals exposed to high concentrations of DDT are moderate, subacute degeneration of the liver. Histopathological changes in the brain and spinal column of animals dying with typical DDT tremors are very slight. In fact, sufficient pathological changes have not been found in any organs to account for the death of the animals." This also is borne out in the present study, for although neither time nor equipment was available for detailed microscopic study, only one case showed any noticeable tissue change and this was not damaging enough to have caused death of the animal.

TABLE XX

CHEMICAL ANALYSES OF POISONED BIRDS

Source of Bird	Identification	Spray Used	Quantitative Organic Chlorine (p.p.m.)	Quantitative DDT (p.p.m.)	Qualitative DDT Test
Table I	A	15% Parathion at 9 lbs./A	---	---	†
"	B	and	---	---	††††
"	C	50% DDT at 18 lbs./A	---	---	††††
Adult Robin	D	Unknown	---	---	††
Juv. Robin	E	"	---	---	††
Wild	F	"	216	432	
Control	G	Not sprayed	66	132	†††
Wild	H	50% DDT at 13 lbs./A	292	584	†
"	I	"	204	408	†††
"	J	"	230	460	†††
"	K	"	258	516	†††
Table II	L	15% Parathion at 7½ lbs./A	4	8	†††
"	M	and	70	140	††††
"	N	50% DDT at 15 lbs./A	8	16	†††
"	O		4	8	†††
"	P		4	8	†
Table III	Q	50% DDT at 18 lbs./A	12	24	††
"	R	"	14	28	††
"	S	"	0	0	††
"	T	"	18	36	†
"	U	"	60	120	††
"	V	"	40	80	†
"	W	"	14	28	††
Table VII	X	Mono DN at 60 oz./A	14	28	†
"	Y	and DDT in Unknown amount	0	0	†††
Table IV	1	50% DDT at 18 lbs./A	16	32	†††
"	2	"	0	0	

It would appear that histopathological and chemical analyses of animals reflect many diversities observed in the animals and spray materials. It is apparent also that some factor (or factors) other than the amount of toxic material in the body must be considered. Thus Coburn and Triechler (5), working with laboratory animals, found considerable variation in the toxic action of DDT due to variation in the rate of absorption, elimination and/or difference in pathological reaction in the animals studied. They found that larger dosages resulted in a higher mortality but that survivals occurred in nearly all cases. Logier (17), working with amphibians and reptiles, found that separate individuals of a species did not always react in the same way and that the degree of poisoning was presumably influenced by other factors than the amount of the toxic substance alone. He suggests that the presence of food in the stomach may increase the absorption of DDT that has been taken into the body orally.

In the present study a great deal of variation appears in the toxic effects of the insecticides used. Regarding DDT, Experiment VI shows that all birds exposed to DDT mist died in two days while 40% of the birds in Experiment V are alive at the present time (February, 1950). A similar situation, though not as clear cut, occurs in the case of Parathion. Yet, when both apparently harmful insecticides were sprayed on pheasants (Experiments I and II) there was

again a variation in the time for death of all birds from two days to 60 days. Further variation may be seen among the individuals of any one experiment. A case in point is the description of the reaction of pheasant chicks sprayed with Parathion and DDT in Experiment I. In fact diversity is shown by all the insecticides used in this study with the possible exception of Mono DN.

Other sources of variability in the toxic effects of insecticides are caused by climate, purity of the toxic substance and solvent used with the harmful reagent. The bulletin entitled "Forest spraying and some effects of DDT (6, 15, 17) states on page 160 that, "surfaces coated with DDT preparation may kill certain insects several months after treatment if not exposed to rain or sunlight." It is also pointed out here that alkali decomposes DDT and reduces the residual effect. Gunther (10) found that during the summer, in California where fruit temperatures may exceed 125 degrees Fahrenheit, two weeks was more than sufficient to eliminate toxic effects of DDT while under winter conditions there was little if any loss of toxicity over several months. Slade (23) found that crude benzene hexachloride given orally to rats is markedly less toxic than the gamma isomer. Some solvents such as kerosene, evaporate quickly leaving needle-like crystals that are very durable, the toxic effect lasting from three to six months under outdoor weathering (8). DDT in non-volatile solvents is absorbed through the skin and

solution of DDT in fatty oils increases its toxicity (19).

Another factor, causing variability in pheasant mortality more than chemical analyses, is the concentration of the toxic material applied. If the spray material is cumulative and a bird stores varying amounts from time to time, it will undoubtedly contain, at death, more of the toxic material than is necessary for death. Chemical analyses will be biased in this case. Further, if the spray has a residual effect, a bird in the orchard may be subjected to very high concentrations. This high concentration may be sufficient to cause death at a single feeding by the end of the spraying season but until this time the bird would have ingested or inhaled varying amounts which would be stored in the body as they were individually not great enough to cause death.

In the Okanagan Valley, the Department of Agriculture recommends that DDT should not be applied within 30 days of picking. It is also suggested that oil should not be used as a solvent for DDT. It is possible that the residual effect of DDT in the Okanagan lasts for some time, although the present study could not determine the duration. It is an important factor to consider however, as most growers spray their orchards three to five times a season. If the residue lasts over the time when the next sprays are applied a multiplied concentration remains. Thus, if DDT (50%) was applied five times at the rate of 15 - 25 lbs./acre, and if the residue remained toxic to some forms throughout that time, the total

concentration affecting those forms would be 37.5 - 57.5 lbs. of actual DDT per acre. Most growers begin spraying in June and stop in August. In one orchard, watched closely throughout the summer, the grower sprayed five times between June 1 and August 12 and each time he sprayed an average of 30 lbs. (50%) DDT/acre. Thus, in six weeks he had applied 75 lbs. of actual DDT per acre.

In general then, many factors cause variation in the toxic effects of spray materials. These factors make it very nearly impossible to use chemical analyses as a reliable evidence of death from toxic sprays. Following is an outline of factors, any combination of which, will cause a variation in the toxic effect of spray materials.

A. Biological:

1. Age of the individual.
2. Physical fitness and resistance of the individual.
3. Metabolic activity and degree of excitation of the individual when the toxic material is contacted.
4. Food present in the digestive tract.

B. Mechanical:

1. Size of spray particles.
2. Concentration and purity of the toxic material in the air contacting the animal and/or on the food the animal will eat.

3. Solvents and other constituents used with the toxic substance.
4. Temperature and other climatic conditions both at the time of spraying and after the spray has settled.

Further work on chemical analyses might lead to more conclusive results. If the conditions under which the toxic material is applied are known then chemical analyses might show a correlation.

THE INFLUENCE OF ORCHARD SPRAYING AND OTHER FACTORS ON PHEASANT POPULATIONS

Toxic Effect:

Three cocks, two hens and fourteen young pheasants died as a result of orchard spraying during the summer. Of these, one hen and four chicks were sprayed with 50% DDT at the rate of 13 lbs./acre. The hen died first with severe tremors and convulsions. The four chicks appeared to be normal but the next morning two were dead and the remaining two had slight tremors. By noon, neither of the remaining chicks could stand. Severe convulsions were evident and they seemed to have no control of their wings. Both chicks were dead before nightfall. These four chicks are H, I, J, and K in Table XX.

A speed sprayer was followed for one entire day. The spray used was 50% DDT at an average of 21 lbs./acre. During the day three adult cocks were observed. One cock was observed running down an irrigation furrow parallel to the course of the spray machine. The bird crouched and when the spray machine came abreast of it, the bird received a good deal of fine mist from the machine. When the machine had passed the bird moved out of the ditch and slowly across the orchard. About five minutes after emerging from the furrow the cock began to stumble

then jumped up into the air. In another five minutes the bird was crouched on the ground and easily approached. The cock had severe tremors, his eyes were closed and he could not hold his head up. Twenty minutes after being exposed to spray the bird fell on his side and in a few seconds was dead. Another cock was found on his side a short distance from the first. He exhibited slight tremors and severe convulsions and died shortly after he was found. The third cock was found dead about three hours later. Post-mortems were done on all three birds and no evidence as to cause of death could be found. The last cock found had slight lesions on the right lung but these were not large enough to cause death.

Three chicks were caught in an orchard that had been sprayed one hour before. They appeared to be quite normal but the next morning all three chicks were dead. The spray used in this instance, 50% DDT, was applied at the rate of 17 lbs./acre.

An adult hen was sent from Oliver to the writer for examination. This hen was reported to have died with tremors in an orchard which had been recently sprayed. She had been accompanied by five chicks which were said to be all right. No reason for the death of the hen could be found upon post-mortem examination. Two days later a trip to Oliver revealed that the five chicks had died in the same manner as the mother hen. The orchard concerned was small (ten to twenty acres)

and was completely surrounded by other orchards. Parathion had been sprayed on the orchard three days before the hen and her brood were found. In the surrounding orchards, DDT and Parathion with DDT had been sprayed. Concentrations were unknown and estimates by the growers concerned ranged from four to thirty pounds per acre of DDT and six to seventeen pounds per acre of Parathion.

Here again is evidence that the adult birds die before the chicks. The reason for this is believed to be in the food habits of the birds. The adults eat more vegetable material than do the chicks.

Habitat Preferences:

Data on nesting densities was obtained whenever possible. Seven growers were asked to watch for pheasant nests in their orchards. The acreage covered in these seven orchards totalled 316 acres and the number of nests found in this acreage was seven. One of the seven nests was a dump nest containing seventeen quail eggs and three pheasant eggs. One nest containing nine and another containing eleven eggs were flooded out during irrigation. Three nests containing nine, thirteen and twelve eggs respectively, were abandoned. The reason for abandonment in orchards is probably the constant activity which flushes birds at various stages of development. The mowing machines in the orchards were followed on many occasions and only the few nests noted

above were found.

Two non-orchard areas were examined while mowing was in progress. One of these, a four acre alfalfa field, contained eight nests totalling 87 eggs. The other field was a three acre oat field and it contained three nests totalling 31 eggs. These nests were found before the mower passed over them and cover was left around all the nests. Four eggs in the alfalfa field and two in the oat field did not hatch.

A 40 acre hayfield was searched by the author with the assistance of two dogs. Eighteen nests were found in all. This hayfield was two miles from the nearest orchard. Time did not permit further observation of these nests but as they were found in June and the hay was not cut until August, it seems safe to assume that a good percentage survived.

Regarding pheasant populations, Table XXI shows that for the Kelowna area the wild pheasants in non-orchard areas significantly outnumber those in orchard areas. Reports from Joe McLaughlin and W.B. Snow at Summerland also bear this out in their district, for while pheasants do go into the orchards during the day they are found for the most part on the steep banks of ravines running down to the lakeshore. These banks have well interspersed cover of sagebrush (Artemisia sp.), antelope bush (Purshia tridentata), willow (Salix sp.), wild-rose (Rosa sp.), waxberry (Symphoricarpus racemosa) and saskatoon (Amelanchier sp.) while an understory of grasses provides food and nest material.

TABLE XXI

ORCHARD VERSUS NON-ORCHARD

.PHEASANT POPULATIONS

	Orchard Areas					Non-orchard Areas				
Month	Cocks	Hens	Young	Observ. hrs.	Total birds	Cocks	Hens	Young	Observ. hrs.	Total birds
May	25	18	(1)	10	44	18	10	0	5	28
June	(3)	1(1)	9 (7)	16	21					
July	0	2(1)	(6)	14	9	31	26	85	3	142
Aug.	1	3	12	10	16	3	3	15	2	21
Grand Total	26 (3)	24(2)	21 (14)	50	90	52	39	100	10	191

Brackets indicate dead birds.

Nesting is now, and has been for several years, fairly heavy in this sagebrush association according to Mr. McLaughlin. Although little is known of the pheasant density in the orchard areas of Oliver and Osoyoos, Dr. I. McT.Cowan tells me that pheasants use the sagebrush association and uncultivated bottoms to a great extent in these localities.

Whether or not pheasants used the orchard areas to a greater extent before the advent of DDT, Parathion and other toxic spray materials is not known. Reports of former abundance in orchards do not concern breeding or nesting seasons but deal with the hunting season. This would seem logical when one considers that picking is still in progress during the hunting period and many growers will not allow hunting at this time. Also, that a pheasant in an orchard may escape the gun more rapidly than in a grain field. All in all the orchard serves as a suitable refuge from hunting pressure for the ring-neck pheasant.

The writer believes that the part of the pheasant population resident in the orchards has always been small and that the bulk of the harvest which made the Okanagan Valley so desirable for hunting has always come from the non-orchard areas given over to mixed farming, grain and vegetables which have sufficient dispersion of cover types. Some small acreages planted to fruit trees, widely separated from other orchards, and surrounded by a varied cover type probably have comparatively heavy densities but for the most

part orchards do not provide preferred habitat. Many orchards are clean cultivated and do not provide food for pheasants. Other orchards with a cover crop (usually red clover) provide excellent food but farming practices such as mowing, ditching, irrigating and spraying are not conducive to successful nesting. Spraying here does not refer to the substance sprayed, rather the disturbance caused and the actual path of the spray machine. Further, orchards, generally speaking, are monotypic as to cover. Thus in large contiguous orchard areas the factors mentioned above are apt to place a severe handicap on the production of large pheasant populations.

Orchard Spraying as a Cause of Population Decline:

Many persons have attributed the recent pheasant decline in the Okanagan Valley to the use of toxic spray materials, particularly DDT. It must be remembered however, that DDT and Parathion, the most toxic materials in general use, were not available to the fruit growers until 1947 when the pheasant decline was already well established. Provincial Game Commission Reports indicate that a peak in pheasant population was reached in 1942, that a gradual reduction in population occurred until the end of 1945 and that a drastic decline was evident in 1946 and 1947 which resulted in a closed season in 1948. Further, if the advent of toxic sprays, which are limited to orchards, was the only cause of

the recent decline it had two possible effects: (1) that spray material eliminated pheasant food and (2) that the toxic substance killed the pheasants directly. The first is unlikely in that pheasants are vegetarians and have no sense of taste or smell (therefore adults not repelled) hence only the young chicks would be affected due to a dearth of insects. This argument hardly stands the test in that a scarcity of insects occurred to the same, or nearly the same extent, prior to 1947 when arsenic was used. The main reason for the use of the new insecticides is that arsenic did not decompose in the soil and was likely to hinder plant growth. Also that today three to five sprays of DDT are applied at a comparatively low cost as compared to twice that many applications of arsenic at a much higher total cost. The second effect, killing pheasants directly, is a possibility shown by the experimental work, but is difficult to correlate with the large decline in that it necessitates a proportionately higher density of pheasants in orchards than is now evident. It seems most probable that other pheasants from non-orchard areas would move into orchard areas thus keeping the relative densities of orchard to non-orchard areas in a more or less constant ratio. In other words, if the orchard population had been high enough for toxic sprays to cause an overall decline there would still be evidence of a higher population in orchard areas than in non-orchard areas.

Despite the arguments above however, there is a possibility of toxic sprays increasing the rate of decline or decreasing the population density which would have been realized if toxic sprays had not been applied. There is the further possibility of toxic sprays inhibiting population increase in that as the population increases more pheasants will be found in orchards and the more in orchards the more will die as a result of orchard spraying.

The Population Decline and its Causes:

The problem now arises that if orchard spraying did not cause the decline, what did? The problem is not easy nor is it obvious and following is a discussion concerning a number of possibilities which may have caused the pheasant decline.

The recent reduction in pheasant populations has occurred not only in the Okanagan but in practically all areas on the North American continent where ring-neck pheasants occur. In Ontario, Clarke and Braffette (4) report that the crash decline apparently began in 1942 and reached its low in 1945. The literature on the pheasant decline in the United States is well presented by Wandell (27) and Kimball (14) who cover the problem as it occurred in some 25 states. The factors thought by various authors to have caused the decline are discussed by these two men but it is deemed desirable to again consider these

points with particular reference, where possible, to the situation in the Okanagan Valley.

1. Inclement weather - It is thought by some that inclement weather was the cause for the decline in their particular areas. The weather data for the Okanagan Valley does not show any good reason for considering this factor. On the nationwide scale weather is apparently not the cause of the pheasant population decrease, for many areas, like the Okanagan, had no significant changes in their climates. Poor weather conditions may favour further decrease in an already decreasing population.

2. Reduction of suitable cover - This factor may be of some importance in the Okanagan as the human population has increased. Many places once suitable to pheasants are now homesites. Nevertheless, it appears doubtful that such changes were sufficient to cause a pheasant decline though they may have aided decline. Such changes certainly do not explain the decline on a continental basis. Also the acreages devoted to various types of farming have remained relatively constant.

3. Increased hunting pressure - Hunting pressure in the Okanagan has definitely increased. Table XXII shows the increase in sale of hunting licences for the four principal communities in the Okanagan Valley.

Increased hunting pressure would indicate a decline to many individuals in that their bag returns would be smaller,

while in actual fact the total number of birds bagged could be greater. Allen (2) shows that, "the first 125 gun-hours harvest most of the crop and that hunting beyond that point results in very little." The results obtained by E. Taylor (26) at the checking stations in the Delta municipality in the Fraser Valley also bear this point out.

TABLE XXII

Increased Numbers of Hunting Licences

1947 over 1937

Year	Vernon	Kelowna	Penticton	Oliver	Total
1937	1386	930	1060	208	3584
1947	2341	2138	2011	656	7146

Schick (22) concluded that one cock could easily service ten to twelve hens in the wild, hence reduction in cocks would have to be very severe to cause an appreciable effect on breeding success.

4. Mortality due to farming practices - Mowing in the Okanagan, as in other places, is probably the largest, single mortality factor. Irrigation causes some mortality but this has been reduced in recent years by introducing sprinkler systems which are more efficient, less costly in the long run and cause less damage from erosion than the older ditching method. However aside from the change in irrigation methods farming practices have remained fairly constant throughout the years.

5. Predation - This factor is of minor or of no importance in the Okanagan so far as can be ascertained. Predator control is carried on extensively by sportsmen's organizations and escape cover is fairly abundant in most places. Indeed fewer predators are seen in the Okanagan than in the Fraser Valley or the prairie regions of pheasant abundance.

6. Disease - This is a possibility and little information is available on the occurrence of pheasant diseases for any part of British Columbia. Elsewhere, investigators have not attributed pheasant decline to disease and it is unlikely that a disease of such epidemic proportions as to cause a decline would escape notice.

7. Recession of an introduced species on a new range - Kimball (14) says that, "This remains an ominous possibility." He points out however that South Dakota and other states have had previous periods of high and low populations, that the reproductive rate is again high and that pheasant populations are increasing. It may be noted also that a decline for this reason would probably have occurred long before this as pheasants were first introduced in the Okanagan Valley around 1896.

8. Spraying - It has already been shown that this was probably not the cause of the decline but the fact remains that spraying or any other mortality factor may speed up the rate of decline and/or result in a lower ebb than would have occurred without that mortality factor. It may also suppress

an increase to a new "high".

9. Possibility of pheasants being cyclic - Facts seem to indicate that the population characteristic of the ring-neck pheasant is not flat as was formerly supposed. Whether or not it is truly cyclic remains to be seen. At least we may say that fluctuations have been observed on a large scale and that these fluctuations apparently result from a cause or causes yet unknown.

SUMMARY AND CONCLUSIONS

To determine the effect of orchard spraying on pheasants, groups of these birds were placed in separate pens and sprayed during the normal course of orchard spraying. Experiment VIII was an exception to this general procedure when Mono DN was sprayed on trees in an area for the sole "benefit" of experimental pheasants. Control groups of the same source and age were set up to compare with experimental groups. Table XXIII briefly shows the mortality resulting from spraying in the various experiments. Following is a summary of the results and conclusions for these experiments.

Parathion and DDT -

The symptoms observed in these experiments were excessive preening, tremors, convulsions and occasional gaping. There is evidence of a cumulative effect in Experiment I where three birds took several days to die after a second spray had been applied. Birds of Experiment II died more rapidly than those of Experiment I. The rapid death is attributed to the different food habits of older birds. It is believed that older birds, which eat more vegetable matter than young birds, are more susceptible to the toxic effects of a Parathion and DDT spray concentration.

TABLE XXIII

SUMMARY OF SPRAY EFFECTS ON EXPERIMENTAL PHEASANTS

Spray Used	How applied	Age at Time of spray	% death Resulting	Refer to Table # -
15% Parathion @ 9 lb./A 50% DDT @ 18 lb./A	Droplets on birds & food	5 days	100	I
15% Parathion @ 7½ lb./A 50% DDT @ 15 lb./A	"	15 days	100	II
50% DDT @ 18 lb./A	"	15 days	78	III
50% DDT @ 18 lb./A	Droplets on food only	4 days	100	IV
50% DDT @ 15 lb./A	Droplets on birds & food	14 wks.	50	V
50% DDT @ 10 lb./A	Steam mist on birds only	25 days	100	VI
Mono DN @ 60 oz./A 50% DDT unknown amt.	Droplets on food only	4 days	100	VII
Mono DN @ 60 oz./A	Droplets on birds & food	15 wks.	0	VIII
15% Parathion @ 16 lb./A	Droplets on food only	4 days	50	IX
15% Parathion @ 12 lb./A	Steam mist on birds only	25 days	50	X
15% Parathion @ 75 lb./A	Droplets on birds & food	15 wks.	0	XI
Hexafoss @ 10 pts./A	"	10 wks.	33	XII
Lindane @ 5 lb./A	"	"	50	XIII
Control # 1	NOT	SPRAYED	0	XIV
Control # 2	"	"	0	XV
Control # 3	"	"	0	XVI
Control # 4	"	"	0	XVII

DDT -

Symptoms observed for this spray were the same as for Parathion and DDT with the exception that excessive preening did not occur. Experiments III, IV, V, and VI indicate that older birds are most susceptible to the toxic effects of DDT; that 7½ lbs. of actual DDT per acre is close to the threshold of tolerance for pheasants when exposure is of the ingestion type; and that inhalation exposure is more toxic than ingestion exposure.

DDT and Mono DN -

Symptoms observed in Experiment VII were the same as those observed for DDT and it is believed that DDT was the toxic substance in this spray.

Mono DN -

Results from Experiment VIII indicate that Mono DN has no harmful effect on pheasants.

Parathion -

Symptoms exhibited by birds sprayed with Parathion were excessive preening, convulsions and occasional gaping. No tremors were observed when Parathion alone was used. Inhalation exposure is probably more toxic than ingestion exposure for Parathion. Experiment XI indicates that 15% Parathion at 7½ lbs./acre is close to the threshold of tolerance for pheasants.

Hexafoss -

Convulsion was the only symptom resulting from this spray that was common to the groups above. Birds exposed to this substance always showed an increased activity of the legs just before death and the head was always directly over the back. General dumpiness was the rule and reminded one of a bird in molt. This insecticide may be widely used in the near future and for this reason it should be more fully experimented with.

Lindane -

Birds exposed to this material reacted much like those sprayed with Hexafoss. However, less activity was involved. The birds were dumpy immediately after spraying and sat quite still with their heads under their wings. Those that died put their heads directly over their backs and did not move them again. They usually died a short while after putting their heads back.

All of the sprays used, with the exception of Mono DN, are toxic to pheasants to some degree. DDT is apparently most toxic of the sprays as they are applied in the orchards. However, Parathion seems to be a very close second. Sufficient experiments have not been made for other subatances to make any real comparisons.

An experiment designed to test the residual effect of

spray materials showed no such effect. However, the experiment was not conclusive as these birds had not been exposed to sprays for very long and it is possible that they did not absorb a dosage large enough to be toxic. Three birds of Experiment I and the chicks of Experiment IV showed possible evidence of a residual or cumulative effect. However, this evidence may have resulted first, from individual differences in the threshold of tolerance, second, from the increased age of the birds which survived longest and from their change in food habits.

Field observations indicated that DDT was toxic to pheasants, bluebirds and robins. Parathion and DDT together do not affect mourning doves or cedar waxwings but at least one of these materials is toxic to young leghorn cockerels. Parathion had no effect on robins or mourning doves. As a matter of fact mourning doves and California quail were not affected by any spray material so far as could be ascertained. Song, chipping and white-crowned sparrows are killed by some spray material but it is not certain which one. In general the whole ecology of the orchard areas is changed after the first spray is applied. Some food chains are apparently broken and birds move to areas of more abundant food. Other birds remain and are reduced in population while still others such as the English sparrow seem to thrive on the areas where competition has been reduced.

During the investigation certain birds were analyzed chemically. The results of these analyses show that they do

not provide adequate evidence of death from toxic sprays. There is a great deal of variability in the toxic effects of spray materials; so much so that toxicity must be dependent on some factors other than the amount of toxic material alone. An outline of factors influencing toxicity and possibly responsible for the discrepancies in chemical analyses are given below.

Biological:

1. Age of the individual.
2. Physical fitness and resistance of the individual.
3. Metabolic activity and degree of excitation of the individual when the toxic material is contacted.
4. Food present in the digestive tract.

Mechanical:

1. Size of spray particle.
2. Concentration and purity of the toxic material in the air contacting the animal and/or on food the animal will eat.
3. Solvents and other constituents used with the toxic substance.
4. Temperature and other climatic conditions both at the time of spraying and after the spray has settled.

The pheasant densities in orchard areas are significantly

lower than those of non-orchard areas in the Kelowna district. Reports from other districts in the valley also support this. It is believed that orchards play only a small part in the pheasant production of the Okanagan Valley, mainly because they offer poor interspersion of cover types and contain too many disturbances for suitable habitat.

For the reason that orchard pheasant density is low and the fact that toxic spray materials were not used until after the pheasant decline had started, it is believed that orchard spraying was not the cause of the pheasant scarcity. Spraying does result in death of some birds however, and like other mortality factors it would possibly result in an increased rate of decline and/or a further decrease in the number of birds surviving the decline. Also as the pheasant population increases and the marginal orchard range is filled, a higher mortality resulting from orchard spraying will occur. Hence orchard spraying may limit the upper asymptote that a pheasant population will reach.

A general decline in pheasant populations took place throughout North America and it is possible that some factor was common to all populations. Several possible causes for the decline are discussed but none of these seems adequate. It is apparent that the population characteristic of the ring-neck pheasant in North America is not flat but that it does show fluctuations. Cyclic behaviour cannot be ascribed to this species with the information so far available.

SUGGESTIONS FOR FURTHER STUDY

During the study several approaches which would lead to a greater understanding of the effects of orchard spraying became apparent. Time did not permit following these ideas in the present study but it was felt that the following suggestions might be a helpful guide to future investigations.

1. That experiments be set up to test the relation of food eaten to toxicity. Also whether birds will actively take insects which have been killed by spray materials.
2. That experiments be set up to test the relation of age and sex to toxicity. Care should be taken that the birds have no choice of food because if they do the diets of old and young birds will not be the same.
3. That control groups should be sprayed with water at the same time their comparable experimental groups are sprayed with insecticide.
4. That experiments be set up to determine whether certain mixtures of spray materials are more toxic than the constituents alone.
5. That certain birds be sprayed several times if possible and kept well fed at all times. That these birds then be subjected to a period of starvation to determine the residual effect of toxic spray materials.

It is suggested that these birds be of like sex or equally divided.

6. That an effort be made to correlate spraying procedures and spraying variables with chemical analyses. In connection with this suggestion it would be most helpful if future work was carried on at the Dominion Entomological Laboratory at Summerland, B.C. An adequate library is available and it would be much easier to keep in contact with spray developments. Further, experimental sprayings are nearly always in progress and experimental pens could be quickly placed with little trouble and on a closer schedule than is possible when dealing with private growers.

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