1963

Study of the predatory effects of a reduced magpie population on the ring-necked pheasant

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A STUDY OF THE PREDATORY EFFECTS OF A REDUCED MAGPIE POPULATION ON THE RING-NECKED PHEASANT

by

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B.S. Montana State University, 1961

Presented in partial fulfillment of the requirements for the degree of

Master of Science in Wildlife Technology

MONTANA STATE UNIVERSITY

1963

Approved by:

Chairman, Board of Examiners

Dean, Graduate School

DEC 20 1963

Date

ACKNOWLEDGMENTS

My gratitude is extended to all individuals and organizations who have made this study possible.

I am especially grateful to Dr. John J. Craighead, Leader of the Montana Cooperative Wildlife Research Unit,[1] for generously providing assistance and guidance throughout the study.

To Dr. P. L. Wright, Chairman of the Department of Zoology, and members of the advisory committee: Dr. R. B. Brunson, Dr. E. W. Pfeiffer, Dr. C. M. Senger, and Dr. R. D. Taber, I wish to express my appreciation for helpful advice received during this study. My thanks are also due Dr. H. E. Reinhardt of the Mathematics Department for valuable assistance in the mathematical treatments.

Financial assistance and use of equipment were provided by the Montana Department of Fish and Game and the Wildlife Research Unit. The Western Montana Sportsmen's Association provided additional financial assistance in the form of a grant amounting to $200 each of the two years of the study.

To Mrs. Alvina Barclay of the Wildlife Research Unit, my thanks for assistance on many problems.

I extend my appreciation to the residents of the study area and to the students who assisted in the field work.

Many thanks are due my wife, Gayle, for aiding in the field work and typing portions of this thesis.

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[1]Fish and Wildlife Service, U. S. Department of the Interior, Montana Fish and Game Department, Montana State University, and the Wildlife Management Institute cooperating.

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INTRODUCTION

A study of the predatory effects of a reduced magpie (*Pica pica hudsonia*) population on ring-necked pheasants (*Phasianus colchicus torquatus*) was conducted on a 6.3 square mile area in the Burnt Fork Valley, Montana, during 1962 and 1963. This investigation constituted the fourth and final phase of a long-range study of the magpie as a predator on the eggs of ring-necked pheasants. A review of the previous three phases will provide a background for a better understanding of the present study.

During Phase I, conducted in 1956 and 1957, Brown (1957) determined the density of nesting magpies on the study area and evaluated the natural regulating mechanisms operating within this population. Nesting densities and composition, reproduction, mortalities, and nesting territories of magpies were among the factors studied. The density of nesting magpies present on the study area during this phase has been termed the "natural" or undisturbed magpie population and frequent reference is made to this in the present investigation.

Atwell (1959) initiated Phase II in 1958 and studied the predation of an undisturbed known density magpie population on ring-necked pheasant nests. The magpie population existing during this phase was comparable to that of Phase I. Magpie predation was determined by recording the amount and degree of predation on dummy nests, wild pheasant nests, and nests of released game farm hen pheasants. Reproductive rate, hatching success and productivity of the pheasant were used in evaluating the effects of predation by magpies.

Phase III began in 1960 when O'Halloran (1961) trapped and removed magpies from the normal wintering population in an attempt to procure a significantly reduced spring nesting population. An approximate 50 per cent reduction in nesting magpies was obtained during both years of the study and the dynamics of the reduced population were subsequently studied. O'Halloran concluded that "a decreased magpie nesting population density resulted in no effective compensation by increased productivity, survival, or movement by the magpie."

With knowledge of the predator and prey under unaltered conditions during Phases I and II, and with information of the dynamics of a reduced magpie population, it became feasible to maintain the magpie density at a reduced level and measure the amount and degree of predation by this population on ring-necked pheasant nests. Thus, the following objectives were pursued during the final phase of the long-term investigation:

1. To determine the natality, mortality, and productivity of the ring-necked pheasant on the Burnt Fork study area under the influence of a reduced magpie population.

2. To measure the effects of a reduced magpie population on pheasants by recording predation on dummy pheasant nests and comparing with results obtained when the dummy nests were under the influence of an undisturbed magpie population.

3. To determine predation by a reduced magpie population on the nests of released game farm hen pheasants.

A variety of techniques was employed to accurately record data obtained in the field. Chronological field notes were kept with respect to all pertinent and peculiar observations made during both years of the study. To supplement these records, appropriate mimeographed form sheets were used whenever possible so that a maximum amount of data could be recorded in a minimum amount of time in the field. Duplicates of these forms were then made at a later date. The locations of the nests of magpies, pheasants, and avian predators were plotted on vegetational maps having a scale of 2.4 inches to the mile. These data were later transferred to maps having a scale of eight inches to the mile. The latter maps were also used to record the locations of pheasant broods, skunk dens and red fox dens.

DESCRIPTION OF THE STUDY AREA

The study area is located in the lower portion of the Burnt Fork Valley, one mile east of Stevensville, Ravalli County, Montana. Composed of 6.3 square miles of ranch and farmland, it is bordered on the north and south by terraces rising 150 to 200 feet above the valley floor. The east boundary is the western terminus of a sagebrush (*Artemisa tridentata*) flat and the Bitterroot Valley borders the area on the west.

Land Use

Because the economy of the residents is based primarily on beef ranching and dairy farming, more than 90 per cent of the study area is utilized for pasturage and the production of alfalfa, wild hay, and grain. The lack of summer precipitation has made extensive irrigation a necessity and many small diversion ditches criss-cross the area. Drainage streams and ditches fed by springs, seepage, and spring overflow of the Burnt Fork Creek further dissect the area.

Brown (1957) reported that 325 acres of land were under cultivation for the production of wheat, barley, and oats when the study was initiated in 1956. O'Halloran (1961) found that grain production had decreased to 155 acres in 1961 with the remaining acreage having been converted to hay and pasture. A survey of all residents on the study area in 1963 revealed that 140 acres were sown to grain. This decrease in grain production represents the only significant change in land use during the eight years of study.

Climate

Characteristic of Montana, the climate in the Burnt Fork area consists of dry summers and usually mild winters. Most of the 13 inches of annual average precipitation falls during the spring and fall months (Table I). The temperature extremes during this study were: 1962 -- 94°F. maximum, -25°F. minimum; 1963 -- 95°F. maximum, -28°F. minimum.

TABLE I

CLIMATOLOGICAL SUMMARY

Observations Made at Stevensville Weather Station One Mile West of Study Area

	Temperature				Precipitation			
	1962		1963		1962		1963	
Month	Mean	Departure[1]	Mean	Departure[2]	Total and Departure[1]		Total and Departure[2]	
Jan.	18.1	-4.9	12.8	-10.2	1.00	-.07	1.19	+.12
Feb.	28.1	+0.3	33.6	+5.8	.70	-.30	1.25	+.25
Mar.	34.3	-1.4	38.4	+2.7	.47	-.36	.82	-.01
Apr.	46.6	+1.2	43.6	-1.8	1.09	+.31	.29	-.49
May	51.5	-1.7	52.6	-0.6	1.69	+.17	.82	-.70
June	58.9	-0.2	58.4	-0.7	1.67	-.06	2.89	+1.16
July	62.6	-3.4	63.7	-2.3	.31	-.62	.56	-.37
Aug.	62.9	-0.8	64.0	+0.3	.73	+.04	.52	-.17
Sept.	54.6	-0.6	*	*	.64	-.28	*	*
Oct.	44.3	-1.1	*	*	1.84	+.90	*	*
Nov.	34.4	+1.2	*	*	2.15	+1.05	*	*
Dec.	32.2	+5.2	*	*	1.00	-.20	*	*

[1]Departure from 48-year monthly temperature mean or 50-year monthly precipitation mean.

[2]Departure from 49-year monthly temperature mean or 51-year monthly precipitation mean.

*No data available.

Vegetation

A shrub-tree riparian complex (Alnus tenuifolia, Betula occidentalis, Crataegus douglasi, Prunus sp., Rosa sp., and Salix sp.) largely characterizes the physiognomy of the Burnt Fork study area (Figure 1). This complex provides cover for the pheasant throughout the year while alfalfa, wild hay, and grain crops afford additional cover from late spring to early fall. Some fencerows support wild rose (Rosa sp.), snowberry (Symphoricarpos sp.), goldenrod (Solidago sp.), and various grasses, but these are not common. The type and distribution of vegetation on the study area is presently limited by agricultural land use.

For a more detailed description of the study area see Brown (1957) and Atwell (1959).

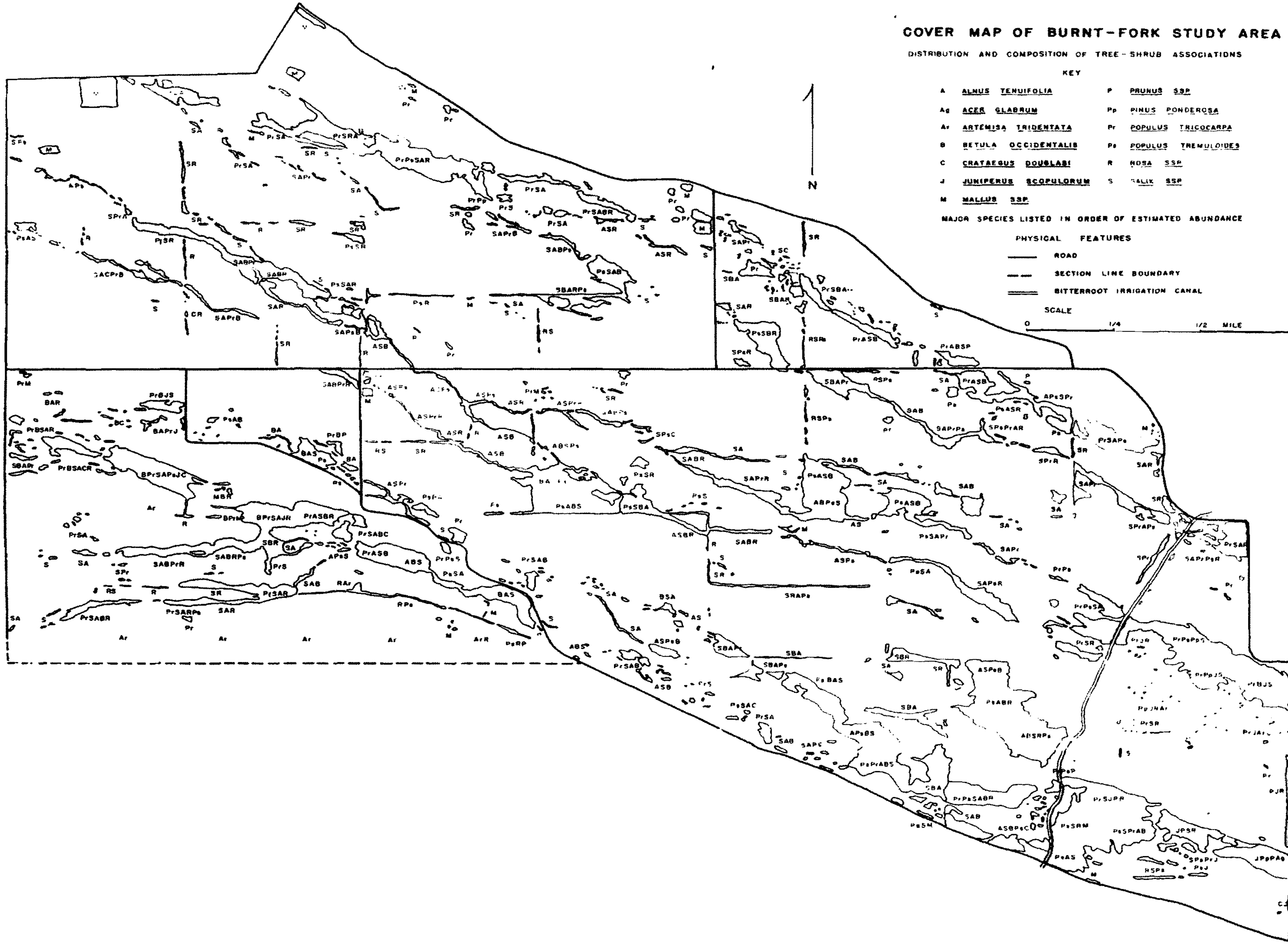

COVER MAP OF BURNT-FORK STUDY AREA
DISTRIBUTION AND COMPOSITION OF TREE-SHRUB ASSOCIATIONS
KEY
A ALNUS TENUIFOLIA
Ag ACER GLABRUM
Ar ARTEMISIA TRIDENTATA
B BETULA OCCIDENTALIS
C CRATAEGUS DOUGLASI
J JUNIPERUS SCOPULORUM
M MALLUS SSP.
P PRUNUS SSP.
Pp PINUS PONDEROSA
Pr POPULUS TRICOCARPA
Pt POPULUS TREMULOIDES
R ROSA SSP.
S SALIX SSP.
MAJOR SPECIES LISTED IN ORDER OF ESTIMATED ABUNDANCE
PHYSICAL FEATURES
ROAD
SECTION LINE BOUNDARY
BITTERROOT IRRIGATION CANAL
SCALE
0
1/4
1/2 MILE
N

FIGURE 1

MAGPIE POPULATION REDUCTION

To obtain a 50 per cent reduction of nesting magpies on the Burnt Fork study area, it was necessary to trap and remove a known number of adult and juvenile birds from the winter population during both years of the study. O'Halloran (1961) found no effective compensation occurred in the nesting magpie population as a result of the 50 per cent reduction. He concluded that populations of nesting magpies could be reduced and maintained at reduced levels through winter removal of birds. Accordingly, 381 and 146 magpies were killed during the reduction programs of 1962 and 1963, respectively. This effected an approximate 50 per cent reduction of nesting magpies during each of the two years (Table II).

Magpie removal during this study began in late December of 1961 and early January of 1962, and was concluded in late March and early April of 1962 and 1963, respectively. Eight traps, five feet square, enclosed with 1-inch mesh chicken wire and having a funnel at ground level were used in the trapping program. The traps were in operation from two to three days a week and were baited with suet, pork cracklings and meat scraps. These baits proved highly effective especially during cold weather or when snow was on the ground.

Early in the winter, traps were placed rather evenly over the entire study area and left at the locations as long as magpies were being captured. Whenever a trap failed to attract new birds for two or three days in succession, the structure was moved to a new location. As trapping progressed, it became evident that some trap sites were more successful

TABLE II
SUMMARY OF BURNT FORK MAGPIE REMOVAL DATA

Winter 1961-62

Date	Trap Units	Magpies Removed	Sex: Male	Sex: Female	Age: Adult	Age: Juv.
12-20-61	8	73	34	39	4	69
12-21-61	8	84	28	56	2	82
12-22-61	10	88	32	56	13	75
12-29-61	8	2	0	2	0	2
12-30-61	8	5	2	3	0	5
12-31-61	8	16	9	7	7	9
1-6-62	8	15	8	7	2	13
1-7-62	8	3	1	2	0	3
1-13-62	8	31	16	15	4	27
1-14-62	8	23	6	17	8	15
2-17-62	8	8	4	4	7	1
3-3-62	8	9	4	5	4	5
3-4-62	8	7	2	5	2	5
3-11-62	7	14	4	10	5	9
	0	3[1]	2	1	2	1
TOTALS	113	381	152	229	60	321

Winter 1962-63

Date	Trap Units	Magpies Removed	Sex: Male	Sex: Female	Age: Adult	Age: Juv.
1-7-63	1	6	1	5	1	5
1-13-63	2	3	0	3	3	0
1-19-63	3	21	9	12	4	17
1-20-63	3	14	10	4	5	9
1-26-63	3	8	1	7	1	7
1-27-63	5	17	7	10	3	14
2-2-63	6	5	1	4	0	5
2-3-63	6	5	2	3	2	3
2-9-63	4	16	6	10	3	13
2-19-63	6	10	2	8	2	8
3-9-63	6	4	3	1	0	4
3-10-63	2	1	1	0	1	0
3-16-63	4	2	1	1	1	1
3-28-63	6	4	3	1	1	3
3-29-63	6	5	1	4	1	4
3-30-63	2	1	0	1	0	1
4-1-63	4	2	1	1	0	2
4-2-63	8	3	0	3	0	3
4-4-63	4	3	1	2	1	2
4-6-63	4	3	0	3	2	1
?	?	13[2]	4	9	3	10
TOTALS	85	146	54	92	34	112

1961-62 Summary

Trapping success: 3.35 magpies per trap unit
Sex ratio: 1 male : 1.51 females
Age ratio: 1 adult : 5.35 juveniles

1962-63 Summary

Trapping success: 1.56 magpies per trap unit
Sex ratio: 1 male : 1.70 females
Age ratio: 1 adult : 3.29 juveniles

[1] Three magpies were found dead in the traps; since no trapping effort was made to remove these birds, they were not included in figures used to determine trapping success.

[2] Rancher trapped and killed 13 magpies; no trapping effort data were available so these birds were not used in determining trapping success. However, they were used in computing sex and age ratios.

than others. Subsequently, trapping effort was concentrated in these areas in an attempt to capture as many magpies as possible. This method proved effective during both trapping seasons.

Sexing and Ageing Magpies

The same methods employed by Brown (1957) were used to sex and age captured magpies. Magpies having a foot pad length (from hallux to middle toe) of 47 mm. or more were considered to be males; those less than 47 mm. were considered females. In using this method, Brown attained 97 per cent accuracy in separation of sexes from a sample of 105 magpies. In 1963, autopsies of 53 magpies showed that 96 per cent of the birds had been sexed correctly by using foot pad lengths as criteria for sexing.

The shape of the terminal portions of the outer retrices was used as a criterion for ageing magpies. As suggested by Lindsdale (1937), roundness of these feathers indicated yearling birds and squareness indicated adults. Brown (1957) found this method to be 100 per cent reliable on observations of a known-age sample of 52 magpies.

Sex and Age Ratios

Of the 381 magpies killed in 1962, 152 were males and 229 were females yielding a sex ratio of 1 male to 1.5 females. In 1963, 54 males and 92 females were removed for a sex ratio of 1 male to 1.7 females. These ratios are similar to those found by Brown (1957) and O'Halloran (1961) in the Burnt Fork during 1956-57 and 1960-61, respectively, which ranged from 1 male to 1 female in 1956 to 1 male to 1.8 females in 1961.

The juvenile to adult ratio in 1962 was 5.4:1 and this ratio decreased to 3.3:1 in 1963. Although this difference probably represented a lower survival of juveniles during the second year, no measure of fledgling survival was made between fledging in 1962 and the following nesting season in 1963 to substantiate this hypothesis. However, it should be noted that removal of less than half as many birds in 1963 as in 1962 resulted in a similar nesting population level.

Banding Magpies

Prior to and during the magpie removal phases of this study, it was necessary to band a known number of captured magpies for release back into the population. These newly banded magpies, along with marked and banded birds released on the Burnt Fork from 1956 through 1961, were essential in forming the basic nesting stock during the two years of this investigation. The magpies were banded with size 3A U. S. Fish and Wildlife Service aluminum leg bands. During the winters of 1961-62 and 1962-63, 78 and 208 magpies, respectively, were banded and released. Owing to an unknown amount of ingress and egress of magpies on the study area, the banded segment of the population could not be used as a direct index in determining the number of magpies to be removed in effecting a 50 per cent reduction. However, this investigator and O'Halloran (1961) both found that by exerting a constant trapping pressure throughout the winter and removing as many unbanded magpies as possible from the population, a reduction of approximately 50 per cent could be procured.

Trapping Effort and Success

A total of 198 trap units (1 trap per day) was required to remove 511 magpies from the study area during the two-year period. This represents an overall trapping success of 2.58 magpies per trap unit. Thirteen additional magpies were killed by a rancher and three by the investigator, but these birds have not been included in determining trapping success. Trapping success decreased from 3.35 magpies per trap unit in 1962 to 1.56 magpies per trap unit in 1963. This difference is thought to have been caused by the combination of a relatively mild late winter (Table I) and an apparently lower survival of juvenile magpies during the second year (Table II).

DETERMINATION OF MAGPIE AND PHEASANT BREEDING POPULATIONS

Pheasant

Both winter flush counts and crowing cock counts were used to determine the pheasant breeding populations during both years of the study. The size of the wild pheasant breeding population was used as a base of reference for determining natality, mortality, and productivity of this basic pheasant stock.

Winter Flush Counts. Winter flush counts of pheasants were conducted from late January to mid-March (Tables XX and XXI, Appendix). With the assistance of a German short-haired pointer, searches for the pheasants at their roosting sites were begun at daylight or shortly thereafter. During periods of mild weather, counts were also obtained while the birds were feeding in stubble fields or in open pastures. The study area was systematically covered twice each winter. In addition, numerous observations were made of birds along the roads when commuting from one section to another. Pheasants were usually in groups of 2 to 5; the largest aggregation consisted of 23 individuals.

Sex Ratios. The winter sex ratios of wild pheasants on the study area were 1 male:2.66 females in 1962 and 1 male:2.1 females in 1963 (Table III). These ratios compare favorably with those found by Atwell (1959) while working in the Burnt Fork in 1958 and 1959 (1 male:2.4 females and 1 male:2.1 females, respectively), and are similar to the ratios of Baskett (1941) in Iowa (1 male:2.4 females), Linduska (1947)

TABLE III

DETERMINATION OF WILD PHEASANT BREEDING POPULATIONS

	Natural Magpie Population[1]		Reduced Magpie Population	
	1958	1959	1962	1963
Total No. Pheasants Censused In Winter Flush Counts	336	431	348	385
Sex Ratio (M:F)	1:2.4	1:2.1	1:2.66	1:2.1
Total No. Crowing Cocks	52	59	73	76
Calculated Wild Hen Population	125	124	194	160
Total No. Wild Pheasants In Early April	177	183	267	236
Pheasants Per Square Mile	30	31	42	37

[1]From Atwell (1959).

in Michigan (1 male:2.1 females), and Schick (1947) in Michigan from 1939 to 1942 (1 male:2 females to 1 male:3 females). The ratios are lower than those found by Craighead and Craighead (1956) in Michigan in 1942 and 1948 (1 male: 4 females), and Stokes (1956) on Pelee Island from 1947 to 1951 (1 male:7.3 females to 1 male:9.6 females).

Crowing Cock Counts. Because of the relatively small size of the study area, the method of counting crowing cocks developed by Kimball (1949) was not used in this study. Instead, a method employed by Atwell (1959) in the Burnt Fork was utilized. It was assumed that each cock was territorial and all cocks crowed. The study area was covered by foot and the general location of the bird was plotted on a field map. Each cock was heard to crow on at least five different days during spring and on several occasions during the mornings of each visit. The census was conducted from one hour before sunrise to an hour after sunrise from late March until mid-April. Using these techniques, totals of 73 and 76 crowing cocks were located on the study area in 1962 and 1963, respectively.

Computed Spring Population. When the crowing cock totals are multiplied times the respective sex ratios, the calculated wild hen and total pheasant population in the Burnt Fork is obtained (Table III). Thus, the prenesting pheasant density in 1962 was determined to be 42 birds per square mile while 37 birds per square mile were present in 1963. Although this represents a slight increase over the 30 and 31 pheasants per square mile densities reported by Atwell (1959) for the Burnt Fork in 1958 and 1959, respectively, such small differences in spring pheasant population levels are considered normal (Lauckhart and McKean, 1956). Spring pheasant densities on the study area are considerably under those reported for eastern Oregon and central Washington where pheasant densities in the spring averaged 173 and 96 birds per square mile, respectively, for a 5-year period from 1947 through 1951 (Lauckhart and McKean, 1956). However, this same 5-year average indicated a density of 40 birds per square mile for southeastern Washington which is comparable to that of the study area. The relatively low pheasant density in the Burnt Fork Valley indicates that pheasant habitat on the area is of mediocre quality.

Magpie Nesting Census

To ascertain whether the removal of magpies from the winter population resulted in a significantly reduced nesting population, an intensive magpie nesting census was carried out from mid-April through early May during both years of this study. An active nest was defined as one where the presence of a nesting pair of magpies could be established by the presence of eggs or young in the nest. These criteria, initially employed by Brown (1957) during 1956 and 1957, have been used by all subsequent workers on this long-term project up through 1963.

In 1956 and 1957, respectively, Brown (1957) located 361 and 370 active magpie nests (Table XXII, Appendix). Censusing one-half of the Burnt Fork in 1958, Atwell (1959) found that the population exhibited little change and a census of the entire area in 1959 revealed 377 active nests were present. These data indicate that the magpie population existing in the Burnt Fork prior to magpie reduction was remarkably stable and averaged 369 active nests per year. Following winter removal of magpies, O'Halloran (1961) located 165 and 189 active nests in 1960 and 1961, respectively, or an average of 177 nests per breeding season. This represented a 52 per cent reduction of nesting birds. During the present investigation, 179 active nests were located in 1962 while 185 nests were present in 1963. The average of 182 nests is a 51 per cent reduction from the pre-reduction average of 369 active nests.

PHEASANT NESTING STUDY

To evaluate the predatory effects of a reduced magpie population on the ring-necked pheasant, it was essential to know the reproductive rate and nesting success of the pheasants on the Burnt Fork study area. Therefore, a detailed study of the nesting activities of wild and released hen pheasants was conducted during both years. Predation by the known density magpie population and other predators could then be measured and the predatory effects evaluated in terms of pheasants produced to a harvestable age. Pheasant productivity during this investigation could subsequently be compared to results obtained prior to magpie control.

Release of Game Farm Hen Pheasants

A total of 1200 adult game farm hens was released on the study area during the two years of this investigation (Table IV). Releases had been made each year since the long-range study was begun in 1956. Two primary objectives were accomplished with the introduction of the game farm population. First, together with the wild population, the introduced birds established a large nesting sample for subsequent study of predation on pheasant nests. Second, the game farm hens provided a sample which allowed comparisons of predation on the nests of released pheasants with predation on nests of wild hens.

It was realized that the releases would cause a sudden but temporary increase in pheasant density during the spring. Each year pheasant numbers dropped to carrying capacity during the winter months. This

TABLE IV

GAME FARM PHEASANT RELEASES IN THE BURNT FORK VALLEY FROM 1956 THROUGH 1963

Year	Month and Day	Number Hens	Number Cocks	Total No. Hens Released For the Year	Total No. Cocks Released For the Year	Total Birds Released For the Year
1956	April 18	165	16	330	32	362
	June 4	165	16			
1957	April 18	150	15	300	80	380
	June 3	150	65			
1958	April 17	299	0	598	0	598
	May 29	299	0			
1959	April 29	299	0	598	0	598
	June 5	299	0			
1960	April 26	300	0	599	0	599
	June 10	299	0			
1961	May 6	300	0	600	0	600
	June 4	300	0			
1962	April 30	300	0	600	0	600
	June 17	300	0			
1963	May 10	300	0	600	0	600
	June 5	300	0			
TOTALS		4,225	112			4,337

was evident in the spring and summer of 1963 when only 8 of 600 hens (1.3 per cent) from the 1962 releases were observed on the study area. Although it might be argued that the introduced birds created an artificial situation, the quantitative data obtained was advantageous to the study as a whole and greatly offset any disruption of the natural conditions that might have occurred.

Each of the 600 game farm hens released each spring was marked with both a numbered aluminum leg band and a colored plastic neck jess of the type developed by Craighead and Stockstad (1956). A variety of colored plastic marking tapes was used to distinguish between release dates of the respective birds. By applying various paint combinations to the different colored jesses, all 600 hens of the 1962 releases were individually marked for identification in the field (Table XXIII, Appendix). Analysis of the data obtained in using this technique showed that birds of the 1963 releases could be marked in groups of five and still meet the needs of the study (Table XXIV, Appendix). This latter technique was employed for two reasons: (1) preparation of the jesses required far less time and allowed the investigator to spend more time in the field, and (2) complex paint combinations were eliminated and this facilitated field identifications of the jesses. Since the chance of locating two similarly marked hens in the same area would be 1 in 120 (5/600), this possibility was regarded as too remote to inject any significant bias into the results.

Neck markers and leg bands were attached to the hens from 3 to 5 days prior to the release date at the Montana State Game Farm, Warm Springs, Montana. The "violent release" method was used to insure a more even dispersal of pheasants throughout the study area (Roby, 1951).

Eight release points were established in the first release of 1962 but one was deleted and two more established when it was found that a nearby rancher's dogs were taking some of the newly liberated birds. The same release points were subsequently used in 1963.

Prior to releasing the game farm hens on the study area, it was realized that survival of these birds would be low since predation on such introduced populations is normally high (Buss, 1946). This proved to be the case as 73 per cent of the pheasant mortalities located during this investigation were known to be game farm hens (Table XXV, Appendix). Predation accounted for 75 per cent of the released pheasant kills (Table XXVI, Appendix). These anticipated losses, plus the expectation of an unknown amount of egress of birds from the area, were the reasons for releasing the large number of hens each year. In addition, the early and late release dates were established so that a nesting population would be available throughout the entire summer for subsequent study of predation on the pheasant nests.

<u>Collection of Nesting Data</u>

The study area was covered repeatedly throughout the summer in search of pheasant nests. Three well-trained German short-haired pointers were used to locate the nests; a single female was used the first year while both a male and a female were employed during the second year. The dogs were trained to hold point while the investigator recorded the condition of the nest and identity of the hen. The pointers were then carried off point and sent in another direction to hunt. Deliberate flushing of hens from the nests was not practiced since periodic visits to the nests during the nesting period invariably provided an opportunity for the investigator to count the number of eggs when the hens were not at the sites. It was felt that this procedure minimized the aspect of desertion which could be attributed to the presence of the investigator in the field. Information obtained during each visit was transferred to a cumulative data sheet of which there was one for each nest. Interviews with ranchers prior to, during, and following mowing operations also provided information about the location of new nests. Using these techniques, 104 and 98 pheasant nests were located in 1962 and 1963, respectively.

Renesting. Numerous references are present in the literature about the probable occurrence of renesting among pheasants, but few substantiating data are published. Some workers have considered pheasant nests to be renests because of the lateness of the season and the small clutch sizes (Hamerstrom, 1936). Other investigators have suggested renesting as a possible cause for large percentages of hens producing broods by the end of the nesting season, even though observed hatching success percentages were comparatively small (Randall, 1940; Knott *et al.*, 1943). To determine the validity of renesting and the extent to which it occurred, Seubert (1952) conducted a study with marked game farm hens which were released into a small enclosure. The results of this study revealed that many hens renested twice and a few as many as three times.

In the current investigation, an attempt was made to gather renesting information each time an active nest was deserted or destroyed. For a period of two weeks, the vicinity within a radius of 100 yards of deserted or destroyed nests was searched intensively every 2 or 3 days. Thereafter, periodic visits to these areas were made throughout the summer. Although many suspected renesting attempts were observed, only two were confirmed and both involved game farm hens. On May 23, 1963, a game farm hen with an individualized neck jess was located on a clutch of 4 eggs. The site was visited two days later, the nest was deserted, and the eggs had not been incubated. The hen was flushed in the area on May 27 and 29, but a renest was not located. Then, on June 22, this hen was observed on a clutch of 14 eggs some 50 feet from the first nest. Six days later, 7 eggs, containing 13-day embryos, were removed from the next by magpies. However, the remaining 7 eggs were incubated until July 1, when an unknown predator completely destroyed the nest. No further renesting was observed. Another game farm hen was observed while incubating a clutch of 5 eggs on July 8, 1963. Incubation continued until July 16 when the nest was destroyed by mowing. The eggs at the time of nest destruction contained 11-day embryos. On August 4, the hen was again located approximately 200 yards from the first nest site and was incubating a clutch of 3 eggs. This renesting attempt was successful as all 3 eggs hatched on August 15.

Although only two instances of renesting were ascertained, this event in pheasant reproduction probably occurs in the Burnt Fork more often than the data indicate. Evidence to this is provided by the fact that both wild and game farm hens were observed incubating clutches as late as the last week of August and first week in September. Observations of relatively large numbers of young chicks in late August may also attest that renesting is not an uncommon occurrence on the area.

Clutch Sizes

Only nests in which incubation had commenced (bona fide nests) were utilized in determining clutch sizes of pheasants in the Burnt Fork. Of the 104 nests located in 1962, 42 (40 per cent) were bona fide nests while in 1963, 49 (50 per cent) of 98 nests underwent incubation. Twelve bona fide wild nests were located in 1962 but only seven were found in 1963, even though two dogs were used to locate nests during the second year. Game farm nests numbered 25 in 1962 and this increased to 37 nests in 1963. Five unknown nests (identity of hen was unknown) were located during each of the two years.

The clutch sizes for nests of wild, game farm, and unknown hens are presented in Table V. Wild hens had an average clutch size of 10.2 eggs during this investigation and this figure is identical to the results found by Atwell (1959) in the Burnt Fork. This figure is also similar to the clutch sizes reported by Salinger (1952) in Idaho and Eklund (1942) in Oregon where they were 9.8 and 10.45, respectively. While working in western Montana in 1950, Woodgerd (1952) observed an average clutch of 10.5 eggs from a sample of 11 successful nests. Findings of workers in California and the Midwest have indicated slightly larger clutches than those observed in the Burnt Fork. Hart *et al.* (1956) found 12 eggs per clutch for the Sacramento Valley in California during the four years from 1947 through 1950. In Iowa, Hamerstrom (1936) reported an average clutch size of 11.6 eggs over a three-year period. Data are lacking with respect to clutch sizes of released game farm pheasants. Working with penned game farm hens in Wisconsin, Buss *et al.* (1951) found an average clutch of 9.9 eggs per nest. A study by Seubert (1952) in central Ohio revealed an average clutch of 9.7 eggs from a sample of 63 nests of game farm hens which were released into a 7.85 acre enclosure during 1950. In 1951, he found a mean clutch of 11.7

TABLE V

PHEASANT REPRODUCTIVE RATE IN THE BURNT FORK VALLEY BEFORE (1958-59) AND AFTER (1962-63) MAGPIE REDUCTION

	Wild Hens		Game Farm Hens		Unknown Hens		Totals	
Before Magpie Reduction[1]	1958	1959	1958	1959	1958	1959	1958	1959
Total No. Nests	9	17	25	25	18	5	52	47
Total No. Eggs	89	175	174	162	143	38	406	375
Avg. No. Eggs Per Nest	9.9	10.3	6.9	6.5	7.9	7.6	7.8	8.0
Two-Year Avg. Clutch	10.2		6.7		7.9		7.9	
After Magpie Reduction	1962	1963	1962	1963	1962	1963	1962	1963
Total No. Nests	12	7	25	37	5	5	42	49
Total No. Eggs	124	69	186	316	36	34	346	419
Avg. No. Eggs Per Nest	10.3	9.9	7.4	8.5	7.2	6.8	8.2	8.6
Two-Year Avg. Clutch	10.2		8.1		7.0		8.4	

[1]From Atwell (1959).

eggs among 155 incubated nests. The foregoing data indicate therefore that clutch sizes in the Burnt Fork are comparable to those found in Idaho, Oregon, and western Montana, but are somewhat smaller than those observed in California and the Midwest. Clutches of game farm hens on the study area are considerably smaller than those reported by other workers but this is understandable since birds released in the Burnt Fork had laid at least one clutch at the Game Farm prior to their release.

When clutch sizes of wild and released pheasants on the study area are compared, those of wild hens averaged 2.9 eggs larger in 1962 and 1.4 eggs larger in 1963, or a two-year average difference of 2.2 eggs (Table V). This is slightly smaller than the two-year average difference of 3.4 eggs (wild over game farm) found by Atwell (1959). It should be noted that wild clutches were identical in the studies of 1958-59 and 1962-63, respectively, and that the difference in overall clutch sizes (8.4 vs. 7.9) between the two periods can be directly attributed to variances in clutches of the released hens. This factor will be considered later in evaluating and comparing the productivity of game farm hens during the reduced and undisturbed magpie population periods.

Successful Nests

Of the 91 bona fide nests located during this investigation, only 16 (17.6 per cent) were successful in hatching (Table VI). Bona fide wild nests numbered 19 of which 5 (26 per cent) hatched. Game farm hens were less successful as only 10 (16.1 per cent) of 62 nests hatched. Hens in the unknown category hatched 1 of 10 nests for a 10 per cent success. The overall hatching success of 17.6 per cent recorded in this study is comparable to the 16 per cent found by Atwell (1959) in the Burnt Fork where only bona fide nests were considered. A similar success figure of 18 per cent was reported by Weston (1953) in Iowa. However, the latter study included both bona fide nests and abandoned nests in determining hatching success. Other studies by Eklund (1942) in Oregon and Stokes (1956) on Pelee Island where abandoned nests were

TABLE VI. FATE OF BONA FIDE PHEASANT NESTS

	Wild Hen		Game Farm Hen		Unknown Hen	
	1962	1963	1962	1963	1962	1963
Total No. of Nests	12	7	25	37	5	5
Successful Nests						
No. of Nests	3	2	3	7	1	0
Total No. Eggs	28	15	18	55	11	0
Eggs Hatched	23	14	12	51	11	0
Fate of Unhatched Eggs						
Dead Embryo	4	1	0	2	0	0
Infertile	1	0	6	2	0	0
Unsuccessful Nests						
Total No. Nests	9	5	22	30	4	5
Total No. Eggs	96	54	168	261	25	34
Fate of Unsuccessful Nests						
Predation						
Magpie						
No. of Nests	2	1	1	1	1	0
Total No. Eggs	18	12	6	7	5	0
Magpie and Unk. Pred.[1]						
No. of Nests	0	0	0	1	0	0
Total No. Eggs	0	0	0	14	0	0
Skunk						
No. of Nests	1	2	9	11	0	3
Total No. Eggs	17	19	81	91	0	19
Weasel						
No. of Nests	0	0	0	0	0	1
Total No. Eggs	0	0	0	0	0	7
Unknown Small Mammal						
No. of Nests	0	0	0	1	1	0
Total No. Eggs	0	0	0	8	5	0
Dog						
No. of Nests	0	0	1	3	0	0
Total No. Eggs	0	0	6	26	0	0
Predation and Other[2]						
Magpie and Mowing						
No. of Nests	0	0	0	1	0	0
Total No. Eggs	0	0	0	9	0	0
Other Than Predation						
Desertion						
No. of Nests	3	0	5	5	0	0
Total No. Eggs	30	0	37	42	0	0
Mowing						
No. of Nests	3	1	6	6	2	1
Total No. Eggs	31	11	38	54	15	8
Overhead Sprinkling						
No. of Nests	0	1	0	1	0	0
Total No. Eggs	0	12	0	10	0	0

[1]Magpies removed 7 eggs and an unknown predator destroyed the remaining 7 eggs.

[2]Magpies removed 3 eggs and mowing demolished the nest 4 days later while the hen was incubating the remaining 6 eggs.

(Continued)

TABLE VI. FATE OF BONA FIDE PHEASANT NESTS (Continued)

	Totals 1962	Totals 1963	Grand Total
Total No. of Nests	42	49	91
Successful Nests			
No. of Nests	7	9	16
Total No. Eggs	57	70	127
Eggs Hatched	46	65	111
Fate of Unhatched Eggs			
Dead Embryo	4	3	7
Infertile	7	2	9
Unsuccessful Nests			
Total No. Nests	35	40	75
Total No. Eggs	289	349	638
Fate of Unsuccessful Nests			
Predation			
Magpie			
No. of Nests	4	2	6
Total No. Eggs	29	19	48
Magpie and Unk. Pred.[1]			
No. of Nests	0	1	1
Total No. Eggs	0	14	14
Skunk			
No. of Nests	10	16	26
Total No. Eggs	98	129	227
Weasel			
No. of Nests	0	1	1
Total No. Eggs	0	7	7
Unknown Small Mammal			
No. of Nests	1	1	2
Total No. Eggs	5	8	13
Dog			
No. of Nests	1	3	4
Total No. Eggs	6	26	32
Predation and Other[2]			
Magpie and Mowing			
No. of Nests	0	1	1
Total No. Eggs	0	9	9
Other Than Predation			
Desertion			
No. of Nests	8	5	13
Total No. Eggs	67	42	109
Mowing			
No. of Nests	11	8	19
Total No. Eggs	84	73	157
Overhead Sprinkling			
No. of Nests	0	2	2
Total No. Eggs	0	22	22

[1]Magpie removed 7 eggs and an unknown predator destroyed the remaining 7 eggs.

[2]Magpie removed 3 eggs and mowing demolished the nest 4 days later while the hen was incubating the remaining 6 eggs.

excluded from the data reported successes of 57 per cent and over 70 per cent, respectively. In western Montana, Woodgerd (1952) observed a 61 per cent success which included abandoned nests. From these data, it is apparent that hatching success has remained comparable in the Burnt Fork during periods of undisturbed (1958-59) and reduced (1962-63) magpie population levels. It is, however, considerably less than the figures determined from studies in other areas.

Infertility and Embryo Mortality. Of 43 eggs in 5 successful wild pheasant nests, only 1 egg (2.3 per cent) was infertile. Game farm hens experienced a lower fertility as 8 (10.9 per cent) of 73 eggs in ten successful nests were infertile. From a sample of 127 eggs in 16 successful nests, including one unknown nest, egg fertility for the two years was computed to be 92.9 per cent (Table VI). The fertility figure of 97.7 per cent observed for eggs of wild hens is comparable to the 96.5 per cent found by Woodgerd (1952) in western Montana, the 98.2 per cent reported by Salinger (1952) in Idaho, and the 98.6 per cent noted by Twining et al. (1948) in California. The 89.1 per cent fertility for eggs of game farm hens is similar to the 89 per cent figure obtained by Seubert (1952) while working with penned game farm hens in Ohio during 1950.

Embryo mortality accounted for 7 eggs not hatching or 5.5 per cent of all eggs in successful nests. This percentage is considerably less than the results of Hamerstrom (1936) in Iowa where dead embryos were found in up to 14 per cent of the eggs observed. However, in Iowa, Baskett (1941) found that embryo mortality was responsible for 6 to 7 per cent of the eggs not hatching in successful nests. This figure then closely resembles that found in this investigation.

When infertility and embryo mortality are considered together, these two factors accounted for 12.6 per cent of the eggs not hatching in successful nests. This is nearly identical to the 12.8 per cent found by Nelson (1956) in South Dakota and is only slightly less than the 16 per cent obtained by Atwell (1959) in the Burnt Fork and by Twining et al. (1948) in California, respectively. These data indicate that the percentage of eggs not hatching in the Burnt Fork because of infertility and embryo mortality is similar to that of other studies.

Fate of Unsuccessful Nests

Desertion. Buss et al. (1951) suggested that laying eggs at random and deserting one or two nests, common among game farm hens, probably represents typical behavior for wild hens as well. This was found to be the case during the present study. With respect to unsuccessful bona fide nests, desertion accounted for 21.4 per cent of the wild nests and 19.2 per cent of the game farm nests (Table VI). When all unsuccessful bona fide nests are combined, desertion was responsible for 22.9 per cent of the nests in 1962 and 12.5 per cent in 1963, or 17.3 per cent for the two years (Table VII). Figure 2 illustrates the abandonment by month and includes both bona fide and non-bona fide nests. As found by Atwell (1959), desertion was highest in June followed closely by May and July. The latter two months had nearly equal amounts of desertion. However, it should be noted that among wild hens, no nest desertion was recorded after June. This was to be expected since desertion among these birds is more frequent early in the nesting season and decreases as the season progresses (Stokes, 1954). The comparatively higher

TABLE VII

FATE OF UNSUCCESSFUL BONA FIDE PHEASANT NESTS DURING PERIODS OF UNDISTURBED (1958-59) AND REDUCED (1962-63) MAGPIE POPULATION LEVELS

	Undisturbed Magpie Population			Reduced Magpie Population		
	1958	1959	Avg.	1962	1963	Avg.
Predation						
Magpie	13.0%	10.5%	11.9%	11.4%	7.5%	9.3%
Skunk	37.0%	36.8%	36.9%	28.6%	40.0%	34.7%
Weasel	2.2%	2.6%	2.4%	0.0%	2.5%	1.3%
Unknown Small Mammal	4.3%	0.0%	2.4%	2.9%	2.5%	2.7%
Dog	2.2%	0.0%	1.2%	2.9%	7.5%	5.3%
Unknown Predator	4.3%	2.6%	3.6%	0.0%	1.3%	0.7%
Totals	63.0%	52.5%	58.4%	45.8%	61.3%	54.0%
Other Than Predation						
Desertion	17.4%	7.9%	13.1%	22.9%	12.5%	17.3%
Mowing	15.2%	36.8%	25.0%	31.4%	21.3%	26.0%
Other Farm Practices	4.3%	2.6%	3.6%	0.0%	5.0%	2.7%
Totals	36.9%	47.3%	41.7%	54.3%	38.8%	46.0%

percentage of desertion which occurred in 1962 was directly attributed to the investigator. Of the 8 bona fide nests deserted, 4 were abandoned as a result of the investigator accidentally approaching the nest too closely or actually making contact with the incubating hen while searching for nests.

Man's Activities. Man and his agricultural activities, especially mowing, have been described as major causes of hen losses and nest destruction in various parts of the pheasant range. Yeager et al. (1951) found that an average of 34.8 per cent of all nests and 50 per cent of unsuccessful nests were destroyed by crop harvesting on irrigated lands in Colorado from 1948 through 1950. In Oregon, Eklund (1942) reported that mowing operations resulted in a 55 per cent loss of pheasant nests. Summarizing the results of studies from four different states, Trippensee (1948) listed the following percentages of nest destruction caused by mowing: Iowa 30 per cent, Michigan 53 per cent, Ohio 54 per cent, and Pennsylvania 50 per cent. In the Burnt Fork, the percentages of nest failure caused by mowing are less than those quoted from other studies. Atwell (1959) found that mowing accounted for an average of 25 per cent of the unsuccessful nests on the study area in 1958 and 1959. Similarly, 26 per cent of unsuccessful nests were demolished by this cause during the present investigation (Tables VI and VII). These data indicate that mowing losses in the Burnt Fork were probably underestimated since obtaining data on this factor was incidental to obtaining information which was more pertinent to the study.

Other than actual nest destruction, it is interesting to note that mowing had additional effects on pheasant reproduction in the Burnt

Fork. During this study, 26 hens (9 per cent of all pheasant mortality) were killed outright by mowers and numerous others were seriously injured (Tables XXV and XXVI, Appendix). Many of the crippled hens were probably rendered incapable of renesting although no quantitative data were obtained on this aspect. By removal of dense nesting and roosting cover, mowing also increased the vulnerability of the nesting hens to predation. This phenomenon was particularly observed during the second year of this study. Only one pheasant kill was attributed to five great horned owls (2 adults and 3 young) for a 38-day period prior to the mowing of an 80-acre hay field which took place during the week of July 14-21. The owls were located in a woodlot immediately adjacent to the hay meadow. Following mowing, a search of the hay field vicinity revealed that 6 game farm hens had recently been killed by these raptors during the mowing period. Since 5 of the 6 hens were known to have been nesting or roosting in the field prior to mowing, the investigator concluded that mowing was indirectly responsible for the loss of these hens and their respective renesting potentials.

Farm practices other than mowing caused the loss of 2.7 per cent of unsuccessful bona fide nests. Overhead sprinkling irrigation was responsible for these nest failures which occurred in 1963 (Tables VI and VII). Considerably more than the figure reported for this study, an average of 10.2 per cent of unsuccessful nests in Colorado were destroyed by flooding which resulted from irrigation (Yeager et al., 1951).

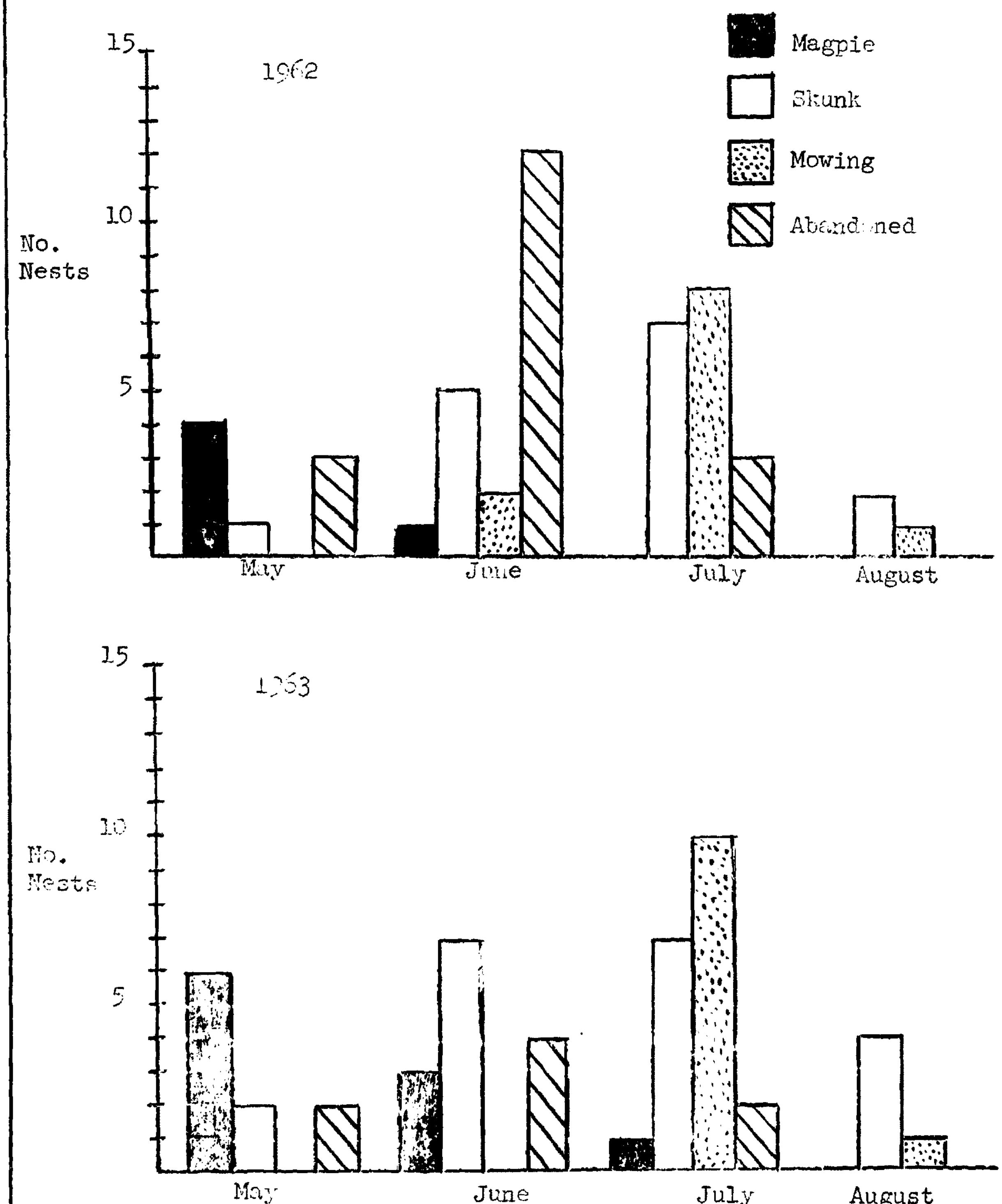
Predation. The same criteria used by Atwell (1959) to identify nest predators were adhered to in this study. Information obtained from the series of dummy pheasant nests (Stanton, 1944) which were placed in the field during May, June, and July proved invaluable in identifying many of the nest predators. The dummy nest studies are discussed later in a separate section (page 58). This information plus information from Darrow (1938), Rearden (1951), and Stanton (op. cit.) made it possible to identify and distinguish between several predators when only indirect evidence was present at the nest.

Predation was the leading cause of egg losses in unsuccessful bona fide nests during both years. In 1962 and 1963, respectively, 45.8 per cent and 61.8 per cent of the unsuccessful nests were destroyed by predators (Table VII). These data compare favorably with the results of Atwell (1959) in the Burnt Fork during 1958-59 (Table VII). Workers from other areas of the nation have reported predation figures which are considerably under those for the study area. In Iowa, Baskett (1941), Hamerstrom (1936), and Klonglan (1955) have expressed predation figures in the form of percentages of unsuccessful nests as 40 per cent, 19 per cent, and 13 per cent, respectively. English (1934) in Michigan and Strode and Leedy (1948) in Ohio found that predation was responsible for the destruction of 6 and 18 per cent of unsuccessful nests, respectively. In the more western portion of the country, Eklund (1942) in the Willamette Valley of Oregon, Salinger (1952) in southwest Idaho, and Yeager et al. (1951) in Colorado reported respective nest predation percentages of 15 per cent, 13.2 per cent and 16.5 per cent. Therefore, except for the 40 per cent figure submitted by Baskett (1941) for Iowa, predation on pheasant nests in the Burnt Fork is 3 to 4 times as great as percentage figures quoted for studies in other portions of the country.

Magpies and skunks were the leading predators on pheasant nests during both years. Magpies were responsible for 11.4 per cent of all losses among unsuccessful bona fide nests during 1962 and 7.5 per cent in 1963, or a two-year average of 9.3 per cent (Table VII). Skunks destroyed 3 to 4 times as many nests as magpies, accounting for 28.6 per cent of the nests in 1962 and 40 per cent in 1963. Other predators combined destroyed 5.8 and 13.8 per cent of the nests in 1962 and 1963, respectively. All predators, other than the magpie, collectively destroyed 75 per cent and 87.8 per cent of the nests lost only to predation in 1962 and 1963, respectively.

Prior to magpie reduction in 1958 and 1959, 10 of 84 (11.9 per cent) unsuccessful bona fide nests were destroyed by magpies. In 1962 and 1963, following a 51 per cent reduction of the magpie population, losses of 7 of 75 (9.3 per cent) nests were attributed to the magpie. Application of the Chi-Square to these data indicates that no significant change in magpie predation occurred at the 5 per cent confidence level between the two periods. Therefore, although magpie predation decreased slightly in 1962-63, this decrease is not statistically significant and is certainly not commensurate with the 51 per cent reduction of the magpie predator population.

When the predation caused nest failures are examined according to months, it is seen that the magpie exerted its heaviest pressure early in the season and became a less important predator as the summer progressed (Figure 2). Conversely, skunk predation was lightest early in the season but surpassed the magpie in June, July, and August. This phenomenon is believed to have resulted from a combination of factors. As the pheasant nesting season advanced, the emergence and growth of



MONTHLY LOSSES OF ACTIVE PHEASANT NESTS[1]

FIGURE 2

[1]Nests containing at least 2 eggs with an incubating or actively laying hen present when the nest was located.

new vegetation provided the pheasants with more dense cover in which to nest. Skunks, which locate nests primarily by scent, were not deterred from their preying on pheasant eggs by the increase of cover. However, magpies, which locate nests by sight alone, were curtailed in their predatory efforts by the new vegetative growth. Evidence of this fact is provided in Table VIII where magpie predation is related to the degrees of nest concealment. An explanation of the method used to rate the degree of nest concealment appears in the section on dummy nest studies (page 58). Magpie predation involving nests located in light cover was approximately one-third greater than that recorded for nests in medium cover and 4 times the amount occurring among nests in heavy cover. Even among nests of light concealment, magpie predation decreased as the summer progressed. This would suggest that the shortage of other staple foods early in the season may have caused the magpie to prey on pheasant eggs more intensively during May and June. While evaluating destructive agents of pheasant nests in Iowa, Kozicky and Hendrickson (1956) reported similar findings with respect to crow predation. These workers stated, "Crows are especially active on nests early in the pheasant nesting season, April and May, when cover conditions are poor and there is a relative scarcity of natural food." Since the food habits and preying abilities of crows and magpies are comparable, such findings are applicable to the magpie as well.

Magpie Predation On Nests Of Game Farm Hens

An integral part of the present study was to measure the effects of a reduced magpie population on pheasants by recording magpie predation on the nests of game farm hens. Both early and late releases

TABLE VIII

MAGPIE PREDATION ON PHEASANT NESTS RELATED TO MONTHS AND DEGREE OF NEST CONCEALMENT (1962-63)

Months	Light	Medium	Heavy	Totals
MAY				
Total No. of Nests	10	10	3	23
No. of Nests Disturbed by Magpies	7	4	1	12
Per cent of Nests Disturbed by Magpies	70.0	40.0	33.3	52.2
JUNE				
Total No. of Nests	36	31	8	75
No. of Nests Disturbed by Magpies	9	6	0	15
Per cent of Nests Disturbed by Magpies	25.0	19.4	0.0	20.0
JULY				
Total No. of Nests	28	38	6	72
No. of Nests Disturbed by Magpies	2	2	0	4
Per cent of Nests Disturbed by Magpies	7.1	5.3	0.0	5.6
AUGUST				
Total No. of Nests	11	8	2	21
No. of Nests Disturbed by Magpies	0	0	0	0
Per cent of Nests Disturbed by Magpies	0.0	0.0	0.0	0.0
TOTALS (1962-63)				
Total No. of Nests	85	87	19	191
No. of Nests Disturbed by Magpies	18	12	1	31
Per cent of Nests Disturbed by Magpies	21.2	13.8	5.3	16.2

(Table IV) of pheasants were made during both years so that a nesting segment of the pheasant population would be available for study throughout the entire summer. Because only a small number of wild nests were located, especially after June, this phase of the two-year investigation was invaluable in measuring and evaluating magpie predation during the entire nesting season of May through August.

Methods and Techniques. Only active game farm nests were used in measuring magpie predation on the introduced pheasants. An active nest was defined as a nest containing at least 2 eggs and having either an incubating or nesting hen present when the nest was located. Dropped eggs, single eggs in poorly fashioned nests, and deserted nests were not considered since predation on such nests and eggs is inconsequential to pheasant reproduction (Buss et al., 1951; Dale, 1956). With the exception of two cases, magpies removed all eggs when preying upon a nest. Since only portions of the total clutches were removed in these instances, destruction of one-half of the respective nests was attributed to magpie predation (Table IX).

Results. Only 9.2 per cent of all active game farm nests located during the two years were destroyed by magpies (Table IX). Predation was greatest in May, showed a drastic drop during June, and was practically nonexistent in July and August. These results are similar to those reported for the Burnt Fork population as a whole (Table VIII). However, since many of the nests destroyed in May represented initial attempts of the nesting season and would probably have been deserted (Seubert, 1952), even the 9.2 per cent figure tends to overemphasize the intensity of magpie predation and its effects on pheasant reproduction.

TABLE IX

MAGPIE PREDATION ON NESTS OF GAME FARM HENS
RELATED TO MONTHS AND DATES OF HEN RELEASES
(1962-63)

	May	June	July	August	Totals
Early Releases[1]					
Total No. Active Nests	11	13	11	4	39
No. Nests Destroyed by Magpies	7	1.5	0	0	8.5
Per cent of Nests Destroyed	63.6	11.5	0.0	0.0	21.8
Late Releases[2]					
Total No. Active Nests	0	22	32	5	59
No. Nests Destroyed by Magpies	0	0	0.5	0	0.5
Per cent of Nests Destroyed	0.0	0.0	1.6	0.0	0.8
Totals					
Total No. Active Nests	11	35	43	9	98
No. Nests Destroyed by Magpies	7	1.5	0.5	0	9
Per cent of Nests Destroyed	63.6	4.3	1.2	0.0	9.2

[1]Releases made on April 30, 1962, and May 10, 1963.
[2]Releases made on June 17, 1962, and June 5, 1963.

When bona fide nests (nests in which incubation had commenced) only are considered, magpies were responsible for losses of 5.8 per cent of the unsuccessful nests in this category. The latter figure then presents a more accurate picture with respect to the effects of a reduced magpie population on nests of introduced hens during the present investigation.

Prior to magpie reduction, Atwell (1959) reported that 14 per cent of unsuccessful bona fide game farm nests were destroyed by magpies. This figure is slightly more than twice as great as the 5.8 per cent found in 1962-63. Although this difference would appear to be correlated with the 50 per cent reduction of magpies, analysis of the data suggests another cause for the dissimilarity. Dates of first releases of game farm hens in 1958 and 1959 averaged nearly 2 weeks earlier than first releases of 1962 and 1963 (Table IV). Figure 2 illustrated that magpie predation was most intense early in the season and correspondingly, Table IX shows nests of first releases suffered considerably more magpie predation than nests of later releases. Therefore, prior to magpie reduction, game farm nests were exposed to predation not only for a longer period, but also at a time when magpie predation was of greatest intensity. These data suggest that differences in magpie predation on game farm nests were more directly correlated with release dates of introduced pheasants, rather than magpie population levels existing before and after magpie control.

In all but two cases, magpies destroy all eggs when preying upon eggs in active nests. Since both nests were bona fide and the hen continued to incubate after the predation attempts were made, these two instances are noteworthy. The first of these observances was made on June 28, 1963. A game farm nest (early release) known to have contained

14 eggs was visited in late afternoon and 7 eggs had been destroyed. An egg with mandibular punctures was located about 12 inches from the nest bowl. In addition, egg shell fragments and excretia below a nearby fence post made it possible to definitely identify magpies as the predators. The hen returned to the nest by the following morning and continued to incubate the remaining 7 eggs which contained 13-day embryos. On July 1, this nest was completely destroy by an unknown predator. The second occurrence of partial clutch destruction by magpies was noted on July 9, 1963. On this occasion, with the aid of 7 X 50 binoculars, the investigator observed five juvenile magpies feeding on a game farm nest (late release). The magpies had been at the site for less than a minute when they were frightened away by a rancher irrigating a nearby field. A visit to the nest revealed that 3 eggs, from a known clutch of 9 eggs, had been destroyed. Upon breaking another egg in the nest, the investigator found it contained a living 12-13 day embryo. When the site was again visited on July 12, the hen was incubating the remaining eggs. On July 14, mowing operations demolished the nest and seriously injured the hen as evidenced by the presence of numerous feathers and a portion of the neck jess at the nest.

Productivity

Pheasant productivity was also used to measure the effects of a reduced magpie population on pheasants. Provided other influencing factors (weather, land use, etc.) remained comparable both before and after magpie control, productivity data obtained during these periods could be compared and evaluated with respect to the existent magpie population levels. Two methods were used to secure productivity information: summer brood counts and late August pheasant censuses.

Brood Count Methods and Techniques. For comparative purposes, the brood count methods and techniques employed by Atwell (1959) were utilized during this investigation. Brood data were usually gathered in the early morning and late afternoon hours throughout the summer with the aid of a German short-haired pointer. Broods were classified into the following size and age groups:

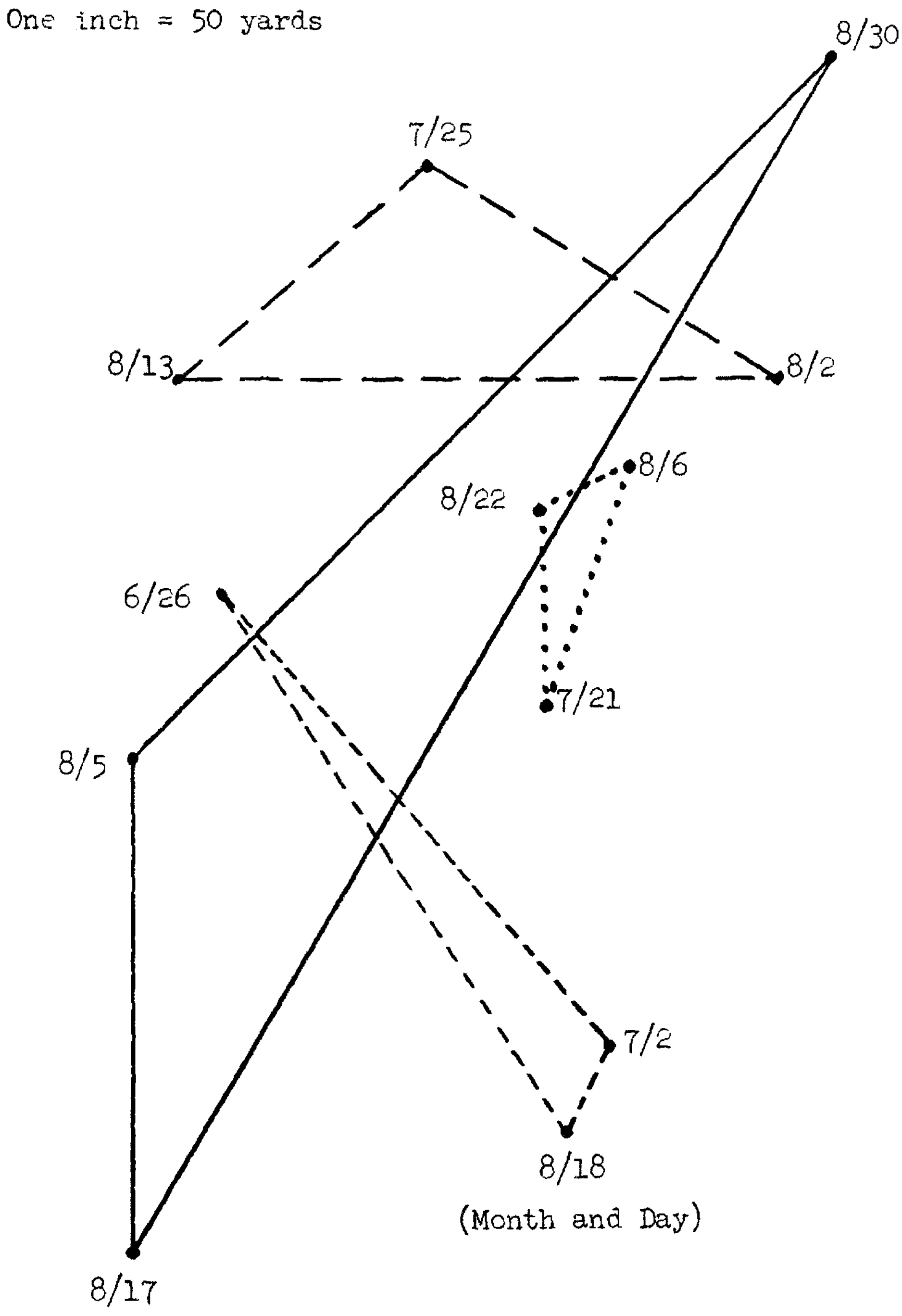
Phase I ---- From hatching until flight status was gained.

Phase II --- When the bird was able to fly until it reached the size of a Hungarian partridge (*Perdix perdix*).

Phase III -- Larger than a Hungarian partridge but smaller than an adult pheasant.

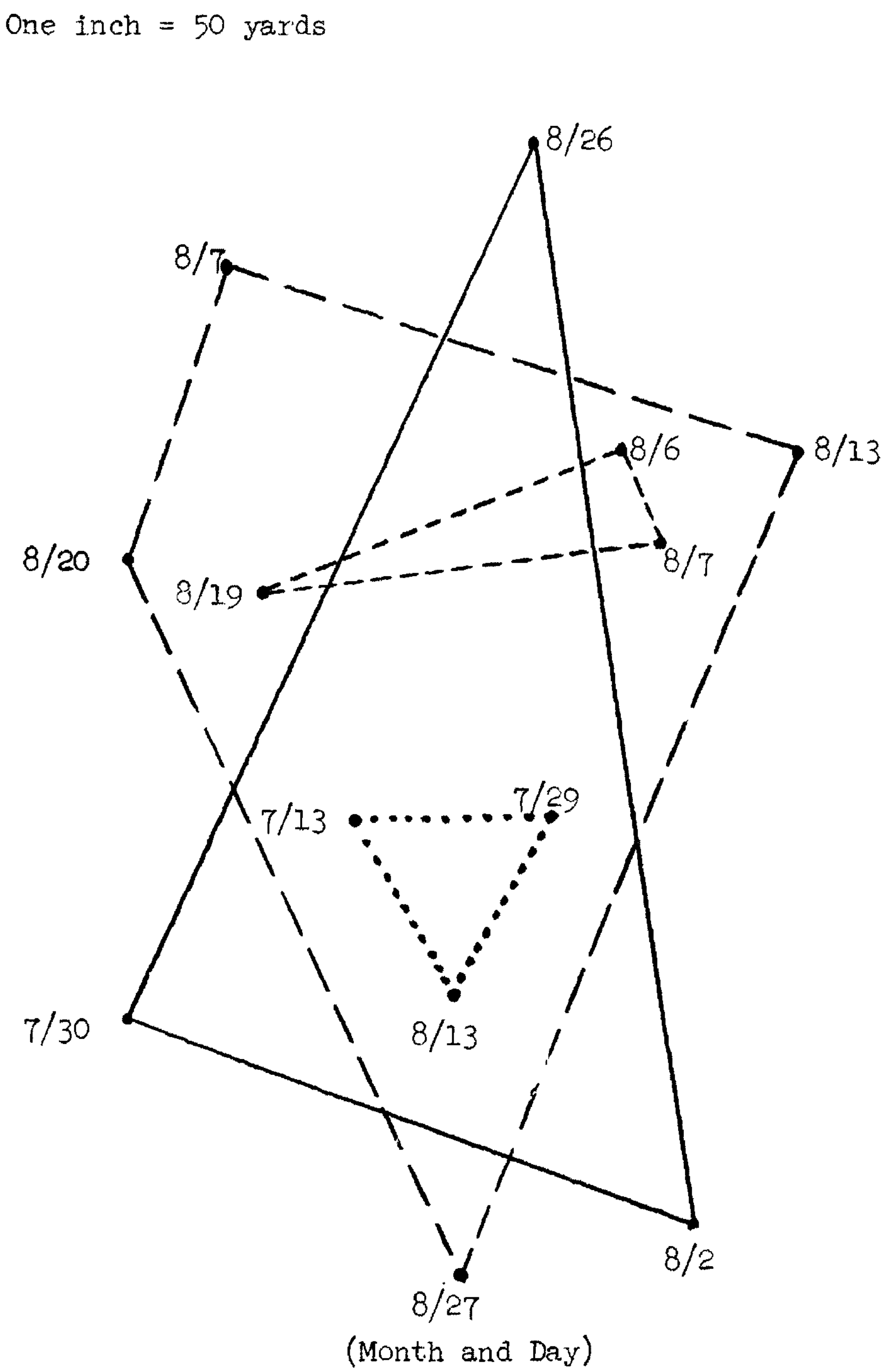
During the course of this investigation, the study area was covered repeatedly each summer and the movements of wild broods (Figure 3) and broods of marked game farm hens (Figure 4) were determined. With knowledge of these movements plus information on the size (number) and age of the respective broods, it was possible to associate the broods with specific areas and differentiate between them in counts. These techniques minimized the possibility of brood duplications. Individual cumulative data sheets were used to record brood size, age, and movements each time a particular brood was observed.

Late August Census Methods and Techniques. Two men, each with a dog, systematically searched the study area section by section during each year. The census of 1962 required a total of 86 man hours of flushing time and was conducted from August 24 through September 1.



MOVEMENTS OF WILD HENS WITH BROODS

FIGURE 3



MOVEMENTS OF MARKED GAME FARM HENS WITH BROODS

FIGURE 4

In 1963, 106 man hours were spent in covering the area from August 21 through September 2. This flushing-type census subsequently yielded the total number of hens as well as hens with broods in the Burnt Fork during the last week of August.

Results of Brood Counts. Pheasant productivity data with respect to summer brood counts are presented in Tables VIII and IX. A total of 118 separate broods were located in the Burnt Fork in 1962 and 90 broods were present in 1963. During the first year there were 72 wild broods, 20 game farm broods, and 26 broods for which the identity of the hen was unknown. Twenty-one of the 26 unknown broods consisted of young, usually in the phase III age group, with no hen present. In 1963, 37 wild broods, 43 game farm broods, and 10 unknown broods were located on the area. The average brood size for all hens was 4.7 young in 1962 and 5.6 young in 1963. These data yield a two-year average of 5.0 young per brood. This figure is only slightly larger than the average of 4.9 young per brood found by Atwell (1959) in the Burnt Fork during 1958 and 1959.

When data on brood sizes of 1962 and 1963 are combined, wild broods averaged 6.2 young per brood. This average is 0.9 young larger than the 5.3 young per brood determined from brood counts when magpie control was not in effect. Although the difference appears to be related to the reduction of magpies, inspection of the data reveals that a greater variation in average brood sizes occurred during the present investigation when magpie control was practiced each year (Table X). Therefore, it is assumed that other controlling factors were either responsible for the increased brood size, or were successful in masking

TABLE X

SUMMER BROOD COUNTS RELATED TO IDENTITY OF HEN

	May		June		July		August		Totals		Grand Total
	62	63	62	63	62	63	62	63	62	63	
Wild Hen											
No. Broods	0	1	6	6	32	12	34	18	72	37	109
No. Young	0	8	33	61	208	87	177	100	418	256	674
Average No. Young/Brood	0	8.0	5.5	10.2	6.5	7.3	5.2	5.6	5.8	6.9	6.2
Game Farm Hen											
No. Broods	0	1	0	1	2	11	18	30	20	43	63
No. Young	0	6	0	6	15	56	55	143	70	211	281
Average No. Young/Brood	0	6.0	0	6.0	7.5	5.1	3.1	4.8	3.5	4.9	4.5
Unknown Hen											
No. Broods	0	0	0	0	12	4	14	6	26	10	36
No. Young	0	0	0	0	28	16	34	17	62	33	95
Average No. Young/Brood	0	0	0	0	2.3	4.0	2.4	2.8	2.4	3.3	2.6
Total No. Broods/Month	0	2	6	7	46	27	66	54	118	90	208
Total No. Young/Month	0	14	33	67	251	159	266	260	550	500	1050
Average No. Young/Brood/Month	0	7.0	5.5	9.6	5.5	5.9	4.0	4.8	4.7	5.6	5.0

TABLE XI

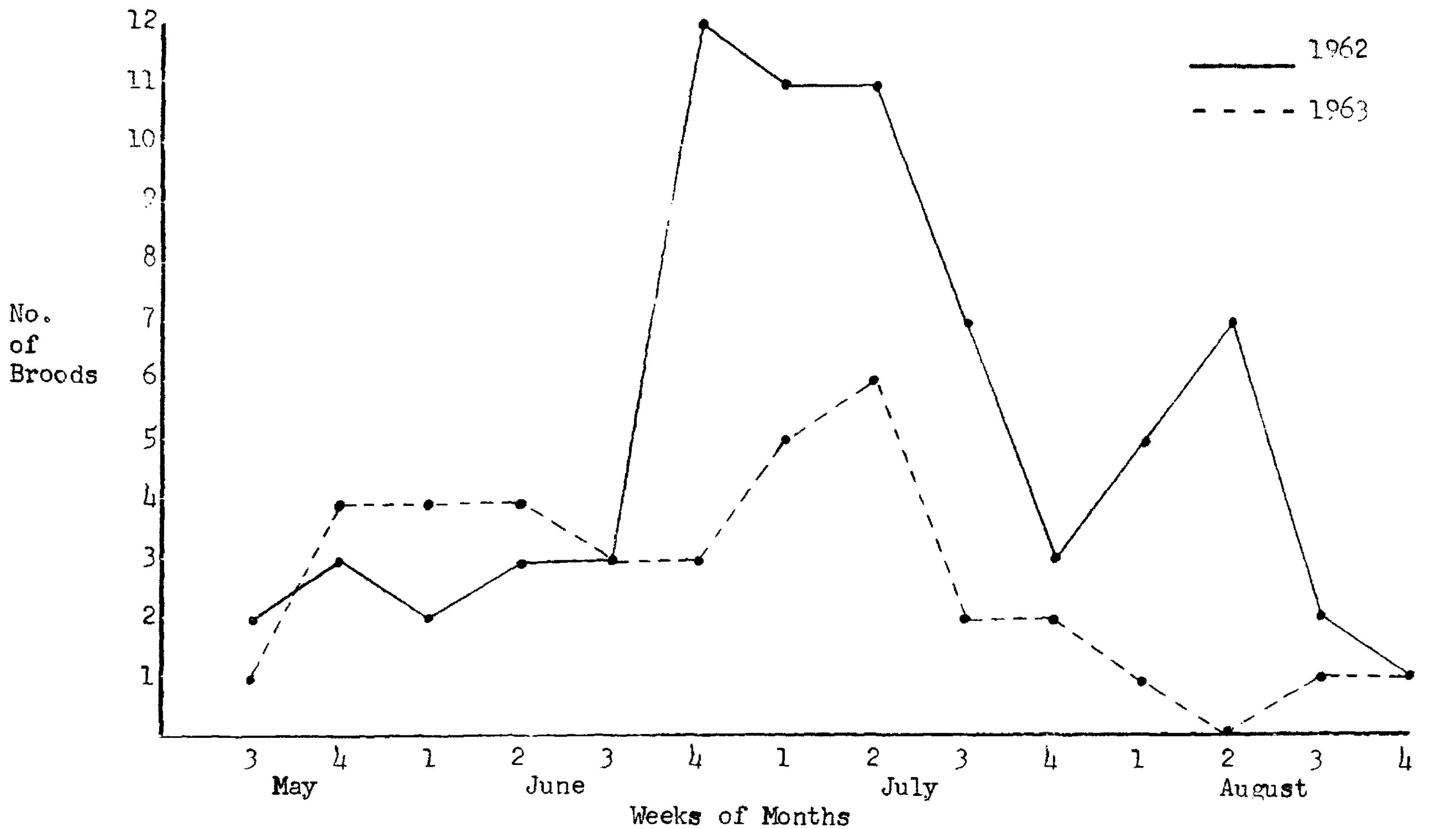
SUMMER BROOD COUNTS RELATED TO GROWTH OF YOUNG

	May		June		July		August		Totals		Grand Total
	62	63	62	63	62	63	62	63	62	63	
Phase I											
No. Broods	0	2	0	2	7	8	10	9	17	21	38
No. Young	0	14	0	19	33	52	38	46	71	131	202
Average No. Young/Brood	0	7.0	0	9.5	4.7	6.5	3.8	5.1	4.2	6.2	5.3
Phase II											
No. Broods	0	0	6	5	27	13	31	22	64	40	104
No. Young	0	0	33	48	185	84	145	102	363	234	597
Average No. Young/Brood	0	0	5.5	9.6	6.9	6.5	4.7	4.6	5.7	5.9	5.7
Phase III											
No. Broods	0	0	0	0	12	6	25	23	37	29	66
No. Young	0	0	0	0	33	23	83	112	116	135	251
Average No. Young/Brood	0	0	0	0	2.8	3.8	3.3	4.9	3.1	4.7	3.8
Total No. Broods/Month	0	2	6	7	46	27	66	54	118	90	208
Total No. Young/Month	0	14	33	67	251	159	266	260	550	500	1050
Average No. Young/Month	0	7.0	5.5	9.6	5.5	5.9	4.0	4.8	4.7	5.6	5.0

the influence of a reduced magpie population on wild pheasant productivity. Game farm broods remained comparable with 4.2 young per brood and 4.5 young per brood before and after magpie control, respectively. Brood sizes in the unknown category decreased from 4.7 young per brood in 1958-59 to 2.6 young per brood in 1962-63, but this difference cannot be explained in relation to the magpie population levels existing during the two periods. In terms of total numbers of broods produced, magpie control had no demonstrable effect as 202 broods were located in 1958-59 as compared to 208 broods in 1962-63.

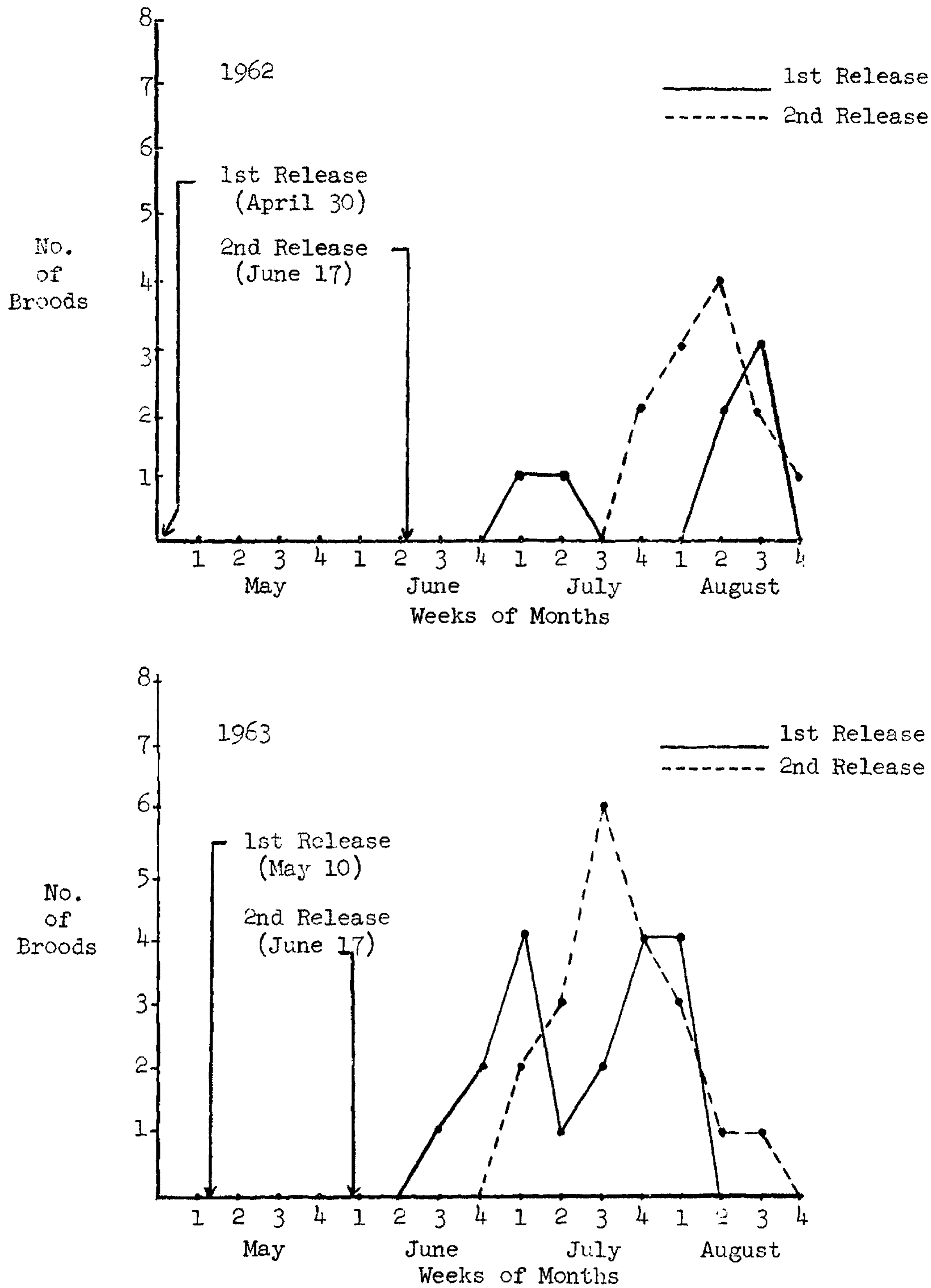
Records were kept with respect to the growth phases (I, II, III) of all broods and these data appear in Table XI. The ages of the broods was estimated visually while the young were in flight or when observed on the ground. Upon comparing the estimating method of ageing broods with the primary molt stage technique, Thompson and Taber (1948) found a maximum difference of only one week between the two methods. By projecting the estimated ages of the broods back to the dates of probable hatch, hatching curves were plotted for successful nests of wild (Figure 5) and game farm (Figure 6) hens during each year. Because entire broods may have been extirpated from the population before they were located, it is realized that these curves relate only to brood survival and are not indicative of actual hatching success during the respective months.

In 1962, the peak hatch for wild nests began during the fourth week in June and continued through mid-July. A second peak was reached in mid-August and was probably the result of successful renesting efforts (Figure 5). In 1958-59, Atwell (1959) also used brood information and found that the peak of hatch during those years occurred during the



HATCHING DATES OF WILD BROODS AS DETERMINED FROM SUMMER BROOD COUNTS

FIGURE 5



HATCHING DATES OF GAME FARM BROODS AS
DETERMINED FROM SUMMER BROOD COUNTS
FIGURE 6

second half of June. The extended and delayed hatching periods of the present study is thought to have been caused by the adverse weather conditions existing early in the nesting season. During a 46-day period from May 1 to June 15, rain fell in the Burnt Fork on 50 days and apparently hampered early nesting activities. In southeastern Washington, Buss et al. (1952) similarly found that the peak of hatching in 1948 and 1950 was delayed by 2 weeks because of adverse weather conditions, mainly precipitation, early in the nesting season.

The peak of hatch in 1963 did not take place until mid-July, and this was of comparative low magnitude. The total number of wild broods located during the second year was only 51 per cent of the total found in 1962. It was apparent therefore that the inclement weather conditions during the latter part of June, the time when peak of hatch normally occurred in the Burnt Fork, were responsible for the losses of broods in the early stages of life. Precipitation fell daily on the study area during the period of June 20 through 30, with maximum amounts of .74 inches and .60 inches being recorded on June 21 and 29, respectively. In conjunction with the heavy rainfall, minimum temperatures ranged from 33°F to 47°F. Under laboratory conditions, MacMullan and Everhardt (1953) found that newly hatched chicks became lethargic or unconscious following an exposure of 15 minutes at 45°F. At the same temperature, 3 of 4 chicks survived an exposure of one hour while no chicks survived an exposure of 3 hours. Ryser and Morrison (1954) reported that repeated chillings of 2 to 3 day old pheasant chicks for 20 minites at 20°C (68°F) impaired the development of cold resistance and the young birds experienced a high rate of mortality. In addition to chilling, rainfall and cold weather cause mortality by reducing the abundance of insects which compose 87.3 per cent of the diet of one-week old chicks (Eklund, 1942). Therefore, although other factors may have accounted for minor losses, the period of inclement weather in late June was considered to be the major cause of brood mortality and the resulting low production of wild broods in 1963.

Results of Late August Censuses. The results of the late August pheasant censuses of 1962 and 1963 appear in Table XII. Only 41 of 72 wild broods located during the summer of 1962, and 16 of 37 wild broods in 1963, were known to survive until late August of the respective years. These data indicate wild brood mortality in the Burnt Fork ranged between 43 per cent (1962) and 57 per cent (1963) during the two summers of this investigation. Similarly, prior to magpie reduction, Atwell (1959) found that 43 per cent of the total number of wild broods located in 1959 were all that remained by late August. The average brood sizes for wild hens in late August was 5.3 young in 1962 and 5.2 young in 1963. These figures agree closely with the average of 5.3 young per brood determined from 52 wild broods located in the August brood counts of 1962 and 1963. They are also comparable to the figure of 5.6 young per wild brood reported by Atwell (1959) for the Burnt Fork in late August, and by Hiatt and Fisher (1947) for central Montana from August 16 to August 30. A somewhat larger wild brood size of 7.0 young was reported by Randall (1940) in Pennsylvania and Robertson (1958) in Illinois for late August, while Kozicky (1951) in Iowa found an average of 3.9 young per wild brood during August and September.

Based on summer brood counts and late August censuses, game farm broods experienced a mortality of 35 per cent during each year as

TABLE XII

PHEASANT PRODUCTIVITY BASED ON LATE AUGUST CENSUSES OF 1962 AND 1963

	Identity of Hen						Broods Without Hens[2]		Totals		Grand Total
	Wild		Game Farm		Unknown[1]						
	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	
Total No. Broods Produced	72	37	20	43	5	4	21	6	118	90	208
Total No. Broods Present in Late Aug.	41	16	13	28	1	2	10	3	65	49	114
Brood Mortality	31	21	7	15	4	2	11	3	53	41	94
Total No. Young in Late August	216	83	33	119	6	6	25	3	280	211	491
Average No. Young Per Brood in Late August Based on Hens With Broods	5.3	5.2	2.5	4.3	6.0	3.0			4.6	4.5	4.6
Total No. Hens Without Young in Late August	26	15	33	40	0	6			59	61	120
No. Young Per Hen Based on Total Hen Population In Late August	3.2	2.7	0.7	1.8	6.0	0.8	2.5	1.0	2.5	2.0	2.2
Two-Year Average	3.1		1.3		1.3		2.2		2.2		

[1]Hen present but identity was unknown.
[2]No hen was located in the vicinity of the broods.

compared to the average of 48 per cent for wild broods. Theoretically, this was to be expected since the later hatched game farm broods were not subjected to mortalities for as long a period as were the earlier hatched wild broods (Figures 5 and 6). The average brood sizes for game farm hens in late August were 2.5 in 1962 and 4.3 in 1963, or a two-year average of 3.7 young per brood. This average is 0.8 birds smaller than the average of 4.5 young per brood for game farm hens determined from the August brood counts of 1962 and 1963. In 1960 and 1961, when magpie control was also in effect, O'Halloran (1961) conducted late August censuses in the Burnt Fork and found respective averages of 4.2 and 2.4 young per brood for game farm hens. These figures agree closely with those presented for the current study. Prior to magpie reduction in 1959, game farm broods averaged 4.3 young per brood. It is evident that magpie control had no influence with respect to increasing brood sizes among wild and game farm hens in late August.

An integral part of the late August censuses was to obtain a count of all hens without broods as well as those with broods. With this information it was possible to compute the average number of young per hen based on the total hen populations of wild, game farm, and unknown hens in late August. In 1962, these figures were 3.2 young per wild hen, 0.7 young per game farm hen, and 6.0 young for hens in the unknown category (Table XII). In 1963, the late August census revealed averages of 2.7 young per wild hen, 1.8 young per hen for the game farm population, and 0.8 young per unknown hen. For the two-year period, the averages were 3.1, 1.3, and 1.3 young per hen for wild, game farm, and unknown hens, respectively. Considering all hens on the area, there were 2.5 young per hen in 1962 and 2.0 young per hen in 1963, for a two-year average of 2.2 young per hen in late August.

Comparing the average of 2.2 young per hen found in this study with the average of 1.5 young per hen reported by Atwell (1959) in late August prior to magpie control, there is a difference of 0.7 young per hen between the two periods (Table XIII). However, even a greater difference (0.9) was noted when comparing the 2.2 figure with the average of 1.3 young per hen found by O'Halloran (1961) in late August following magpie control. These data indicate then that magpie control cannot be considered responsible for the increased pheasant productivity during the present investigation. Rather, the inclement weather conditions in the spring of 1962 apparently were the major causes for the comparatively large number of young per hen in late August of that year. Similar to the findings of Buss et al. (1952) in Washington, damp weather early in the nesting season of 1962 extended the "peak" of hatch for wild broods into mid-July. Before magpie control was practiced, the peak of hatch occurred during the last half of June (Atwell, 1959). Therefore, the wild broods of 1962 were not subjected to mortalities for as long as those in 1959. More young survived to late August, there was a decrease in the number of hens without young, and the number of young per hen subsequently increased. These findings were evidenced by the fact that 57 per cent of all wild broods in 1962 survived to late August as compared to 43 per cent in 1959; 61 per cent of all wild hens had broods in late August of 1962 as opposed to 41 per cent in 1959.

Summarizing the productivity studies then, summer brood counts revealed that wild broods in 1962-63 averaged 0.9 young per brood larger than those of 1958-59. However, this difference could not be related

TABLE XIII

PHEASANT PRODUCTIVITY IN THE BURNT FORK BASED ON LATE AUGUST CENSUSES BEFORE (1959) AND AFTER (1960-63) MAGPIE CONTROL

	Identity of Hen	Before 1959	After Magpie Control 1960	1961	1962	1963
Total No. Broods Present in Late August	Wild	26	4	22	41	16
	Game Farm	11	10	17	13	28
	Unknown	1	1	3	1	2
Total No. Young in Late August	Wild	146	12	87	216	83
	Game Farm	47	42	41	33	119
	Unknown	7	9	15	6	6
Average No. Young Per Brood in Late August Based on Hens With Broods	Wild	5.6	3.0	4.0	5.3	5.2
	Game Farm	4.3	4.2	2.4	2.5	4.3
	Unknown	7.0	9.0	5.0	6.0	3.0
Total No. Hens Without Young in Late August	Wild	37	24	20	26	15
	Game Farm	57	20	33	33	40
	Unknown	6	4	4	0	6
No. Young Per Hen Based On Total Hen Population in Late August	Wild	2.3	0.4	2.1	3.2	2.7
	Game Farm	0.7	1.4	0.9	0.7	1.8
	Unknown	1.0	2.5	2.1	6.0	0.8
	All Hens	1.5	1.0	1.5	2.5	2.0

to magpie reduction. Game farm brood sizes in the summer were similar during the respective periods. The late August censuses of 1962-63 yielded wild brood sizes which were comparable to those existing in the Burnt Fork prior to magpie reduction, but game farm broods averaged 0.6 young per brood smaller than those reported for 1959. These data indicate that magpie control had no measurable influence with respect to increasing the brood sizes among wild and game farm hens present in late August. All hens considered, there was an average of 2.2 young per hen in late August during 1962-63. Although this represented an increase of 0.7 young over the 1.5 figure reported in 1959 prior to magpie control, climatological factors were considered responsible for the difference, not magpies.

PREDATION ON DUMMY PHEASANT NESTS

There were two primary objectives for the dummy nest studies which were conducted during both years of this investigation: (1) To obtain information on predation at the dummy nests which would supplement data acquired at wild and game farm nests, and (2) to compare the results obtained when the dummy nests were under the influence of a reduced magpie population with results obtained while the nests were under the influence of an undisturbed magpie population (1958-59).

Methods and Techniques

Sixty dummy pheasant nests were placed in the field for a period of 4 days during May, June, and July of each year. The same methods and criteria employed by Atwell (1959) and O'Halloran (1961), prior to (1958-59) and following (1960-61) magpie reduction, were used in the present study. A section of the study area, selected by previous workers because of its contrasting high and low magpie nesting populations existing one-half mile apart, was deemed usable during this investigation. By confining the dummy nests to one locality, any mortality inflicted upon the nest predators through trapping would be restricted to this portion of the study area.

Each dummy nest, containing 10 eggs secured from the State Game Farm at Warm Springs, Montana, was constructed to simulate an actual pheasant nest as closely as possible. During the actual construction of the nest and visits thereafter, considerable care was taken not to disturb the surrounding cover so that predators would not be given clues as to the location of the nests. A close grid arrangement, consisting of 3 rows of 5 nests at 15 yard intervals, was placed in both the area of high magpie concentration and in the area of low magpie concentration. An open grid, differing from the close grid by having a nest interval of 100 yards, was also set in both population areas during the same period. An attempt was made to situate the grids so that nests were placed in a variety of cover types. However, these efforts were limited in cases involving the close grids. The degree of nest concealment was then rated as heavy, medium, or light. "A nest was considered to have heavy cover if the eggs were not visible at any angle. The cover was noted as medium if the eggs could be observed from either directly above or from one side. Cover was rated as light if the eggs could be seen from two or more sides or from above and one or more sides" (Atwell, 1959).

To obtain either the predator or evidence as to its identity, a padded number zero long-spring trap was concealed at each nest. The nests were visited at sunrise each morning and the condition of the nests and their contents were noted. Skunks which were captured were shot but magpies were released. Often times the traps were sprung and the predators had escaped. In these instances, hairs or feathers left in the traps or near the nests provided evidence as to the predator involved. Information from Darrow (1938), Rearden (1951), and Stanton (1944) also made it possible to identify many of the nest predators.

For comparative purposes, two categories for magpie predation attempts were used in this study. An actual "magpie" attempt was recorded when a magpie was captured at the nest, or when a trap was sprung and it held a portion of the bird's foot or wing. A "probably magpie" attempt was noted when all eggs were missing, the trap was not sprung, and the nest structure was not at all or only slightly disturbed. In addition, egg shells were sometimes present within 50 feet of the nest.

Results

Of the 360 dummy nests placed in the field during this study, 173 (48 per cent) were disturbed by various predators. These nest disturbances involved 187 separate predation attempts. Magpies were the most important predators during both years, accounting for 120 or 64 per cent of all predation attempts. Skunks were second with 50 or 27 per cent, while all other predators were responsible for 17 or 9 per cent of the attempts.

During the natural magpie population period in 1958 and 1959, dummy nests were placed in the field in May and June only. Following magpie population reductions from 1960 through 1963, these nests were exposed to predation during July as well as the May-June period. To facilitate further discussion, only the May-June period will be considered in comparing magpie and other predation of the two periods. The results of the July dummy nest studies will be discussed in a separate section.

Magpie Predation in May and June. A comparative summary of magpie predation between the natural and reduced magpie population periods is presented in Table IV. Predation attempts by magpies in May decreased from 79 during the natural period (1958-59) to 51 and 66 in the reduced periods of 1960-61 and 1962-63, respectively. In June 57 predation attempts were made by these birds during the natural period as opposed to 20 in 1960-1961 and 45 in 1962-63. When May and June are considered

TABLE XIV

COMPARATIVE SUMMARY OF PREDATION ON DUMMY PHEASANT NESTS BETWEEN PERIODS OF NATURAL AND REDUCED MAGPIE POPULATIONS

	Natural Magpie Populations		Reduced Magpie Populations			
	1958-1959		1960-1961		1962-1963	
	Number	Per cent	Number	Per cent	Number	Per cent
Total Calculated Dummy Nests	265		248		249	
MAY						
Predation attempts by magpie	79	30	51	21	66	27
Predation attempts by skunk	8	3	4	2	12	5
Predation attempts by other predator	10	4	8	3	3	1
Total predation attempts	97	37	63	26	81	33
JUNE						
Predation attempts by magpie	57	22	20	8	45	18
Predation attempts by skunk	10	4	9	4	17	7
Predation attempts by other predator	8	3	11	4	10	4
Total predation attempts	75	29	40	16	72	29
MAY-JUNE TOTAL						
Predation attempts by magpie	136	51	71	29	111	45
Predation attempts by skunk	18	7	13	5	29	12
Predation attempts by other predator	18	7	19	8	13	5
Total predation attempts	172	65	103	42	153	62
Avg. No. Active Magpie Nests on:[1]						
(a) Study Area	369[1]	100	177	48[2]	182	49[2]
(b) Section with Dummy Nests	74	100	27	36[2]	27	36[2]

[1]Average number of nests on the study area prior to magpie reduction in 1956, 1957, and 1959.

[2]Per cent of nests on study area, and section with dummy nests, based on numbers of nests in natural period.

together, a total of 136 nests were preyed upon by magpies before magpie reduction, while 71 attempts and 111 attempts were made by magpies during the reduced periods of 1960-61 and 1962-63, respectively.

Statistical comparisons of changes in magpie predation between the respective periods were made by applying the Chi-Square test (5 per cent confidence level using 2 X 2 table) to the number of magpie predation attempts on nests as opposed to the number of nests not preyed upon by magpies. In a few instances, predators did not remove all eggs when preying on nests, and so, these nests were vulnerable to more than one predation attempt by magpies or other predators. To compensate for this factor, such nests were considered to be two different nests and a calculated number of dummy nests was arrived at for each month and for May and June combined during the natural and reduced periods (Table XIV). Comparing the natural period with the reduced period of 1960-61, significant changes in predation by magpies occurred in May, in June, and in the May-June periods. Conversely, when the reduced period of 1962-63 was compared with the natural period, no significant changes were noted during either of these months or when May and June were considered together. Upon combining the four years of data collected following magpie control (1960-63) and comparing with results obtained prior to magpie reduction (1958-59), no significant difference occurred during May, but significant changes did occur in June and when May and June were combined.

Although statistical treatment of the data indicates some changes in magpie predation occurred between the natural and reduced periods, it is obvious that such changes were not commensurate with the numbers of nesting magpies effecting predation. The number of active magpie nests on the section to which the dummy nests were confined, decreased from an average of 74 nests during 1958-59 to an average of 27 nests in 1960-61 and 1962-63, respectively (Table XIV). Therefore, the number of magpie predation attempts during the reduced periods should have theoretically amounted to only 36 per cent of the attempts recorded prior to magpie control. Only in June of 1960-61 was such a proportionate decrease noted. Indeed, even when relating the number of attempts to the approximate 50 per cent reduction of nesting magpies over the entire area, June of 1960-61 was the only period in which magpie attempts decreased in accordance with magpie reduction. Further information, secured from grids in the high and low magpie population areas, also indicate that magpie predation was not strictly proportionate to the numbers of nesting magpies on the area. Of the 111 predation attempts by magpies during May and June, 60 (54 per cent) occurred in the area of high magpie concentration and 51 (46 per cent) in the area of low magpie concentration (Table XV). This occurred despite the fact that 9 and 7 magpie nests respectively were located in the high density area in 1962 and 1963, while no nests were present in the low density area during either of these years. These results suggest that most magpies in an area of high nesting density will tend to disperse and carry on their foraging at a considerable distance from the nest sites (Atwell, 1959). The foregoing data also indicate the magpies are capable of locating nests with the hen absent (dummy nests) with such ease, that the number of nests located has no direct relation with the number of magpies present. This is born out by the fact that even between the respective reduced periods when magpie densities were nearly identical, significant differences in magpie predation were noted in June and when

TABLE XV

COMPARISON OF PREDATION ON DUMMY NESTS BETWEEN PERIODS OF NATURAL AND PERIODS OF REDUCED MAGPIE POPULATIONS

Predator	Natural Magpie Population			Reduced Magpie Populations					
	1958	1959	Avg.	1960	1961	Avg.	1962	1963	Avg.
High Magpie Population Area									
Close Grid - May									
Magpie	5	1	3	1	2	1.5	1	0	.5
Probable Magpie[1]	11	13	12	1	9	5	6	9	7.5
Skunk	1	0	.5	0	0	0	1	1	1
Crow	0	0	0	1	0	.5	0	0	0
Microtus sp.	0	0	0	1	0	.5	0	0	0
Mink	0	0	0	0	0	0	0	1	.5
Unknown	0	1	.5	0	0	0	0	0	0
Undisturbed	3	1	2	11	5	8	7	4	5.5
Open Grid - May									
Magpie	4	5	4.5	1	3	2	2	2	2
Probable Magpie	3	5	4	9	4	6.5	9	7	8
Skunk	2	2	2	1	3	2	2	2	2
Unknown	0	0	0	1	3	2	1	0	.5
Undisturbed	7	5	6	4	8	6	3	5	4
Low Magpie Population Area									
Close Grid - May									
Magpie	3	1	2	1	0	.5	0	2	1
Probable Magpie	10	0	5	0	11	5.5	1	7	4
Skunk	0	3	1.5	2	1	1.5	2	0	1
Pine Squirrel	2	0	1	0	0	0	0	0	0
House Cat	1	0	.5	0	0	0	0	0	0
Crow	0	0	0	0	1	.5	0	0	0
Unknown	1	0	.5	0	0	0	0	0	0
Undisturbed	3	11	7	13	3	8	12	6	9
Open Grid - May									
Magpie	2	4	3	1	1	1	1	1	1
Probable Magpie	3	9	6	2	5	3.5	10	8	9
Skunk	0	0	0	0	1	.5	2	2	2
Crow	1	1	1	0	0	0	0	1	.5
Man	0	0	0	0	1	.5	0	0	0
Unknown	2	1	1.5	0	0	0	0	0	0
Undisturbed	7	4	5.5	12	7	9.5	6	4	5

(Continued)

[1]All eggs missing without a sign of shells in the vicinity, nest cover and lining not at all or only slightly disturbed, and trap not sprung.

TABLE XV (Continued)

COMPARISON OF PREDATION ON DUMMY NESTS BETWEEN PERIODS OF NATURAL AND PERIODS OF REDUCED MAGPIE POPULATIONS

Predator	Natural Magpie Population			Reduced Magpie Populations					
	1958	1959	Avg.	1960	1961	Avg.	1962	1963	Avg.
				High Magpie Population Area Close Grid - June					
Magpie	4	4	4	4	0	2	0	4	2
Probable Magpie	7	7	7	4	0	2	10	5	7.5
Skunk	1	2	1.5	3	0	1.5	2	1	1.5
Crow	0	0	0	1	0	.5	2	1	1.5
Microtus sp.	0	0	0	1	0	.5	0	0	0
Unknown	1	0	.5	2	1	1.5	0	0	0
Undisturbed	2	3	2.5	1	14	7.5	3	4	3.5
				Open Grid - June					
Magpie	1	0	.5	0	1	.5	0	0	0
Probable Magpie	2	3	2.5	0	0	0	4	1	2.5
Skunk	1	2	1.5	0	1	.5	5	1	3
Crow	0	0	0	0	1	.5	0	0	0
Microtus sp.	0	0	0	0	0	0	0	1	.5
Unknown	2	0	1	1	0	.5	0	0	0
Undisturbed	9	10	9.5	14	12	13	6	12	9
				Low Magpie Population Area Close Grid - June					
Magpie	3	0	1.5	1	0	.5	1	0	.5
Probable Magpie	8	12	10	0	8	4	6	6	6
Skunk	0	1	.5	0	4	2	3	1	2
Crow	0	0	0	0	1	.5	2	1	1.5
Starling	0	0	0	0	0	0	1	0	.5
House Cat	0	0	0	0	1	.5	0	0	0
Unknown	1	0	.5	0	1	.5	0	0	0
Undisturbed	5	5	5	14	2	8	3	7	5
				Open Grid - June					
Magpie	2	1	1.5	0	0	0	0	0	0
Probable Magpie	1	2	1.5	0	2	1	4	4	4
Skunk	1	2	1.5	0	1	.5	3	1	2
Crow	0	1	.5	0	0	0	0	2	1
Pine Squirrel	0	0	0	0	0	0	1	0	.5
Unknown	1	2	1.5	1	0	.5	1	0	.5
Undisturbed	10	8	9	14	12	13	6	8	7

May and June were considered together.

As found with wild and game farm nests, magpie predation on dummy nests was greatest in May and decreased as the season advanced. This relationship can be seen In Table XVI where magpie predation is expressed as a percentage of the total predation. The suspected causes for the decrease in magpie predation from May to June were discussed in the section of predation on natural pheasant nests (page 36). Of the total predation attempts by magpies, 59 per cent occurred in May and 41 per cent in June. Similar results were reported by Atwell (1959) prior to magpie reduction when 58 per cent of the magpie attempts were made during May and 42 per cent during June.

The close grid arrangements appeared to be more favorable to magpie predation than open grids as 56 per cent of the magpie predation attempts occurred in the close grids. This was believed due to the comparatively short distance (15 yards) between nests. Figures comparable to that of this study were found during the natural magpie population period (65 per cent) and the reduced period (59 per cent) of 1960-61.

Because magpies locate nests by sight alone, predation by these birds was naturally heaviest among nests which were concealed lightly. During this study, 58 per cent of the total magpie predation attempts occurred at nests located in light cover, 31 per cent at nests in medium cover, and only 11 per cent at nests which were concealed in heavy cover (Table XVII). With reference to the amount of nest disturbance in each cover class, magpies disturbed 42 per cent, 25 per cent, and 22 per cent of the nests in light, medium, and heavy cover, respectively. Similar results were found from 1958 through 1961 when 43 per cent, 30 per cent, and 27 per cent of the nests located in light, medium, and heavy cover,

TABLE XVI

COMPARISON OF MAGPIE, SKUNK, AND OTHER PREDATION ON DUMMY NESTS BETWEEN PERIODS OF NATURAL AND REDUCED MAGPIE POPULATION LEVELS

	Total Predation Attempts	Total No. Undisturbed Nests	Per cent Magpie Predation	Per cent Skunk Predation	Per cent Other Predation
MAY					
Natural	97	41	81	8	11
Reduced (60 61)	63	62	81	6	13
Reduced (62-63)	81	47	81	15	4
JUNE					
Natural	75	52	76	13	11
Reduced (60-61)	40	83	50	22	28
Reduced (62-63)	72	49	62	24	14
MAY-JUNE TOTALS					
Natural	172	94	79	10.5	10.5
Reduced (60-61)	103	145	69	13	18
Reduced (62-63)	153	96	73	19	8
JULY					
Reduced (60-61)	32	89	50	41	9
Reduced (62-63)	34	91	26	62	12
Totals (July)	66	180	38	51	11

respectively, were preyed upon by magpies. However, the magpie predation figures reported for the dummy nest studies, with respect to the degrees of nest concealment, are considerably higher than those found for wild and game farm nests (Table VIII). This was expected since natural nests are not only covered by an incubating or laying hen, but are also afforded some physical protection by the hen involved.

Magpie Predation in July. The combination of increased nesting cover for pheasants, and the abundance of other natural magpie foods, apparently deterred magpie predation on pheasant eggs during July. This

TABLE XVII

MAGPIE PREDATION ON DUMMY NESTS RELATED TO DEGREE OF NEST CONCEALMENT

	Degree of Nest Concealment			
	Light	Medium	Heavy	Totals
MAY				
Total No. Nests	56	44	20	120
Nests Disturbed by Magpies	33	21	8	62
Per cent of Nests Disturbed	58.9	47.7	40.0	51.7
Predation Attempts by Magpies	36	22	8	66
Per cent of Predation Attempts	54.6	33.3	12.1	100.0
JUNE				
Total No. Nests	53	47	20	120
Nests Disturbed by Magpies	27	12	5	44
Per cent of Nests Disturbed	50.9	25.5	25.0	36.7
Predation Attempts by Magpies	28	12	5	45
Per cent of Predation Attempts	62.2	26.7	11.1	100.0
JULY				
Total No. Nests	49	51	20	120
Nests Disturbed by Magpies	6	3	0	9
Per cent of Nests Disturbed	12.2	5.9	0.0	7.5
Predation Attempts by Magpies	6	3	0	9
Per cent of Predation Attempts	66.7	33.3	0.0	100.0
TOTALS				
Total No. Nests	158	142	60	360
Nests Disturbed by Magpies	66	36	13	115
Per cent of Nests Disturbed	41.8	25.4	21.7	31.9
Predation Attempts by Magpies	70	37	13	120
Per cent of Predation Attempts	58.3	30.8	10.8	99.9

is exemplified by the fact that of 207 magpie predation attempts recorded during the four years of the reduced periods, only 25 or 12 per cent were made in July (Table XVIII). These results agree closely with those obtained for wild and game farm nests in 1962-63 when 4 of 31 (13 per cent) magpie attempts were made during this same period. Thus, these data indicate that magpie predation during July would be of minor consequence

TABLE XVIII

PREDATION ON DUMMY NESTS DURING JULY OF THE REDUCED MAGPIE POPULATION PERIODS

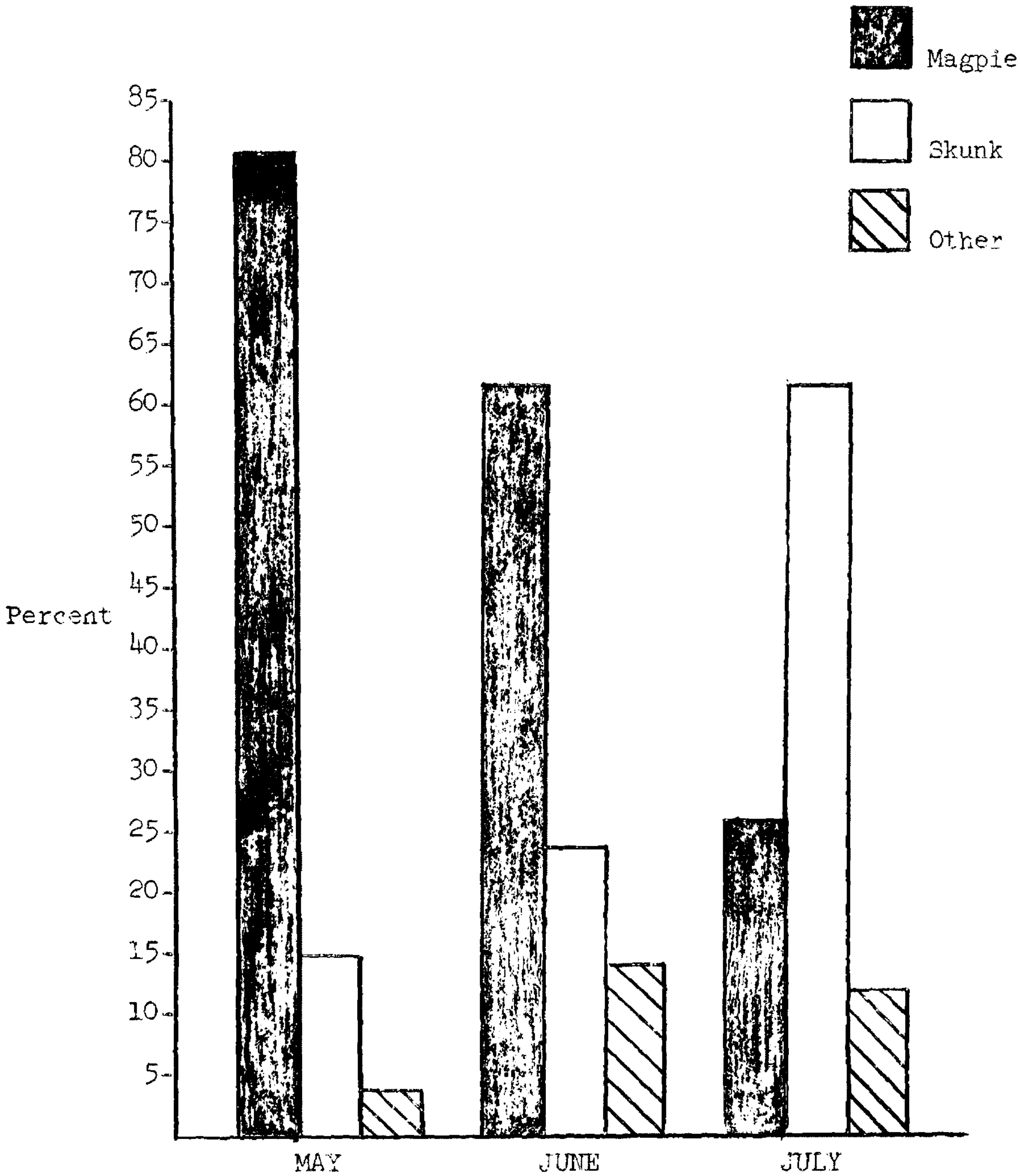
Predator	Reduced Magpie Populations					
	1960	1961	Avg.	1962	1963	Avg.
			High Magpie Population Area Close Grid - July			
Magpie	1	1	1	0	0	0
Probable Magpie	1	3	2	0	0	0
Skunk	1	2	1.5	2	0	1
Unknown	0	0	0	0	1	.5
Undisturbed	12	10	11	13	14	13.5
			Open Grid - July			
Magpie	0	1	.5	1	0	.5
Probable Magpie	1	0	.5	1	0	.5
Skunk	1	1	1	5	1	3
Microtus sp.	0	0	0	2	0	1
Unknown	0	0	0	1	0	.5
Undisturbed	13	13	13	7	14	10.5
			Low Magpie Population Area Close Grid - July			
Magpie	0	0	0	1	3	2
Probable Magpie	2	0	1	0	1	.5
Skunk	5	1	3	3	1	2
Unknown	0	1	.5	0	0	0
Undisturbsd	9	11	10	12	11	11.5
			Open Grid - July			
Magpie	1	0	.5	0	1	.5
Probable Magpie	4	1	2.5	0	1	.5
Skunk	2	0	1	5	4	4.5
Unknown	2	0	1	0	0	0
Undisturbed	7	14	10.5	11	9	10

with respect to its effects on pheasant reproduction.

Other Predation. Predators other than the magpie were responsible for 67 (36 per cent) of the total 187 predation attempts recorded during this investigation. Skunks accounted for 50 (27 per cent) attempts while all other predators combined made 17 (9 per cent) predation attempts.

Despite the fact that skunks were shot when caught in the traps at dummy nests, skunk predation increased from May through July (Figure 7). This is in direct opposition to magpie predation which decreased during the same period. It is evident from these findings that skunks, which locate nests primarily by scent, were not curtailed in their predation by the increase of cover as the season progressed. Further evidence to support this conclusion was provided in 1963 when a comparable number of dummy nests was located in each concealment class. Of the 15 predation attempts by skunks, four (27 per cent) were made at nests in light cover, five (33 per cent) at nests in medium cover, and six (40 per cent) at nests concealed in heavy cover. Even so, skunk predation was not of sufficient intensity to compensate for the decrease in magpie predation as the number of undisturbed dummy nests also increased from May through July (Table XVI).

Predation by crows (*Corvus brachyrhynchos*), red squirrels (*Tamiasciurus hudsonicus*), voles (*Microtus* sp.), mink (*Mustela vison*), starlings (*Sturnus vulgaris*), house cats, and unknown predators was relatively light, accounting for 9 per cent of all predation attempts. A comparable figure of 10.5 per cent was obtained by Atwell (1959) prior to magpie reduction. These results also agree closely with the 9.5 per



PREDATION ON DUMMY NESTS RELATED TO MONTHS

FIGURE 7

cent figure found for bona fide wild and game farm nests during 1962 and 1963.

Comparison of Predation Between Dummy Nests and Natural Nests. A summary of predation on dummy nests as compared to natural nests is presented in Table XIX. With respect to natural nests, only those eggs which were deposited in a conspicuous nest bowl were considered in the summary. Singly dropped eggs and nests which were partially or completely destroyed prior to location were excluded from the data. In addition, if a natural nest was undisturbed during any one month and was still present for at least four days during the following month, it was recorded in Table XIX as a separate nest during each of the respective months. It is realized that natural nests were exposed to predation for a considerably longer time than were the dummy nests. However, the purpose of this comparison is not to determine the differences of predation under similar conditions, but rather to test the feasibility of using dummy nests as a method for measuring predation on natural nests, regardless of the length of exposure.

Among both the dummy nests and natural nests, magpie predation decreased from May through July while skunk predation showed an increase during the same period. In neither of the nest classes was skunk predation of sufficient intensity to compensate for the decrease in magpie predation as the season progressed. Thus, it would appear that dummy nests have some value as a tool for measuring the relative intensities of predation by the respective predators throughout the nesting season. On the other hand, the rates of change in magpie and skunk predation did not correspond in the two classes of nests. The dummy nests tended

TABLE XIX

COMPARISON OF PREDATION BETWEEN DUMMY PHEASANT NESTS AND NATURAL PHEASANT NESTS DURING 1962 AND 1963

	Dummy Nests	Natural Nests: Wild Nests	Natural Nests: Game Farm Nests	Natural Nests: Unk. Nests	Natural Nest Totals
MAY					
Total Nests	120	10	11	2	23
Total Predation Attempts	81	7	9	1	17
Total Magpie Predation	66	4	7	1	12
Per cent Magpie Predation	81.5	57.1	77.8	100.0	70.6
Total Skunk Predation	12	3	0	0	3
Per cent Skunk Predation	14.8	42.9	0.0	0.0	25.0
Total Other Predation	3	0	2	0	2
Per cent Other Predation	3.7	0.0	22.2	0.0	11.8
Total Undisturbed Nests	47	3	2	0	5
Per cent Undisturbed Nests	39.2	30.0	18.2	0.0	21.7
JUNE					
Total Nests	120	15	46	14	75
Total Predation Attempts	72	6	26	11	43
Total Magpie Predation	45	1	9	5	15
Per cent Magpie Predation	62.5	16.7	34.6	45.5	34.9
Total Skunk Predation	17	5	13	6	24
Per cent Skunk Predation	23.6	83.3	50.0	54.5	55.8
Total Other Predation	10	0	4	0	4
Per cent Other Predation	13.9	0.0	15.4	0.0	9.3
Total Undisturbed Nests	49	9	24	5	38
Per cent Undisturbed Nests	40.8	60.0	52.2	35.7	50.7
JULY					
Total Nests	120	6	53	13	72
Total Predation Attempts	34	0	18	5	23
Total Magpie Predation	9	0	2	2	4
Per cent Magpie Predation	26.5	0.0	11.1	40.0	17.4
Total Skunk Predation	21	0	15	3	18
Per cent Skunk Predation	61.8	0.0	83.3	60.0	78.3
Total Other Predation	4	0	1	0	1
Per cent Other Predation	11.7	0.0	5.6	0.0	4.3
Total Undisturbed Nests	91	6	35	9	50
Per cent Undisturbed Nests	75.8	100.0	66.0	69.2	69.4
TOTALS					
Total Nests	360	31	110	29	170
Total Predation Attempts	187	13	53	17	83
Total Magpie Predation	120	5	18	8	31
Per cent Magpie Predation	64.2	38.5	40.0	47.1	37.3
Total Skunk Predation	50	8	28	9	45
Per cent Skunk Predation	26.7	61.5	52.8	52.9	54.2
Total Other Predation	17	0	7	0	7
Per cent Other Predation	9.1	0.0	7.2	0.0	8.4
Total Undisturbed Nests	187	18	61	14	93
Per cent Undisturbed Nests	51.9	58.1	55.5	48.3	54.7

to overemphasize magpie predation because they lacked the increased cover and physical protection afforded by a hen pheasant. Conversely, because skunks locate nests by scent, the presence of hens at natural nests favored predation by skunks. This relationship can be seen by inspection of the data acquired during each month. In May, since natural nests consisted primarily of abandoned nests, magpie and skunk predation were comparable to the results obtained at the dummy nests. By June and July, however, the majority of the nests were under incubation and consequently, magpie predation dropped while skunk predation showed a drastic increase during this period. In the final analysis, skunks were the leading predators at the natural nests rather than magpies, as was indicated by the dummy nest results.

Summary of Dummy Nest Studies

Statistical treatment of the dummy nest data showed significant decreases in magpie predation occurred during May and June of the first reduced period in 1960-61. No such changes were noted during the current investigation. When the four years of data following magpie population reductions were combined, no significant difference in magpie predation was observed during May, but significant decreases did occur during June and when May and June were considered together. However, only in June of 1960-61 was the decrease in magpie predation commensurate with magpie reduction on the entire study area and on the section containing the dummy nests. Similar amounts of magpie predation on dummy nests were observed in both areas of high and low magpie concentrations. Magpie predation decreased from May through July while skunk predation increased over this same period. It is believed that since magpies locate nests by sight alone, the increase of cover from May through July was partly responsible for the decrease of magpie predation. Skunks were not deterred by the new vegetation since these predators locate nests primarily by scent. These findings were evidenced by the fact that magpies were less successful at locating nests in heavy and medium cover than those in light cover. Skunks were equally successful in all degrees of nest concealment. Dummy nests provided valuable information for identifying predators at wild and game farm nests, as well as indicating which predators were most active in the Burnt Fork. The intensity of magpie and skunk predation on dummy nests from May through July supported the findings obtained among natural pheasant nests. However, the amounts of predation on dummy nests differed from those of the true nests; dummy nests over-emphasized magpie predation while natural pheasant nests were more favorable to predation by skunks.

EVALUATION OF MAGPIE CONTROL AND ITS EFFECTS ON THE PHEASANT

Local sportsmen and ranchers have long considered the magpie to be an important predator on pheasant eggs. This has resulted in numerous sporadic control programs which have been largely undirected and have produced few, if any, significant results. Therefore, a long-range study of magpie predation on pheasant eggs was initiated in the Burnt Fork Valley to evaluate the desirability and feasibility of magpie control as a method for increasing pheasant production.

Magpie Control

Population Reduction. Prior to magpie reduction in 1956 and 1957, Brown (1957) determined the average density of active magpie nests on the study area to be 58.0 active nests per square mile. Censusing the entire area in the spring of 1959, Atwell (1959) found a similar density of 59.8 active nests per square mile. Therefore, the average density during the four years when magpie control was not in effect was 58.6 nests per square mile.

In 1960 and 1961, O'Halloran (1961) conducted an intensive magpie control program, removing 408 and 148 magpies from the study area during the respective years. Spring nesting censuses showed an average density of 28.1 active nests per square mile, or a 52 per cent reduction from the natural magpie population. Maintaining this reduced level necessitated winter trapping during the current study also. In 1962 and 1963, 381 and 146 magpies, respectively, were removed from the winter populations. These reductions resulted in a spring nesting density of 28.9

nests per square mile, a 51 per cent reduction from the natural period. Such findings indicate that magpie control may be feasible, but only from the standpoint that magpie populations can be reduced; to maintain the reduced level, it was necessary to trap and remove magpies each winter.

Cost of Reduction. The feasibility of a predator control program can be measured, not only in terms of reduction of the predator, but also with respect to the cost involved in such a reduction. In 1960 and 1961, O'Halloran (1961) trapped a total of 1,031 magpies at a cost of about $.74 per bird captured. The amount varied from a low of $.64 in 1960 to $.95 in 1961. However, O'Halloran concluded that even this cost must be considered very general, ". . . for only 556 birds were actually removed. The remainder were banded birds that were released when captured. As the presence of birds in the trap tended to attract other birds to the trap, the removal of banded birds would be expected to decrease the catch." Therefore, the cost per magpie removed would have been considerably greater if the banded birds had not been released.

The cost per bird captured as computed for 1960 and 1961, included trap construction, labor, bait, and vehicle expenses in running the trap line. It is unlikely that an organized magpie control program could trap and remove birds at a lesser expense than was determined for this study. Therefore, the cost of magpie control seems prohibitive.

Effects of Magpie Control on Pheasant Reproduction

The success and desirability of the magpie control program was evaluated with respect to its effects on pheasant reproduction. Two aspects were primarily used to measure these effects; changes in intensity of egg predation and differences in pheasant productivity between the natural and reduced magpie population periods.

Pheasant egg predation by magpies accounted for 11.9 per cent of all bona fide clutches destroyed in the Burnt Fork before magpie control was practiced. This represented an average of 20.4 per cent of all nests destroyed by predators alone. Following magpie control, 9.3 per cent of all bona fide nests were destroyed by magpies, or 17.4 per cent of the nests destroyed by various predators. These differences were tested statistically and no changes occurred at the 5 per cent confidence level. Neither were the changes proportionate to the 50 per cent reduction of the magpie population. It is apparent then that control had little effect on decreasing the amount of magpie predation on eggs in bona fide nests.

The success of a predator control program can also be measured with respect to the resulting increase of the prey population. Being comparable both before and after magpie control, the wild pheasant populations especially should be indicative of any increased production. In 1959, 26 wild broods consisting of 146 young survived to the last week of August. Following magpie control in 1962 and 1963, nearly identical results were obtained when an average of 29 wild broods and 150 young were located during a comparable period in August. Likewise, when the average numbers of young per hen based on the total wild hen population in late August was compared, there were 2.3 young per hen before magpie reduction as opposed to 2.4 young per hen during the entire reduced period of 1960 through 1963. Thus, no demonstrable change in pheasant productivity was observed following a 50 per cent reduction of nesting magpies on the study area.

The foregoing data indicate that although magpies were an important part of the total predatory force which acted upon the pheasant population in the Burnt Fork, they themselves were not limiting factors of pheasant reproduction. Accordingly, magpie control can be considered neither feasible nor desirable as a method of increasing pheasant productivity.

SUMMARY AND CONCLUSIONS

1. The fourth and final phase of a long-term investigation to determine the role of the magpie as a predator on pheasant eggs was conducted on a 6.3 square mile study area in the Burnt Fork Valley, 30 miles south of Missoula, Montana, during 1962 and 1963.

2. A 50 per cent reduction from the natural magpie nesting population was procured through winter trapping and removal of magpies during both years of the study. The degree to which the reduced magpie population affected the reproductive rate and productivity of wild and released pheasants was measured and compared to data obtained prior to magpie control. Supplementary information was obtained by recording magpie predation on dummy pheasant nests.

3. Observations of 19 bona fide wild clutches and 62 bona fide clutches of game farm hens during the two years revealed average clutch sizes of 10.2 eggs and 8.1 eggs for wild and released hens, respectively. The average wild clutch size was identical to that produced in the Burnt Fork prior to magpie reduction, and was comparable to wild clutches found in Idaho, Oregon, and western Montana.

4. The hatching success of 17.6 per cent for bona fide nests during this study was only slightly greater than the 16 per cent success observed before magpie control was practiced. Bona fide wild nests had a 26 per cent success as compared to 16.1 per cent for game farm nests. Hatching percentages for wild nests were 2 to 3 times less than those reported for other sections of the nation, indicating losses of pheasant eggs in the Burnt Fork were excessive.

5. Predation of eggs in bona fide nests was the most important single factor limiting pheasant production. Nearly 54 per cent of unsuccessful bona fide nests were destroyed by various predators, a figure which was 3 to 4 times as great as found by other workers in the Midwest, Idaho, and Oregon.

6. Magpies destroyed an average of 11.9 per cent of the wild and game farm nests during the natural magpie population period. This decreased to 9.3 per cent following reduction. The difference was not significant at the 5 per cent level of confidence and was not commensurate with the 50 per cent reduction of magpies. Of the nests destroyed by predators only, magpies were responsible for 20.4 per cent prior to reduction, as compared to 17.4 per cent following reduction. Again, no significant change occurred at the 5 per cent confidence level. Magpie predation on pheasant eggs was most intense in May, decreased through June, and was practically nonexistent in July and August. The combination of increased pheasant nesting cover, and the abundance of natural magpie foods other than pheasant eggs as the summer progressed, was apparently responsible for this decrease.

7. Magpie predation on eggs in game farm nests decreased from 14 per cent in 1958-59 to 5.8 per cent in 1962-63. This decrease was correlated, not with magpie reduction, but with dates of releases of game farm hens during the respective periods. Game farm nests established during April and May were more susceptible to magpie predation than those established in June.

8. Skunks were the leading predators of pheasant eggs during both years. A yearly average of 34.7 per cent of unsuccessful wild and game farm nests was destroyed by skunks, nearly 4 times the amount

attributed to magpies. Skunk predation was lowest in May and increased through June and July. Since these predators locate nests by scent, the increase of cover as the summer advanced did not deter predation by skunks.

9. Factors other than predation accounted for the loss of 46.6 per cent of all unsuccessful bona fide nests. Mowing was the leading cause of nest destruction in this category and was responsible for 26.6 per cent of the nest losses, nearly 3 times the amount caused by magpie predation.

10. Summer brood counts, involving 208 separate broods for the two years, revealed average brood sizes of 6.2 young for wild hens, 4.2 young for game farm hens, and 2.6 young for unknown hens. Except for the unknown broods, which showed a decrease in average size during this study, these averages were comparable to those found while the pheasants were under the influence of the natural magpie population.

11. An increase, over the natural period, in brood survival and the number of hens with broods was observed during the late August censuses of 1962 and 1963. However, it was ascertained that the late peaks of hatch during the current study were responsible for the increases, not magpie reduction. Average wild and game farm brood sizes in late August were slightly smaller than respective averages during the natural period.

12. The number of young per hen, based on the entire female population in late August of 1959, was 1.5. Following magpie control, the number of young per hen in late August ranged from 1.0 in 1960 to 2.5 in 1962, and averaged 1.9. However, it was established that magpie control was not the major cause effecting this increase. It may be

concluded that no measurable increase in pheasant productivity resulted from the 50 per cent reduction of magpies, or, if a minor increase did occur, it was masked by other controlling factors.

13. Dummy pheasant nests were placed in the field during May and June of both the reduced and natural magpie population periods. Statistical comparisons of respective data were made and no significant change in magpie predation occurred during the current study. When data from all four years of the reduced periods were combined and compared to data of the natural period, no significant difference was noted in May, but significant changes did occur during June and when May and June were considered together. However, none of the changes were commensurate with the 50 per cent reduction of nesting magpies.

14. It may be concluded that magpie control is neither feasible nor successful as a method of increasing pheasant production. The cost of such a program is in itself prohibitive. A 50 per cent reduction of magpie nesting population resulted in no proportionable decrease of magpie predation on eggs of true pheasant nests, or of dummy pheasant nests. Accordingly, no significant increase in pheasant productivity occurred following magpie control. The magpie appears to be important only as it contributes to the total predatory force and to other regulating factors which limit pheasant production.

APPENDIX

TABLE XX

PHEASANT WINTER FLUSH COUNTS

BURNT FORK 1962

Date	Cocks	Hens	Daily Totals	Flushing Hours	Running Total
2-4-62	12	20	32	2.5	32
2-10-62	6	33	39	2.5	71
2-11-62	28	73	101	4.0	172
2-17-62	4	2	6	3.0	178
3-3-62	13	52	65	4.0	243
3-4-62	20	34	54	4.0	297
3-15-62	3	15	18	2.0	315
3-20-62	9	24	33	3.0	348

SUMMARY

Cocks . . . 95 Hens . . . 253

Sex ratio (M:F) = 1 cock : 2.66 hens

Total flushing hours = 25 hours

Birds flushed per hour (avg.) = 13.9 birds/hour

Note: Area covered twice plus searching and flushing pheasants at roosting and feeding sites where concentrations were high.

TABLE XXI

PHEASANT WINTER FLUSH COUNTS

BURNT FORK 1963

Date	Cocks	Hens	Daily Totals	Flushing Hours	Running Total
1-20-63	29	33	62	2.0	62
1-27-63	15	36	51	3.0	113
2-10-63	16	17	33	3.0	146
2-16-63	8	15	23	2.0	169
2-17-63	7	13	20	1.0	189
2-24-63	12	38	50	5.0	239
3-1-63	10	26	36	4.0	275
3-3-63	0	8	8	0.5	283
3-14-63	3	14	17	0.5	300
3-15-63	6	13	19	1.5	319
3-16-63	7	21	28	3.5	347
3-17-63	2	5	7	2.0	354
3-25-63	3	11	14	3.0	368
3-26-63	6	11	17	2.5	385

SUMMARY

Cocks . . . 124 Hens . . . 261

Sex Ratio (M:F) = 1 cock : 2.10 hens

Total flushing hours = 33.5 hours

Pheasants flushed per hour (avg.) = 11.3 pheasants/hour

Note: Area covered twice plus searching and flushing pheasants at roosting and feeding sites where concentrations were high.

TABLE XXII

SUMMARY OF MAGPIE POPULATION DENSITIES

BURNT FORK STUDY AREA

1956-1963

Section	Natural Magpie Population				Reduced Magpie Population			
	1956	1957	1958	1959	1960	1961	1962	1963
4	*	*	*	*	9	4	6	10
5	*	61	*	67	25	34	31	32
6	*	25	*	28	8	8	12	6
25	84	63	43	34	21	32	28	29
29	*	18	*	26	9	11	13	10
30	*	26	*	18	9	10	9	12
31	42	41	50	37	11	16	13	11
32	*	42	*	57	26	21	27	21
33	*	9	*	43	26	21	15	25
36	84	79	80	67	21	32	31	23
Total	210	364	173	377	165	189	185	179
TOTAL ACTIVE NESTS	361	370	*	377	165	189	185	179
Total Magpies Removed					408	148	381	146

*Data unavailable.
Note: Sections 4, 5, 6, 29, 30, 33, are not complete sections.

TABLE XXIII

PHEASANT COLOR MARKER KEY
BURNT FORK STUDY
1962 Releases

April 30 Release	June 17 Release[1]
100 brown markers	100 pink markers
100 green markers	100 blue markers
100 orange markers	100 white markers

GENERAL KEY
(For each 100 individual colors)

I. 33 Single Streamer Markers
  A. 17 Square-tip streamers
    1. 9 one-color combinations
      a. white tip d. tape, white, tape g. white, tape, white
      b. red tip e. tape, yellow, tape h. yellow, tape, yellow
      c. yellow tip f. tape, red, tape i. plain tape
    2. 8 two-color combinations
      a. white, tape, yellow e. tape, white, yellow
      b. yellow, tape, white f. tape, yellow, white
      c. white, yellow, tape g. red, tape, yellow
      d. yellow, white, tape h. red, tape, white
  B. 16 slant-tip streamers
    1. 8 one-color combinations
      a. white tip d. tape, white, tape g. white, tape, white
      b. red tip e. tape, yellow, tape h. yellow, tape, yellow
      c. yellow tip f. tape, red, tape
    2. 8 two-color combinations
      a. white, tape, yellow e. tape, white, yellow
      b. yellow, tape, white f. tape, yellow, white
      c. white, yellow, tape g. red, tape, yellow
      d. yellow, white, tape h. red, tape, white

II. 33 One and One-half ($1\frac{1}{2}$) Streamer Markers
  A. 17 Square-tip streamers
    1. 9 one-color combinations (one solid tape) (see above)
    2. 8 two-color combinations (see above)
  B. 16 Slant-tip Streamers
    1. 8 one-color combinations (see above)
    2. 8 two-color combinations (see above)

III. 34 Double Streamer Markers
  A. 17 Square-tip streamers
    1. 9 one-color combinations (one solid tape) (see above)
    2. 8 two-color combinations (see above)
  B. 17 Slant-tip streamers
    1. 9 one-color combinations (one solid tape) (see above)
    2. 8 two-color combinations (see above)

[1]Green paint was substituted for white on all markers of these releases.

TABLE XXIV

PHEASANT COLOR MARKER KEY
BURNT FORK STUDY
1963 Releases

May 10 Release

I. 150 Purple Neck Jesses

A. 50 Single Streamer Markers

1. 25 Square-tip streamers
   a. 5 white, tape
   b. 5 yellow, tape
   c. 5 tape, white
   d. 5 tape, yellow
   e. 5 plain tape
2. 25 Slant-tip streamers
   a. 5 white, tape
   b. 5 yellow, tape
   c. 5 tape, white
   d. 5 tape, yellow
   e. 5 plain tape

B. 50 One and One-half Streamer Markers

1. 25 Square-tip streamers
   a. 5 white, tape
   b. 5 yellow, tape
   c. 5 tape, white
   d. 5 tape, yellow
   e. 5 plain tape
2. 25 Slant-tip streamers
   a. 5 white, tape
   b. 5 yellow, tape
   c. 5 tape, white
   d. 5 tape, yellow
   e. 5 plain tape

C. 50 Double Streamer Markers

1. 25 Square-tip streamers
   a. 5 white, tape
   b. 5 yellow, tape
   c. 5 tape, white
   d. 5 tape, yellow
   e. 5 plain tape
2. 25 Slant-tip streamers
   a. 5 white, tape
   b. 5 yellow, tape
   c. 5 tape, white
   d. 5 tape, yellow
   e. 5 plain tape

II. 150 Red Neck Jesses (Same combinations as given above.)

June 5 Release

III. 150 Brown Neck Jesses (Same combinations as given above.)

IV. 150 Green Neck Jesses (Same combinations as given above.)

TABLE XXV

ADULT PHEASANT MORTALITIES[1]

	Wild				Game Farm Hens						Unknown Whether Wild or Game Farm Hens		Unknown Release of Game Farm Hens[3]		Totals		Grand Total
	Hens		Cocks		Previous Releases[2]		1962 Releases		1963 Releases								
	62	63	62	63	62	63	62	63	62	63	62	63	62	63	62	63	
Great-Horned Owl	5	11	0	8	14	4	26	6	0	42	7	7	0	0	38	74	112
Red-Tailed Hawk	0	0	0	0	0	0	0	0	0	0	2	1	0	0	2	1	3
Red Fox	0	0	0	2	0	0	0	0	0	33	0	0	0	1	0	36	36
Skunk	0	0	0	0	0	0	2	0	0	0	0	1	0	0	2	1	3
House Cat	3	1	1	0	0	1	16	1	0	6	1	0	0	0	21	8	29
Dog	2	0	1	2	2	0	13	2	0	8	4	0	1	0	21	12	33
Car	0	1	0	0	0	0	2	0	0	4	0	0	0	0	2	5	7
Mowing	3	2	0	0	0	0	10	0	0	9	1	0	0	1	14	12	26
Unknown	1	1	1	0	21	19	7	12	0	7	9	2	5	1	23	23	46
Totals	14	16	3	12	(37)	(24)	76	21	0	109	24	11	6	3	123	172	295

[1]Data covers from January 1, 1962, through August 31, 1963.
[2]Mortalities determined from recovery of neck markers and/or leg bands of game farm hens released prior to 1962; these kills were not included in the totals.
[3]Landowner information of kills where neck markers or leg bands were not recovered.

TABLE XXVI

CAUSES OF GAME FARM HEN PHEASANT MORTALITIES RELATED TO RELEASE DATES[1]

	1962 Releases[2]						1963 Releases						Totals	
	April 30		June 17		Both		May 10		June 5		Both		Total	% of
Cause of Mortality	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	Total
Great-Horned Owl	19	38.8	13	27.1	32	33.0	31	42.5	11	30.6	42	38.5	74	35.9
Red Fox	0	0.0	0	0.0	0	0.0	24	32.9	9	25.0	33	30.3	33	16.0
House Cat	5	10.2	12	25.0	17	17.5	1	1.4	5	13.9	6	5.5	23	11.2
Dog	12	24.5	3	6.3	15	15.5	6	8.2	2	5.6	8	7.3	23	11.2
Skunk	0	0.0	2	4.2	2	2.1	0	0.0	0	0.0	0	0.0	2	1.0
Mowing	2	4.1	8	16.7	10	10.3	5	6.9	4	11.1	9	8.3	19	9.2
Car	2	4.1	0	0.0	2	2.1	2	2.7	2	5.6	4	3.7	6	2.9
Unknown	9	18.3	10	20.7	19	19.5	4	5.5	3	8.3	7	6.4	26	12.6
Totals	49	100.0	48	100.0	97	100.0	73	100.0	36	100.0	109	100.0	206	100.0

[1]Nine game farm hens for which the release dates were unknown are not included; see table XXV.

[2]Twenty-one mortalities of the 1962 releases were located on the study area in 1963; see table XXV.

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