AN ANALYSIS OF FACTORS INFLUENCING ROAD KILL OF PHEASANTS IN THE WILLAMETTE VALLEY

by

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A THESIS

submitted to

OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June 1960

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Date thesis is presented June 9, 1959

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ACKNOWLEDGMENT

Special thanks are extended to Mr. Arthur S. Einarsen, Leader and Biologist, Oregon Cooperative Wildlife Research Unit, for the opportunity to work on the study and for continuous guidance throughout its tenure.

The study would have been impossible without the support of the Oregon Cooperative Wildlife Research Unit. Organizations cooperating were United States Fish and Wildlife Service, Oregon State College, Oregon State Game Commission, the Wildlife Management Institute, and the Agricultural Research Foundation.

Particular thanks are extended to Professor R. E. Dimick, Head, Department of Fish and Game Management, for critically reading the manuscript and contributing unsparingly his time and guidance throughout my association with Oregon State College.

The fine cooperation of Mr. Don Kirkpatrick, Supervisor of the Corvallis Game Farm, and other members of the Oregon State Game Commission staff at the Game Farm, Regional Office, and at the College were sincerely appreciated.

My fellow graduate students are thanked for their friendships and the assistances given me on the road kill study during my absence.

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INTRODUCTION

This thesis presents an analysis of data collected during a field study on the factors contributing to the excessive traffic kill of the ring-necked pheasant, *Phasianus colchicus* Linnaeus, that occurred during the summer months of 1954 through 1958 on US Highway 99W adjacent to the E. E. Wilson Game Management Area. The location was the 3.75 mile section of road bordering the west boundary of the management area, located in the northern part of Benton County, Oregon. The area contained a high population of pheasants because of limited hunting and presence of good pheasant habitat. Particular attentions were directed to the amounts of traffic by months, days of the week, and daylight hours; to the heights of road banks and bank vegetation; and to the attractiveness of food and cover areas adjacent to both sides of the highway. Consideration was also given to structures and to vegetational manipulations that might modify the behavior of the birds when crossing the road, in an attempt to minimize traffic kills.

The three main objectives of the field work were: (1) to determine why excessive road kills occurred; (2) to analyze vegetational patterns and road banks which may have influenced the location of bird crossings; and

(3) to attempt to develop structures or land management practices which might decrease the number of birds killed by automobiles.

The section of highway, eight miles north of Corvallis, and bordering the west side of the management area was chosen because it was close to Oregon State College, thus being convenient for study by the graduate students of the Unit; and since one side of the highway bordered Oregon State Game Commission property, it was possible to experiment with vegetation adjacent to the road in an attempt to reduce road kills. The management area also contained good habitats and had a high pheasant population density adjacent to a well-traveled highway.

For clarity in reporting, "management area" refers to the E. E. Wilson Game Management Area, and "study area" refers to the section of road and bordering vegetation.

This research study was initiated in 1954 by the Oregon State Game Commission as a step towards the development of techniques to reduce pheasant road mortality. From this preliminary investigation, the Commission may suggest and might develop means by which to reduce the kills.

While investigating the repellent qualities of lindane to pheasants, William McCaleb, graduate research assistant, initiated and conducted the road kill study in

the summer of 1954. Harry Gillam conducted the road kill investigation in 1955 and 1957 while collecting and analyzing the availability and use of various grains and plants by pheasants on the area. In addition to studying the pheasant road mortality in the summers of 1956 and 1958, additional investigations were pursued during the winters of 1956-57 and 1957-58 on the winter mortality and movement of the pheasants on the management area.

An analysis of the actions of pheasants, as influenced by the food and cover, and bank and vegetation heights located along the highway, will be discussed in this thesis.

HISTORY OF THE AREA

The land in the vicinity of the study area, prior to 1942, was utilized for grain production and general farming. In 1942 the United States Army acquired approximately 200,000 acres for Camp Adair. In 1946, when the camp was closed, 2,000 acres, east of highway 99W, was transferred to the Oregon State Game Commission. The Commission utilizes the land as the site for a game farm and a research area. The tract has been used by personnel of the Oregon Cooperative Wildlife Research Unit as a place for investigating and for practicing certain phases of

game research management. In addition, records of habitat and other ecological changes and fluctuations of game bird populations have been made on the area from 1953 to date. Most of the land in the original Camp Adair, east and west of highway 99W, was bought by private individuals and returned to pasturage and grain production. The actual utilization of the land in the study area is diagrammed in Figure 1. Each year several hundred acres of the management area are planted to grain for the penned game farm birds. The grain harvest wastage and that left standing provided food for the wild birds during the winter periods.

From a review of several journals, periodicals, reviews and text books on wildlife management, only two reports were found that discussed or were pertinent to pheasant road mortality. In the first one, Leopold, in his text book, Game Management (7, p. 352-353), concluded that "while motor killing of game on highways is believed to be ordinarily a minor 'leakage' in productivity, there are occasional circumstances under which it becomes serious". One of the circumstances he mentioned was when game were baited to or across the highway. He considered speed roads so far apart that only a small per cent of birds ever came in contact with a highway. Grondahl (6, p. 14-16), in the second report, was in agreement with

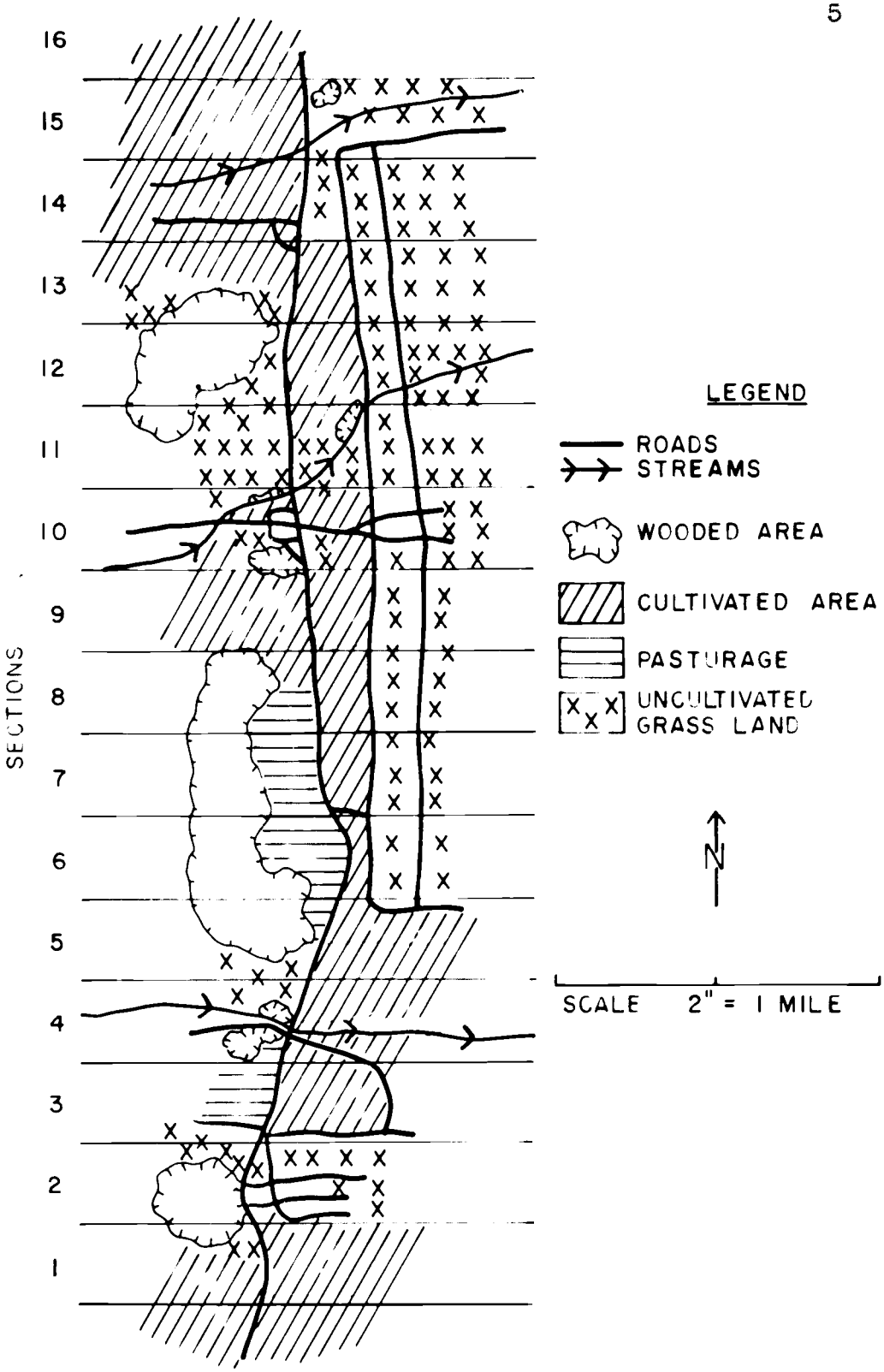

FIGURE 1. A MAP SHOWING GENERAL LAND USE.

Leopold after studying the highway mortality of pheasants in North Dakota from 1953 through 1957. By driving two routes, one 12 and the other 27.4 miles long for varying periods of time, he determined the number of pheasants killed per mile of highway. The first route was checked approximately 14 times per month for 22 consecutive months. A total of 145 dead birds were found, averaging 12.2 birds per mile of road. The 27.4 mile section of road was checked for two periods of 10.5 and 12 months in duration. A total of three hundred eighteen dead pheasants were picked up each period, averaging 11.6 birds per mile of road. The road passed through what he called areas of "medium to high populations of pheasants". Approximately 600 cars a day passed through his areas. He believed that extent of highway mortality varied with the volumes of traffic, speed of vehicles, and the populations of the pheasants in the area. His suggested method to alleviate the problem was for the motorist to slow down and to attempt to avoid hitting the birds. Grondahl concluded that the road kills were not a significant factor in decreasing the pheasant population density in North Dakota.

METHODS

In order to record the locations of each traffic-killed pheasant in relation to particular portions of the

highway, the road and adjacent land were divided into 16 sections, each one-fourth of a mile long, Figure 1. The width of the study area varied from 10 to 40 yards so as to include only those vegetational features believed to influence road kills. The sections were numbered consecutively from 1 to 16, starting at the southwest corner of the management area, south of the Commission's regional office, and ending at the northwest boundary at the Benton-Polk County line. Each section was divided into 40 subdivisions. The subdivisions were numbered consecutively from 1 to 40 starting at the southern edge of each section.

When the carcass of a bird was found, its location was recorded on a prepared form having columns for the date, time of find, estimated time of kill, age and sex, and location of kill. Also recorded were bank heights, bank distances from pavement, cover and food species present, and heights and densities of cover on each side of the road.

The procedure used in locating the carcasses in 1956, 1957, and 1958 was to drive along the shoulders of the highway at approximately 25 miles per hour carefully observing the road and banks for dead birds. This was done twice daily from 8 to 10 a.m. and from 5 to 6 p.m., before all the bird activity was over because if the road

was driven any later, the deep shadows occurring resulted in many fresh kills being missed. In 1954 and 1955, in addition to the daily automobile census, the road edges were walked on Mondays and Fridays in an attempt to locate carcasses which might have been concealed by vegetation. The walking was discontinued in 1956, when it was found that most of the road kills were located by the car-census method.

During the five summers of the study, three different observers, all graduate research assistants of the unit, made the road kill counts. Slight variations occurring in the periods of censusing were as follows:

Year	Observers	Dates of observational periods
1954	William McCaleb	July 16-Oct. 17 (94 days)
1955	Harry Gillam	June 16-Sept. 20 (97 days)
1956	John McCann	June 16-Sept. 26 (103 days)
1957	Harry Gillam	June 15-Aug. 26 (73 days)
1958	John McCann	June 14-Sept. 15 (93 days)

In 1957 and 1958, a mechanical traffic counter was installed across the road in section 3 about 100 yards north of the Commission's regional office. The 1957 counts were taken at such irregular intervals however, that daily or weekly traffic volumes could not be determined. From the 1958 data and from some hourly traffic counts taken by the Oregon State Highway Department on August 26 to September 2, 1952, north of the study area,

an analysis was made of traffic kills in relation to seasonal periods, days of the week, and by daylight hours. Two interruptions in recordings occurred due to mechanical failure and to vandalism. On July 17, 1958, about five hours of traffic recording was missed when the cord pulled loose from the recorder. On August 28, 1958, the recorder and cord were stolen, terminating the counting of the daily traffic, for the season. All volumes of traffic passing through the area during daylight hours were obtained from the Highway Department's survey in August and September of 1952.

The condition of the birds, when found, was used to estimate the time of kill so that a comparison could be made with the traffic volume and the number of birds killed during various portions of the daylight hours. The approximate time of death was estimated by noting the rigidity of the bird and the color and condition of the eyes. Allowances were made in these estimates for the variations in temperatures affecting carcasses in the several different location types (pavement, roadside shoulders, vegetation, etc.), time of day and exposure to the sun.

Two groups of birds were used to find criteria by which to estimate the time of kill. Those birds that were seen struck by an automobile or were found freshly killed

on the road on the return trip during the summer census were analyzed as one group. These birds were left lying on the road and were inspected at hourly intervals to ascertain the changes occurring so that criteria could be estimated for determining the approximate time of death of other road kills. In one hour the birds became rigid, at three hours the eyes had started to turn white and glazed over and by four hours the eyes had become completely opaque and started to shrivel. The second group of birds were roosters killed during the hunting season. The time of kill was recorded; they were also inspected at hourly intervals during the day, prior to cleaning, for characteristics indicative of the time elapsing since death. By one half an hour the birds were rigid. The eyes remained clear for as long as eight hours. It appears the carcasses subject to higher temperatures tended to "age" faster than those in a cooler situation.

The ages of the juvenile birds at the time of kill were estimated by using two criteria: the relative size of the birds and the stages of development of the primary wing feathers. In 1954 and 1958, both these methods were used. During the summers of 1955, 1956, and 1957, the ages of juveniles were determined by visually estimating the sizes of road-killed birds with those of juvenile game farm birds of known age. Since variations in sizes

occurred in the game farm birds of the same age and probably occurred in the wild pheasants, too, this method did not accurately predict the ages of road kills. Furthermore, variations in estimating may have occurred in each of the summers because different persons made the age evaluations.

In 1954, the photographs of wings of pheasant chicks of known age (2, p. 68-69) were believed to have been used by McCaleb in aging juveniles from 1 to 16 weeks of age. In 1958, in addition to the above mentioned criteria, two keys were used in aging juveniles. The first was derived from wings collected from 1 to 16 day old game farm chicks of known age, Table 1. Differences in size, shape, and number of flight feathers of the wing were used. At three weeks of age, the sheath of the tenth and last juvenile flight feather was evident. Chicks four weeks old started to molt the juvenile primary feathers, which then were replaced by adult flight feathers at the rate of approximately one per week, Figure 2. Allen, in 1946 (1, p. 10), stated that only birds four weeks or older can be aged by feather molting and replacement. The second key used to age chicks from 4 to 11 weeks of age, developed in 1948 in Wisconsin, by Thompson and Tabor (11, p. 14-19), was based on the replacement of juvenile flight feathers. Generally by the time all of the juvenile feathers were replaced,

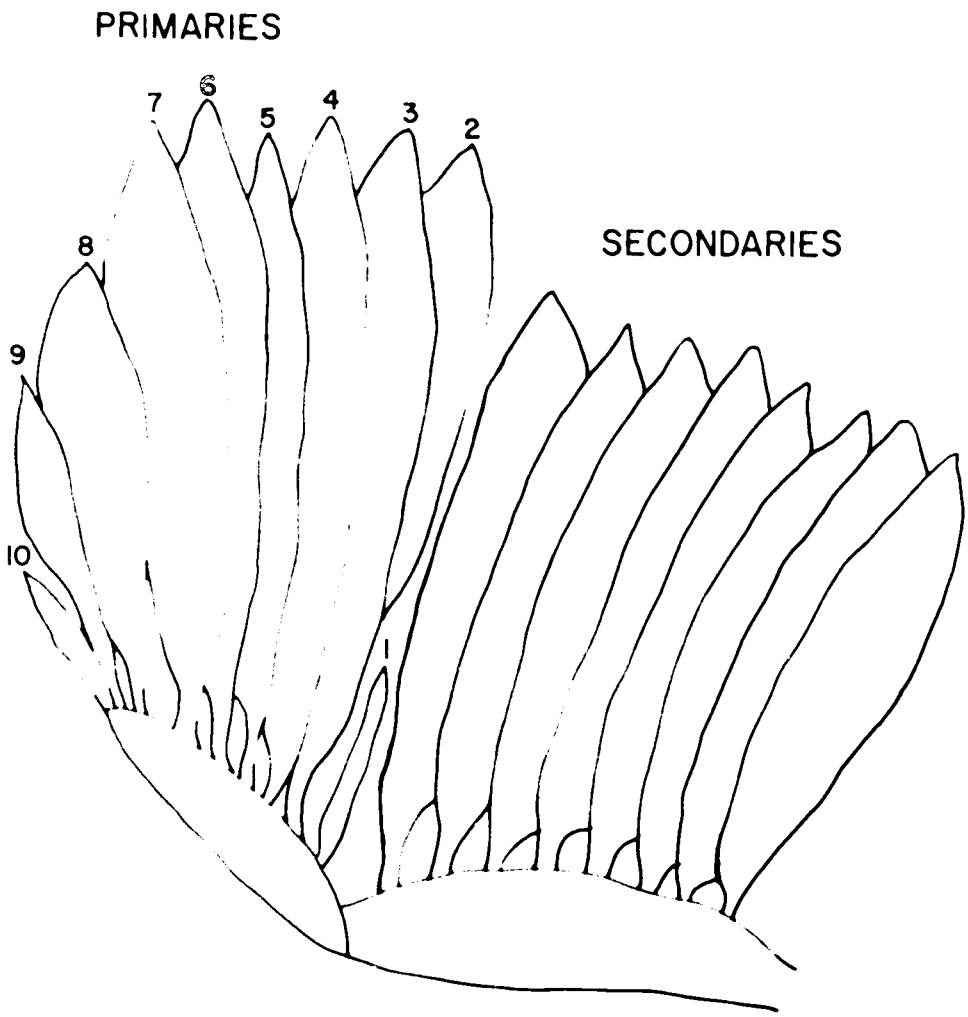

FIGURE 2. A DIAGRAMATIC PHEASANT WING SHOWING NUMBER AND PLACEMENT OF THE PRIMARIES USED TO AGE JUVENILE BIRDS.

the bird was 14 weeks old and almost adult size.

Additional references containing information on feather replacement were found while writing this thesis and therefore were not used or considered in the collection of the field data. They include factors which probably should be employed in future studies on this problem. Buss, in Wisconsin (2, p. 70), found that hens molt their post-juvenile primaries before the roosters. Studies done in Wisconsin after Buss's work indicated that game farm birds molt the juvenile primaries more slowly than wild birds. In this later study, Woehler, 1953, found that it takes from 1 to 3 weeks for a juvenile flight feather to drop out and to be replaced. Also, that "later hatched birds were 5 to 8 days in advance of the regular lot of birds" (14, p. 14-16) in feather development.

RESULTS AND DISCUSSION

Ages and Sexes of the Pheasant Road Kills

During the five years of the study, the traffic-killed pheasants found totaled 642, ranging from a low of 109 in 1955 to a high of 144 in 1954, Table 2. The average summer kill for the five year period was 128.4 birds. In the summers 1955 and 1958, the road kills were less than the average by minus deviations of 19.4 and 2.4

Table 1

A Key to the Aging of 8 to 16 day old Chicks
By Number and Arrangement of Wing Primaries

Age	Number of Juvenile Feathers	Number of Adult Feathers	Comments
8 days	7	0	sheath of number 8 is visible
12 days	8	0	number 1 juvenile primary feather lacks sheath at base. Number 8 feather is one-eighth of an inch out of sheath.
16 days	9	1	number 9 juvenile primary is half its length out of sheath. Number 1, adult primary feather sheath is half an inch long.

respectively. In each of the other summers, the kills exceeded the average by 15.6 in 1954, 4.6 in 1956, and 1.6 in 1957. The number of days the study was conducted in 1954 was approximately the same as the other years, but occurred one month later, July 16 to October 17. When the total observation days for the five summers were considered, the average daily kill for the 3.75 miles of road was 1.40 birds.

The approximate sex ratios, males to females, of pheasants killed in 1954, 1956, 1957, and 1958 were 43:57,

Table 2

Number and Sexes of Pheasant Carcasses Found during Summers 1954 through 1958; Percentages are in Parentheses

Year	Male	Female	Unknown Sex	Total	Sex Ratio
1954	53 (36.81)	71 (49.31)	20 (13.89)	144	43:57
1955	26 (23.85)	56 (51.38)	27 (24.77)	109	32:68
1956	52 (39.10)	60 (45.11)	21 (15.79)	133	46:54
1957	51 (39.23)	70 (53.85)	9 (6.92)	130	42:58
1958	53 (42.06)	60 (47.62)	13 (10.32)	126	47:53
Total	235 (36.60)	317 (49.38)	90 (14.02)	642	43:57
Average	47.0	63.4	18.0	128.4	42:58

46:54, 42:58, and 47:53, averaging about 43:57. About 73 per cent of the kills were juveniles having a sex ratio of 52:48. The sex ratio of juveniles was approximately 1 to 1 while for adults the sex ratio was 1 to 3, Table 3.

The sex ratio of all the pheasants killed in 1955 was 32:68. A total of 62 birds or about 58 per cent were juveniles having a sex ratio of 45:55. The lower number of juveniles found, 62, in 1955 resulted from birds over eight weeks old being recorded as adults. In the other years birds over 11 weeks old were recorded as adults. Since different criteria were used in 1955 in recording adults and juveniles, that summer's data was treated separately in Table 3. The 36 adult females recorded in 1955 were seven more than were found in 1954, the second highest year. The large number of adult females recorded killed in 1955 was probably due to some of the older juvenile males and females, from 9 to 11 weeks of age, being recorded as mature hens.

Since the dates of the beginning and end of the summer observations did not coincide for each of the five years, the period of July 16 through August 26, which occurred in each year of the study, was selected as a comparison period so that the number of kills occurring each year during this period could be compared. The ratio of juveniles to adults during the comparison periods of

Table 3

Sexes and Ages of Pheasant Carcasses Found during 1954 through 1958, Except for 1955 Data Presented Separately in Parentheses

Year	Juvenile			Adult			Sex Ratios				Ratio Juveniles to Adults
							Juvenile		Adult		
	Total	Male	Female	Total	Male	Female	Male	Female	Male	Female	
1954	98	37	40	43	13	29	48:52		31:69		70:30
1956	92	43	35	34	9	25	55:45		26:74		73:27
1957	104	47	47	27	4	23	50:50		14:86		79:21
1958	85	42	31	36	9	26	58:42		26:74		70:30
Total	379	169	153	140	35	103	52:48		25:75		73:27
1955	(62)	(17)	(20)	(44)	(8)	(36)	(45:55)		(18:82)		(58:42)

the five years was 74:26. During the comparison period, the juveniles killed had a sex ratio of 1 to 1 while that for the adults was 1 to 3, males to females. These ratios were identical to those of the overall study data. The sex ratio of adults in 1955 during the comparison period was 6:94 and for juveniles, 52:48. The ratio of juveniles to adults in 1955 was 67:33.

The overall sex ratio for the 381 birds killed during the comparison periods was 42:58. For the entire study the average sex ratio of the 642 pheasants was 43:57. The percentages and sex ratios of the complete summer's road kill, Tables 2 and 3, were generally in agreement with those of the comparison periods, Tables 4 and 5.

The average adult sex ratio as recorded in the spring of 1954 through 1956 for the southern part of the Willamette Valley from census figures compiled by the Oregon State Game Commission was 61:100 (9, p. 79) indicating that more females than males might have been in the study area, thus partially accounting for a greater road kill of females than males. Also, hens are generally considered to be more vulnerable to traffic mishaps while leading broods across the road than cautious roosters. Consequently, the probability of larger numbers of females than males on the area and greater vulnerability of females may have accounted for the 59 to 41 per cent kill

Table 4

Number and Sexes of Pheasant Carcasses Found During the Comparison Period, July 16 through August 26, for 1954 through 1958; Percentages are in Parentheses

Year	Male	Female	Unknown Sex	Total	Sex Ratio
1954	37 (33.64)	51 (46.36)	22 (20.00)	110	42:58
1955	13 (25.00)	28 (53.85)	11 (21.15)	52	32:68
1956	32 (37.65)	39 (45.88)	14 (16.47)	85	45:55
1957	26 (38.23)	37 (54.41)	5 (7.35)	68	41:59
1958	31 (46.97)	35 (53.03)	0	66	47:53
Total	139 (36.48)	190 (49.87)	52 (13.65)	381	42:58
Average	27.8	38.0	10.4	76.2	41:59

Table 5

Sexes and Ages of Pheasant Carcasses Found During the Comparison Period, July 16 through August 26, for 1954 through 1958, Except for 1955 Data Presented Separately in Parentheses

Year	Juvenile			Adult			Sex Ratios				Ratio Juveniles to Adults
							Juvenile		Adult		
	Total	Male	Female	Total	Male	Female	Male	Female	Male	Female	
1954	78	28	30	32	9	22	48:52		29:71		71:29
1956	59	28	22	21	4	17	56:44		21:79		74:26
1957	56	24	24	15	2	13	50:50		13:87		79:21
1958	49	22	24	15	4	11	49:51		27:73		76:24
Total	242	102	100	83	19	56	50:50		25:75		74:26
1955	(34)	(12)	(11)	(17)	(1)	(16)	(52:48)		(6:94)		(67:33)

of females over males.

An average of 44.5 birds from 3 to 6 weeks of age were killed on the area during the summers of 1955 through 1958, Table 6. At about six weeks of age the juveniles on the area appeared to become more cautious while crossing the highway, thus probably resulting in a decline in the number of advanced juveniles killed. Trippensee, 1948 (12, p. 60), stated that 6 to 8 week old pheasant chicks were very active and ready to separate from the hen. Therefore, the chicks, after separating from the hen at about six weeks of age, probably become cautious while crossing roads, decreasing the number killed. Also, the number of advanced chicks near the road was less than the number of chicks present immediately after hatching due to the occurrence of natural juvenile mortality.

In 1954, the mortality peak of juveniles occurred in the 6 to 12 week old group of birds. Of the total 93 killed in 1954, 75 were in this age bracket. An older group of birds was recorded killed this year because the census did not start until July 16, after many juveniles had reached six weeks of age.

The April populations of adults on the area did not appear to be correlated to the amount of road mortality which occurred during the summer. In 1955, when a population of 84 pheasants per 100 acres was recorded, the

Table 6

The Number of Immature Pheasants (by Week Age Classes) Killed During the Summers of 1954 through 1958

Year	Weeks of Age															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1955	1	3	11	14	10	4	3	3	-	-	-					
1956	3	5	9	11	7	7	3	7	0	8	15					
1957	2	9	12	9	24	18	5	11	1	10	4					
1958	2	6	10	14	4	14	9	4	4	3	5					
Total	8	23	42	48	45	43	20	25	6	21	24					
1954	0	3	4	5	6	10	14	13	6	10	12	10	8	6	4	3

Table 7

The April Pheasant Populations, July Production Estimates and Road Kill Figures During the Period of July 16 through August 26, for 1954 through 1958

Year	Road Kill	*Population per 100 Acres	**Population per 100 Acres	***Average chicks per brood	***Average chicks per hen
1954	110	77.0	23.7	7.2	6.8
1955	52	84.0	28.2	6.2	5.5
1956	85	31.5	24.6	4.6	3.3
1957	68	27.0	9.6	8.9	8.5
1958	66	68.0	22.5	7.6	6.8
Average	76	57.5	21.7	6.9	6.2

* Data from total area censuses taken by game management classes, Oregon State College, in April.

** Data collected by Oregon State Game Commission personnel conducting census strips in the South Willamette Valley.

*** Data obtained by Oregon State Game Commission personnel in the South Willamette Valley in late July.

number of road kills during the period July 16 to August 26 was the lowest at 52 birds, Table 7. The greatest kill during the comparison period, 110 birds, occurred in 1954 when the estimated pheasant population was second highest at 77 birds per 100 acres. In 1957 and 1958, when the numbers of kills were similar during the comparison period, 68 to 66, the April population estimates per 100 acres were quite dissimilar, being 27 and 68 respectively.

In 1957, when the average number of chicks per brood was highest, 8.9, and the number of juveniles killed was high at 104, Table 3, the number of road kills recorded during the comparison period was 68, being considerably below the average of 76, Table 7. Conversely, in 1956, the year of lowest average number of chicks per brood and per hen, 4.6 and 3.3 respectively, the kill was 85, nine birds above the comparison period average. In 1954 and 1958 when the birds per 100 acres were 77 and 66 respectively and the average chicks per hen was 6.8, the number of road kills during the comparison period were almost at the extremes, 110 to 66. The numbers of juveniles killed in 1954 and 1958 were dissimilar, 98 and 85, while the chicks per brood averaged 7.2 and 7.6 respectively. Consequently, the number of juveniles killed by cars on the study area may have been unrelated to the size of the broods recorded in nearby areas.

In conclusion, the April density of pheasant populations present on the area and the number of chicks recorded per hen and per brood in the South Willamette Valley each year did not appear related to the number of birds killed on the study area highway.

Food and Cover

Food and cover were important factors influencing pheasant movement across the highway. High numbers of road kills usually occurred in locations where grain fields were across the highway from good pheasant holding cover. The birds were killed while crossing between the grain and cover. On the north end of the area, grains were planted across the road from an uncultivated field having good cover. A total of 193, or 30 per cent of the pheasants found during the five summers, were killed on the one-half mile section of road between these particular fields.

Certain preferred grains appeared to have attracted pheasants across the highway, resulting in many kills. In 1954, 1956, and 1957, when barley, oats and vetch in combination, and spring barley were planted in fields W2 through W4, Table 8 and Figure 3, 40, 43, and 48 pheasants respectively were killed on three-eighths of a mile of road adjacent to the fields, thus approximating 116 kills per mile. The kill was greatest in the vicinity of the bridge in this area rather than scattered through the whole section, probably because of the covered travel lanes provided by the stream vegetation. Figure 8 shows the bridge, grain fields W2 through W5, the cover to the east of the road (left side of the photograph), the road

Table 8

Listing of Grains Planted in the Study Area from 1954 through 1958 on both the East and West Side of the Road. Location of coded field numbers indicated in Figure 5.

Field	1954	1955	1956	1957	1958
		East Side of Road			
E1	Wheat	Wheat, rye grass	Summer fallow	Wheat	Summer fallow
E2	Wheat	Sod	Sod	Sod	Summer fallow
E3	Hull less oats	Summer fallow	Wheat	Hull less oats	Summer fallow
E4	Hull less oats	Summer fallow	Wheat	Hull less oats	Summer fallow
E5	Summer fallow	Wheat	Summer fallow	Wheat	Summer fallow
E6	Wheat	Summer fallow	Wheat	Summer fallow	Wheat
E7	Summer fallow	Wheat	Summer fallow	Wheat	Summer fallow
E8	Oats	Summer fallow	Wheat	Summer fallow	Wheat
E9	Sod	Summer fallow	Oats	Barley	Wheat
E10	Sod	Summer fallow	Oats	Summer fallow	Construction
E11	Unknown	Barley	Grass	Rye	Rye
		West Side of Road			
W1	Oats, peas	Wheat	Wheat	Spring barley	Oats, vetch
W2	Barley	Spring barley	Oats, vetch	Spring barley	Rye grass
W3	Barley	Summer fallow	Oats, vetch	Spring barley	Rye grass
W4	Barley	Spring barley	Oats, vetch	Spring barley	Spring oats
W5	Wheat	Oats, vetch	Spring barley	Red clover	Wheat
W6	not cultivated	not cultivated	not cultivated	Oats, barley	Barley
W7	Wheat	Oats	Barley	Oats, vetch	Wheat
W8	Spring barley	Wheat	Oats	Oats, vetch	Wheat

Table 8 (continued)

Field	1954	1955	1956	1957	1958
W9	not cultivated	not cultivated	Grass	Grass	Summer fallow

banks, and the covered travel lanes between the fields, provided by the stream vegetation in section 15.

Gillam in 1955 (5, p. 43, 48-51) found from crop and gizzard analyses of summer road killed birds that barley, wheat, oats, and vetch were preferred pheasant foods in the vicinity of the E. E. Wilson Game Management Area. Barley appeared to be particularly effective in attracting birds across the road. In 1955, in section nine, when 18 birds were killed on one-tenth of a mile of roadway, which would have been equivalent to 180 per mile, barley and oats were planted on the west side of the road. In 1958, when 16 birds were killed along the west border of W6, approximately 160 per mile, barley was planted in this field.

Wheat, rye grass and spring oats did not appear to attract the pheasants to the same extent as barley or vetch because lower numbers of kills occurred adjacent to such fields. In 1955 and 1958, when W2 through W4 were either in spring oats and rye grasses or were in part

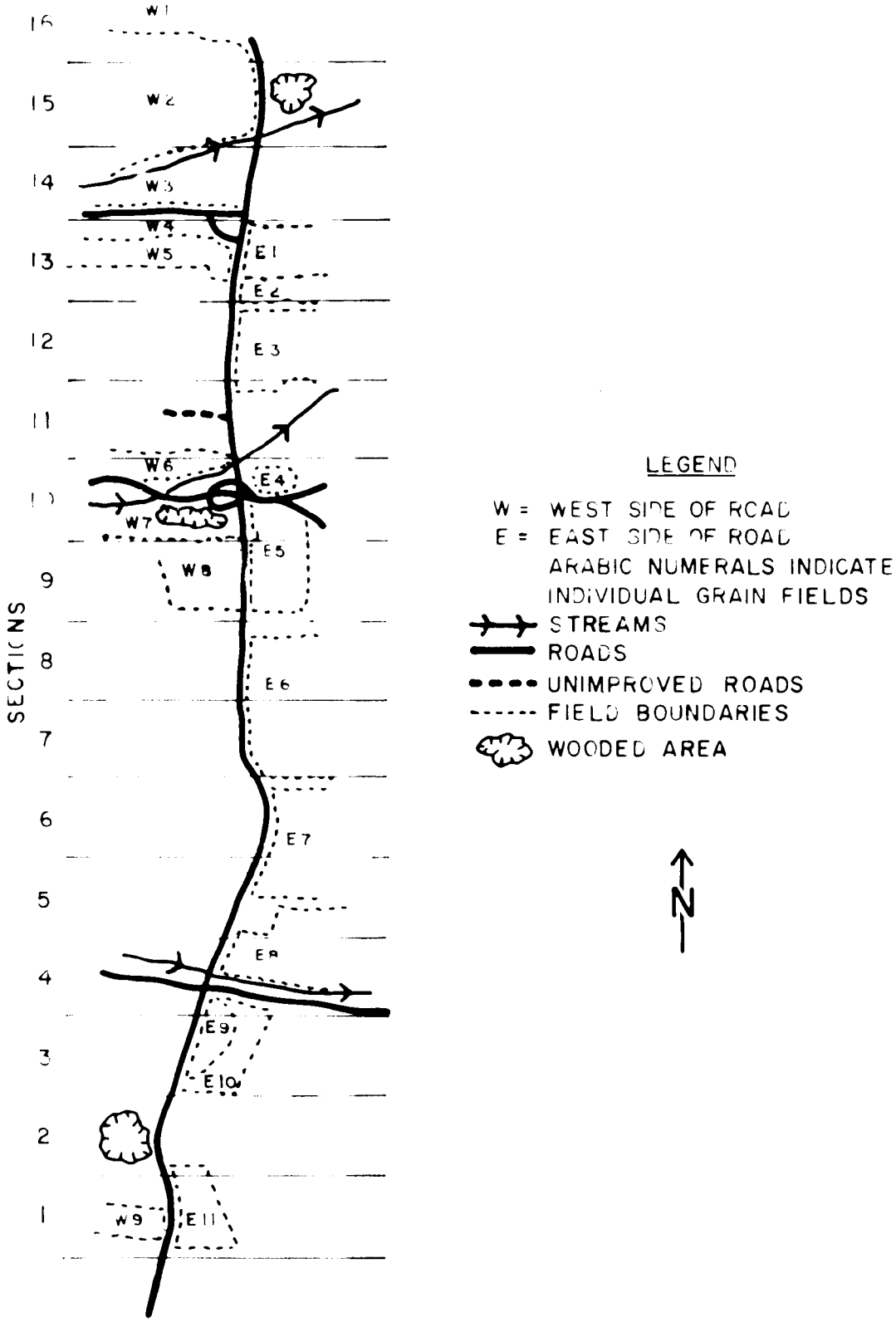

FIGURE 3. LOCATION OF GRAIN FIELDS ON THE STUDY AREA

Photographs of the highway and cover on to north and south of the main entrance to the E. E. Wilson Game Management Area in section 10. The road kills were noticeably high where strips of cover on travel lanes intersected the highway. Figure 4 is of the road north of the main entrance. Figure 5 is of the vegetation immediately south of the entrance.

Figure 4

Figure 5

summer fallow, an average of 20 birds each summer were killed which would be equivalent to 53 per mile on the length of highway bordering these fields. In 1958, rye grass planted in fields W2 and W3 attracted relatively few birds to the area, resulting in an average of only 11 kills per quarter mile of road, or equivalent to 44 per mile. Wheat, summer fallow and sod in fields E1 through E3 during the study may have had little, or possibly a negative, effect on the number of kills since an average of 5.3 birds each summer, ranging from zero to nine, were killed in this quarter mile section.

Road kills often occurred where strips of cover ended on or bordered the road. In 1954 and 1956 a high bird highway mortality occurred immediately north of the main entrance to the management area where travel lanes ended at the road or cover bordered the highway. The photographs of the habitat around the main entrance, Figures 4 and 5, show the strips of cover intersecting the highway where the road kills were concentrated.

The multiflora rose hedges planted 25 feet from the road along the west boundary of the management area provided excellent pheasant cover and travel lanes. Pheasants flying over these hedges before crossing the road were at slightly higher elevations while over the pavement than birds flying from under the hedges, and

therefore were less frequently struck by automobiles. Birds flying at least five feet over the roadway because of the influences of either high vegetation or banks on one or both sides of the road were usually above the passing cars. With the exception of the wood lots that were close to the road, little of the roadside vegetation was sufficiently dense or tall enough to force the birds to fly five feet or higher above the pavement and thus escape injury by passing over the traffic.

Road Banks

The road banks adjacent to the highway influenced the manner in which pheasants crossed the road and to some extent the places of crossing. Since most pheasants flying across the highway did so at a height no higher than necessary to clear the vegetation and road banks, natural or constructed obstacles to force pheasants to fly above the cars had to be at least five feet above the road level (8, p. 14-15).

The northern one-half of field W2 was on the crest of a 20-foot high bank, opposite good cover, Figure 7. During each of the five years of the study, grain was planted in field W2. The road kill probably would have been high in this area because of the attraction of the

grain and cover to pheasants except for the bank. Only pheasants flying toward the high bank were subject to being struck by traffic. These birds remained close to the pavement while flying across the highway until they were within 20 feet of the bank, when they would glide up the slope, alighting on the top. Such flying birds were vulnerable to passing cars. Birds flying across the road in the opposite direction from the high bank glided above the passing cars and were not vulnerable to traffic. Comparable observations of bird behavior were made in a similar situation south of the study area. Banks less than five feet above the level of the pavement were not of sufficient height to cause the birds to fly over the traffic, Figure 6.

Pheasants seldom walked across the road in areas where the banks were too steep to climb, as frequently occurred in road cuts. All observations, except one, of birds crossing the highway in sections 6 through 8, where road cuts occurred, were of flying birds.

It was mentioned in the section on Food and Cover that the road kills were greatest near the bridge in section 15, where a stream passed under the road. This area is shown in Figures 8 and 9. Not only was the stream cover good leading to the road, but the bank heights and vegetation were below the road level, resulting in either

Figure 6. This four foot high road bank did not appear to influence the number of road kills occurring in section 9.

Figure 7. This 20 foot high bank in section 15 affected the flight pattern of the birds crossing the highway, reducing the number of road kills.

Figure 8. The grain, vegetation, and stream cover near the bridge in sections 14 and 15 where 30 per cent of the road kills occurred.

Figure 9. The road and vegetational cover immediately south of the bridge, where the combination of low banks and good roadside cover opposite grain fields resulted in an area of high pheasant kill.

low flying or walking birds being vulnerable to passing traffic.

Traffic and Bird Activity

Combinations of traffic volume and bird activities appeared to influence the number of pheasants that were killed. A maximum of either condition alone did not seem to result in an increase of mortality but rather it was the simultaneous effects of large volumes of traffic and greatest bird activity that resulted in the most road kills. When either of these factors were minimal, the kill was slight.

On the average, the number of road kills per week for the entire section of highway from the start of the summer studied, about June 14 to July 25, remained nearly constant, averaging 9.5 a week. During the period July 26 to August 22, the average road kills per seven day interval rose and peaked at approximately 15. After August 23, the number of kills rapidly declined to three or four a week, Figure 10 or Table 9.

In 1954, the kill from July 26 to August 22 was well above average, peaking during the period August 16 through August 22 at 30 birds. During the week of September 20 through 26, 11 birds were killed. In 1955, the kill per week was below the five year average from about the first

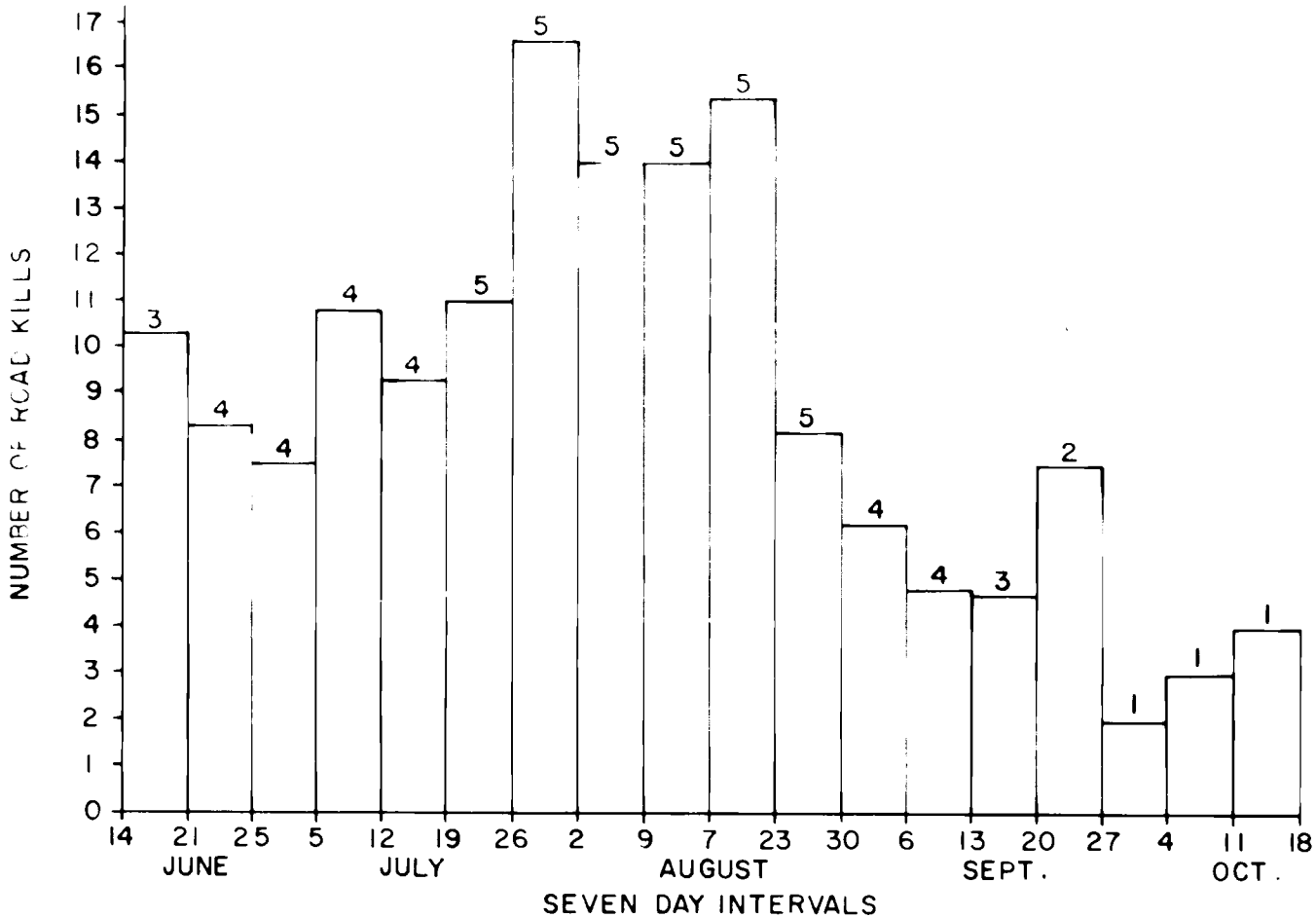

FIGURE 10. AVERAGE NUMBER OF PHEASANTS KILLED DURING SEVEN DAY INTERVALS FROM JUNE 14 TO OCTOBER 18 FOR THE YEARS 1954 THROUGH 1958. NUMERALS AT TOP OF BARS INDICATE NUMBER OF YEARS DATA WAS AVERAGED FROM.

Table 9

Number of Pheasants Killed by Seven Day Intervals from June 14 to October 17, for 1954 through 1958. Dashes (-) represent the time intervals that were missed during any particular year.

7 day intervals	Year 1954	1955	1956	1957	1958	Average
June 14-June 20	-	8	-	12	11	10.3
June 21-June 27	-	7	12	11	3	8.3
June 28-July 4	-	10	3	11	5	7.5
July 5-July 11	-	5	7	22	9	10.8
July 12-July 18	-	6	11	10	10	9.3
July 19-July 25	13	10	17	10	5	11.0
July 26-Aug. 1	16	7	33	10	17	16.6
Aug. 2-Aug. 8	21	9	9	17	14	14.0
Aug. 9-Aug. 15	18	6	22	9	15	14.0
Aug. 16-Aug. 22	30	13	8	13	13	15.4
Aug. 23-Aug. 29	10	8	6	9	8	8.2
Aug. 30-Sept. 5	5	2	5	-	13	6.3
Sept. 6-Sept. 12	2	13	1	-	3	4.8
Sept. 13-Sept. 19	*3	6	5	-	-	4.7
Sept. 20-Sept. 26	*11	-	4	-	-	7.5
Sept. 27-Oct. 3	2	-	-	-	-	2.0
Oct. 4-Oct. 10	3	-	-	-	-	3.0
Oct. 11-Oct. 17	4	-	-	-	-	4.0

* indicates incomplete census data. The student was on vacation.

of July to the first of September. The peaks of kills, 13 birds a week, came during the periods August 16 to August 22 and September 6 to September 13. The 1956 peak occurred from July 26 to August 1, when 33 pheasants a week were killed. After August 9, 1956, the rate of mortality declined until the second week in September when a slight rise in the number of kills occurred. In 1957, the peak in pheasant mortality occurred during the period July 5 to 11, when 22 were killed.

The average peak in kills occurring during the last week in July through the middle of August probably was due to the increased movement of pheasants across the road from protective cover to the grain ripening in the fields. By early August in 1956 and 1958, the wheat and oats and vetch planted in combination on the management area and in fields W2 through W4 had ripened and were being harvested. In these particular summers, the road kill numbers peaked the period July 26 through August 1, at 33 and 17 birds respectively. The 1955 road kill peak occurred late, between August 16 through August 22, probably because of the delayed planting and harvesting season caused by a wet spring. During this year 4.58 inches of rain fell in April alone.

Generally about one week after the fields were harvested in mid-August and the grain wastage had been eaten

by the pheasants, the movement of the birds to the field was reduced as was the number of kills recorded. The slight rise in kills in 1955 and 1958, during the first week in September, probably occurred because of the increase in traffic volumes over the Labor Day weekend. In 1955, 11 kills occurred on Labor Day. On the Sunday and Monday of the 1958 Labor Day weekend seven kills occurred. Increases in road kills in late September might be due to the rise in daily traffic as the students returned to Oregon State College for the fall term.

The number of road-killed birds counted on particular days of the week were related to the volumes of traffic during the times of bird activity. During the summer of 1958, a mechanical counter was used to record the daily traffic volume. In 1958, the four days of the week with greatest traffic volume were Sunday, Friday, Monday, and Thursday arranged in descending order, Table 10. The average number of cars passing through the area from 9:30 a.m. to 5:30 p.m. recorded in 1958 for these four days averaged 1724, 1448, 1439, and 1387 respectively. Tuesdays and Saturdays averaged 1338 and 1309 cars a day. Wednesday had the least traffic, averaging 1261 cars.

Road kills varied by particular week days, also. The number killed in descending order by days of the week for the five years of the study were as follows: Monday-117,

Table 10

The Number of Kills Occurring by Days of the Week During the Summers of 1954 through 1958, and the Average Daily Traffic Volumes on the Highway During the Summer of 1958, from 9:30 a.m. to 5:30 p.m.

Day of Week	Number of Kills	Average number of cars in 1958
Sunday	96	1724
Monday	117	1439
Tuesday	72	1338
Wednesday	88	1261
Thursday	86	1387
Friday	108	1448
Saturday	79	1309

Friday-108, Sunday-96, Wednesday-88, Thursday-86, Saturday-79, and Tuesday-72. Wednesday, the day of least traffic, ranked fourth in number of birds killed, because on August 13, 1958, two large broods, six and seven birds apiece, were struck.

The only factor known to vary by particular days of the week was the traffic volume. Even though Sunday had the highest average volume of traffic, 1724 cars, it ranked third in road kills. The Sunday traffic volume appeared to rise steadily in the morning, reaching a peak from 12 noon to 3 p.m., then generally decreasing during

the afternoon and evening hour. Therefore the peak in traffic occurred during midday when pheasant activity was negligible. Then too, when large numbers of cars were passing on the highway, the pheasants may have taken more precaution in crossing. On Mondays and Fridays, the traffic volumes through the area appeared from general observations to be the greater during the time of high bird activity. Consequently, a larger number of birds were killed on these days with a total volume of traffic being considerably less than on Sundays. Saturday was low in bird mortality because the daily traffic peak recorded by the highway department and observed in 1956 and 1958 occurred from 2 to 3 p.m. when the pheasants were least active.

The Oregon State Highway Department recorded the hourly traffic volume passing through the area during the period August 26 to September 2, 1952, including the Labor Day weekend. From this data the trends of traffic volumes on the area during an average Monday through Friday and for the weekends and holidays were obtained. On Mondays through Fridays, the volumes through the area varied from 75 cars per hour, 7 to 8 a.m., to a peak of 190 from 10 to 11 a.m. During the noon hours, 11 a.m. to 1 p.m., the volume dropped to about 170 an hour, only to increase to the highest peak of the day between 4 to 5 p.m. at 235

cars an hour. After 5 p.m. the traffic volume decreased to 160 cars per hour from 7 to 8 p.m., Table 11.

From observations made during the summers of 1956 and 1958, the average traffic volume on Monday through Friday appeared to peak at 8 to 10 p.m. and again from 3 to 5 p.m. On Saturdays and Sundays during the same two years, the traffic volume appeared to be the greater at midday. The traffic volume records of the highway department, made the last week of August, 1952, agree with the above observations with the exception of the Sunday before Labor Day when the traffic peak occurred at 5 to 6 p.m.

Pheasant activity appeared from observations to be greatest during the early morning from dawn to 10 a.m. and again late in the afternoon from 3 to 5 p.m. Activity in the late morning and fore part of the afternoon was negligible. Number of road kills usually peaked between 8 to 10 a.m. and 3 to 5 p.m. when the pheasant activity and traffic volume were both high, Figure 11 or Table 12. From inspection, numbers of road kills in the morning increased as the traffic increased and decreased as the birds became less active during the heat of the day. The road kills increased in the late afternoon as the birds again became active and decreased as bird activity and traffic diminished after 5 p.m. During midday, 10 a.m. to 2 p.m., when traffic was moderate and pheasants were

Table 11

Hourly Daylight Traffic Volume on US 99W Immediately North of the Polk-Benton County Line, from August 26 through September 2, 1952. (10, p. 1)

Hour of Day	Sun. Aug. 31	Mon. Sept. 1	Tues. Aug. 26*	Wed. Aug. 27	Thur. Aug. 28	Fri. Aug. 29	Sat. Aug. 30
5-6 AM	44	39	60	33	33	37	58
6-7 AM	51	46	116	75	86	75	77
7-8 AM	75	82	114	95	87	90	105
8-9 AM	151	113	142	104	127	135	150
9-10 AM	229	215	145	148	136	173	210
10-11 AM	256	285	112	147	138	119	218
11-12 PM	233	251	168	121	129	149	225
12-1 PM	215	234	117	142	120	133	241
1-2 PM	217	266	136	154	151	153	265
2-3 PM	227	340	146	148	152	196	295
3-4 PM	210	358	175	174	157	227	271
4-5 PM	274	400	169	163	174	221	243
5-6 PM	239	344	136	123	145	216	205
6-7 PM	272	312	99	101	110	223	187
7-8 PM	212	262	86	108	88	193	173

* The counter was started 10:55 a.m. August 26 and was stopped September 2 at 12:10 p.m.

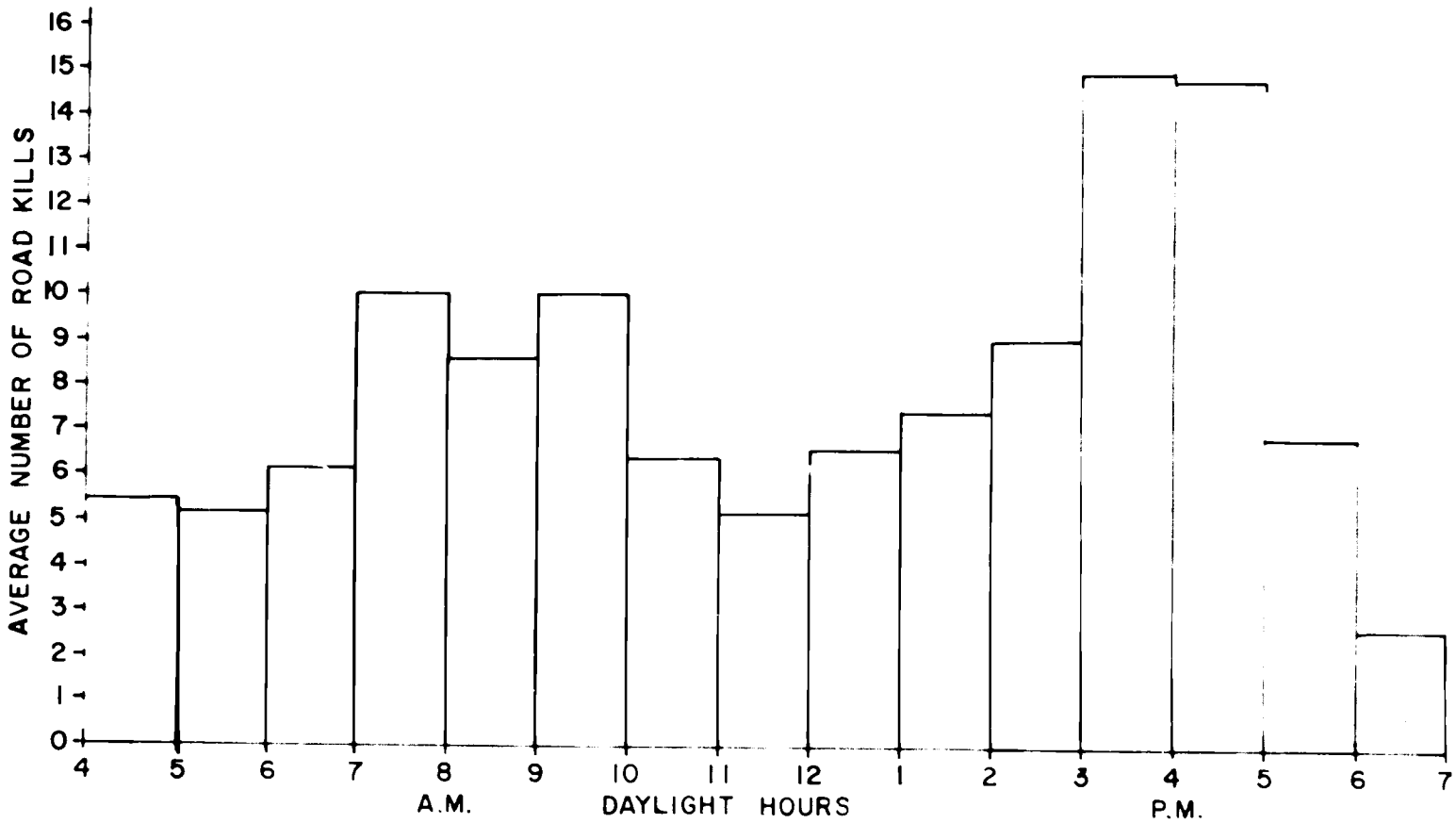

FIGURE 11. DISTRIBUTION OF THE AVERAGE KILLS BY DAYLIGHT HOURS FOR THE SUMMERS OF 1954 THROUGH 1958.

Table 12

Number of Kills Occurring by Daylight Hours,
4 a.m. to 6 p.m. for 1954 - 1958

Hourly Intervals	Number of Kills Each Year				
	1954	1955	1956	1957	1958
4-5 a.m.	6	5	8	-	3
5-6 a.m.	7	1	8	-	5
6-7 a.m.	12	5	7	1	6
7-8 a.m.	11	4	14	15	9
8-9 a.m.	6	8	10	16	3
9-10 a.m.	5	8	11	19	7
10-11 a.m.	7	4	8	5	8
11-12 p.m.	3	7	5	7	4
12-1 p.m.	6	11	9	0	7
1-2 p.m.	14	5	3	5	10
2-3 p.m.	10	4	11	16	3
3-4 p.m.	18	8	14	25	10
4-5 p.m.	16	9	16	16	17
5-6 p.m.	3	11	4	3	13
6-7 p.m.	6	-	1	-	1
7-8 p.m.	3	-	-	-	1

normally relatively inactive, only an average of 26 birds a year were killed, Table 12.

The number of kills occurring by sections of the highway, Figure 12 or Table 13, varied due to such factors as the amount and kind of food and cover available and road bank heights. Following are the descriptions of each of the quarter-mile sections of highway with the average number of kills occurring there and a discussion of the factors believed to have affected the pheasant mortality.

Section 1 - In this section, very few kills occurred, totaling only seven in the five years. In three years no birds were killed in this section. In 1955, when barley was planted in field E11, six of the kills occurred. With the exception of 1955, grains unattractive to pheasants were planted in this field. Consequently, few birds were attracted across the highway to feed. Then, too, the cover west of the road consisted of short, sparse grass being of little value to pheasants. The lack of attractive cover and grain in this section probably accounted for a minimum of pheasant movement across the road and, therefore, was an area of low kills.

Section 2 - The only pheasant killed in this section was in 1956. The east side of the highway was bordered by the Game Commission Regional Office grounds, while a stand of tall firs was located along the west side of the road.

The area was not utilized by pheasants because of the lack of suitable food and cover; therefore, the road kill was low in this section.

Section 3 - Only 10 kills occurred in section 3 over five summers even though several travel lanes bordered the roadway. The field west of the road was in pasturage, thus lacking good cover. Fields E9 and E10 were either in sod, summer fallow, or oats in 1954 through 1956. In 1957 and 1958, there was a great deal of disturbance on the fields east of the highway when construction for a new defense installation and housing began. The absence of attractive food and cover and the disturbance from construction was sufficient to discourage pheasant activity and to keep the number of road kills low.

Sections 4 and 5 - In sections 4 and 5 a total of 43 and 37 pheasants were killed during the study. Fields E7 and E8 were alternately planted to wheat or summer fallow each year from 1955 through 1958. Several good travel lanes bordered the road. The cover west of the road was too open and sparse to provide good cover for pheasants. The banks on the west side of the road were not steep or high enough to markedly affect the kill in these sections. Evidently the cover opposite the grain fields was attractive enough to draw pheasants across the road, resulting in a medium kill.

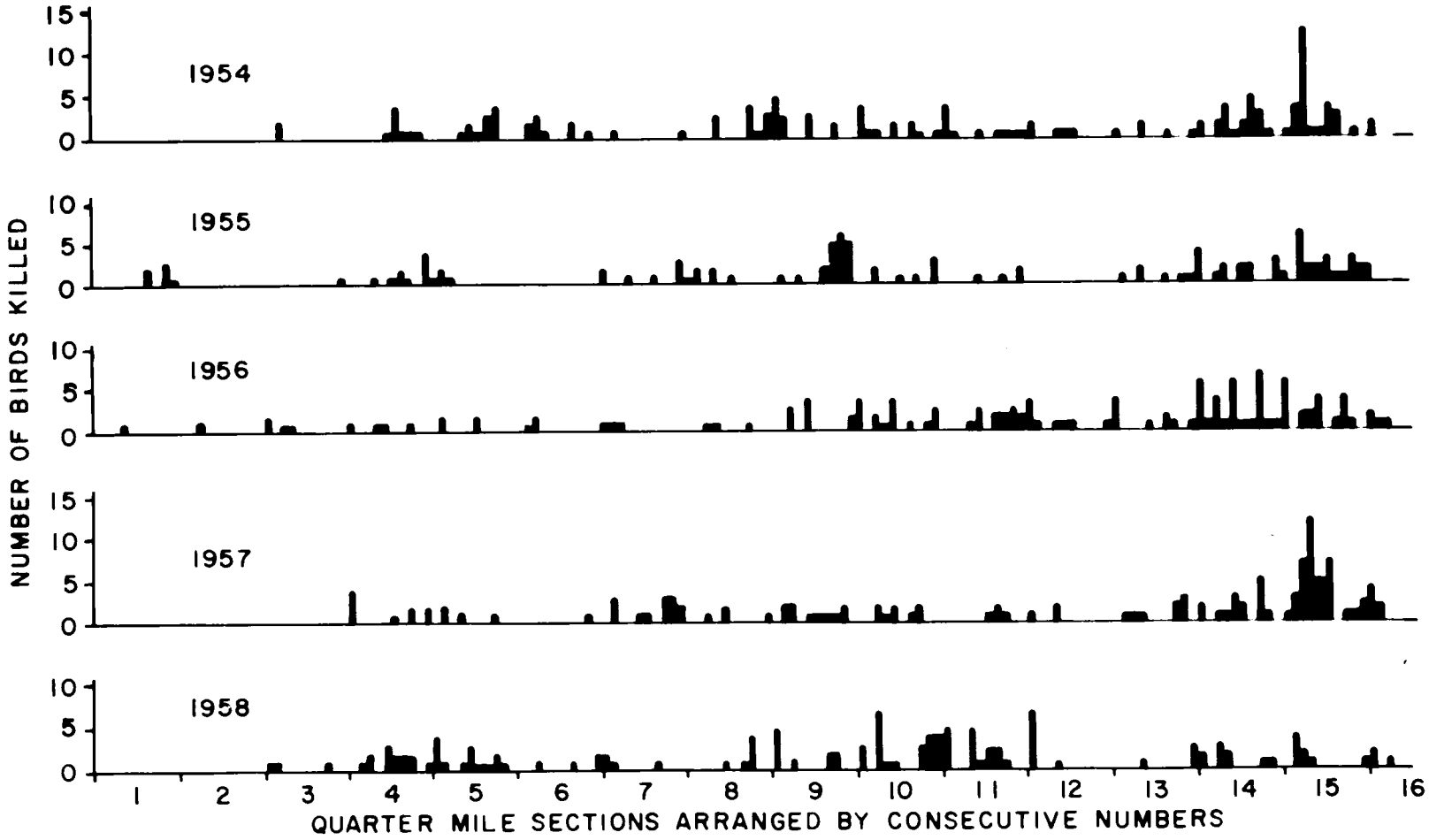

FIGURE 12. LOCATION OF ROAD KILLS BY ONE-FORTIETH MILE SECTIONS ON THE STUDY AREA DURING THE SUMMERS OF 1954 THROUGH 1958.

Table 13

Number of Road Kills on the Study Area by Quarter Mile Sections of Highway Showing Areas of Mortality during 1954 through 1958

	Quarter mile sections of road															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1954	-	-	2	8	11	9	2	11	13	12	10	5	5	20	28	2
1955	6	-	1	9	4	-	7	6	20	7	4	-	6	14	21	2
1956	1	1	4	4	4	3	3	3	9	16	13	8	9	29	20	4
1957	-	-	-	9	4	1	13	4	10	8	7	3	8	15	39	6
1958	-	-	3	13	14	4	4	6	11	23	16	8	4	9	8	3
Totals	7	1	10	43	37	17	29	30	63	66	50	25	32	87	106	17
Average	1.4	.2	2	8.6	7.4	3.4	5.8	6	12.6	12.2	10	5	6.4	17.6	21.2	3.4

Sections 6 through 8 - The total road kills in these sections, 17, 29 and 30 respectively, were low because of three factors: the field west of the road was used for sheep pasturage; fields E6 and E7 were in wheat and summer fallow during alternate years, neither of which appeared attractive to pheasants; and the road bed was cut into the sides of the hill, leaving several high steep banks. Several of the road banks of the west side of section 6 were high enough to markedly influence the number of road kills by encouraging pheasants to fly above passing traffic. The vegetation left by the sheep did not provide good pheasant cover. Whether the fields were in wheat or summer fallow appeared to have negligible influence on pheasant mortality.

Section 9 - Almost the entire length of the road in Section 9 was bordered on the west by grain field W8 and on the east by field E5. Field W8 was planted to spring barley, wheat, oats, oats and vetch and wheat respectively for the five years. Field E5 was alternately in summer fallow or planted to wheat for the five years of the study. The road banks in this section were only slightly above the level of the pavement, having negligible influence on numbers of road kills. The attractiveness of the grain, the fence rows, and the cover at the north end of this section drew enough birds across the roadway so

that a total of 63 were killed in the five summers of the study.

Section 10 - The vegetation in section 10 was heterogeneous varying from grain fields to mature woods. Several grain fields east and west of the highway were planted to various grains during the duration of the study, Figure 5 and Table 8. Strips of cover ended at and bordered the highway in this section. A high road kill, totaling 66 birds, occurred in this section for the entire study period. An average of 12.2 birds a year were killed because the road passed through the centers of good pheasant cover, travel lanes, and a variety of preferred grains, such as barley, wheat, oats, and vetch, which undoubtedly attracted pheasants to the area.

Section 11 - In this section, 50 birds were killed during the study. Fair to good cover was present on both sides of the road and the road banks were level with the pavement. The south end of field E3 was located in this section. The grain planted in this field was not attractive to the birds. Evidently the pheasants used the cover on both sides of the roadway as travel lanes on their way to grain fields beyond the boundary of the section, resulting in an average of 10 birds a year being killed.

Section 12 - The highway was bordered on its entire

east side by field E3. Field E3 was in summer fallow in 1955 and 1958, and planted to oats in 1954 and 1957 and wheat in 1956. Across the road was a short sparsely grassed field. In 1956 and 1958 the grass cover in this field was mowed very short during early July. On both the north and south ends of this section west of the road, strips of cover ended at the highway. In 1956, four of the nine kills were located opposite the strip of cover at the south end. In 1958, seven of the eight kills in this section were found opposite this same strip of cover. Of the total 25 kills occurring in this section, 11 were found in this area in only two of the study years. Since the cover and grain, with the exception of the two travel lanes, was not attractive to pheasants, the movement of birds across the road and the resulting kill was relatively low.

Section 13 - The entire east side of the road in section 13 was bordered by grain fields E1 and E2. The northwestern half of this section was bordered by fields W4 and W5. The ground cover in the southwestern corner of this section was considered to be good pheasant cover. Since there was very little road kill or bird movement across the road in this section during any of the study years, it was assumed that the grains, wheat, rye, sod and summer fallow in fields E1 and E2 were not attractive to

pheasants. Portions of highways with cultivated fields containing unattractive grains, across the highway from either other grain fields or good pheasant cover, did not create pheasant movement between the two and therefore had a low road kill.

Section 14 - The road kill in section 14 was high, totaling 87 pheasants. The excellent cover on the east side of the road was opposite grain fields W3 and W4. Field W3 was in barley, summer fallow, oats and vetch, spring barley and rye grass respectively during the five years of the study. Field W4 was planted to barley, spring oats, oats and vetch, spring barley and spring oats respectively during the summers of 1954 through 1958. Several covered travel lanes along the west side of the road ended at the pavement. Of the 87 kills in this section, 56 per cent occurred in 1954 and 1956 when barley and oats and vetch were planted in fields W3 and W4. Only nine kills occurred in 1958 in this section when rye grass and spring oats were planted in these fields. The number of road kills occurring in this section each year appeared related to the attractiveness of the grain planted across from the good pheasant cover east of the road. The plantings of preferred grains such as barley and oats and vetch in combination across from the cover apparently encouraged the movement of birds between the two and influenced the

number of road kills.

Section 15 - The highest number of road kills occurred in this section. A total of 106 birds for the five year period, or an average of 21.2 birds a summer, were killed in this quarter mile of highway. A total of 64 birds, or 79 per cent, were killed on the one-eighth of a mile of road in this section having a west bank less than five feet above the pavement level. The pheasant cover east of the road was particularly good opposite the eighth of a mile section of highway mentioned above. Barley, spring barley, oats and vetch, and rye grass, respectively, were planted in field W2 during the five years of the study. Kills of 28, 21, 20, and 39 birds occurred in 1954, 1955, 1956, and 1957, respectively, when barley or oats and vetch were planted in these fields. Only eight kills occurred in this section in 1958 when rye grass was planted in W2. Preferred grains attracted birds across the highway resulting in an increased number of kills. Roadside banks, over five feet in height and present on 40 per cent of the west side of the highway through this section were probably instrumental in reducing the number of road kills. A stream flowing through excellent cover and grain fields provided almost an ideal situation for pheasant activity and for a high road kill.

Section 16 - A total of 17 birds were killed in the

one-tenth mile area of section 16 studied. The banks in this section were less than five feet above the road level. Grain was planted west of the highway opposite fair to good cover. Had the entire section been studied, the kill probably would have been high since the conditions of bank height, cover, grain field location, and type of plantings were such as to attract pheasant across the roadway.

For classification and an overall discussion of the factors influencing road kills, the pheasant mortality per quarter mile section for the five years was divided arbitrarily into 3 categories: high, medium, and low. An average of more than 17 kills a year was considered high, 7-13 medium, and below 7 as low.

The roadside conditions indicative of areas of high kills were presence of good pheasant cover opposite fields planted to preferred grains such as barley, spring barley, or oats and vetch in combination, and roadside banks extending less than five feet above the surface of the pavement. In the sections of highway where the factors were unattractive to pheasants, the kill would probably average less than seven a year per quarter mile section.

Areas where the vegetational types varied, or the cover either bordered or abutted on the pavement, providing pheasant travel lanes, the kills were concentrated.

Places where stream vegetation or roadside vegetation intersected the highway were good examples of this type of situation.

Weather

Precipitation was found to have an influence on the daily and weekly movement and mortality of pheasants. In 1956, when a low of 4.05 inches of rain fell from April 1 to June 30, Table 14, the road kill peak occurred during the week of July 22 to July 28, 1 to 3 weeks earlier than in 1954, 1955, 1957, and 1958, Table 9. The drier 1956 spring allowed farmers to plow their fields earlier, resulting in the grain ripening sooner than usual. The increase in the activity of pheasants because of the early maturing grain could possibly account for the premature road kill peak that occurred. In 1954, 1955, 1957, and 1958 an average of 6.78 inches of rain fell during the months of April through June, delaying the plowing of the fields and the planting of the grain which tended to make the harvesting of the grain from 1 to 2 weeks later than in 1956. The road kill peak for these four years was 1 to 3 weeks later than in 1956, Table 9.

Continuous daily precipitation had a varying influence on pheasant activity depending on the duration of the precipitation period. During the first day of steady

Table 14

The Total Rainfall in Inches and Deviation from the Mean by Month, from March through September of 1954 through 1958, at Corvallis, Oregon

	Years									
	1954		1955		1956		1957		1958	
Month	Total	Deviation	Total	Deviation	Total	Deviation	Total	Deviation	Total	Deviation
March	2.91	-1.22	6.12	1.99	5.89	1.76	7.01	3.13	2.55	-1.33
April	2.71	.15	4.91	2.35	.93	-1.63	2.11	.10	3.66	1.65
May	.78	-1.10	1.01	-8.70	1.98	.10	3.21	1.54	1.12	-.55
June	3.11	1.97	.85	-2.90	1.14	.00	1.07	-.15	2.91	1.69
July	.53	.25	.62	.34	.02	-.26	.17	-.18	.02	-.33
Aug.	.64	.21	.00	-.43	.34	-.09	.22	-.19	.02	-.39
Sept.	1.60	.03	1.97	.40	1.12	-.45	1.50	.24	1.30	.04

rain, few, if any, pheasants were seen or found dead while driving the road. On the second day, a few birds were seen and by the third day of continuous rain, pheasant activity was almost back to normal.

Variations in daily and monthly temperatures were other factors considered that might indirectly influence pheasant mortality by determining the time of grain ripening and the development of chicks. Table 15 presents the recorded average monthly temperatures for the study area during the months of March through September for the five years. Temperature variations which influenced the number of road kills by depressing pheasant activity during the day have already been briefly discussed in a previous chapter.

The average monthly temperatures for March and April during each of the five years of the study were below the long-term mean. The warmest average monthly temperatures for March and April in 1957 was 46.3 and 51.0 degrees Fahrenheit with deviations of -.05 and -.09 from the long term mean. The year of 1955 had the lowest average temperatures for March and April with minus deviations of -5.3 and -6.5 respectively. The warmest spring and summer average monthly temperatures occurred in 1958, with temperatures from May to September being above the long-term mean. With the exception of 1958, spring and summer

Table 15

The Average Monthly Temperature and Deviations from the Long Term Means by Month for Oregon State College from March through September for 1954 through 1958

	Year									
	1954		1955		1956		1957		1958	
Month	Aver. Temp.	Deviation	Aver. Temp.	Deviation	Aver. Temp.	Deviation	Aver. Temp.	Deviation	Aver. Temp.	Deviation
March	42.7	-3.5	40.9	-5.3	43.5	-2.7	46.3	-0.5	44.3	-2.5
April	49.0	-1.9	44.4	-6.5	50.6	-0.3	51.0	-0.9	49.8	-2.1
May	55.8	0.1	52.2	-3.5	58.0	2.3	57.5	0.3	59.9	2.7
June	57.2	-3.7	59.5	-1.4	57.6	-3.3	61.2	-0.6	63.7	1.9
July	62.8	-3.4	61.2	-5.0	66.8	.06	63.6	-2.9	70.3	3.8
Aug.	63.1	-3.1	63.9	-2.3	65.2	-1.0	63.0	-3.7	69.7	3.0
Sept.	59.3	-1.7	59.8	-1.2	61.8	.8	64.4	1.5	62.0	-0.09

temperatures for the other four years were colder than the average, Table 15. It was difficult to make an estimation of the influences of temperatures on grain ripening and chick development since the effect on either may have been indirect. Cold temperatures might kill or delay hatching of the insects, etc. on which pheasant chicks feed. Cold temperatures could also tend to discourage nesting and possibly lengthen the breeding time or deposition of the eggs. Buss and Swanson (3, p. 366-367) believed there may be at least two critical temperatures, one to start egg laying and another to arouse broodiness in the hens. These may indicate two other ways in which temperature could influence the nesting of hens and the development of chicks, which would affect the time of summer road kill peaks. All weather data used in this report were obtained from the Oregon State College Farm Crop Department's weather station at Hyslop Agronomy Farm, Corvallis, Oregon, which is located about five air miles southeast of the study area.

The amounts of precipitation affected the time of sowing and harvesting of grain as well as pheasant nesting and movements. Since pheasants prefer to nest on dry ground and farmers cannot plow soft wet fields, both generally wait until the fields dry out, thus delaying both the nesting and planting season. As a result, the

grain harvesting seasons and road kill peaks tend to occur later in the summer. Buss, Swanson, and Woodside in Southeastern Washington in 1948 (4, p. 270) found that after an exceptionally warm and dry March through July period the peak in hatching was two weeks earlier than usual. Similar weather conditions occurring on the study area in 1956 might explain that year's early road kill peak.

General Pheasant Behavior

In 1958, a study was conducted to determine some of the activities of pheasants along highways which might contribute to their deaths from automobile traffic. The activities observed that could lead to such deaths were: pheasants congregating on the shoulders of the highway for grit; flying or walking across the road from dense vegetation; and flying into the sides of passing vehicles.

During the early mornings and late afternoons, pheasants congregate frequently on the shoulders of the road to pick up grit. Passing automobiles did not seem to bother the birds unless they slowed down. Then the birds would either hide in the grass or scatter. Honking the horn of the census truck did not frighten the birds from the edges of the roadway.

Frequently young birds from 3 to 7 weeks old were

observed standing on the highway watching on-coming traffic. When they appeared to realize that they were in danger, many of them were not nimble enough to avoid being hit. Some of these birds, scurrying across the road, ran into moving cars. Those that tried to fly only succeeded in rising a few feet off the ground before being struck. Some birds that appeared to become aware of oncoming traffic while flying over the road tried to race across the road before the automobiles arrived, rather than gain sufficient altitude to fly above the cars.

Several birds which were observed to be hit first flew out of the vegetation on the edge of the road and then flew low across the road in front of traffic. In many cases the vegetation hid the oncoming traffic from the bird until it was too late. In four recorded cases, four adults, two males and two females, which apparently saw approaching cars while gaining altitude in flight over high roadside vegetation continued to rise until they were well over the vehicles and thus flew safely across the road.

In three other recorded instances, juveniles varying from 4 to 9 weeks of age flew toward the sides of moving vehicles. In each case the bird stopped flying forward, then flew straight upward and then back to the side of the road from which it had come, thus escaping injury.

In another instance, three mature birds took off to cross the road as a pickup truck came alongside of them. The truck barely missed hitting one which flew in front of the windshield. The second turned and flew parallel to the truck in the direction of the vehicle. When the cab had passed, the bird then flew over the bed of the truck and across the road safely. The third gained altitude rapidly and flew over the truck.

Both young and adult birds generally flew less than four feet over the pavement unless high banks or vegetation caused them to fly higher. Birds flying at less than five feet above the road were vulnerable to automobile traffic.

During the summers of 1956 and 1958, three birds were hit by the observer's truck while he was driving the census routes. One juvenile was hit when it was flushed from the vegetation at the side of the road and flew directly into the headlamp of the truck. An adult hen was killed when it flew through some trees at the road edge and into the windshield in the late afternoon. This bird was with eight or ten other pheasants which were flying into a grain field to feed. The third bird, an adult rooster, ran across the road on a foggy morning, making no attempt to fly or to avoid the slow moving truck.

Two Management Techniques Attempted to Reduce Road Kills

Two management techniques were tried to reduce road kills on the highway by altering the manner in which pheasants cross the road. The roadside vegetation was cut back from the pavement and a fence was constructed as a barrier to force the birds to fly high enough over the road to avoid passing vehicles.

The cutting of the vegetation back from the edges of the highway, which allowed the birds the opportunity to see and avoid motor vehicles, was only partially successful. Certain birds, seeing the traffic in plenty of time, were able to increase their flying altitudes and thus pass over the moving vehicles while other birds tried to race across the road in front of the cars and were often hit.

Originally, the Oregon State Game Commission game farm personnel intended to mow only certain roadside vegetation in order that kill comparisons could be made with undisturbed locations. Comparisons were not possible because State Highway Department workers cut the roadside vegetation in such a way as to leave no suitable uncut vegetation. On the east side of the road, the herbaceous vegetation was cut back to the multiflora hedge, or for approximately 25 feet. On the west side, where no hedges were present, the herbaceous vegetation was mowed for about 25 feet from the road wherever it could be reached

by a tractor using a side blade. When the vegetation was cut in early July, no appreciable effect on the number of road kills was noted. In 1955, 1956, and 1958 an average of seven birds a week were killed from the third week in June to the third week in July, Figure 10.

The cutting of the roadside vegetation affected the activities of pheasants near the road by causing them to fly from beneath the tallest remaining roadside vegetation, which was the multiflora rose hedge on the east side of the road. Unfortunately, this did not cause them to fly high enough over the road to be above passing traffic. However, this did allow both the driver and the birds better opportunities to see each other, which may have provided them more time to avoid a collision: Figure 13.

In June 1958, a two inch mesh chicken wire fence, 150 feet long, was constructed adjacent to the west side of the multiflora hedge on the north end of section 14 where the kills had been high in 1954 through 1957, Figure 14. The fence was made with four 50 foot lengths of wire stretched between poles. The center section was 10 feet high and made by connecting two six-foot sections of wire together, Figure 14. On each end of the ten foot fence a trap was built to catch the birds attempting to walk around the fence. No birds were caught in the traps. The fence was constructed adjacent to an area where kills

Figure 13. The roadside vegetation was cut to force birds to fly from a greater distance from the highway, allowing the motorist and the birds to see each other and avoid accidents.

Figure 14. The fence constructed to force birds to fly at least five feet above the pavement, over the traffic and thus escape being hit.

had previously been high so that the birds in this section might become accustomed to the structure and would fly over the fence when crossing the road.

The low mortality, nine birds, killed in section 14 in 1958 was believed due to the unattractiveness of the rye grass planted in field W3 rather than the effect of the fence. In general, the fence was believed to be inefficient in reducing road kills in section 14 in 1958 for several reasons: the 100 feet of five-foot-high fence was too low to cause pheasants to fly over the road above passing cars; the rye grass in W3 was unattractive to pheasants, encouraging few birds to cross the road to feed, and, also, the fence was too short to have influenced enough of the area to make its effect noticeable. The 10-foot-high section on several occasions appeared to cause pheasants to fly high enough over the road to be above passing traffic. A long 10-foot-high fence, constructed in areas where considerable number of pheasants move across the road, might help reduce the number of road kills.

SUMMARY AND CONCLUSIONS

1. As part of the general investigation of the ring-necked pheasant being carried on in the E. E. Wilson Game Management Area, Corvallis, Oregon, by the Oregon

Cooperative Wildlife Research Unit a mortality study of the factors influencing road kills was conducted during the summers of 1954 through 1958. The three main objectives of the field work were: (1) to determine why there were excessive road kills, (2) to analyze effects of vegetational patterns and roadside banks which may have influenced the places of bird crossing, and (3) to attempt to develop structures or land management practices which might decrease the numbers of pheasants killed by automobiles. The study was conducted by three different investigators who introduced slight variations in the seasonal times of study, methods of study, and in the manner the data were recorded.

2. To locate and record the number of kills, a truck was driven by the observers along the shoulders of the road in the mid-morning and late afternoon. Standards were developed to record the length of time a bird had been dead when found. The size of the bird and wing-feather development were used to age juveniles. The markings on the primary feathers of young juveniles were used to determine the sex of the bird.

3. A traffic counter was installed across the highway during 1957 and 1958 to record daily traffic volumes passing through the area.

4. A total of 642 pheasants, averaging 128.4 per year,

were killed on the 3.75 miles of study area during the summer months. Approximately 70 per cent of the kills were juveniles having a 50:50 sex ratio. The sex ratio of adults averaged about one rooster to three hens.

5. In general, the juveniles most often killed by automobiles were from three to six weeks of age. An average of about 44.5 birds per year were killed in this age group on the study area.

6. The yearly recorded April population density of adults on the area, the brood size and nesting success, and the average population density of pheasants recorded in the southern part of the Willamette Valley did not appear related to the number of birds killed on the highway during the summer months. Years of estimated high pheasant population numbers in the area were not usually the years of highest kill.

7. High road kills occurred on sections of highway between grain fields and good pheasant holding cover. About 30 per cent of the kills occurred on the north end of the area in a one half mile stretch of road passing between two such fields. The grains planted in the cultivated field, such as barley, oats and vetch in combination, and spring barley were preferred foods of pheasants and, consequently, attracted birds across the road. Rye grass, wheat, and spring oats did not appear as attractive to

birds since lower number of kills occurred adjacent to fields planted to these grains. Also, sections of road bordered by fields in summer fallow had low road kills.

8. Road kills often occurred where strips of cover ended on or bordered the road. Pheasants used the cover as travel lanes to the road and were killed while crossing where the cover ended.

9. The multiflora rose hedge on the edge of the management area provided the pheasants with cover close to the road and may have caused some birds to fly high enough over the pavement when crossing to escape being hit by automobiles, especially if the bird flew over a hedge five feet above the pavement of the highway.

10. Road banks influenced the way in which pheasants crossed the highway and, to some extent, the places of crossing. Road banks five feet or more above the pavement were sufficiently high to cause birds flying over them to pass above the traffic, thereby escaping injury. Birds flying across from lower banks were generally not high enough to escape injury if an automobile was passing at the time.

11. Pheasants seldom walked across the road where banks on either side of the highway were too steep for them to climb. All but one seen crossing the road where the banks were steep, such as in sections 6 through 8, were flying

birds.

12. The combination of traffic volume and bird activity appeared to influence the number of pheasants killed. Generally large volumes of traffic and many active birds were present when road kills were found to be large. If the intensity of either condition was low, few birds were hit.

13. The average road kill per seven-day interval peaked at 30 birds during the period July 26 to August 22 because the grain ripening in the fields tended to attract many birds across the highway where they were vulnerable to passing traffic. When the grain was harvested and the attraction to the area lessened, the number of birds killed decreased.

14. The number of birds killed varied by days of the week depending on the volume and the time of day traffic was greatest. Monday and Friday with a five year total of 117 and 108 kills a day, respectively, ranked first and second in kills but third and second in traffic, probably because the peak of traffic volume on these days was in mid-morning and late afternoon when pheasant activity was greatest. Sunday ranked third with an average of 96 kills because its peak in traffic volume occurred at midday when bird activity was slight. Sunday ranked first in traffic volume with an average of 1724 cars passing through the

area from 9:30 a.m. to 5:30 p.m.

15. The pheasant kill during the day was highest from 8 to 10 a.m. and 3 to 5 p.m. when pheasant activity and traffic volume were at their daily peaks. Generally, when either decreased in intensity the number of road kills an hour also dropped.

16. Sections of highway having good pheasant cover opposite grain fields or had cover bordering both sides of the road forming travel lanes for birds to grain fields more distant from the highway, had the highest number of road kills. Few birds were found on the road adjacent to areas unattractive to pheasants.

17. Two weather dependent factors, average monthly rainfall and average monthly temperature, were believed to affect the time of the road kill peak by influencing the ripening of the grain and the nesting of the hens. Warm, dry spring and summer weather tended to encourage an early grain ripening, nesting season, and road kill peak. In 1956 when the spring and summer were relatively dry, the road kill peak occurred earlier than in the other four years. Constant daily precipitation reduced the pheasant activity for the first two days. After two days of continual rain the pheasant activity appeared almost back to normal.

18. Some of the activities of the birds in the vicinity

of the highway which contributed to their mortality were: picking up grit on the shoulders of the road, flying or walking across the road from dense vegetation, and flying into the side of vehicles. Several times the pheasants appeared capable of flying above approaching traffic but instead tried to race across in front of the automobiles and were killed. Of the few birds seen flying at the side of passing vehicles, none of them actually hit the car but generally flew back to the side of the road from where they had started.

19. Neither of the two techniques tried in an effort to reduce the number of road kills were completely successful. Cutting roadside vegetation, thereby allowing both the birds and drivers a better opportunity to avoid accidents, was not successful because the birds still tried to race across the road in front of the oncoming traffic and were often killed. The fence built to cause pheasants to fly high over the road was too low and too short to show an influence on the road kill. Then, too, the rye grass planted in the field across the road from the fence was not attractive to pheasants in 1958, so few birds used the area.

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