1957

Population ecology of the magpie in western Montana

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THE POPULATION ECOLOGY OF
THE MAGPIE IN WESTERN MONTANA

by

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B.S. Montana State University, 1955

Presented in partial fulfillment of the requirements
for the degree of

Master of Science in Wildlife Technology

Montana State University

1957

Approved by:

Chairman, Board of Examiners

Dean, Graduate School

Date

ACKNOWLEDGMENTS

Invaluable assistance was received from many persons and organizations during this study.

I am indebted to Dr. John J. Craighead, Leader of the Montana Cooperative Wildlife Research Unit[1], for advice and assistance given throughout the study.

To Dr. P. L. Wright, Chairman of the Department of Zoology, and members of the thesis committee: Dr. L. H. Harvey, Dr. [illegible] Hoffman, and Dr. G. F. Weisel, I wish to express my appreciation for helpful advice received during the planning and writing phases of this investigation.

Financial assistance and use of equipment was provided by the Montana Department of Fish and Game and the Wildlife Research Unit. Additional financial assistance was given, in the form of a grant amounting to $200 each year of the study, by the Western Montana Sportsmen's Association. I am grateful for this help.

Many thanks are due the residents of the study area for their helpful cooperation throughout the field investigation.

To Mrs. Alvina Barclay I wish to express my appreciation for typing this thesis and for the many times helpful assistance was willingly given.

[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 population ecology of the American Magpie (*Pica pica hudsonia*) was conducted on a six square mile area in the Burnt Fork Valley during the years 1956 and 1957. This investigation represents the initial phase of a long-term project concerning predation by a magpie population on nesting Ring-necked Pheasants (*Phasianus colchicus torquatus*).

Local sportsmen and ranchers have long regarded the magpie as an important predator upon the Ring-necked pheasant. This has resulted in the initiation of sporadic, extensive control programs which, in the past, have been notably undirected and inconclusive.

A reevaluation of the desirability and feasibility of artificially controlling magpie numbers in pheasant nesting habitat is needed. A prime requirement for such an evaluation is specific information on reproductive factors and natural regulating mechanisms within a magpie population.

The primary objectives of this investigation were:

1. To determine nesting density and composition on a definite land area.
2. To determine magpie reproductive, survival, and mortality factors.
3. To determine size and relationships of nesting territories and ranges by banding and color marking.

THE STUDY AREA

Geographic Location

The study area is located in an eastern, lateral drainage of the Bitterroot River, approximately midway between the headwaters of the Bitterroot and its confluence with the Clark's Fork River. The area includes the lower Burnt Fork Valley two miles above the junction of Burnt Fork Creek with the Bitterroot River. It is situated one mile east of Stevensville, Ravalli County, Montana.

Geology

The lower Burnt Fork Valley is of recent origin and transects a series of cenozoic terraces that form the east side of the inner Bitterroot Valley. It is cut in Pleistocene silts, sands, and gravels that were derived from the neighboring highlands by the ancient Burnt Fork River and deposited in glacial lake Missoula. The floor of the valley is underlain in part by boulder fill of the ancient Burnt Fork River channel, and is covered by a thin veneer of recent soils.[1]

Physiography

Terraces rising 100-200 feet above the Burnt Fork Valley floor border the study area on the north and south. The west boundary of the study area, at an elevation of 3,400 feet[2], borders the four mile broad Bitterroot Valley floor. Four miles to the east at an elevation of 3,900 feet[2], the eastern boundary transects the Burnt Fork Valley. One creek channel, two flood channels, and many irrigation diversion ditches traverse the relatively flat valley floor.

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1 Personal communication, R. Konizeski.

2 Data from Geological Survey Topographic Map, Missoula Quadrangle and Hamilton Quadrangle.

Climate

The climate is moderated by air masses of Pacific origin and by a rainshadow effect of the Bitterroot Mountains (Anon., 1941) Data from Table 1 indicate that precipitation occurs primarily during the spring and fall seasons, and averages thirteen inches annually. Precipitation data are listed as monthly totals. Temperature data during the period of investigation are given in terms of monthly means and departures from long term means. Temperature extremes ranged from 95 degrees F. to minus 36 degrees F. The average growing season is 113 days.

Table 1

Climatological Summary

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

	Temperature				Precipitation			
	1956		1957		1956		1957	
	Mean	Departure[1]	Mean	Departure[1]	Total	Departure[2]	Total	Departure[2]
Jan.	24.1	1.0	11.0	12.1[3]	.70	.36[3]	1.44	.38
Feb.	22.6	5.3[3]	25.8	2.1[3]	.51	.49[3]	1.04	.04
Mar.	35.2	0.4[3]	36.0	0.4	.77	.08[3]	.86	.01
Apr.	47.2	1.9	45.1	0.2[3]	1.01	.28	.64	.09[3]
May	59.3	6.5	56.4	3.6	.70	.77[3]	2.12	.65
June	62.4[4]	3.8	60.2	1.6	2.40	.66	.77	.97[3]
July	[3]	[3]	66.4	0.6	2.12	1.19	.52	.41[3]
Aug.	62.4	1.3[3]			1.32	.66		
Sept.	55.9	0.8			.15	.78[3]		
Oct.	44.9	0.6[3]			1.01	.10		
Nov.	31.2	2.2[3]			.42	.71[3]		
Dec.	31.1	4.5			.82	.41[3]		
Annual	[3]	[3]	3	3	11.93	.71[3]	3	3

1 Departure from 42 year monthly temp. mean or 44 year monthly precip. mean.

2 Departure from 43 year monthly temp. mean or 45 year monthly precip. mean.

3 No observations taken.

4 Data from more than 20 days observations.

Additional Data

	1956	1957
Latest freezing date	4/23	4/27
Maximum temperatures	93	95
Minimum temperatures	-24	-36

The average date for the first killing frost is September 20th and for the last killing frost is May 30th[5].

Time of daily observation 6 P.M., M.S.T.

Data from Climatological Data Bulletins, U.S. Department of Commerce Westner Bureau.

5 Anon., 1941.

Economic Land Use

Because of extensive development of diversion ditches, 83 percent of the study area is presently under irrigation (Table 2). As shown in Table 3, the majority of farms derive income from beef ranching or dairy farming. Grazing is important and acreage devoted to hay and pasture constitutes 93 percent of the total acreage (Table 3).

Table 2

Economic Land Use in the Burnt Fork Valley - 1956

Data from a Survey of All Residents on the Six Square Mile Study Area

Classification and Use	Total Acreage	Percent of Total
Cultivated		
Hay	1681	36.3
Barley	150	3.2
Oats	144	3.1
Wheat	31	0.7
Potatoes	18	0.4
Pasture	2608	56.3
Total	4632[1]	99.6
Total under irrigation	3863	83.4

[1] Including 500 acres around the periphery of the study area.

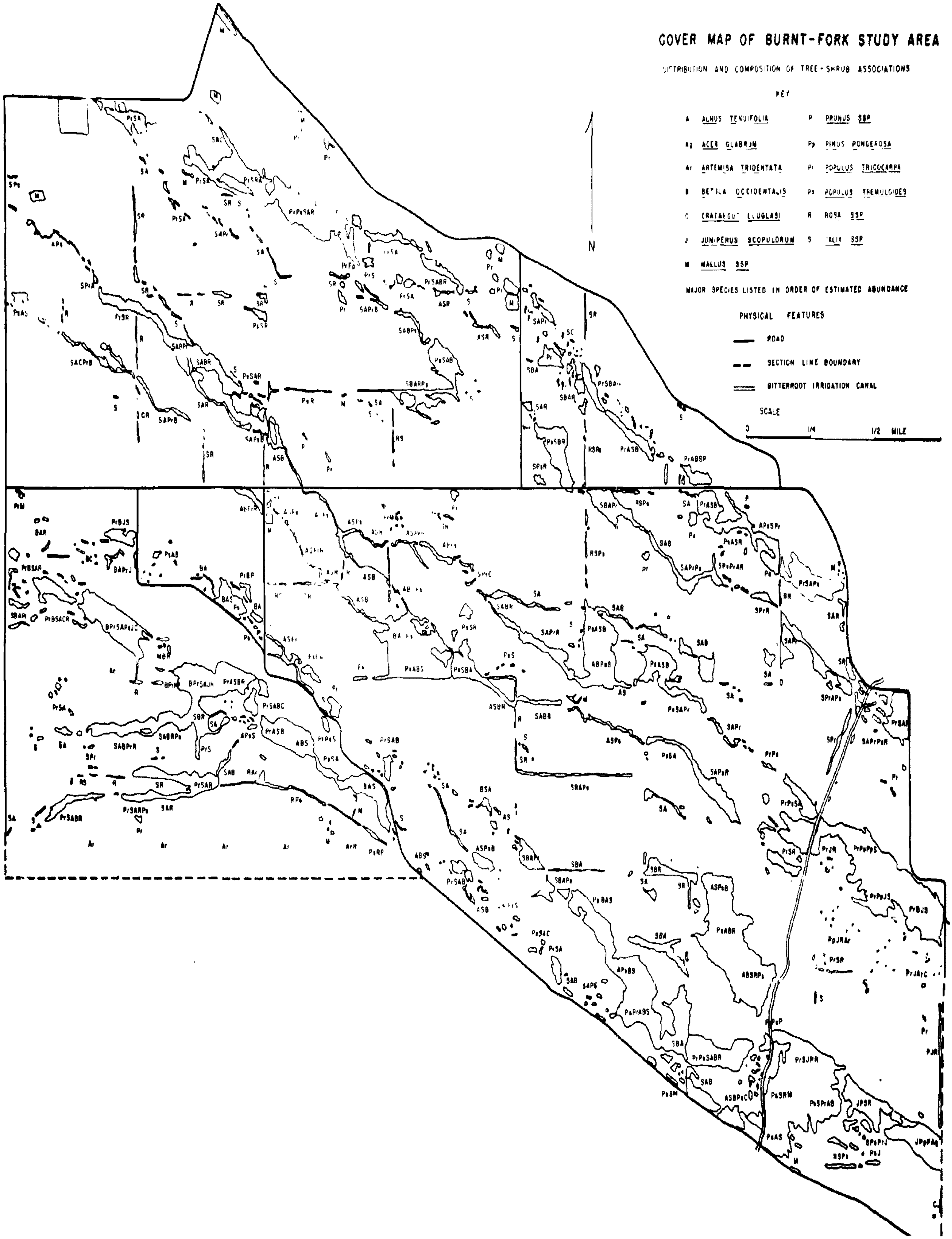
Table 3

Source of Farm Income - 1956

	Farm Units			
	Primary Income		Secondary Income	
Income Source	Numbers	% of Total	Numbers	% of Total
Beef Cattle	12	38	7	21
Dairy Cattle	9	28	4	12
Sheep	2	6	3	9
Hogs	-	-	7	21
Horses	-	-	4	12
Sale of Cultivated Crops	3	9	-	-
Off Area Income	6	19	9	26
Totals	32	100	34	101
% of Total Number of Units with Off Area Income				78

Vegetation

The physiognomy of the area is characterized primarily by a riparian tree-shrub association and by agricultural hay and pasture vegetation. In terms of Daubenmire's classification of vegetational zones in the Rocky Mountains (1943), the study area lies in the lower limits of the Ponderosa pine zone. Considerable interspersion of xeric and mesic sites occur along the drainage lines of the Burnt Fork Valley. A sage brush-juniper (Artemisa tridentata - Juniperus scopulorum) association occurs on the xeric sites while various deciduous tree - shrub associations occur on the mesic sites (Fig. 1). The present type and distribution of vegetation largely results from intensive agricultural development and land use primarily in the form of cultivation, irrigation, and grazing (Table 2).


COVER MAP OF BURNT-FORK STUDY AREA
DISTRIBUTION AND COMPOSITION OF TREE-SHRUB ASSOCIATIONS
KEY
A ALNUS TENUIFOLIA
Ag ACER GLABRUM
Ar ARTEMISA TRIDENTATA
B BETULA OCCIDENTALIS
C CRATAEGUS
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

METHODS AND TECHNIQUES

Collection of Nesting Data

Specific methods and techniques were required to observe and record accurately data from 731 active magpie nests on a six square mile area during two nesting seasons. The locations of nest structures were plotted on detailed field maps made from overlays of eight-inch-to-the-mile aerial photographs. Pertinent nesting data were recorded on numbered nest forms (see Appendix). Each nesting season the area was systematically searched about four times, principally during the peak periods of each stage of the nesting cycle (i.e. nest building, incubation, nestling, and fledgling). This procedure enabled the investigator to obtain a maximum quantity of nesting data with minimum disturbance to the nesting population. To further minimize possible disturbing effects the investigator:

a. Terminated observations during periods of inclement weather,

b. Exercised care in climbing nest trees and in examining nest contents with the hand, and

c. Reduced observation time to a minimum in areas of high nesting density.

Trapping

An effective, easily constructed, portable live trap was needed for obtaining population samples during the winter season. One meeting these requirements was obtained from William Woods (Chairman of the Predation Committee, Western Montana Sportsman's Association). The frame type trap having a funnel entrance at ground level was covered with one-inch chicken wire. The overall dimensions were 5x5x5 feet. Seven similar traps were constructed by the investigator with minor modifications incorporated following considerable use. The traps proved most effective when placed between roosting and foraging areas during periods of snow cover, with pork cracklings, fresh offal, or meat scraps used for bait. During two winter seasons 540 captures and 291 recaptures were made by operating six traps about two to three days a week.

Banding

Size 3a U.S. Fish and Wildlife Service aluminum leg bands were used to band 1,371 magpies during the course of this investigation. The recovery of banded birds furnished information relating to mortality, movement, population age composition, and the reliability of ageing criteria. Future band returns may provide additional data on longevity and population turn over.

A loss of leg bands of less than one percent was observed from color marked magpies during the study period. This loss was determined from about 350 observations of color marked magpies recaptured and recovered after various intervals of time since banding. These time intervals varied between one day and one year.

Banding and recapture records (see Appendix) were completed in the field and recopied in duplicate at a later time. The number of magpies banded during each season is listed in Table 4.

Table 4

Banding and Marking Summary

Data from Banding Record

Season	No. Banded	No. Marked	Color
Winter 1956	262	262 neck jesses	Yellow
Spring 1956			
Adults	20	21 neck jesses	Individually marked
Young	654	202 neck jesses	Orange
Fall 1956	35	8 neck jesses	Orange
		28 leg jesses	Orange
Winter 1957	222	223 leg jesses	Red 131, Yellow 92
Spring 1957	174	27 leg jesses	Purple-white
Totals	1,371	771 493 neck jesses 278 leg jesses	

Marking

A color marking technique developed for Canada Geese by Craighead and Stockstad (1955) was employed with modification in size and place of attachment. This color marker on magpies was discernable at about 400 yards with a 21 power spotting scope and was observable with 6 power binoculars at flushing distances up to 100 yards. The number of magpies marked each season is presented in Table 4.

Marking experiments were conducted on caged magpies during both years of the investigation. The most suitable dimensions for the neck markers were found to be 5x3/8x62/1000 inches with the holes spaced 2 1/2 inches apart. The leg markers measuring 3 1/8x3/8x62/1000 inches with holes spaced 7/8 inch apart were tied around the tarsus.

The attachment of markers around the neck was discontinued after the first year of the study when the observed-marker-induced-mortality equalled 4.6 percent of the total number of birds marked. Mortality was caused by one or both mandibles becoming hooked under the neck loop of the marker. Leg markers used during the second year of the study were considered adequate for the identification of birds of the year in the nesting population. As indicated in Tables 5 and 6, the loss of markers appears to be related to the age at which the birds were marked with the adult age classes exhibiting the greater loss.

Table 5

Relative Lasting Qualities of Color Markers

Data from Recaptures - Winter 1957

Sex and Age Class	No. of Birds	Time Since 1st Marking in Months	Color Marker Type: Yellow Neck	Orange Neck	Orange Leg	Markers Lost: Number	Percent
Adult Female	10	12	10			4	40
	4	4			4	1	25
Adult Male	8	12	8			5	62
	1	9	1			0	0
	1	4	1			0	0
	3	4			3	0	0
Juv. Female	4	7		4		0	0
	1	4			1	0	0
Juv. Male	3	7		3		0	0
Totals	35		20	7	8	10	

35 initially marked, and 233 unmarked magpies in sample

521 magpies previously marked in population

Table 6

Loss of Color Markers Observed During the Nesting Season

Data from Field Observations - Spring 1957

	Male: Adult	Male: Yearling	Female: Adult	Female: Yearling	Unknown Sex: Yearling
Number of birds observed with leg bands, but without markers	3	0	5	1[1]	2[2]

1 Red leg marker found in active nest and leg banded bird observed

2 Two red leg markers found under roost sites

Sexing and Ageing Techniques

A search of the literature revealed one reference which listed general criteria of sex and age in the American Magpie. Lindsdale (1937) presents a list of body weights and external morphological measurements taken from 28 and 2 specimens, respectively. From this list, body weight and bill length were chosen by the investigator as tentative criteria of sex. Body weight greater than 179 grams and bill length, from nostril to tip, greater than 26 mm. was thought to indicate a male.

During the first year these two measurements were not found to be sufficiently reliable as criteria of sex, therefore other external measurements were made of known sex specimens. As a result the length of the foot pad from hallux to middle toe was chosen as the most reliable criterion of sex.

The reliability of these criteria of sex are indicated in Figure 2. The foot pad length was observed to indicate true sex 102 times out of 105, or in 97 percent of the cases. The bill length criterion indicated true sex 80 times out of 95, or in 84 percent of the cases. Body weight indicated true sex 56 out of 67 times, or in 84 percent of the cases. The length of the foot pad was used as a criterion of sex in determining the sex ratio of a trapped sample of the population during the second winter of the investigation.

An ageing criterion selected from Linsdale (1937) was the shape of the terminal portions of the outer retrices, with roundness indicating birds of the year and squareness indicating adults. This criterion of age was found to be 100 percent reliable on observations of 29 banded-known age-adult magpies and 23 banded-known age-yearling magpies. These observations were made during the winter of 1957.

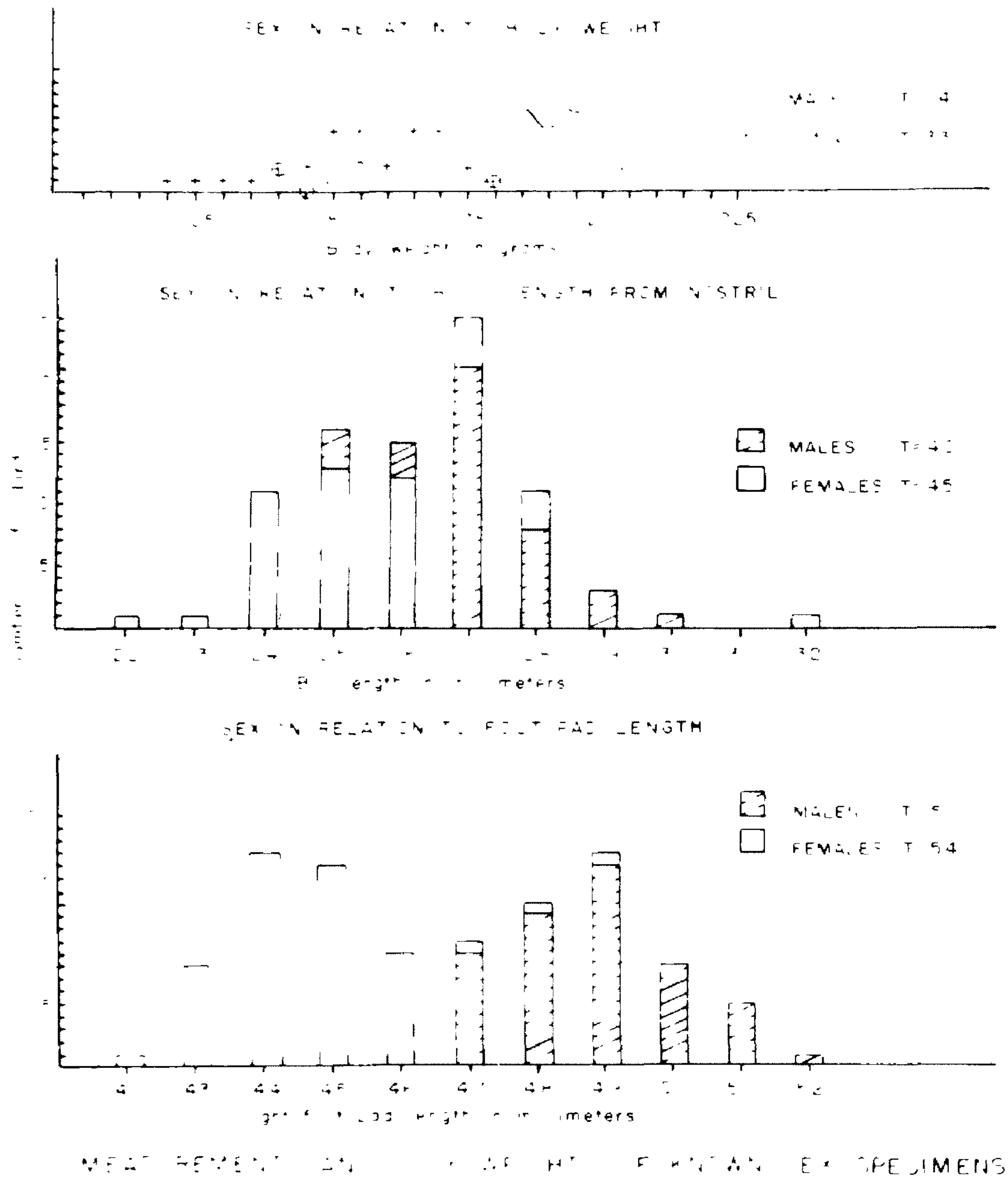


Figure 2

THE NESTING SEASON

Density Determination

The number of nesting pairs on the 6.4 square mile area during each nesting season was determined through a reasonably accurate, indirect census of the nesting population. This was accomplished by making systematic field searches for the relatively easily observable, bulky, magpie nesting structures.

Criteria indicating active nests, i.e. the presence of a nesting pair, were defined as those observed to contain eggs or young, and those visibly disturbed indicating predation had probably occurred before observation. In the latter case renesting activity in the same vicinity frequently occurred, which verified the presence of a nesting pair. These criteria were established because nesting magpies were regularly observed to construct or repair accessory nests during the early stages of the nesting cycle. Similar activity is commonly exhibited in the European Magpie (Pica pica pica) according to Kleinschmidt (1892), Peiter (1899), and Comte (1930). The number of nesting pairs indicated by this indirect census then equals the number of active nests less the number of renests.

Nesting density was remarkably stable during the 1956 and 1957 nesting seasons. As shown in Table 7 the total number of nesting pairs on the 6.3 square mile area was 348 in 1956 and 351 in 1957. The average density per square mile for both years was 55.5 nesting pairs. Maximum and minimum densities in terms of nesting pairs per square mile were 79 and 26 respectively. The total number of nesting pairs will be used later in expressions of nesting success.

Table 7

Magpie Population Density

Six Square Mile Burnt Fork Study Area

	1956	1957	Average
Total Number of Nests	361	370	365.5
Total Number of Renests	13	19	16
Total Number of Nesting Pairs	348	351	350
Average Number Nesting Pairs per Square Mile[1]	55	56	55.5
Maximum Number Nesting Pairs per Square Mile[2]	72	79	75
Minimum Number Nesting Pairs per Square Mile[3]	30	26	28

[1] Average density computed using 6.3 square mile area figure.

[2] Maximum density observed on one section.

[3] Minimum density observed on 0.21 of a square mile portion of one section was projected in terms of one square mile.

Observed and Calculated Data

The extensive field observational method employed, enabled the investigator to obtain complete nest histories from most nests. If a nest was not observed during the period when feathered nestlings developed to flying fledglings, its status could, nevertheless, be determined. A flattened nest lining and an accumulation of excreta on the sides of the dome indicated an unknown number of feathered nestlings had been present, and had presumably fledged. Such a nest was recorded as being successful. The average number of observed young fledging during the nesting season was projected to nests in this category. Similar projections of eggs or nestlings were made if incubated eggs (complete clutches), or unfeathered nestlings (young hatched) were not observed prior to the observation of feathered nestlings. Calculations involving these projected data were necessary for the expression of reproductive success in terms of the nesting population on a given land area.

Both observed and calculated nesting data are presented in Table 7. The decrease in the number of nests with incomplete data in 1957 is believed primarily due to more effective synchrony of nest observations with peak periods of the population nesting cycle. The greatest projection was of unknown egg numbers in nests during the 1956 nesting season. In this calculation 37 percent of the total number of nests required projected egg numbers. However, as other projections were considerably smaller and as they were never based upon less than 194 nests, the observed and calculated data is considered adequate for the expression and analysis of the reproductive success of the nesting populations.

Table 8

Observed and Calculated Magpie Nesting Data - 1956-1957

	1956	1957	Totals
Total number of active nests observed	361	370	731
Nests successful	264	250	514
Percent nests successful	73.1	67.6	70.3
Number of nesting pairs in area	348	351	699
Number of renesting pairs	13	19	32
Total nests with complete clutch	229	274	503
Observed number of eggs in nests	1,468	1,806	3,274
Average clutch size observed	6.41	6.59	6.51
Number of nests with unknown number of eggs	132	96	228
Calculated total number of eggs	2,314	2,439	4,753
Average number of eggs per nesting pair	6.65	6.95	6.80
Total nests with known hatch	211	241	452
Observed number of eggs hatched	1,031	1,242	2,273
Average number of eggs hatched per nest	4.89	5.15	5.03
Number of nests with unknown number of eggs hatched	63	36	99
Calculated total number of eggs hatched	1,339	1,427	2,766
Total nests with known number of young fledged	194	212	406
Number of young observed at fledging stage	900	1,028	1,928
Average number of young observed at fledging stage/nest	4.64	4.85	4.74
Number of nests with unknown number of young fledged	70	38	108
Computed total number of young fledged	1,225	1,212	2,437
Average number of young fledged per nesting pair	3.52	3.45	3.49

Reproductive Rate

The number of eggs produced in a population per breeding season is an expression of the reproductive rate of the population (Lack, 1954). This is applied in the analysis of reproductive data in the present study. The reproductive rates for the nesting populations during the investigative period were: 2,314 eggs from 348 nesting pairs during the 1956 nesting season, for an average of 6.65 per nesting pair; and 2,439 eggs from 351 nesting pairs during the 1957 nesting season, for an average of 6.95 per nesting pair (Table 9).

Table 9

Clutch Size, Frequency, and Nesting Success

Data from Nests with Complete Clutches Only

	Observed	Successful Nests[1]			Unsuccessful Nests			Total		% of
Year	Clutch Size	Eggs	Nests	Percent Succ.	Eggs	Nests	Percent Unsucc.	Eggs	Nests	Total
56	4	24	6	48	28	7	54	52	13	5.7
57	4	20	5	56	16	4	44	36	9	3.3
56	5	105	21	72	40	8	28	145	29	12.7
57	5	95	19	58	70	14	42	165	33	12.0
56	6	330	55	81	78	13	19	408	68	29.7
57	6	330	55	70	144	24	30	474	79	28.8
56	7	546	78	87	84	12	13	630	90	39.3
57	7	581	83	85	105	15	15	686	98	35.8
56	8	192	24	86	32	4	14	224	28	12.2
57	8	312	39	78	88	11	22	400	50	18.2
56	9	9	1	100				9	1	0.4
57	9	45	5	100				45	5	1.8
56 Totals		1,206	185	81	262	44	19	1,468	229	110.0
56 Means		6.52			5.95			6.41		
57 Totals		1,383	206	75	423	68	25	1,806	274	99.9
57 Means		6.71			6.22			6.59		

1 Successful nest - one from which at least one fledgling departed.

It is generally recognized that in an avian population the reproductive rate is primarily dependent upon the following factors: clutch size, number of clutches per year, incidence of renesting, breeding age, and sex ratio. These factors will be evaluated in relation to previously indicated reproductive rates of the nesting magpie populations.

Clutch Size:

Data from complete clutches are presented in Table 9. Clutches of three eggs or less were not included in the computations because minimum bias appears probable through egg loss preceding observation. Average values were projected onto these clutches. Clutch size appears to be directly related to nesting success.

Average clutch sizes of 6.41 from 229 nests in 1956, and 6.59 from 274 nests in 1957, may be compared to 6.85 from 13 nests in Washington by Dice (1917), 5.7 from 12 nests in Nevada by Lindsdale (1937), and 7.2 from 22 nests in Montana by Hartkorn (1949). The latter average is not strictly comparable as only nests with eggs hatching were included in the computation. These data indicate the average clutch size in the determinant laying American Magpie (Hartkorn, 1949) is six or seven eggs. The most frequent clutch size observed during this investigation was seven eggs (Table 9).

Clutch size relates directly to the reproductive rate of a population. It is the unit upon which total egg numbers of a nesting population are based.

Number of Clutches per Year:

The literature shows that one clutch of eggs per nesting season is normal for undisturbed nesting magpies. Data supporting the normal occurrence of single clutches or broods in this investigation is indicated in Table 21 by the distribution of fledging dates.

The total number of eggs which constitute a part of the expression of the reproductive rate is largely composed of the sum of single clutches of nesting pairs in the population.

Incidence of Renesting:

Bendire (1895) found that as many as two sets of eggs may be replaced by the magpie. Hartkorn (1949) found, through removing clutches, ten cases of clutch replacement in initial nests and numerous cases of second clutches in repaired or newly built nests in the immediate vicinity of the disturbed, initial nests.

No case of clutch replacement was observed in initial nests during this study. Renesting was determined indirectly during this investigation. When a new nest was constructed in the territory of one previously destroyed, it was designated a renest. Data from Table 10 indicates 15 percent of the unsuccessful nesting pairs in 1956, and 18 percent in 1957 renested following initial nesting failure. In renests, the nesting success, clutch size, and survival of both eggs and young were less than in total nests (Tables 8 and 10).

Table 10

Reproductive Success of Renesting Pairs

Observed and Calculated Figures - 1956 and 1957

	1956	1957
Total number of initial nests unsuccessful	89	106
Total number of renesting pairs	13	19
Percent of nesting pairs renesting	15	18
Number of renesting pairs successful	5	5
Percent of renesting pairs successful	38	26
Number of eggs produced	50	73
Mean number of eggs per nest	5.6	6.1
Number of eggs hatching	17	23
Mean number of eggs hatching per nest	3.4	4.6
Number of young fledging	17	21
Mean number of young fledging per nest	3.4	4.2
Mean number of young fledging per renesting pair	1.3	1.1

Second clutches from renesting pairs composed 2.6 percent of the total eggs produced during both nesting seasons. Success of initial nests during both nesting seasons was over 70 percent. Therefore, the number of second clutches resulting from renesting increased the reproductive rate during both seasons by less than 3 percent (Tables 8 and 10).

Breeding Age:

A search of the literature produced no significant information regarding the breeding age of the American Magpie. From 202 nestlings marked as a specific age class with orange and white neck markers in 1956 (Table 4) three were observed carrying on nesting activity at active nesting sites in 1957 (Table 25, see Appendix). During the winter of 1957, 141 magpies were trapped, aged as young of the year, and marked as a specific age class with red leg markers (Table 4). Fifteen of these marked birds were observed carrying on nesting activity at active nests during the following nesting season (Table 25, see Appendix).

From these data it appears reasonable to conclude that the minimum breeding age of the American Magpie is one year. However, the presence of a possible non-nesting, yearling segment in the population was indicated through the following observations made during the 1957 nesting season. Two flocks of magpies, including two birds marked as nestlings in 1956 were observed exhibiting gregarious flocking, and atypical mating behavior during the peak of the incubation period. Many loose flocks were observed during both nesting seasons. The investigator was unable to differentiate between possible non-breeding flocks and nesting individuals congregated on common foraging areas.

It appears reasonable to assume that an unknown proportion of the yearling age class is represented by non-breeding individuals. This complicates the reproductive picture of the population. It is not possible at present to quantitatively express the relationship between breeding age and reproductive rate.

Sex Ratio:

No preponderance of one sex is evident in this population from 105 specimens examined (Fig. 2) or from 522 trapped birds sexed using the previously described sexing criteria (Table 26, see Appendix). The sex ratios of these samples were 51 males to 54 females and 249 males to 273 females, respectively.

Considering the accuracy of the sexing criteria utilized (Fig. 2), these data indicate a population sex ratio of 1:1. The reproductive rate may therefore be expressed in terms of total eggs per pair, total eggs per female or $\frac{\text{total eggs}}{2}$ per nesting individual.

During the 1956 and 1957 seasons the nesting density remained relatively the same. The reproductive rate in 1956 was 2,314 eggs from

348 nesting pairs, which represents a potential rate of increase of over 330 percent. This rate of increase is obviously not reflected in the unchanged nesting population density the following year. The next section will treat the quantitative relationships between reproductive rate and survival.

Survival

Survival may deal with the number of eggs hatching and number of young fledging in a population, or, more significantly, it may be expressed in relation to reproductive rate, as the percent of young hatching or fledging from total eggs laid (Nice, 1937). The latter expression of survival may be retained in the form of a decimal fraction, and expressed in terms of probability of survival, which facilitates further mathematical manipulation (Davis, 1952). Another expression of survival is in terms of average numbers of eggs hatching, or young fledging, per nest.

Eggs Hatching:

Survival in terms of total numbers of eggs hatching, or the percent of eggs hatching from total numbers laid, is presented in Table 11. The probabilities of survival may be also obtained from data in Table 11 by dividing a given percentage by 100 (Davis, 1952). final expression of egg survival is in terms of the average hatch per nest which was 4.9 in 1956 and 5.2 in 1957 (Table 8). These averages are slightly higher than an average of 4.75 from 8 nests in Washington by Dice (1917), and are slightly lower than an average of 5.3 from 22 nests in Montana by Hartkorn (1949).

Table 11

Magpie Reproductive Success and Survival

Observed and Calculated Data - 1956 and 1957

	1956	1957	Total	Average
Total number of eggs produced	2,314	2,439	4,753	2,376
Total number of eggs hatching	1,339	1,427	2,766	1,383
Total number of young fledging	1,225	1,212	2,437	1,218
Percent of eggs laid hatching	57.9	58.5		58.2
Percent of young fledging from eggs laid	52.9	49.7		51.3
Percent of young fledging from eggs hatching	91.5	84.9		88.1

Young Fledging:

The number and percent of young surviving to fledge, and the percent of young fledging from eggs laid and from eggs hatched, are listed in Table 11. Again, the probability of survival may be obtained by dividing the percentage of youngfledging in each case by 100 (Davis, 1952). The percent of young fledging from eggs laid equalled 53 and 50 for the two years of this investigation. This survival rate is somewhat higher than the average of 45 percent for open-nesting passerine birds presented by Lack (1954), and is considerably lower than the average of 67 percent he lists for hole-nesting species. Lack considers predation to be a primary factor affecting the survival of open-nesting species, but a relatively unimportant factor in relation to the survival of hole-nesting species. The domed nests of the magpie, from a consideration of vulnerability to nest predators, may be classed as an intermediate between open and hole-nest types. The average egg-to-fledgling survival rate of the dome-nesting magpie lies between the rates given by Lack which tend to support the relationship he indicates between nesting survival rates and vulnerability to nest predators.

Productivity

A definition of productivity, modified from Leopold (1937) by Craighead and Craighead (1955) as being the number of fledglings produced by a nesting population per nesting season, is used as a final expression of reproductive success. Data presented in Table 8 indicate a relatively stable productivity rate during both nesting seasons, averaging 3.49 fledglings produced per nesting pair per nesting season.

Survival in Relation to Clutch and Brood Size

The data presented in Tables 12 and 13 do not indicate any relationship between clutch or brood size and survival. This strongly indicates that the availability of food for nestlings is not a factor limiting reproductive success. This might be expected in the magpie which has general feeding habits (Kalmbach, 1927). This lack of a relationship between survival and clutch size is similar to one found in the Swiss Starling (Sturnus vulgaris) by Lack (1954). Through banding recoveries he measured the survival rate past the nesting period and found the rate of survival to be inversely related to clutch size. The young from smaller clutch sizes were heavier, thus he postulated the survival factor was related to body weight and hence indirectly to food.

An insufficient quantity of data were collected to determine if this inverse relation of body weight at fledging to post nesting survival exists in the magpie.

Table 12

Survival in Relation to Clutch Size

Nests with Complete Data on Clutch and Hatch Only - 1956 and 1957

		Eggs Hatched				Young Fledged			% Young Fledged	
Year	Clutch Size	No. of Nests	No. of Eggs	Mean	Per-cent	No. of Nests	No. of Young	Mean	Per Eggs Laid	Per Eggs Hatched
56	4	6	15	2.5	62	6	14	2.3	58	93
57	4	4	15	3.8	94	4	15	3.8	94	100
56	5	14	54	3.9	77	14	49	3.5	70	91
57	5	19	70	3.7	74	19	65	3.4	68	93
56	6	41	201	4.9	82	41	187	4.6	77	93
57	6	43	200	4.6	78	43	191	4.4	74	95
56	7	53	290	5.5	78	53	279	5.3	76	96
57	7	65	373	5.7	82	65	350	5.4	77	94
56	8	16	104	6.5	81	16	101	6.3	79	97
57	8	28	160	5.7	71	28	154	5.5	69	96
56	9	1	7	7.0	78	1	6	6.0	67	86
57	9	4	29	7.2	81	4	28	7.0	78	97
56 Totals		131	671			131	636			
Means				5.1	79			4.8	95	75
57 Totals		163	847			163	803			
Means				5.2	78			4.9	95	74
Totals		294	1,518			294	1,439			
Means				5.16	78.6			4.89	94.8	74.5

Table 13

Survival in Relation to Brood Size

Nests With Complete Data Only

Year	Brood Size	Nests in Class	Young Fledged No.	Young Fledged Mean	Young Fledged % per Brood
56	1	3	3	1.0	100
57	1	2	2	1.0	100
56	2	9	17	1.9	94
57	2	9	18	2.0	100
56	3	17	50	2.9	98
57	3	16	46	2.9	96
56	4	23	89	3.9	97
57	4	30	116	3.9	97
56	5	53	251	4.7	95
57	5	54	259	4.8	96
56	6	47	264	5.6	94
57	6	45	260	5.8	96
56	7	22	144	6.5	93
57	7	33	213	6.4	92
56	8	0			
57	8	3	24	8.0	100
56 Totals	4.97	174	865	4.7	95
57 Totals	5.11	192	983	4.9	95

Factors Affecting Survival

Mortality:

As the counterpart of survival, mortality will be considered only with regard to observed quantitative losses, causative agents, and times of occurrence during the nesting cycle.

The causes of only the quantitative losses of observed eggs per nest are presented in relation to nesting success in Table 14 under the number of infertile eggs presumably removed by the nesting birds prior to observation,and a number of eggs removed by predators which did not visibly disturb the nest structure are included under the column heading "unknown". An indication of red squirrel (Tamiasciurus hudsonicus) predation was based on observation of the squirrel at the nest, or by the presence of squirrel nests in previously observed active magpie nests. The relative importance of man, primarily in the form of small boys, is undoubtedly not represented in the respective column. Human disturbance was detected by broken tree branches, displaced nest structures, and from direct information. The total observed egg loss is almost equally divided between successful and unsuccessful nests.

Table 14

Fate of Observed Eggs in Successful and Unsuccessful Nests - 1956 and 1957

		Fate of Eggs						
Category	Year	Unknown	Inf. or D.E.[1]	Deserted	Unk. Predator	Red Squirrel	Man	Total
Successful Nests								
No. of Eggs	56	185	25	-	6	-	-	216
	57	225	49	-	24	-	-	298
No. of Nests	56	106	15	-	2	-	-	123
	57	125	35	-	10	-	-	170
Ave.No.Eggs/Nest	56	1.7	1.7	-	3.0	-	-	1.8
	57	1.8	1.4	-	2.4	-	-	1.8
Unsuccessful Nests								
No. Eggs	56	14	25	39	156	12	22	268
	57	30	33	54	111	37	35	300
No. of Nests	56	4	4	9	34	2	3	56
	57	13	12	11	21	6	6	69
Ave.NolEggs/Nest	56	3.5	6.2	4.3	4.6	6.0	7.3	4.8
	57	2.3	2.8	4.9	5.3	6.2	5.8	4.4

[1] D.E. - dead embryo

The causes of only the quantitative losses of observed nestlings per nest are presented in relation to nesting success in Table 15. Nestlings observed missing between observations, when no visible evidence of human activity was evident, are listed under "unknown predator". An unknown number of young falling out of nests and dying from other causes may be included under this heading. In the "dead young in nest" category, no signs of predation were observed in the successful nests, but in the unsuccessful nests some indications of disturbances by nest predators were observed. The difference in the total number of young observed missing from nests during the two years reflects more effective synchrony of nest observations with specific periods of the reproductive cycle. A relative indication of egg and nestling losses which occur through the activity of nest predators is indicated in Tables 14 and 15.

Table 15.

Fate of Observed Young in Successful and Unsuccessful Nests in 1956 and 1957

		Fate of Young				
	Year	Unknown	Dead in Nest	Unknown Predator	Man	Total
Successful Nests						
No. of Young	56	11	5	31	-	47
	57	23	1	30	9	63
No. of Nests	56	8	5	22	-	35
	57	15	1	20	3	39
Ave.No.Young/Nest	56	1.4	1.0	1.4	-	1.3
	57	1.5	1.0	1.5	3.0	1.6
Unsuccessful Nests						
No. of Young	56	-	6	12	12	30
	57	11	19	37	44	111
No. of Nests	56	-	3	4	3	10
	57	2	4	10	8	24
Ave.No.Young/Nest	56	-	2.0	3.0	4.0	3.0
	57	5.5	4.8	3.7	5.7	4.6

The causes of complete nesting failure during both nesting seasons are listed in Table 16. Nest losses due to man are undoubtedly included in both the "unknown" and the "unknown predator" categories. Nests were listed under the heading "unknown predator" if the nest structure was visibly disturbed, and under "man" if the nest tree and nest structure were visibly disturbed. Many nest predators were implicated by observation near the nest prior to or following destruction. Others were implicated by observation of their activity in a previously active nest. The activity observed consisted of tooth marks on eggs or young, red squirrel nests, crow nests, and dead nesting magpies. In the nests where infertility was designated the cause of failure the nesting bird was observed to remain on the eggs from one to two weeks past the average 18 day incubation period (Lindsdale, 1937). All eggs in these nests were found to be addled when examined after incubation was observed to have been extended by one or two weeks. It appears that man was the most important single nest predator during both nesting seasons.

Table 16

Causes of Complete Nesting Failure - 1956 and 1957 Nesting Seasons

	1956		1957		Total	
Causes of Failure	Number	% of Total	Number	% of Total	Number	% of Total
Unknown (incl. Des.)	13	13.4	21	17.6	34	15.7
Unknown predator	42	43.3	41	34.2	83	38.2
Infertility	3	3.1	4	3.3	7	3.2
Man	8	8.3	23	19.2	31	14.3
Pine squirrel	12	12.4	14	11.7	26	12.0
Crow	6	6.2	6	5.0	12	5.5
Wind	4	4.1	-	-	4	1.8
Dead nesting bird (2 mamm. predators, 5 unknown)	5	5.2	2	1.7	7	3.2
Dead young in nest	1	1.0	4	3.3	5	2.3
Ants	-	-	1	0.8	1	0.5
Starling	1	1.0	1	0.8	2	0.9
Coopers hawk	-	-	1	0.8	1	0.5
Weasel	1	1.0	1	0.8	2	0.9
Nest mites	1	1.0	1	0.8	2	0.9
Total Unsuccessful Nests	97	100.0	120	100.0	217	99.9
Total Active Nests	361		370		731	

Because of the time interval between observations and the lack of evidence at some nests, many approximations were made when nesting failure occurred during advanced stages of the nesting cycle (Table 17). For example nests with disturbed structures in which no eggs were observed were included in the laying stage of nesting failure because the majority of these nesting failures were observed during the laying period of the nesting cycle. The condition of the nest bowl was used as an indicator of the occurrence of nest failure during the nestling period. In the absence of nestlings or of remnants of dead nestlings, nesting failure during the nestling period was indicated if the nest was observed within 21 days after hatching, and if the inner lining was flattened, indicating nestlings had been present but had not fledged. The nests listed under mud bowl and inner lining stages of nest building were those involved in renesting activity. It appears that more than 80 percent of the nesting failures occurred before the hatching period. Less than 20 percent of the unsuccessful nesting pairs were observed to renest in the vicinity of their initial nests (Table 10). The lack of specific information concerning the renesting behavior of the magpie may result in the introduction of considerable error in the calculation of nesting pairs from active nests.

Table 17

Stage of Nesting Cycle when Complete Nesting Failure Occurred
1956 and 1957

Year	Category	Mud Bowl	Inner Lining	Laying	Incubation	Nestling	Totals
1956	No. of Nests	5	14	49	30	10	97
	% of Class	5.2	14.4	50.5	30.9	10.3	
1957	No. of Nests	1	18	45	34	27	120
	% of Class	0.8	15.0	37.5	28.3	22.5	

The stage of nesting failure and fate of initial nests and renests are indicated in Table 18. The nesting failures of the initial nests occurred mainly during the period of nest building but never past the period of incubation. The disturbing factors were determined in the same manner as previously described. Pine squirrels and man are indicated as being the major known predators involved.

Table 18

Stage of Nesting Failure and Fate of Initial Nests and Renests 1956 and 1957

	1956	1957
Initial Nests		
Number	13	19
Nesting stage when activity terminated		
Nest Building	8	10
Laying	4	6
Early incubation	1	3
Number of eggs observed	19	29
Disturbing factor		
Unknown	4	9
Unknown predator	3	6
Pine squirrel	3	1
Man	2	3
Wind	1	-
Renests		
Number	13	19
Nesting stages completed		
Nest building	13	19
Laying or incubating	8	12
Nestling	5	5
Fledgling	5	5
Disturbing factor		
Unknown	4	8
Unknown predator	2	3
Pine squirrel	1	2
Man	1	1
Total	8	14
Percent nests successful	38	26
Percent non renests successful[1]	71	80

[1] Calculated from Table 8

Nesting Success:

Nesting success may express the number of nests that successfully produce young, or it may be used as a measure of the survival of nest units, which in terms of the reproductive success of the population mean very little except as it may act as a limiting factor. This is evident because the survival of nest units does not express losses of eggs and young from successful nests nor does it reflect the compensating effects of renesting, but it may act as a limiting factor because by definition if the nest unit does not survive, neither do the eggs or young.

The nesting success of the renesting-pairs was 44 percent lower than the nesting success of the non-renesting-pairs during both years of the study (Table 18). Therefore, renesting within the proximity of the initial nest may be a disadvantageous behavior pattern, or the intensity of the nesting instinct may decrease considerably during the nesting cycle. Nesting success may also be considered as it may relate to factors of the nest environment.

During the two nesting seasons 63 and 59 percent of the nests occurred in riparian cover (Table 19). This distribution appears to be a function of availability. The preponderance of riparian cover on the study area is evident from the covermap (Figure 1). The nesting success was 16 and 10 percent higher during the two seasons in riparian type cover. This may be partially due to the fact that red squirrel nest displacement was observed to occur only in non-riparian cover. Other nest predators inhabited both types of cover, but to what extent one cover type was favored over the other is not known.

Table 19

The Distribution of Nests and Nesting Success in Relation to Cover Type

	Cover Type							
	Riparian		Percent	Non-Riparian		Percent	Total
	No.	%	Successful	No.	%	Successful	No.
Total Number							
1956	227	62.9		134	37.1		361
1957	217	58.6		153	41.4		370
Successful only							
1956	179		78.9	85		63.4	264
1957	156		71.9	94		61.4	250

Data pertaining to the nest support structure and height of the nest above ground are presented in relation to nesting success in Table 20. The height of nests above ground from the top of the nest bowl was measured to the nearest foot with a 12 foot climbing ladder. The occurrence of nests in the various tree species does not appear directly related to availability. A definite preference for willow was indicated by the number of nests in willows adjacent to cottonwood, hawthorn, alder, and river birch. The occurrence of nests in other trees appeared to be dependent on their relation to unoccupied territories and available foraging areas. The general increase in nest heights between the two years may be a function of disturbance by the investigator. During both years of the study there was about 50 percent reuse of old nest structures. There was less than 5 percent difference in nesting success between new nests and reused nests.

Table 20

Nesting Success in Relation to Nest Site

Nest Support Structure	Year	Successful Nests No.	Successful Nests %	Successful Nests Mean Ht.	Unsuccessful Nests No.	Unsuccessful Nests %	Unsuccessful Nests Mean Ht.	Total No.	% of Total	Mean Ht. Total
Salix	56	182	72	11.2	71	28	11.6	253	70	11.3
ssp.	57	174	65	11.4	94	35	11.9	268	72	11.6
Populus	56	17	61	13.5	11	39	12.6	28	8	13.1
tricocarpa	57	15	65	16.3	8	35	13.2	23	6	15.2
Crataegus	56	13	93	8.7	1	7	8.0	14	4	8.6
Douglasii	57	14	78	9.6	4	22	12.5	18	5	10.3
Alnus	56	13	76	12.9	4	24	12.2	17	5	12.8
tenuifolia	57	7	78	15.7	2	22	11.0	9	2	14.2
Betula	56	12	80	16.6	3	20	17.3	15	4	16.7
occidentalis	57	9	82	17.7	2	18	15.0	11	3	17.2
Juniperus	56	10	83	10.3	2	17	10.0	12	3	10.2
scopulorum	57	10	100	9.5	-	-	-	10	3	9.5
Malus	56	9	82	12.2	2	18	15.0	11	3	12.7
ssp.	57	6	55	12.3	5	45	11.4	11	3	11.9
Prunus	56	2	100	19.0	-	-	-	2	1	19.0
virginiana	57	6	100	15.3	-	-	-	6	2	15.3
Pinus	56	1	50	1010	1	50	10.0	2	1	10.0
ponderosa	57	3	60	13.7	2	40	11.0	5	1	12.6
Populus	56	3	75	19.7	1	25	8.0	4	1	16.8
tremuloides	57	1	50	16.0	1	50	17.0	2	1	16.5
Prunus ssp.	56	1	100	9.0	-	-	-	1	0	9.0
(plum)	57	2	100	10.5	-	-	-	2	1	10.5
Rosa	56	-	-	-	-	-	-	-	-	-
ssp.	57	1	50	9.0	1	50	6.0	2	1	7.5
Sambucus	56	-	-	-	-	-	-	-	-	-
sp.	57	-	-	-	1	100	9.0	1	0	9.0
Acer	56	1	50	6.0	1	50	5.0	2	1	5.5
glabrum	57	-	-	-	-	-	-	-	-	-
Hay Barn	56	-	-	-	-	-	-	-	-	-
	57	2	100	40.0	-	-	-	2	1	40.0

Factors relating to nesting success and mortality have been considered. A number of factors tend to limit the reproductive success of a magpie population through the nesting cycle. The reproductive rate indicated a potential increase of 330 percent, but the survival of fledged young showed that only an increase of 150 percent occurred.

The determination of losses past the fledging period is considerably less reliable and more difficult than during the nesting period. The attempts to determine post nesting losses through observations of adult-fledgling age classes during the summer of 1956 were unsuccessful. The length of the retrices was found unreliable as a field criterion of age as early in the season as July 1st. Differences in alarm reactions of the adult and fledgling age classes also represented a biasing factor. Further considerations of post nesting losses are presented in terms of mortality factors and the incidence of mortality.

Great Horned Owl Predation upon Fledgling Magpies

The young from nests of great horned owls (*Bubo virginianus*) on the study area were tethered during both years of the investigation. The techniques employed were described by Errington (1932) and modified by Craighead and Craighead (1955). Young owls were tethered under the nest trees shortly before they were able to fly. Prey data were gathered over a three-week period from two young at two nests in 1956 and during a four-week period from five young at three nests in 1957. Observations were made and prey items collected between one and two day intervals. The magpie fledgling mortality data presented in Table 21 were obtained through observations of tethered young and analysis of castings from the young.

The fledging dates presented in Table 21 were observed or calculated from known and estimated hatching dates. In 1957, 21 nests were observed within a day of hatching and fledging. The average nesting period of these nests was 24 days. In determining a calculated fledging date, this average was added to the observed or calculated date of hatching.

Table 21

Great Horned Owl Predation upon Fledgling Magpies in Relation to the Incidence of Young Leaving the Nest

		May				June						Total No.
	Year	15	20	25	30	5	10	15	20	25	30	Observed
Nests fledging	56	1	1	7	17	59	77	65	25	11	1	264
GHO predation on fledglings	56				2	8	4	3	4	2		23
Tethering period	56					———	———	———	———			
Nests fledging	57	1	3	23	62	70	47	30	9	4	1	250
GHO predation on fledglings	57				5	6	9	10	2	2		34
Tethering period	57		———	———	———	———	———	———	———			

A factor which undoubtedly reduced magpie fledgling predation by great horned owls was the release of game farm pheasants on the study area. This occurred preceding and during the tethering period. On June 3, 1956, 163 marked and/or banded pheasants were released. During the tethering period, 7 marked and/or banded pheasants and 7 pheasants of unknown status were observed at the sites of the tethered owls. In 1957, 175 and 215 marked and banded pheasants were released on April 14 and June 3 respectively. During the tethering period, 21 marked and/or banded pheasants and 10 pheasants of unknown status were observed at the sites of the tethered owls.

During the tethering periods magpie fledglings and released pheasants were included in a variety of prey species taken by the adult great horned owls and fed to their tethered young. Because of the alteration in the composition of prey species and the limitations of the techniques employed, the following expressions of the predator prey relationships between great horned owls and fledgling magpies are given in terms of minimum numbers. The data in Table 21 indicates the minimum number of fledgling magpies preyed upon by great horned owls in relation to the relative abundance of newly-fledged magpies. There appears to be a direct relation between the incidence of predation by great horned owls and the relative abundance of newly fledged magpies in the population.

Because three of the five great horned owl nests were located near the study area boundaries, the following considerations are necessary. The observed nesting range of the western great horned owl is given as one square mile with a greatest diameter of one and one-half miles by Craighead and Craighead (1955). Within a radius of three-quarters of a mile of each great horned owl nest, or tethering site, about one percent of the magpie nests were located outside the boundaries of the study area. Therefore, considering the limited cruising radius of fledgling magpies, it may safely be assumed that the "magpie fledglings" observed at the tethering sites were from the study area. Thus a minimum number of 23 and 34 fledglings were removed from the population during the two years of the study. This represents a loss of 1.9 and 2.8 percent of the total number of fledglings, respectively, in the 1956 and 1957 populations.

SEASONAL MORTALITY

The seasonal occurrence of mortality, as represented by the recovery data in Table 22, was determined by field observations, rancher interviews, and band returns. About two hundred incidents of magpie mortality were observed in the field between December, 1956, and July, 1957. Seven band returns were obtained during this period through the Bird Banding Office of the Fish and Wildlife Service. The mortality of the remaining 400 was determined through rancher interviews. Of the 602 magpies listed in Table 22, 143 banded birds were observed and reported. Eighty-seven bands or band numbers were obtained from these recoveries. The majority of the residents on the study area considered magpies vermin and were thus more interested in killing birds than examining them for bands. Many band recoveries were facilitated by residents who first observed the more obvious and unusual color marker.

Table 22

Magpie Mortality Factors and the Seasonal Occurrences of Mortality
Data from Field Observations and Rancher Interviews
Excluding Nestling Mortality
1956 and 1957

Cause of Mortality	No. of Individuals Known Dead - Adult/Unknown Age/Young of Year						Age Class Totals	Total No.	% of Total
	Winter,56	Spring,56	Summer,56	Fall,56	Winter,57	Spring,57			
Shooting	1/5/1	0/20/34	1/10/50	0/82/5	0/71/2	1/0/23	5/188/115	308	51.2
Captured and killed by hand	1/0/0	0/0/6	0/0/15			0/0/1	1/0/22	23	3.8
Trapping	0/0/6		4/1/5	0/0/1	6/27/9	1/0/1	11/34/16	61	10.1
Marking, bill in neck marker	6/14/0	5/1/7	2/0/10			1/0/0	14/15/17	46	7.6
Great horned owl		4/1/25	0/0/2	1/2/0	0/1/1	3/0/35	8/4/63	75	12.5
Avian predator			0/1/2		7/0/2	0/0/1	7/1/5	13	2.2
Mammalian predator		0/0/1			0/0/2	2/0/3	2/0/6	8	1.3
Unknown predator	0/2/0	1/3/2	0/1/5		7/5/8	0/0/2	8/11/17	36	6.0
Unknown cause	0/1/0	1/1/1	0/0/4	1/5/8	2/3/1	0/0/1	4/10/15	29	4.8
Accidental			0/0/3				0/0/3	3	0.5
Seasonal age class totals	8/28/1	11/26/76	7/13/96	4/89/14	22/107/25	8/0/67	60/263/279	602	100.0
Total number	37	113	116	107	154	75	602		

The seasonal occurrence of mortality is indicated by the data presented in Table 22. Differences between seasonal mortality totals undoubtedly reflect variations in the intensity and effectiveness of field investigations during each year.

The most significant data in terms of the population appears to be represented by the preponderance of birds of the year in the mortality age ratios. During the study period the total mortality age ratio of birds of the year to adults was 279 to 60, or 4.6 to 1. The annual losses determined from Table 22, beginning with the spring of 1956, may be expressed as a sample of the age ratio of the mortality rate. The yearling to adult ratio of this rate is 4.8 to 1. This may be compared to yearling and adult ratios of annual mortality rates of 3.6 to 1 found in the common swift (*apus apus*) by Lack (1954) and of 1.8 to 1 found in the song sparrow (*Melospiza melodia*) by Nice (1937).

NESTING RANGES AND TERRITORIES

Procedure:

An early attempt to determine the size of nesting ranges of marked magpies during the course of making nest observations was not successful. This was primarily due to the wariness exhibited by nesting magpies in response to the presence of the observer. An observation area was then selected which was located below a 200 foot terrace in the southwest corner of the study area. Through the use of a pair of 6 power binoculars and a 21 power spotting scope, the observer, situated on the hillside, was able to observe movements and activity of marked and unmarked nesting magpies within a three-quarter mile radius. These data were recorded on activity form sheets (see Appendix) and on outline maps pantographed to double scale from eight-inch-to-the mile aerial photographs. The nest locations and nesting status of the observed pairs had been determined through previous nest searches. Once each nesting season the areas were observed through a complete daylight period. Other observations were made during the early morning and late afternoon. No schedule was followed, as observations were made during periods of time available between nesting searches of the study area.

Observations were not continued on the 1956 area the following year. A decrease in the number of nesting pairs, and a shift in land use from grazing to hay and grain farming completely altered the activity pattern of the nesting magpies. On an area located one mile east of the previous observation site five nesting pairs, including four marked birds, were observed during the 1957 nesting season.

Nesting Ranges:

The observed nesting ranges are represented in Figures 3 and 4 by solid lines which connect the most distant points of observation of one nesting pair. The number of these observations per pair is given in Tables 23 and 24. In the case of unmarked birds, only observed flights from the nest to distant foraging sites were recorded. The size of an observed nesting range is expressed in terms of the greatest diameter in miles.

Table 23

Observed Magpie Ranges and Territories - 1956

Nest No.	Ranges: Number of Observations	Ranges: Range Dia. Miles	Territories: Number of Observations	Territories: Terr. Dia. Miles/Ft.	Marking: Male	Marking: Female
1	6	.34	6[1]	-	Yellow neck jesse	Yellow neck jesse
2	11	.33	2[1]	-	Unmarked	Unmarked
3	5	.35	5	.087/460	White neck jesse	Yellow neck jesse
4	10	.40	11	.112/600	Unmarked	Unmarked
5	7	.42	11	.069/360	Red neck jesse	Unmarked
6	12	.58	8	.075/400	Unmarked	Unmarked
Averages	8.5	.40	8.8	.086/455		

Inclusive Dates of observations 5/8 - 6/21
Number of hours observed - 33

[1] Not included in the calculations

Table 24

Observed Magpie Ranges and Territorial Defense - 1957

Nest No.	Ranges: Number of Observations	Ranges: Range Dia. Miles	Terr. Defense: Number of Observations	Marking: Male	Marking: Female
1	11	.39	0	Unmarked	Yellow leg jesse-right
2	12	.36	2	Red leg jesse-left	Unmarked
3	14	.32	2	Unmarked	Unmarked
4	19	.41	2	Yellow leg jesse-left	Leg band, left leg
5	7[1]	.26[1]	1	Unmarked	Unmarked
Averages	14	.37			

Inclusive dates of observations 4/17-6/19
Number of hours observed - 28

[1] Not included in the calculations

No quantitative data relating to the nesting ranges of the magpie are available in the literature. From Tables 23 and 24, the average maximum diameters of six and four observed nesting ranges during the 1956 and 1957 nesting seasons were 0.40 and 0.37 miles, respectively. From these data it appears that during the nesting cycle, from the laying period to approximately one week past the fledging period, the range of a nesting pair of magpies in riparian areas of the study area may include approximately one-half a square mile. This represents a considerable restriction in ranging activity when compared to intermittent flight distances of from one and one-half/to three miles which were commonly observed during the post-nesting season.

Nesting Territories:

Lindsdale (1937) from general field observations of unmarked magpies concludes, "It is difficult to separate the actions of the nesting time, which have to do with territory, from other phases of the life cycle

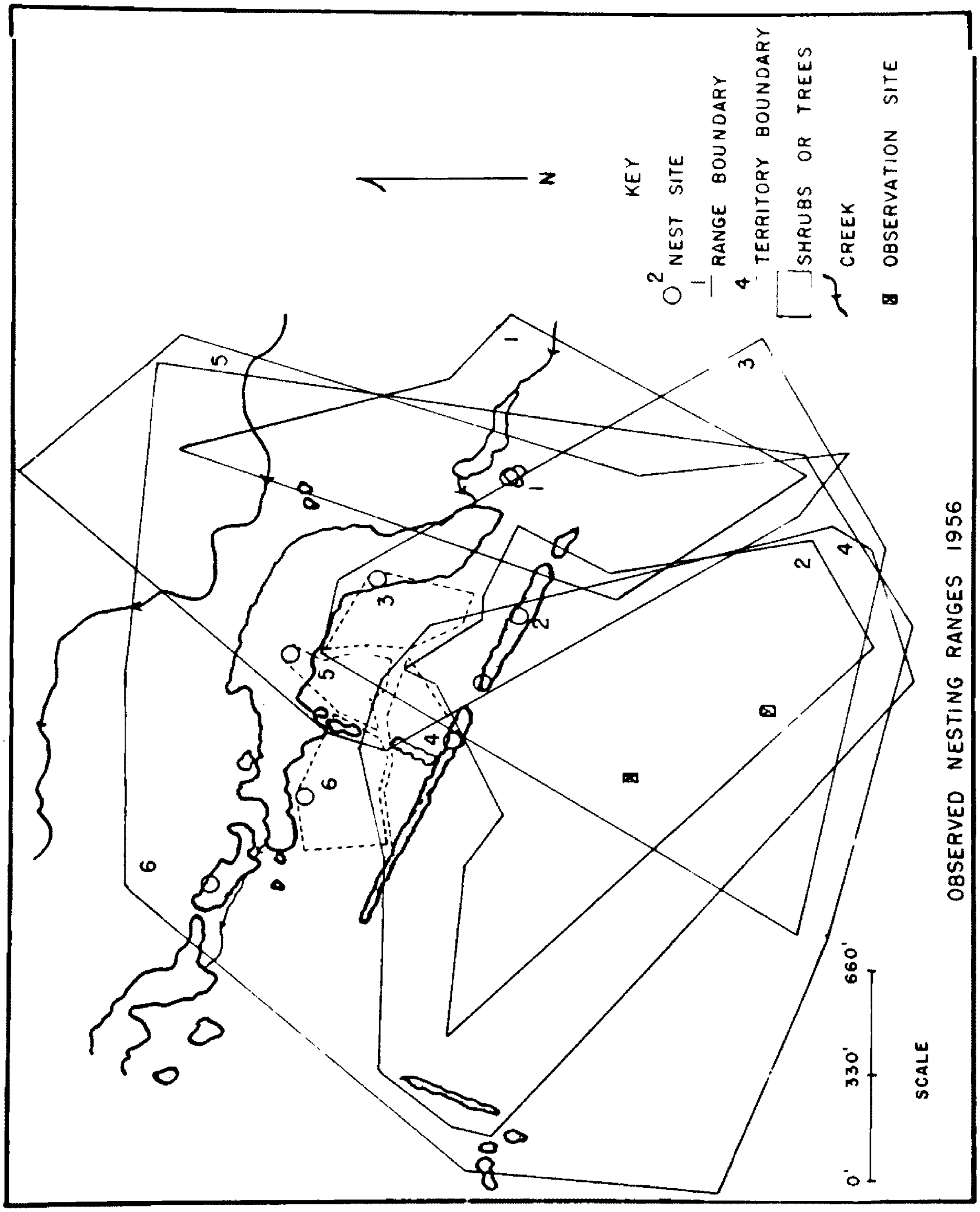
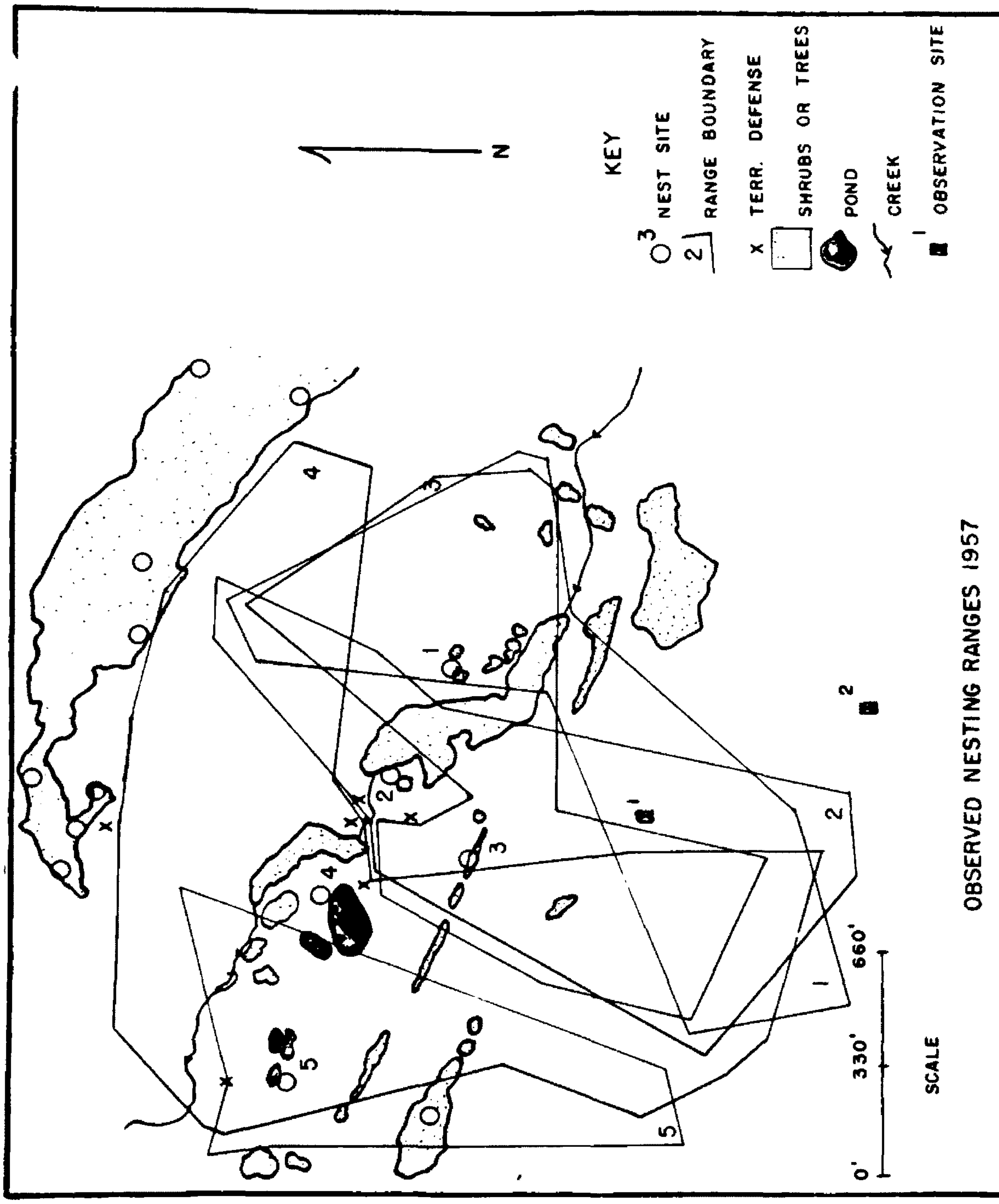

N
KEY
NEST SITE
RANGE BOUNDARY
TERRITORY BOUNDARY
SHRUBS OR TREES
CREEK
OBSERVATION SITE
OBSERVED NESTING RANGES 1956
0'
330'
660'
SCALE

Figure 3



N
KEY
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RANGE BOUNDARY
TERR. DEFENSE
SHRUBS OR TREES
POND
CREEK
OBSERVATION SITE
OBSERVED NESTING RANGES 1957
SCALE
0'
330'
660'

Figure 4

of the bird." Hartkorn (1949) through intensive nest observations of unmarked birds, also found no positive evidence of territorial behavior in the magpie.

From a series of intensive observations made during intermittent periods of two nesting seasons, it appears that the magpie definitely exhibits territorial behavior. The intraspecific defense observed was primarily directed toward the defense of the immediate area surrounding the nest, and secondarily toward the defense of a feeding area surrounding the nest. This type of territorialism may be designated a combination of type a (nesting and feeding) and type b (nesting only), from a classification of bird territories by Nice (1941). The territorial behavior exhibited by chasing and fighting was directed toward the displacement of intruding individuals away from an area surrounding the nest. The male was primarily engaged in this activity, being joined occasionally by the female.

An insufficient number of observations was made to adequately describe the establishment of the territory. The number of times a nesting bird was observed to defend its feeding territory through fighting or bodily contact is included under territorial observations in Table 23. A sufficient number of these observations were made in 1956 to delimit four feeding territory boundaries. The greatest diameters of these areas varied between 360 and 600 feet.

On the 1956 area the feeding territories were maintained from the time of egg laying to the time of flying young by decreasingly aggressive defensive behavior. This began with frequent fighting and chasing, which became less frequent during the nestling period, to be largely replaced by intimidation in the form of directional, rather hurried foraging toward the intruder. In the latter case, almost invariably before the defender approached within 20 feet, the intruder retreated by walking, flying, or combinations of both. Quite often the behavioral sequence was repeated in the reverse direction if the retreating bird was followed approximately 20 feet into his territory. This reciprocating defense behavior across feeding territory boundaries was observed to occur as often as three times in succession. With the approach of the fledging time, the nesting pairs foraged more frequently at distant, common foraging areas. In the absence of the defenders, frequent encroachment of the feeding territories by neighboring birds occurred. As the young approached the flying stage, feeding territories were no longer evident.

Considerable variation was observed between the behavior of nesting pairs on the two observational areas in the degree territorialism was exhibited in relation to the defense of a feeding area. On the 1957 area the nesting pairs exhibited much weaker territorialism in relation to the defense of a feeding area surrounding the nest (Table 24). Boundaries of these areas were not clearly evident because of the infrequent occurrence of territorial defense in the form of fighting. The extent to which territorial defense of a feeding area was exhibited appears to be dependent upon the relation of nest locations to available ground-foraging areas. The nests on the 1956 area were located in tree-shrub cover surrounding one area of irrigated grassland cover: On the 1957 area the nests were located in tree-shrub cover interspersed through irrigated grassland cover. On the former observational site intensive foraging activity by the nesting pairs was primarily observed on the single open ground grassland area with strong territorialism evident. On the later observational site extensive foraging activity by the nesting pairs on a number of open grassland areas was primarily observed with weak territorial evident.

Vigorous intra- and inter-specific defense of the nest site by nesting pairs was observed during both nesting seasons. Nesting pairs were never observed to allow other magpies to remain in the nest tree or near the nest structure, even in the presence of various mammalian predators. Inter-specific defense of the nest site by nesting magpies was observed against the presence of domestic cats (Felis domestica), red squirrels (Tamiasciurus hudsonicus), short-tailed weasels (Mustela erminea), crows (Corvus brachyrhynchos), starlings (Sturnus vulgarus), robins (Turdus migratorius), and kingfishers (Megaceryle alcyon).

Summary

Considerable variations were observed in the specific ranging and territorial behavior of nesting magpies on two observational areas. The size of a nesting range or a feeding territory was represented by the greatest distance between peripheral observations, or greatest diameter. The average size of ten observed nesting ranges was 0.39 miles, with the largest being 0.58 miles, and the smallest 0.33 miles. The average size of four feeding territories observed on the 1956 area was 450 feet. No feeding territory boundaries were delimited on the 1957 area because territorialism was rather weakly exhibited. There appeared to be less competition for feeding areas when tree-shrub nesting cover was interspersed through open grassland cover. The defense of nesting sites was strongly exhibited throughout both nesting seasons.

SUMMARY

1. A study of the population ecology of the American Magpie (Pica pica hudsonia) was conducted on a six square mile area in the Burnt Fork Valley of Western Montana during 1956 and 1957.

2. The distribution and composition of tree-shrub associations was indicated on a cover map. The present type and distribution of vegetation was largely affected by cultivation, irrigation, and grazing, the occurrence of which were quantitatively expressed.

3. During the investigation 1,371 magpies were banded and 771 were also color marked with colored plastic neck or leg markers.

4. The reliability of sexing and ageing techniques was indicated. Bill length and body weight as criteria of sex indicated true sex 84 per cent of the time. Foot pad length was determined as a criterion of sex, being reliable 102 times out of 105, or in 97 per cent of the cases. Retrice shape was found 100 per cent reliable as a criterion of age from 52 known age magpies.

5. The nesting density and reproductive success of the nesting populations were determined from observations of 731 active magpie nests on the 6.3 square mile study area during both years of the study.

6. The total density was 348 and 351 nesting pairs, respectively, during 1956 and 1957. The average density was 55.5 nesting pairs per section during each nesting season.

7. The factors affecting the reproductive rate of 2,314 eggs from 348 nesting pairs in 1956 and of 2,439 eggs from 351 nesting pairs in 1957 were: An average clutch size of 6.41 from 229 nests in 1956 and 6.59 from 274 nests in 1957; a normal occurrence of single clutches being laid with second clutches from renesting pairs composing 2.6 per cent of

the total eggs produced during both nesting seasons; a determination of the minimum breeding age of one year for the magpie from observations of 18 known age yearlings carried on nesting activity; and a sex ratio of the population of 1:1 from 525 trapped birds sexed using the various sexing criteria, and from 105 specimens collected and sexed.

8. The nesting success of the magpie populations was expressed in terms of the survival of eggs and young to the hatching or fledging stage. During both years of the investigation the percent of the eggs laid hatching was 58.2, the percent of young fledging from eggs laid was 51.3 percent, and the percent of young fledging from eggs hatching was 88.1.

9. No relation was evident between survival of eggs and young and clutch or brood size. Relative indications of mortality factors were presented. Man and pine squirrels were the major known predators causing 14 and 12 percent of the nesting failures during both years of the study.

10. During the investigation no organized magpie control program was in effect. Considerable effort was made to study the populations under "normal conditions". A potential rate of increase of 330 percent of the nesting population was indicated by the number of eggs produced in 1956. This increase was reduced to 150 percent by the end of the nesting period when 1,225 fledglings were produced by 796 nesting birds. Through a differential rate of mortality in the age classes, the age ratio approached 1:1 by the winter period. By the following nesting season natural regulating mechanisms reduced the population to essentially the same level as the previous year.

11. The minimum extent of post nesting mortality from only one predator, the great horned owl, was 57 fledgling magpies, or 2.3 percent of the annual increment of the magpie populations during both years. Tethering techniques were employed in the collection of these data.

12. The mortality of 602 magpies was determined through field observations, resident interviews, and band returns. These data were presented in terms of magpie age classes in relation to mortality factors and seasonal occurrence of mortality. Man was the most important mortality factor with shooting the cause of 51 percent of the mortality indicated. The mortality age ratio of yearlings to adults was 4.5 to 1.

13. Nesting ranges and territories were determined from intensive observations made at two sites on the study area. The average size of 10 observed ranges expressed in terms of the greatest diameter was 0.39 miles. Four feeding territories on the 1956 site had an average greatest diameter of 400 feet. Considerable variation was observed in the specific ranging and territorial behavior of nesting magpies on the two observational areas.

APPENDIX

Table 25

Nesting Magpie Population Composition

Determined through Field Observations during Nesting Seasons of 1956 and 1957

I 1956

Nesting Birds Observed at the Nest	None	One	Pair
Number observed	220	96	45

Marked and Unmarked Nesting Birds Observed	Male	Female	Total
Yellow neck marker	14	4	18
Observed unmarked	85	95	180
Percent of nesting population known to be winter residents	16	4	10

II 1957

Nesting Birds Observed at the Nest	None	One	Pair
Number observed	208	91	71

Sex and Age Ratio of Observed Segment of Population (Based upon Marking, Leg Banding, and Behavior).

	Male		Female		
	Adult	Yearling	Adult	Yearling	Totals
Type and color of observed marker:					
White leg	2				2
Yellow neck	6		3		9
Yellow leg	9		5		14
Red leg		9		6	15
Orange neck		2			2
White neck				1	1
Totals marked	17	11	8	7	43
Total observed unmarked	55	2	72	6	135
Total observed without leg bands	51	4	29	7	91
Total observed with leg bands	13	6	9	6	34

Table 26

Magpie Winter Population Sex and Age Composition

Determined from Live Trapped Population Sample During Winters of 1956 and 1957

I Winter 1956

Segment of Sample	Adult		Yearling	
	Male	Female	Male	Female
Initial captures	79	62	52	64

Sex Ratios	Actual Numbers	Terms of 100
Initial captures:		
Adult male:adult female	79:62	56:44
Yearling male:female	52:64	45:55
Total male:female	131:126	51.49
Age ratios		
Initial captures:		
Adult:yearling	141:116	55:45

II Winter 1957

Segment of Sample	Adult		Yearling	
	Male	Female	Male	Female
Initial captures	44	48	52	78
Recaptures (banded winter, spring, and fall of 1956)	13	14	9	8
Recaptures (banded winter, spring of 1956):				
1½ year class	5	7		
2½ year class	4	3		
Total	9	10		

Sex Ratios	Actual Numbers	Terms of 100
Initial captures:		
Adult Male:female	44:48	48:52
Yearling male:female	52:78	40:60
Total male:female	96:126	43:57
Recaptures:		
Adult male:female	13:14	48:52
Yearling male:female	9:8	53:47
Total male:female	22:22	50:50
Total sample:		
Male:female	118:148	45:55
Age ratios		
Initial captures:		
Adult:yearling	92:130	41:59
Recaptures (banded winter, spring of 1956)	19:17	53:47
earling	7:12:17	20:32:47
winter, spring, and		
	119:147	45:55

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