Some population parameters of Iowa coyotes and an analysis of reported livestock losses

by

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INTRODUCTION

A combination of factors has resulted in recent nationwide interest in the study of the coyote (*Canis latrans*). The issuance of Executive Order 11643 in February 1972, and the subsequent withdrawal by the Environmental Protection Agency of the registration of toxicants used in predator control effectively halted the chemical control of predatory animals. These actions, at a time when the demand for production of food and fiber is increasing, have spurred research on coyote populations, their impact on livestock production, and on techniques of predator damage control.

The first study of the coyote in Iowa was initiated by Mathwig (1973) to obtain general information on coyote food habits, populations, and reported livestock losses. Since that investigation, livestock damage complaints and the number of coyotes claimed for bounty each year have continued to increase, with over 7000 coyotes claimed for bounty in the state in 1974. The coyote currently has the status of a game animal in Iowa, without any restrictions on season or bag limit. Before more intensive management can be justified or evaluated, more quantitative information is needed with regard to coyote population levels, movements, and actual and potential effects of coyotes on livestock production in Iowa.

The objectives of the present study were: 1) to obtain more detailed information on the age and sex composition of coyote populations in the state; 2) to attempt to find and evaluate a suitable index for monitoring coyote population densities; 3) to obtain information on the chronology and magnitude of livestock losses in the state; and 4) to gather preliminary information on coyote movements and mortality factors.

The age composition of natural populations of coyotes has been determined from tooth wear (Gier 1968), by counting the cementum annuli of the tooth root (Knowlton 1972; Mathwig 1973; Chesness 1973), and by analyzing tag return data in combination with aging (Nellis and Keith, unpublished ms.[1]). More detailed analyses of population structure in local areas are still needed.

Attempts to determine coyote densities have generally been unsuccessful, largely because of the animal's extreme mobility and because of the difficulty in making direct observations. Methods attempted for estimating relative numbers of coyotes include: catch-per-unit-effort; elicited howling responses, aerial surveys; scent-post visitations; Humane Coyote-getters or M-44 devices set in standard lines; and capture-recapture techniques (Robinson 1961; Pimlott and Joslin 1968; Denver Wildlife Research Center, unpublished progress report, 1970-1971; Clark 1972; Knowlton 1972; R. B. Roughton, U.S. Fish and Wildlife Service, Logan, Utah, personal communication; Nellis and Keith, unpublished ms.). The only technique in general use at this time, to my knowledge, is the scent-post visitation index which is being evaluated in the western states (R. B. Roughton, personal communication). Attempts to estimate absolute densities of coyotes have involved analysis of bounty

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[1]Manuscript provided by Carl H. Nellis, Idaho Department of Fish and Game, Garden City, Idaho.

records in combination with reproductive data, and mark-recapture (Lincoln Index) techniques (Bennitt 1948; Gier 1968; Nellis and Keith, unpublished ms.). None of the techniques mentioned above has been evaluated fully enough to substantiate its validity for monitoring changes in coyote abundance.

Most studies have dealt with livestock depredations by coyotes either indirectly or incidentally through interpretation of food habits (Sperry 1941; Murie 1945; Ferrel et al. 1953; Fichter et al. 1955; Tiemeier 1955; Korschgen 1957, 1973; Hawthorne 1971; Gipson 1974). Gier (1968) summarized data on livestock losses from the annual farm census as well as analyzing food habits of coyotes in Kansas. Bowns et al. (1973) initiated a study of sheep losses in Utah in which all possible kills were verified and photographically documented and Early et al. (1974a, 1974b) reported results of an economic study of predation on sheep in Idaho. To my knowledge, there is currently no quantitative appraisal of sheep losses being conducted in any of the "farm" states.

Limited information is available on the home range of coyotes and data on dispersal is almost nonexistent (Robinson and Cummings 1951; Young and Jackson 1951; Robinson and Grand 1958; Chesness 1972; Hawthorne 1971; Gipson and Sealander 1972; Nellis and Keith, unpublished ms.). Mathwig (1973) tagged eight coyotes in western Iowa. Dispersal is probably the most important aspect of coyote movements with regard to management schemes because it provides the means for restocking areas where removal has been the primary objective of coyote management (Knowlton 1972).

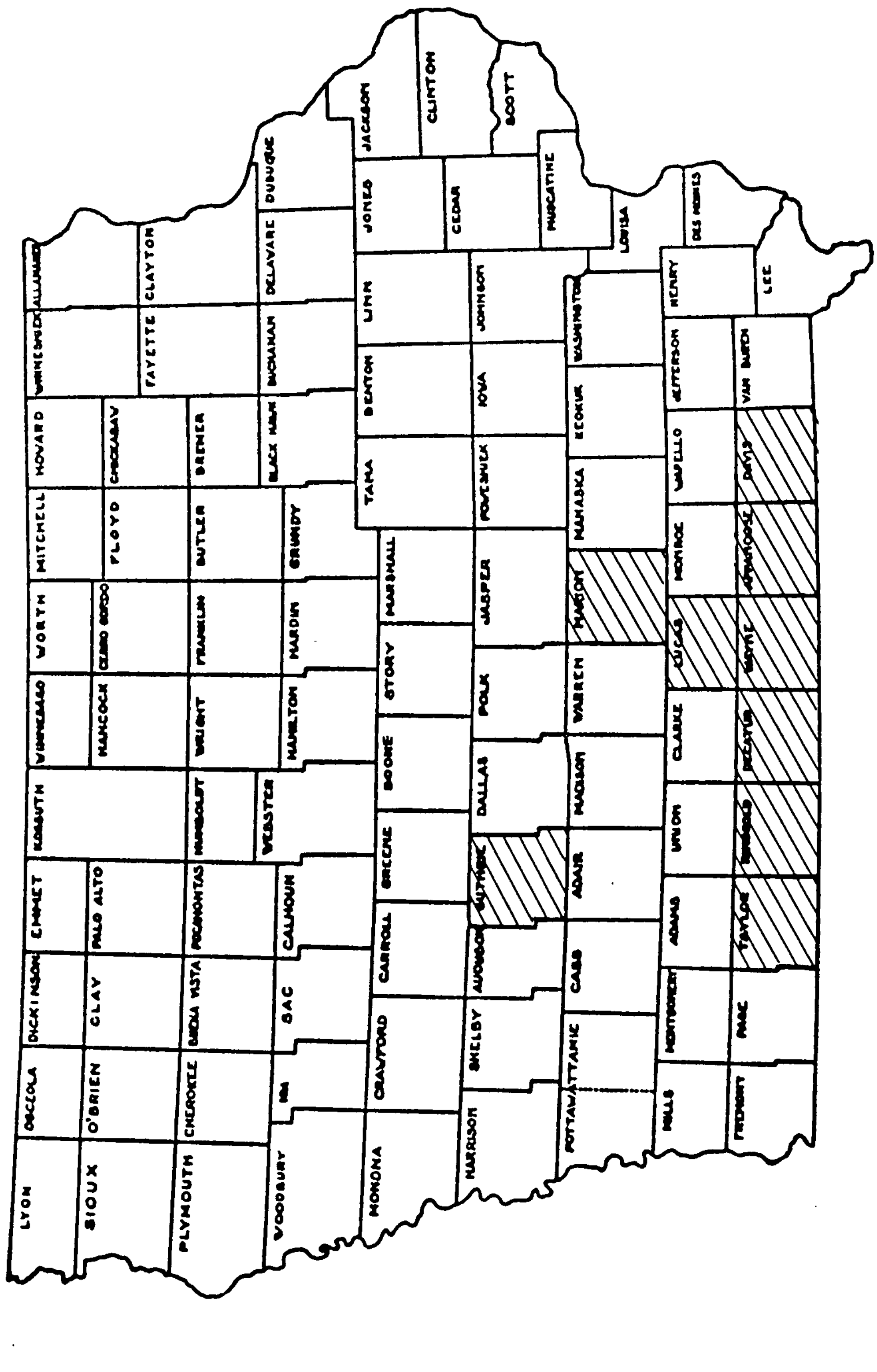
STUDY AREA

A nine-county study area containing substantial numbers of both coyotes and sheep was selected in southcentral Iowa (Fig. 1). The present topography of the area is gently rolling to hilly and represents remnants of an undulating to level till plain which was modified by erosional processes following the retreat of the Kansan glaciers (Oschwald et al. 1965). The soils on the area were formed from loess or glacial till, primarily under prairie vegetation, although on the steeper slopes soils were formed under oak-hickory or mixed forest-grassland vegetation (Oschwald et al. 1965).

Vegetative coverage estimates are based on information compiled from the Iowa Assessors Annual Farm Census (1973). Approximately 50 percent of the area is in crop production including corn (Zea mays), soybeans (Glycine max), oats (Avena sativa), alfalfa (Medicago sativa), and red clover (Trifolium pratense). Approximately 35 percent of the area is in permanent pasture, including some brushy and old-field areas. The major pasture grasses are bluegrass (Poa pratense) and smooth brome (Bromus inermus). Some of the idle upland areas contain native prairie species, including Indian grass (Sorghastrum nutans), big bluestem (Andropogon gerardii), little bluestem (Andropogon scoparius), and some of the prairie forbs.

Timbered draws and uplands make up approximately 15 percent of the area. The dominant canopy species in the upland areas are oak (Quercus sp.) and shagbark hickory (Carya ovata). The major components of the understory are ironwood (Ostrya virginiana), buckbrush (Symphoricarpos orbiculatus), hazelnut (Corylus americana), and gooseberry (Ribes sp.).

Fig. 1. Counties where field investigations were conducted 1973-1974


LYON
SIOUX
PLYMOUTH
WOODBURY
MONONA
HARRISON
POTTAWATTAMIE
MILLS
FREMONT
OSCEOLA
O'BRIEN
CHEROKEE
IDA
CRAWFORD
SHELBY
MONTGOMERY
PAGE
DICKINSON
CLAY
BUENA VISTA
SAC
CARROLL
AUDUBON
CASS
ADAMS
TAYLOR
EMMET
PALO ALTO
POCAHONTAS
CALHOUN
GREENE
GUTHRIE
ADAIR
UNION
RINGGOLD
KOSSUTH
HUMBOLDT
WEBSTER
BOONE
DALLAS
MADISON
CLARKE
DECATUR
WINNEBAGO
HANCOCK
WRIGHT
HAMILTON
STORY
POLK
WARREN
LUCAS
WAYNE
WORTH
CERRO GORDO
FRANKLIN
HARDIN
MARSHALL
JASPER
MARION
MONROE
APPANOOSE
MITCHELL
FLOYD
BUTLER
GRUNDY
TAMA
POWESHIEK
MAHASKA
WAPELLO
DAVIS
HOVARD
CHICKASAV
BREMER
BLACK HAWK
BENTON
IOWA
KEOKUK
JEFFERSON
VAN BUREN
WINNESHIEK
FAYETTE
BUCHANAN
LINN
JOHNSON
WASHINGTON
HENRY
ALLAMAKEE
CLAYTON
DELAVARE
DUBUQUE
JONES
CEDAR
MUSCATINE
LOUISA
DES MOINES
LEE
JACKSON
CLINTON
SCOTT

Timbered draws are dominated by boxelder (Acer negundo), cottonwood (Populus deltoides), and dead American elm (Ulmus americana). Bottomland areas are composed primarily of silver maple (Acer saccharinum), American basswood (Tilia americana), and willow (Salix sp.).

Since 1960, the number of people living on farms in the study area has decreased by approximately 35 percent which has resulted in a reduction in the total number of farms and in a 34 percent increase in the average size of farms (calculated from Iowa Assessors Annual Farm Census, 1960-1973). Most sheep production on the area involves relatively small farm-flocks which lamb in sheds and are allowed to graze on open pasture during the summer months.

METHODS

Age Determination

All coyotes aged in this study were collected during the months of January and February from furbuyers at six locations in southern and western Iowa (Fig. 2). Entire skinned carcasses were taken to the laboratory where they were processed for aging, food habits analysis, and examination of female reproductive tracts. Whole coyotes were weighed, when available, but were not collected.

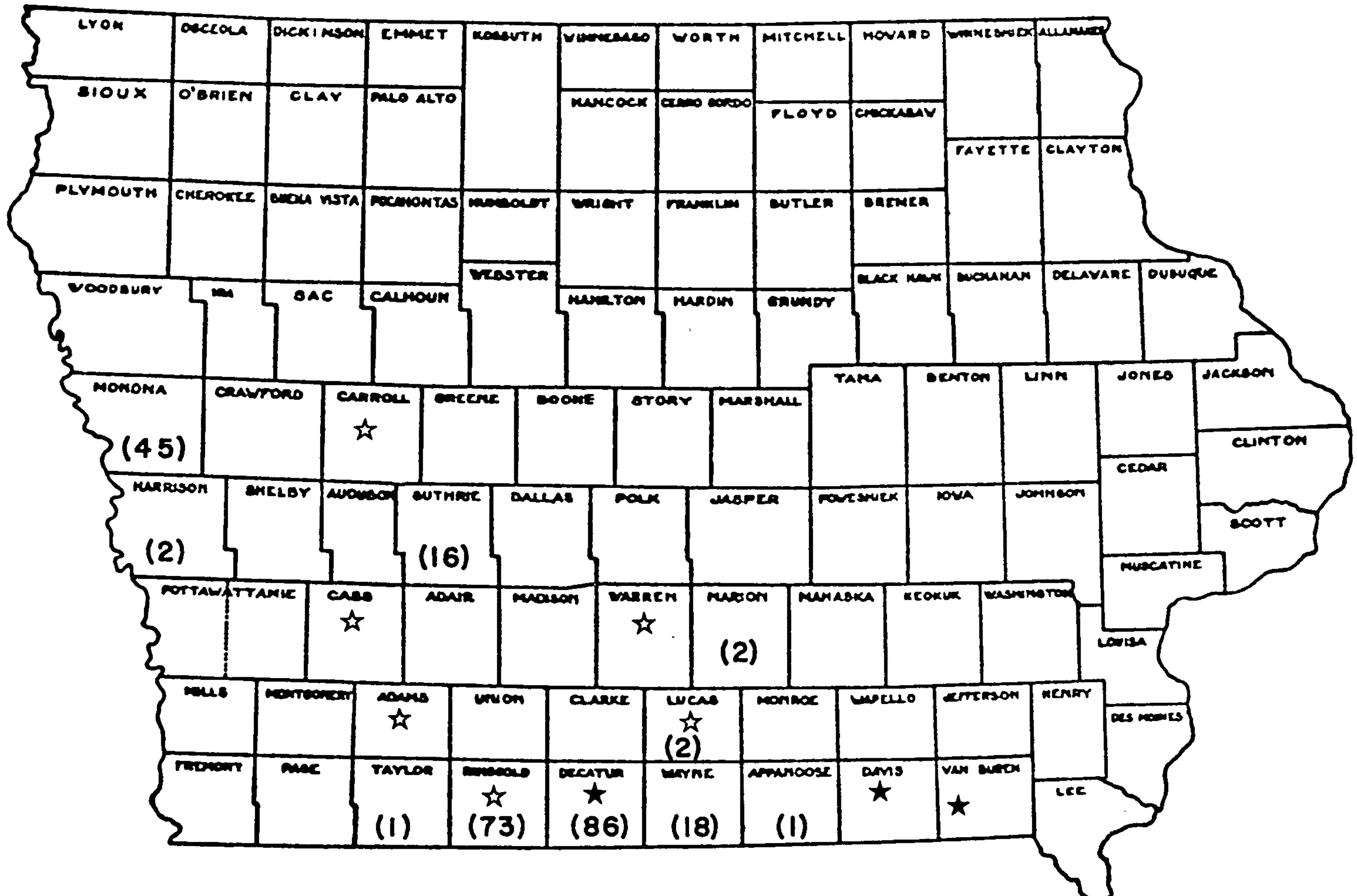
A canine tooth was extracted from each coyote, decrowned, and the relative widths of the dentin and pulp cavity were determined with a Helios dial calipers. The tooth root was then sectioned, stained, and mounted on a glass slide by a commercial microscopic company (Matson, Box 308, Milltown, Montana). A subsample of coyotes to be aged was randomly selected from the overall total each year because limited funds were available for tooth sectioning. Tooth sections were examined under a compound microscope for the presence of annuli and coyotes less than two years old were aged by the relative width of the pulp cavity and the thickness and extent of the cementum layer (Linhart and Knowlton 1967).

Estimation of Population Density

Siren index

During the summers of 1973-1974, attempts were made to use elicited howling responses from coyotes as a basis for an index to their

Fig. 2. Collection sites for carcasses, summer stomachs, and scats examined in this study



☆ CARCASS COLLECTIONS

★ SUMMER STOMACHS

( ) NUMBER OF SCATS

relative density. The technique used was the same as that described in an unpublished annual progress report of the Denver Wildlife Research Center (1970-1971). A Dominator electronic siren was sounded at 3-mile (4.8 km) intervals along a pre-established 27-mile (43.4 km) route in each county, beginning approximately 0.5 hours after sunset. At each of 10 stations the siren was sounded for two complete pitch cycles, followed by a 1-minute listening period, then again for two pitch cycles, followed by a final 2-minute listening period. Routes were each run either two or three times per county in 1973 and four times per county in 1974. At each station the number and direction of responding groups were noted and an attempt was made to distinguish adults from juveniles by the difference in pitch of their howling. An attempt was made to survey each county at approximately the same time of the summer each year.

Scent-post survey

During the summer of 1974, another population index was tested which involved visitation to scent-stations as determined from tracks. The technique followed that employed by the U.S. Fish and Wildlife Service in the 17 western states for the past three years (R. B. Roughton, personal communication). Basically, a scent-station route consisted of 50 three-foot circles of sifted dirt placed at 0.3-mile (0.48 km) intervals on the shoulders of alternating sides of a road. A plastic capsule containing a fermented egg attractant was placed in the center of each station. Routes were run for either three or four days instead of the recommended five-day period because of inclement weather. Identifiable tracks for all species of animal visiting the stations were recorded.

Collection of Livestock Loss Data

Domestic animal claims

Most Iowa counties collect taxes on dogs from which they provide partial compensation to owners of domestic animals allegedly killed by dogs or "wolves" (coyotes). To collect compensation, a claimant is required to file a claim at the local county courthouse which must bear the signature of one, or usually two, witnesses. The claims are paid regardless of whether the animal was killed by a dog or by a coyote.

Claims were examined individually at county courthouses and the number, age, sex, value, and species of domestic animal claimed were recorded. In addition, the animal allegedly responsible for the kill, if specified, was recorded as was the name of the claimant.

Food habits

Winter food habits were investigated by analyzing the stomach contents of coyotes collected in 1973, only. During the summers of 1973-1974, wide-mouth gallon jars containing formaldehyde were left with hunters known to take coyotes at that season of the year along with a request for them to save the stomachs of any coyotes they killed. Scats were collected whenever found, placed in paper envelopes, and labeled as to date and location.

Analysis of food habits basically followed the procedures described by Korschgen (1971). All stomach and scat contents were washed in a screen sieve under hot running water and oven-dried for at least 24 hours. Volumes of all contents were determined by water displacement. For scats, volumes of individual food items were estimated visually as a proportion of the total because food items were seldom easily segregated. All food items were identified to species when possible with the aid of a reference hair collection and hair keys by Stains (1958) and by Adorjan and Kolenosky (1969).

Ear-Tagging

Tagging at dens

During the spring of 1972, R. D. Andrews of the Iowa Conservation Commission initiated an effort to tag coyote pups at dens in south-central Iowa. He enlisted the aid of local hunters who were familiar with the area and who were adept at locating dens. That tagging effort was continued in 1973 and 1974 as part of the present study.

Once a den was located, the entrance was excavated and the pups were captured by hand. Very young pups were tagged with small monel metal tags (National Band and Tag Company, Newport, Kentucky) and older pups having larger ears were tagged with button-type aluminum tags or with self-punching plastic rotating tags (Nasco, Inc., Fort Atkinson, Wisconsin). All pups were tagged in both ears, sexed, and approximately aged.

Trapping

During July, 1973, a trapping program was initiated to increase the sample size of coyotes tagged. Family groups of coyotes were located for trapping with the aid of the siren, usually during daylight hours. Once the coyotes were located, 3 to 12 Victor coilspring number two or number one and one-half traps were set in the area. Some traps were padded with electrical tape but this apparently had little effect on injuries and was discontinued. Traps were left set in an area for three or four days and then moved to a new location. Trapped coyotes were tagged in both ears with self-punching plastic tags or, occasionally, with aluminum button tags.

RESULTS

Population Structure

Ages were determined for 130 of 313, 129 of 173, and 130 of 319 coyotes collected in 1973, 1974, and 1975, respectively. Time-specific life tables (Deevey 1947; Quick 1963; Eberhardt 1971) were calculated for all coyotes aged and for males and females separately (Tables 1 and 2).

A regression estimate of the survival rate (Eberhardt 1971; Chapman and Robson 1960) was obtained by calculating the least-squares regression of the natural log of the survivorship (lx) on age (Fig. 3). The negative slope of the regression line was expressed as a positive decimal survival rate by finding its negative antilog (Table 3). Slopes of the regression lines were tested for significant differences using Student's t-tests (Snedecor and Cochran 1967). Calculated survival for coyotes collected in 1973 was significantly ($P<0.01$) higher than in 1974 and 1975, which did not differ significantly. The calculated survival rate for males was significantly ($P<0.05$) higher than that for females in 1973 and 1975.

Survival rates were recalculated for each sample using the Chapman-Robson equation (Chapman and Robson 1960), excluding the first age-class which was inconsistent with the required assumption of a constant survival rate (Table 3). Calculated Q-values (Robson and Chapman 1961; Eberhardt 1971) for the second age-class did not indicate

Table 1. Life tables[a] for male coyotes collected 1973-1975

x	d'x 73	d'x 74	d'x 75	dx 73	dx 74	dx 75	lx 73	lx 74	lx 75	qx 73	qx 74	qx 75	e_x 73	e_x 74	e_x 75
1	42	42	39	592	627	500	1000	1000	1000	59.2	62.7	50.0	1.58	1.56	2.03
2	14	5	9	197	75	115	408	373	500	48.3	20.1	23.0	2.15	2.34	2.55
3	6	8	9	85	119	115	211	298	385	40.3	39.9	29.9	2.69	1.81	2.16
4	3	6	10	42	89	128	126	179	270	33.3	49.7	47.4	3.17	1.67	1.87
5	0	2	3	0	30	39	84	90	142	0.0	33.3	27.5	3.50	1.83	2.11
6	2	2	3	28	30	39	84	60	103	33.3	50.0	37.9	2.50	1.50	1.72
7	1	0	2	14	0	26	56	30	64	25.0	0.0	40.6	2.50	1.50	1.47
8	1	2	2	14	30	26	42	30	38	33.3	100	68.4	2.17	0.50	1.13
9	1	-	0	14	-	0	28	-	12	50.0	-	0.0	2.00	-	1.50
10	0	-	1	0	-	12	14	-	12	0.0	-	100	2.50	-	0.50
11	0	-	-	0	-	-	14	-	-	0.0	-	-	1.50	-	-
12	1	-	-	14	-	-	14	-	-	100	-	-	0.50	-	-

[a]x - age in years; d'x - actual number of deaths; dx - deaths per thousand; lx - survivors per thousand; qx - mortality rate; e_x - mean expectation of life in years.

Table 2. Life tables[a] for female coyotes collected 1973-1975

x	d'x			dx			lx			qx			e_x		
	73	74	75	73	74	75	73	74	75	73	74	75	73	74	75
1	35	37	27	593	597	519	1000	1000	1000	59.3	59.7	51.9	1.37	1.34	1.58
2	8	12	10	136	193	192	407	403	481	33.4	47.9	39.9	1.63	1.58	1.75
3	9	3	6	152	48	115	271	210	289	56.1	22.8	39.8	1.19	1.58	1.57
4	4	6	4	68	97	77	119	162	174	57.1	59.9	44.3	1.07	0.90	1.28
5	2	4	3	34	65	58	51	65	97	66.7	100	59.8	0.83	0.50	0.90
6	1	-	2	17	-	39	17	-	39	100	-	100	0.50	-	0.50

[a]x - age in years; d'x - actual number of deaths; dx - deaths per thousand; lx - survivors per thousand; qx - mortality rate; e_x - mean expectation of life in years.

Fig. 3. The least-squares regression of the plot of the natural log of the survivorship against age for all coyotes aged in this study

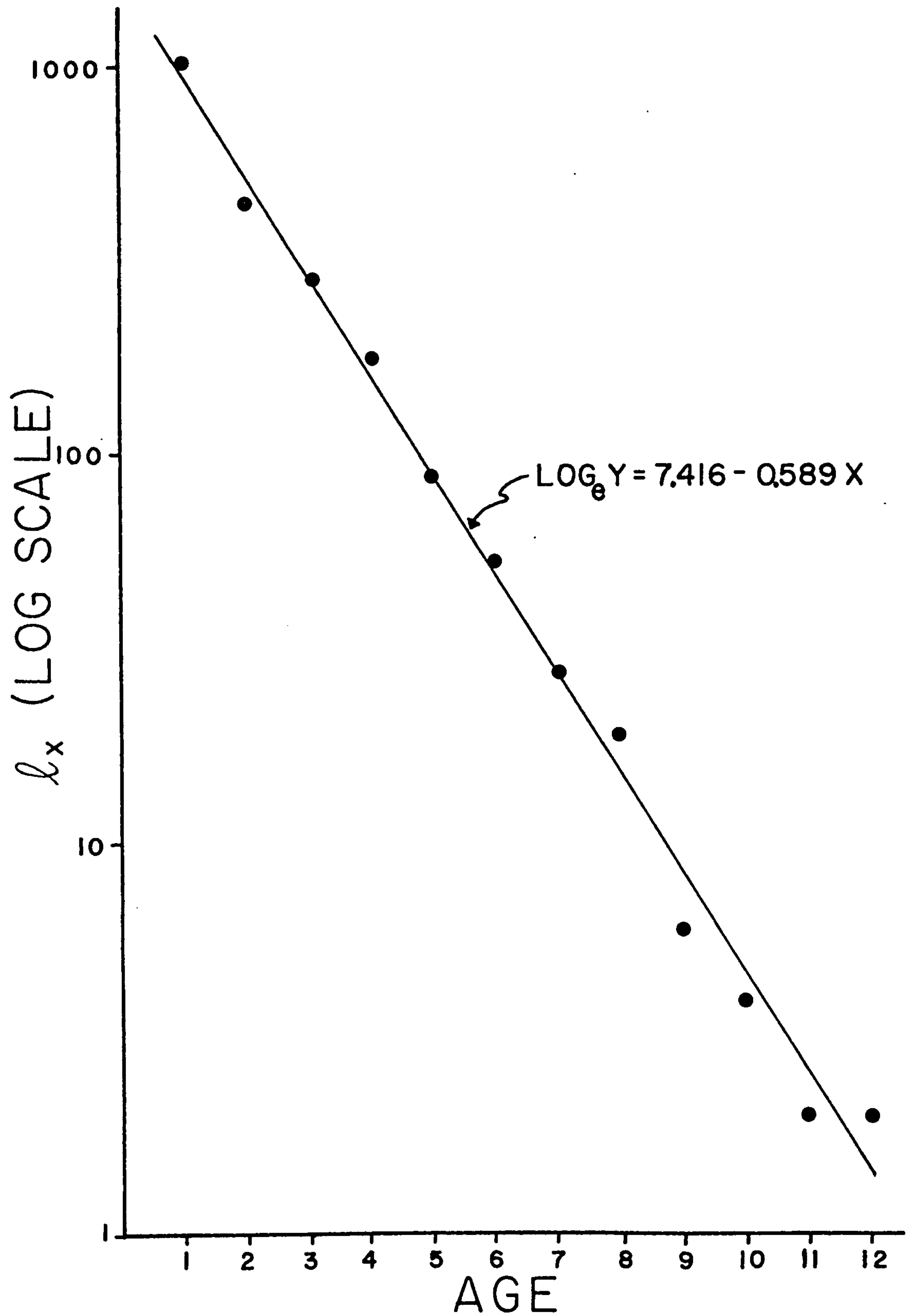

1000
100
10
1
ℓ_x (LOG SCALE)
$LOG_e Y = 7.416 - 0.589 X$
1
2
3
4
5
6
7
8
9
10
11
12
AGE

Table 3. Chapman-Robson and regression estimates of the survival rate, s, for all coyotes aged

Year / Sex	$\hat{s}^a$	95 Percent confidence interval	Q	Goodness-of-fit χ^2	Goodness-of-fit Degrees of freedom	Regression estimate of s^b
1973						
Males	0.631	0.531<s<0.731	2.59	13.90	9	0.689
Females	0.540	0.400<s<0.680	2.94	2.58	3	0.457
Both Sexes	0.591	0.493<s<0.689	0.01	11.13	9	0.642
1974						
Males	0.657	0.542<s<0.772	3.48	7.65	5	0.602
Females	0.529	0.390<s<0.668	0.02	6.98*	2	0.529
Both sexes	0.598	0.513<s<0.683	1.34	7.38	5	0.534
1975						
Males	0.678	0.589<s<0.767	2.19	6.20	7	0.608
Females	0.523[b]	0.431<s<0.615	0.71	2.65	4	0.541
Both sexes	0.638	0.566<s<0.710	1.84	4.89	7	0.574
All years						
Males	0.654	0.601<s<0.707	1.27	8.85	9	0.616
Females	0.538	0.458<s<0.618	1.81	4.81	3	0.470
Total	0.609	0.560<s<0.658	2.23	7.95	9	0.555

[a]Estimated survival excludes the first age-class.

[b]Estimated survival includes the first age-class.

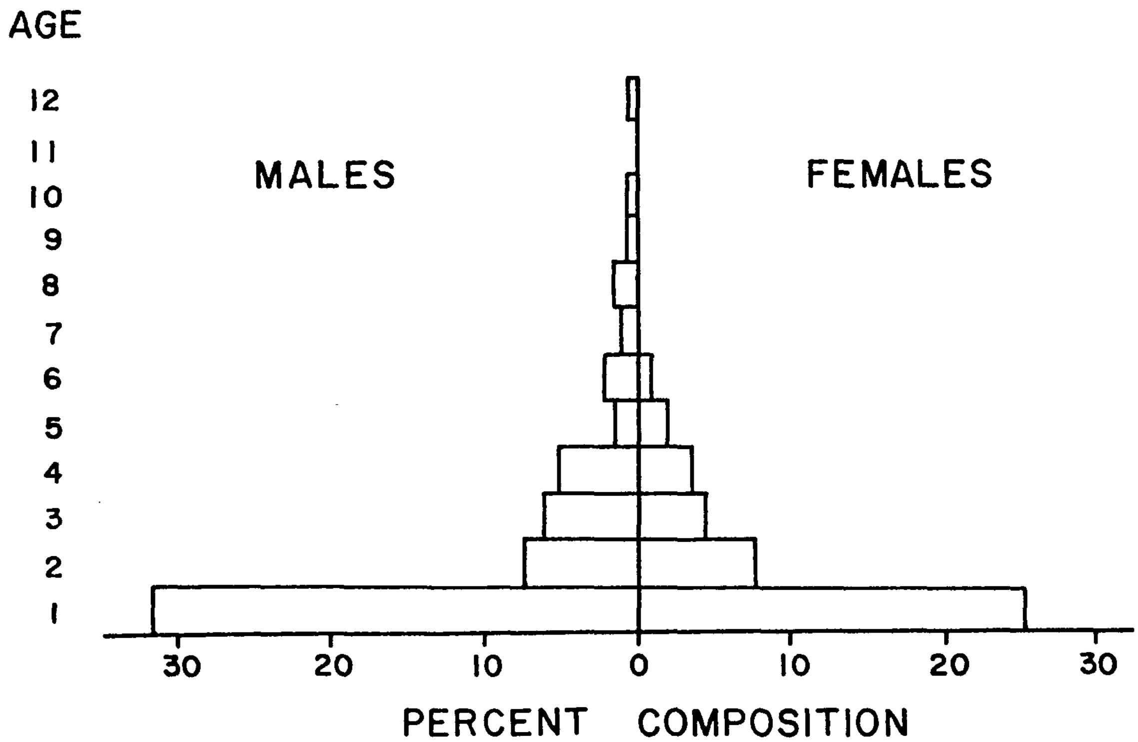
*Significant at P<0.05.

any incompatibility of that age-class with the remainder of the data (Table 3). Tests for goodness-of-fit of the observed age distribution did not reveal any significant deviations from the predicted distribution based on the estimated survival rate, except for the sample of females collected in 1974 (Table 3).

Winter sex ratios were obtained from the carcasses of 805 coyotes collected in 1973-1975 and from 180 whole animals that were weighed at fur houses but not collected in 1974-1975. Over the three-year period, 53.2 percent of the coyotes collected were males which was significantly different from an equal sex ratio ($P<0.05$). Of the three collection periods, however, only the 1975 sample had significantly more males and in 1974 a slight preponderance of females was observed. A preponderance of males was observed among pups tagged at den sites in the spring but the sample size (N = 97) was small and the difference was not statistically significant. The data for all coyotes aged was subdivided by sex for all age-classes (Fig. 4). A general preponderance of males was noted, particularly in the youngest and the oldest age-classes.

Whole weights were obtained from 186 adult coyotes during the months of January and February, 1974-1975. The mean weight for males was 29.6 pounds (s.e. = 0.3, range = 22.9 to 39.5) and for females was 25.1 pounds (s.e. = 0.28, range = 17.0 to 36.2). This difference was statistically significant ($P<0.01$).

Fig. 4. Composite age-sex frequency distribution for all coyotes aged.


AGE
12
11
10
9
8
7
6
5
4
3
2
1
MALES
FEMALES
30
20
10
0
10
20
30
PERCENT COMPOSITION

Ovaries were examined from 103 female coyotes collected in February of 1973 and 1974. Corpora lutea of ovulation, or mature follicles indicating sexual activity, were present in 27.5 percent of one-year-old animals, 30.0 percent of two-year-olds, and in 81.0 percent of female coyotes greater than two years in age. An increase in the incidence of sexual activity was noted in samples collected late in the month, indicating that some coyotes were examined before the onset of sexual activity.

Population Density

Siren index

Siren surveys were conducted in a total of nine counties in 1973 and in seven counties in 1974 (Fig. 5). The number of stations with responses decreased from 3.3 (33 percent) per route in 1972 to 2.1 (21 percent) per route in 1974, representing a decline of 37 percent (Table 4). This decline was significant ($P<0.04$) and the decline in the total response per county was nearly significant ($P<0.06$), when tested with an F-statistic.

Cloud cover was negatively correlated with response ($r = -0.21$, $P<0.05$) and temperature and wind were not correlated. There was no correlation between time and response but an apparent peak in response occurred approximately one hour after sunset.

The components of variability influencing a yearly mean response were calculated from the 1973 and 1974 siren survey data. Approximately

Fig. 5. Counties where siren surveys were conducted, 1973-1974

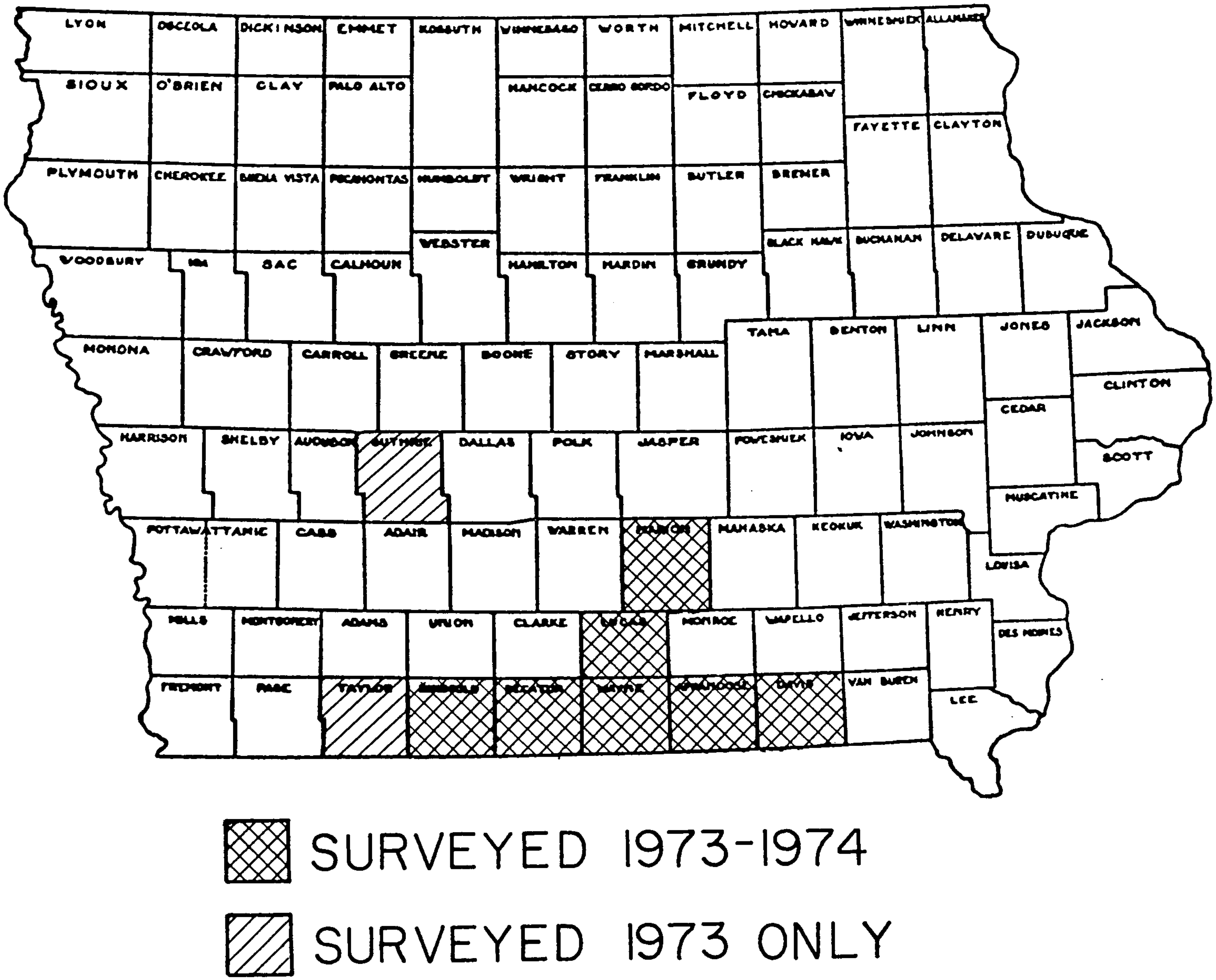

LYON
OSCEOLA
DICKINSON
EMMET
KOSSUTH
WINNEBAGO
WORTH
MITCHELL
HOWARD
SIOUX
O'BRIEN
CLAY
PALO ALTO
HANCOCK
CERRO GORDO
FLOYD
CHICKASAW
FAYETTE
CLAYTON
PLYMOUTH
CHEROKEE
BUENA VISTA
POCAHONTAS
HUMBOLDT
WRIGHT
FRANKLIN
BUTLER
BREMER
WEBSTER
BLACK HAWK
BUCHANAN
DELAWARE
DUBUQUE
WOODBURY
SAC
CALHOUN
HAMILTON
HARDIN
GRUNDY
TAMA
BENTON
LINN
JONES
JACKSON
MONONA
CRAWFORD
CARROLL
GREENE
BOONE
STORY
MARSHALL
CLINTON
CEDAR
HARRISON
SHELBY
AUDUBON
DALLAS
POLK
JASPER
POWESHIEK
IOWA
JOHNSON
SCOTT
MUSCATINE
POTTAWATTAMIE
CASS
ADAIR
MADISON
WARREN
MAHASKA
KEOKUK
WASHINGTON
LOUISA
MILLS
MONTGOMERY
ADAMS
UNION
CLARKE
MONROE
WAPELLO
JEFFERSON
HENRY
DES MOINES
FREMONT
PAGE
TAYLOR
VAN BUREN
LEE
SURVEYED 1973-1974
SURVEYED 1973 ONLY

Table 4. Mean number of responses and stations with responses for siren surveys 1973-1974, with percent change from 1973 to 1974

County	1973		1974		Percent change	
	Response	Stations	Response	Stations	Response	Stations
Decatur	10.0	6.7	5.5	4.3	-45.0	-36.3
Ringgold	4.0	3.3	3.5	3.3	-12.5	00.0
Wayne	6.0	4.5	3.7	3.0	-38.3	-33.3
Appanoose	1.3	1.3	2.3	1.8	+76.9	+38.5
Marion	4.3	3.7	1.5	1.3	-65.1	-64.9
Lucas	3.0	2.0	0.5	0.5	-83.3	-75.0
Davis	1.0	1.0	0.5	0.5	-50.0	-50.0
Taylor	6.7	5.0	-	-	-	-
Guthrie	4.0	4.0	-	-	-	-

20 percent of the variability of the mean response for each year was due to differences between counties and 80 percent was due to differences between stations. The estimated change in the variance of a yearly mean response in relationship to the number of counties sampled is represented in Fig. 6.

The analysis of variance for the mean response within counties revealed that approximately 38 percent of the variation was due to differences within stations and 22 percent to differences between days. The relationship between the expected variance of a county mean and the number of stations sampled is plotted in Fig. 7. The analysis also revealed that the relative gain in efficiency of the estimate did not increase greatly when routes were run more than three or four days.

Scent-post survey

The scent-post survey was implemented on a limited basis in late August of 1974 in Ringgold, Decatur, Wayne, and Appanoose counties. The percentage of operable stations visited by coyotes, multiplied by 1000, gave a visitation index ranging from 36 in Wayne county to 105 in Ringgold county (Table 5). Data were too limited to perform in-depth statistical analyses. None of the above-mentioned environmental factors was significantly correlated with visitation.

Livestock Losses

Domestic animal claims

A total of 3594 domestic animal claims were examined in 13 counties, representing data from 79 separate one-year periods from as early as

Fig. 6. The relative gain in accuracy (decrease in variance) of the estimated yearly howling response as the number of counties surveyed is increased

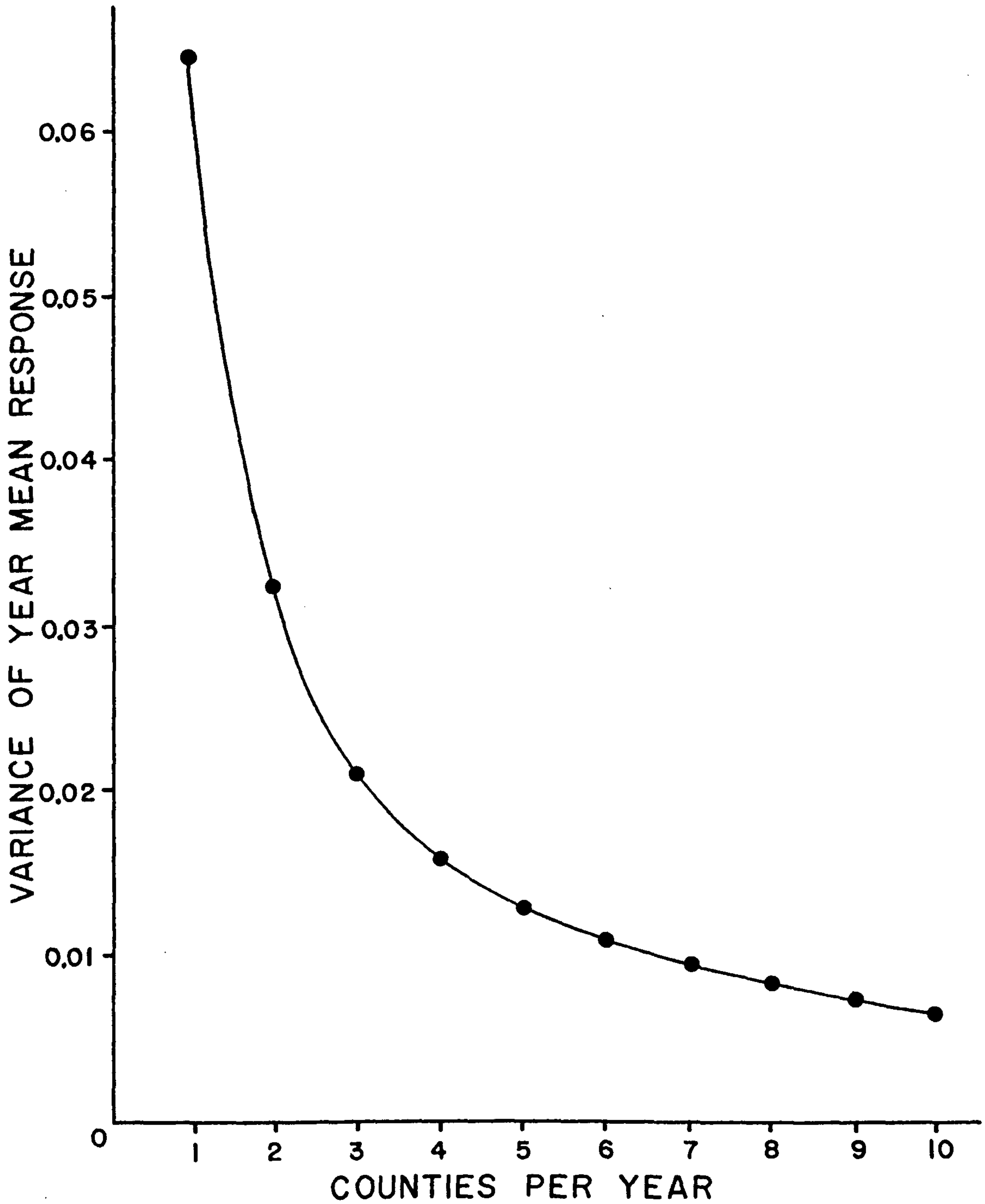

VARIANCE OF YEAR MEAN RESPONSE
0.06
0.05
0.04
0.03
0.02
0.01
0
1
2
3
4
5
6
7
8
9
10
COUNTIES PER YEAR

Fig. 7. The relative gain in accuracy (decrease in variance) of the estimated county mean howling response as the number of stations surveyed is increased

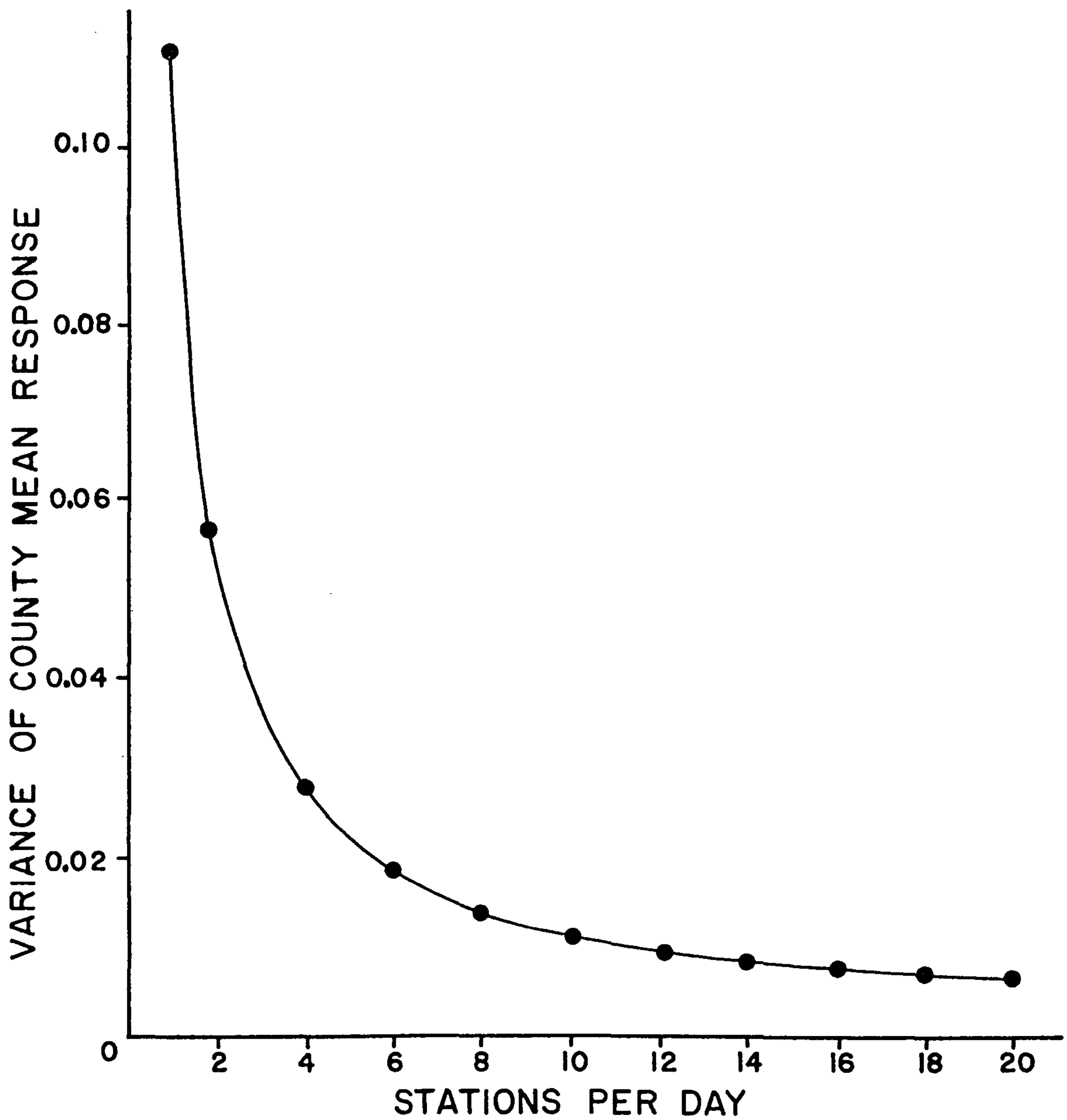

0.10
0.08
0.06
0.04
0.02
0
VARIANCE OF COUNTY MEAN RESPONSE
2
4
6
8
10
12
14
16
18
20
STATIONS PER DAY

Table 5. Results of the 1974 scent-post survey

Species	County							
	Ringgold (133)[a]		Decatur (196)		Wayne (195)		Appanoose (136)	
	Visits	Index[b]	Visits	Index	Visits	Index	Visits	Index
Coyote	14	105	5	26	7	36	6	44
Raccoon	9	68	5	26	4	21	2	15
Skunk	3	23	4	20	-	-	-	-
Opossum	7	53	5	26	1	5	3	22
Dog	12	90	15	77	31	159	23	169
Cat	7	53	14	71	51	262	37	272
Fox (Quest.)	-	-	-	-	1	5	1	7
Rabbit	8	60	3	15	-	-	-	-

[a] Total number of operable scent-station nights.

[b] $\text{Index} = \frac{\text{Total number of animal visits}}{\text{Total number of operable scent-station nights}} \times 1000$

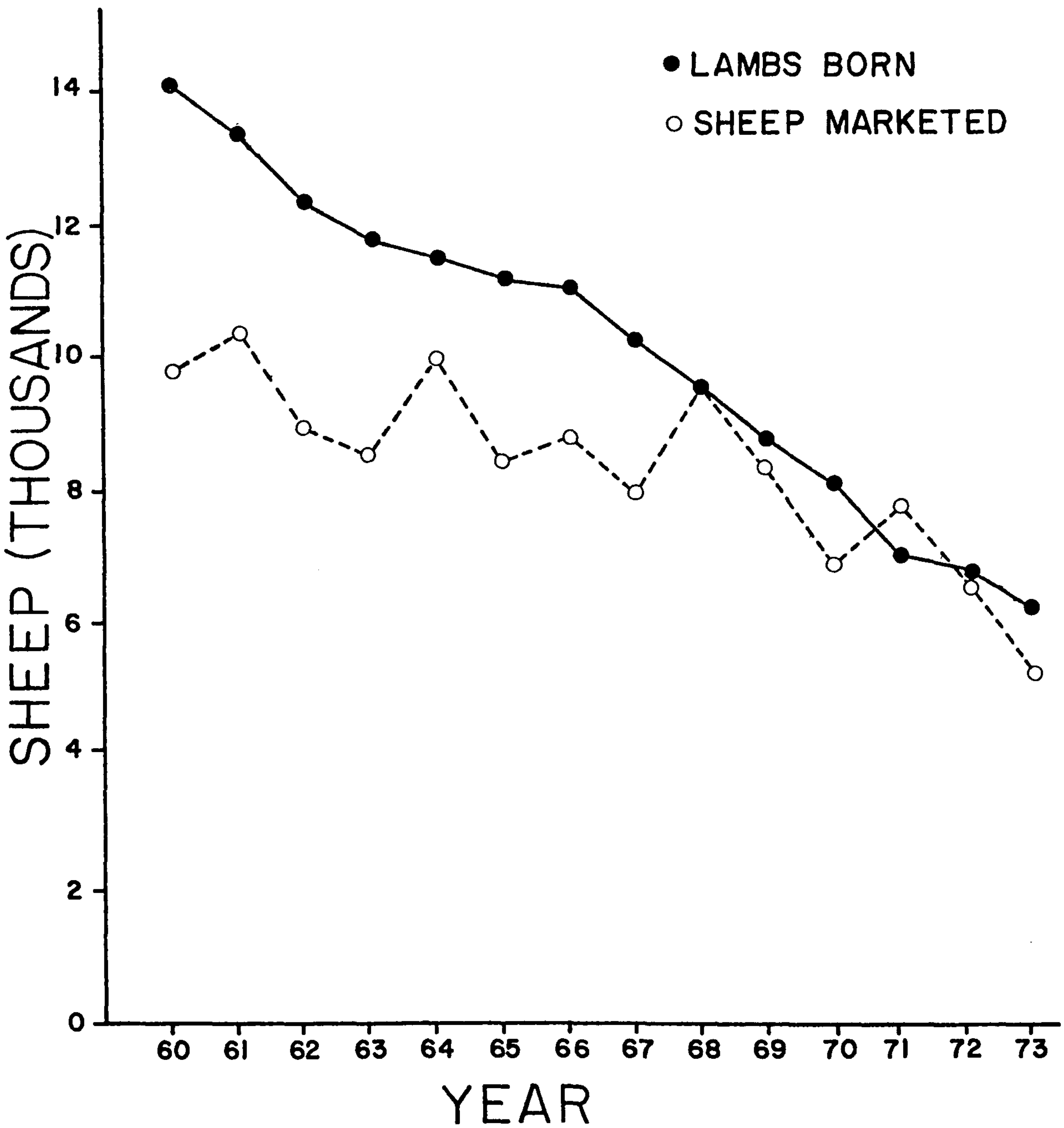
1958 in some counties. The claims included a total of 11,958 sheep and lambs, 489 cattle, 1288 pigs, and 2354 chickens, geese, and ducks.

Sheep production on the study area has declined significantly ($r = -0.89$, $P<0.01$) since 1960 (Fig. 8) (compiled from Iowa Assessors Annual Farm Census 1960-1973). During that same time period, the total proportion of the yearly production reportedly lost to predators ($\bar{x} = 3.11$ percent) has not changed significantly. However, the proportion attributed to dogs has decreased ($r = -0.57$, $P<0.05$) and the proportion attributed to coyotes has increased ($r = 0.85$, $P<0.01$) (Fig. 9).

For all data collected, the total sheep-kill attributed to dogs was significantly higher ($P<0.01$) than that attributed to coyotes (Table 6). During the period 1971-1973, the most recent three years for which data is available, 48.5 percent of the sheep losses were attributed to coyotes and 38.9 percent to dogs. Over the period since 1960, a mean of 2.0 percent of the total annual production, based on the number of sheep marketed, was reportedly lost to dogs. A mean loss of 0.8 percent of the annual production was attributed to coyotes during the same time period.

In 1973 the highest reported sheep-kills by coyotes on the study area, as proportions of total production, were: Monroe, 6.2 percent; Wapello, 4.4 percent; Appanoose, 4.1 percent; and Lucas, 4.1 percent. In terms of total numbers of sheep killed the highest six counties were: Davis, 382; Monroe, 288; Lucas, 282; Appanoose, 249; Marion, 168;

Fig. 8. The relative change in sheep production on the study area since 1960 (compiled from the Iowa Assessors Annual Farm Census 1960-1973)



LAMBS BORN
SHEEP MARKETED
SHEEP (THOUSANDS)
14
12
10
8
6
4
2
0
60
61
62
63
64
65
66
67
68
69
70
71
72
73
YEAR

Fig. 9. The yearly trend in total sheep losses on the study area reportedly incurred by coyotes and dogs since 1960 (from domestic animal claims)

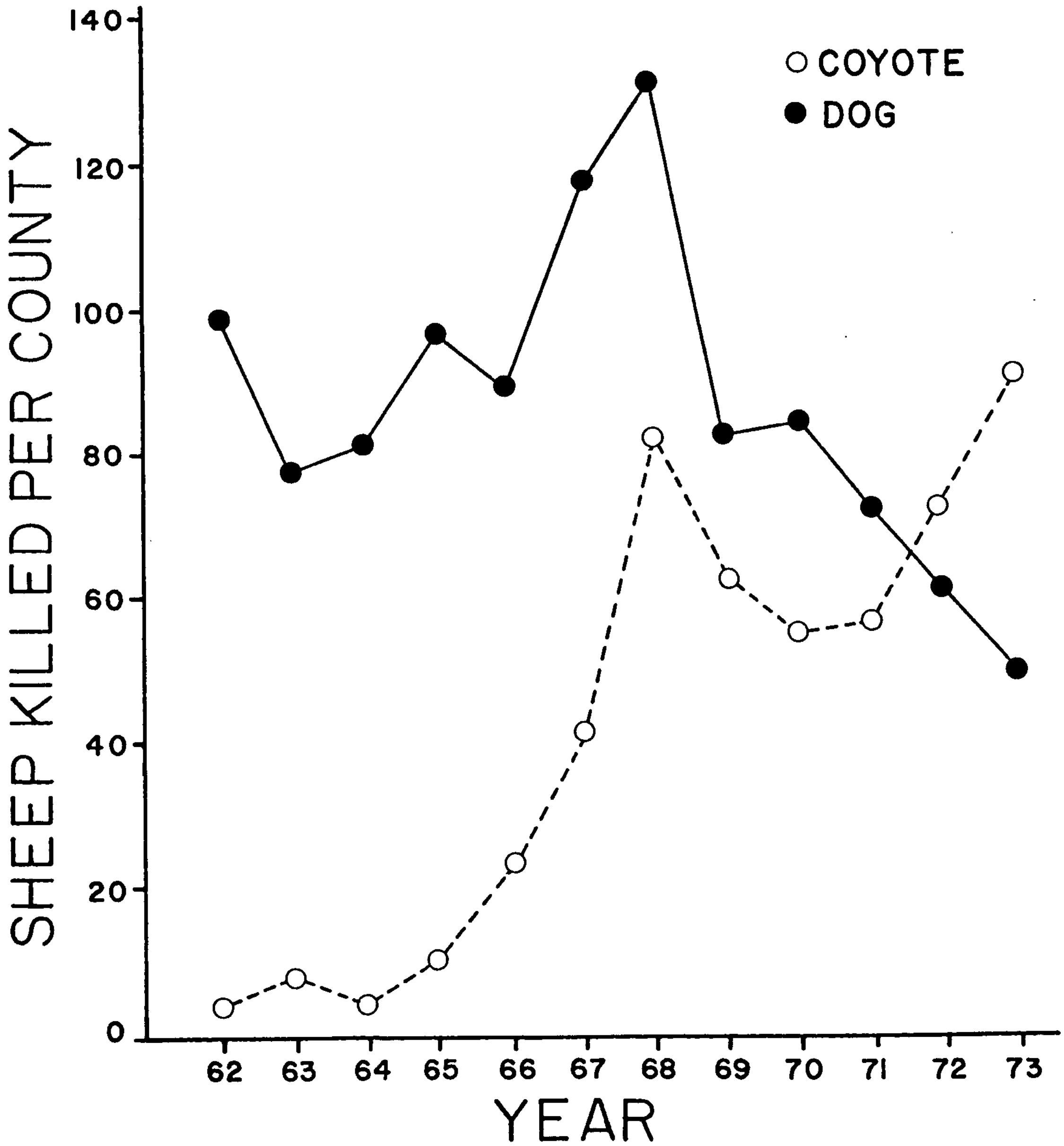

140
120
100
80
60
40
20
0
SHEEP KILLED PER COUNTY
COYOTE
DOG
62
63
64
65
66
67
68
69
70
71
72
73
YEAR

Table 6. The number and percentage of domestic animals reportedly killed by dogs, coyotes or unspecified, for all years examined in 13 southcentral Iowa counties (from livestock claims)

Domestic animal	Killed by Dog No.	(%)	Coyote No.	(%)	Either No.	(%)
Sheep						
Lambs	2660	(39.5)	3168	(47.1)	899	(13.4)
Adults	3663	(70.0)	1091	(20.9)	477	(9.1)
Total	6323	(52.9)	4259	(35.6)	1376	(11.5)
Cattle						
Calves	193	(44.2)	179	(41.0)	65	(14.9)
Cows	41	(78.8)	4	(7.7)	7	(13.5)
Total	234	(47.8)	183	(37.4)	72	(14.7)
Pigs	919	(71.4)	340	(26.4)	29	(2.3)
Poultry	2082	(88.4)	108	(4.6)	164	(7.0)
Other[a]	32	(86.5)	-	-	5	(13.5)

[a]Includes rabbits, goats, and horses.

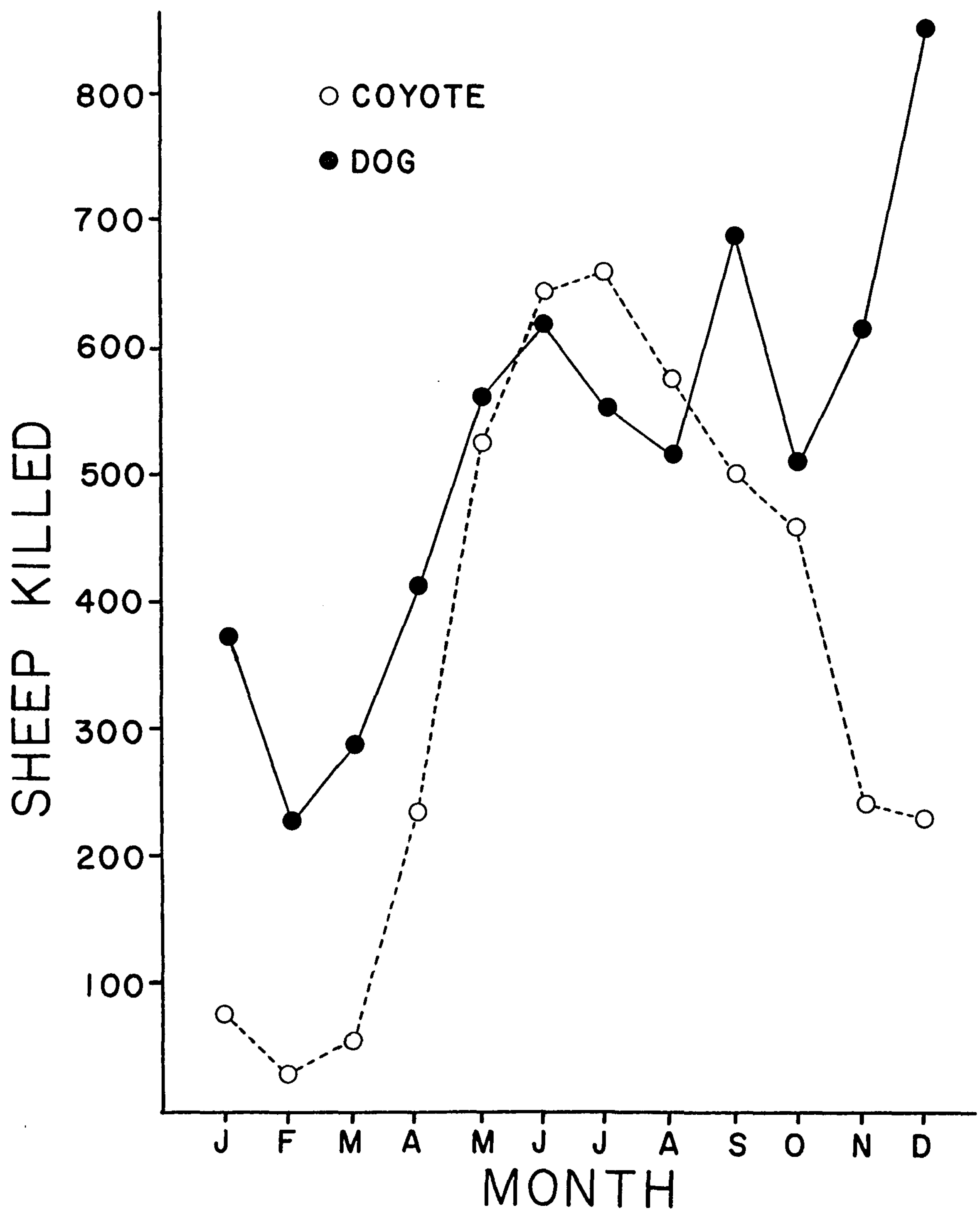
and Wapello, 150. The lowest five counties in terms of the proportion of total sheep reportedly killed by coyotes were: Adams, 0.0 percent; Taylor, 0.1 percent; Decatur, 1.5 percent; Ringgold, 2.3 percent; and Clarke, 2.8 percent.

Sheep kills by coyotes and dogs, as reported in the claims, were not evenly distributed throughout the year (Fig. 10). Sheep losses attributed to coyotes were highest in the summer months, with most losses from May through October. Sheep losses attributed to dogs were at generally high levels from May through the end of the year, with an extreme peak in December (Fig. 10). Reported coyote kills were significantly ($P<0.01$) higher than reported dog kills for the months of June, July, and August.

Cattle production on the study area has increased significantly since 1960 ($r = 0.78$, $P<0.01$) (compiled from Iowa Assessors Annual Farm Census 1960-1973). For all cattle losses reported, 47.8 percent were attributed to dogs and 37.4 percent were attributed to coyotes. Of 52 adult cattle claimed, 7.7 percent were attributed to coyotes and 78.8 percent were attributed to dogs. Forty-one percent of calf losses were attributed to coyotes. Reported cattle losses were greatest in spring for both coyotes and dogs (Fig. 11).

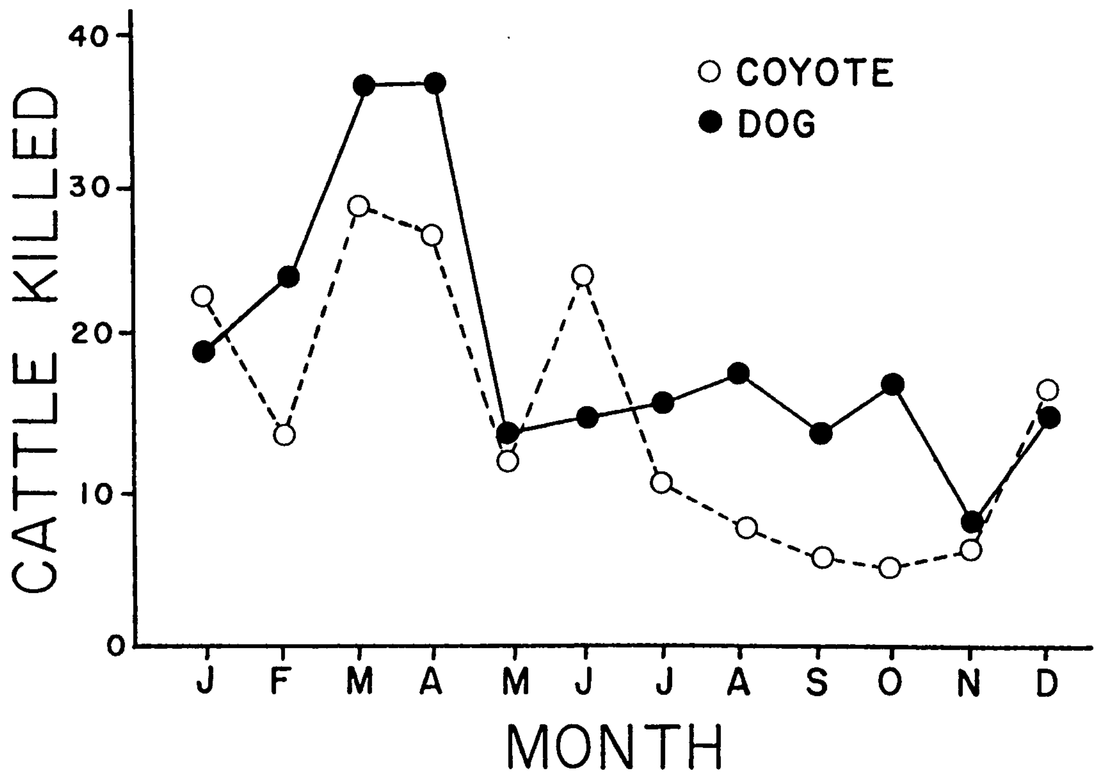
Reported pig losses were variable but, in general, there was a late-summer peak similar to that reported for sheep (Fig. 12). For all claims, 71.4 percent of reported pig kills were attributed to dogs and 26.4 percent to coyotes. A total of 88.4 percent of all poultry losses were attributed to dogs and 4.6 percent were attributed to coyotes.

Fig. 10. Monthly chronology of sheep losses attributed to coyotes and dogs (from livestock claims)



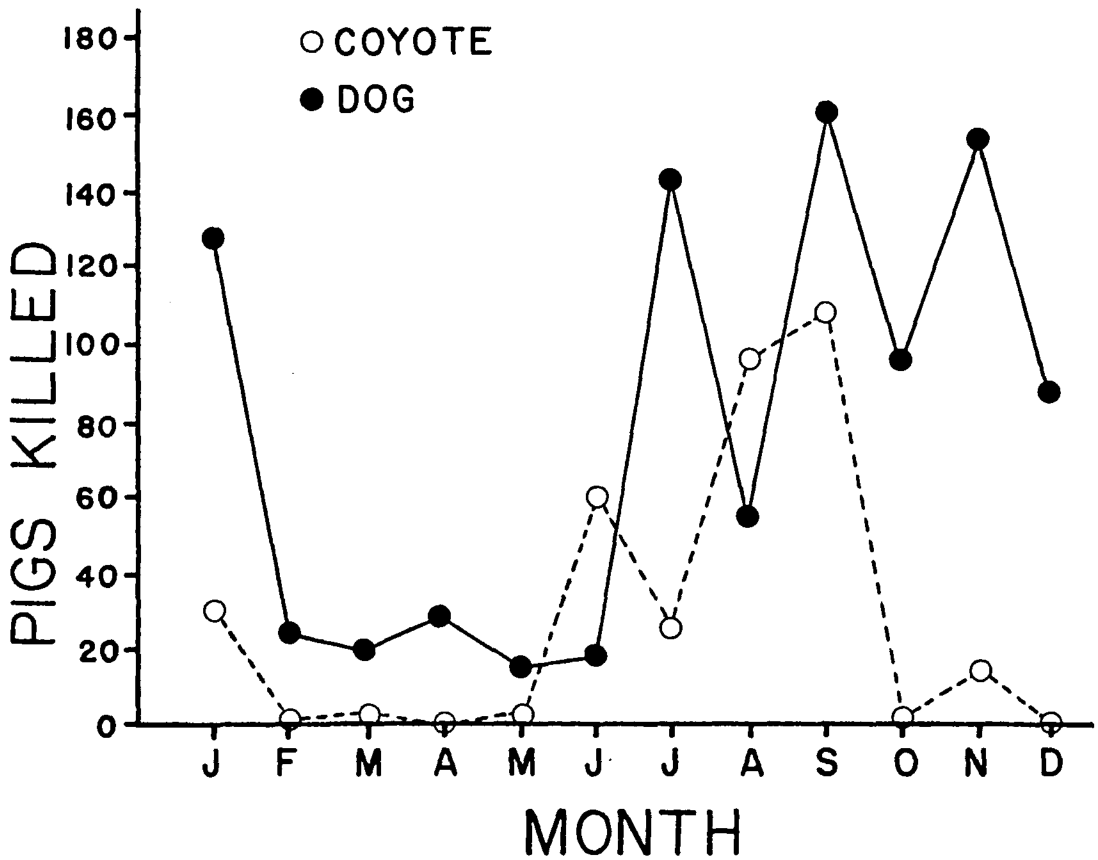
COYOTE
DOG
800
700
600
500
400
300
200
100
SHEEP KILLED
J
F
M
A
M
J
J
A
S
O
N
D
MONTH

Fig. 11. Monthly chronology of cattle losses attributed to coyotes and dogs (from livestock claims)



COYOTE
DOG
40
30
20
10
0
CATTLE KILLED
J
F
M
A
M
J
J
A
S
O
N
D
MONTH

Fig. 12. Monthly chronology of pig losses attributed to coyotes and dogs (from livestock claims)



○ COYOTE
● DOG
PIGS KILLED
0
20
40
60
80
100
120
140
160
180
J
F
M
A
M
J
J
A
S
O
N
D
MONTH

Food habits

Stomachs were obtained from a total of 291 of the coyotes collected in the winter of 1973 and, of those, 69 (23.7 percent) were empty. The contents of the remaining 222 stomachs are summarized in Table 7. The most important food items, by volume, were rabbits, followed by livestock, mice, and miscellaneous mammals. Birds, plant material, and miscellaneous non-food items also were present in small quantities.

The most important foods of coyotes in summer, as determined from scats, were rabbits and plant material followed by mice, livestock, and birds (Table 8). Miscellaneous mammals and invertebrates made up a minor portion of the diet. In general, rabbits and livestock were less important in the summer diet than in winter. Plants, mice, birds, and invertebrates were all most important in the summer diet, with plants becoming particularly important in August when they comprised nearly half of the total food volume (Table 9). Grasshoppers also were present in greater frequencies and volume in late summer (Table 9).

During June, 1974, 22 scats from juvenile coyotes were collected near a bulldozed pile of trees in Decatur county. One of the pups was captured and weighed 4.2 pounds so the pups were too small to be doing much foraging for themselves. The diet of these pups consisted of cottontail rabbit, 56.1 percent; livestock, 23.5 percent; plants, 6.3 percent; birds, 5.5 percent; and mice, 3.9 percent. Livestock occurred in 54.5 percent of all scats collected at this site, located in a large pasture which had recently been cleared and seeded.

Table 7. Summary of the contents of 222 coyote stomachs collected winter 1972-1973

Food Item	Percentage Occurrence	Percentage Volume
Rabbits	(56.8)[a]	(51.0)
Cottontail (*Sylvilagus floridanus*)	56.8	51.0
Livestock	(39.7)	(25.5)
Cattle	23.9	10.2
Pig	17.1	8.1
Sheep	4.5	7.3
Mice	(54.9)	(12.3)
Vole (*Microtus* sp.)	29.3	10.2
Deer mouse (*Peromyscus* sp.)	1.8	0.3
Harvest mouse (*Reithrodontomys megalotis*)	0.9	0.2
House mouse (*Mus musculus*)	0.5	T
Mouse, undetermined	24.3	1.7
Other Mammals	(12.2)	(8.0)
Fox squirrel (*Sciurus niger*)	2.3	2.7
White-tailed deer (*Odocoileus virginianus*)	3.6	2.6
Raccoon (*Procyon lotor*)	0.9	2.6
Muskrat (*Ondatra zibethicus*)	1.4	0.1
Coyote (*Canis latrans*)	1.8	T
Shrew (*Blarina brevicauda*)	0.5	T
Mink or weasel (*Mustela* sp.)	0.5	T
Mammal, undetermined	2.3	0.1
Birds	(19.8)	(2.7)
Chicken (*Gallus gallus*)	8.6	1.9
Pheasant (*Phasianus colchicus*)	2.7	0.3
Bobwhite (*Colinus virginianus*)	0.9	0.2
Bird, undetermined	7.2	0.4
Plants	(35.1)	(0.3)
Grass	32.0	0.1
Corn (*Zea mays*)	3.2	T
Oats (*Avena sativa*)	0.9	T
Bark, leaves, twigs	2.7	0.2
Straw	0.9	T
Carrot (garbage)	0.5	T
Miscellaneous	(3.6)	(0.2)
Paper	1.4	0.2
Gravel	0.9	T
Cloth	0.5	T
Tape	0.5	T
Fence barb	0.5	T
Lead shot	0.9	T

[a]( ) indicates totals for each major category.

Table 8. Summary of the contents of 246 scats collected 1971-1974

Food Item	Percentage Occurrence	Percentage Volume
Plants	(80.8)[a]	(25.2)
Mulberry (*Morus* sp.)	27.2	15.3
Wild plum (*Prunus americana*)	8.5	5.3
Chokecherry (*Prunus virginiana*)	3.3	0.8
Corn (*Zea mays*)	2.8	1.4
Grass	59.3	2.0
Gooseberry (*Ribes* sp.)	0.4	0.1
Oats (*Avena sativa*)	1.2	0.1
Sticktight	0.4	T
Hazelnut (*Corylus americana*)	0.4	T
Bark and twigs	1.2	0.1
Juniper (*Juniperus virginiana*)	1.2	T
Alfalfa (*Medicago sativa*)	0.4	T
Wild grape (*Vitis riparia*)	0.4	T
Leaves, undetermined	1.6	T
Seeds, undetermined	2.8	T
Plant material, undetermined	0.8	T
Rabbits	(42.3)	(33.0)
E. cottontail (*Sylvilagus floridanus*)	42.3	33.0
Mice	(35.0)	(19.5)
Vole (*Microtus* sp.)	23.6	17.3
Deer mouse (*Peromyscus* sp.)	2.8	0.6
Harvest mouse (*Reithrodontomys megalotis*)	0.8	0.1
Mouse, undetermined	9.3	0.7
Livestock	(33.7)	(12.4)
Cattle	24.4	9.5
Pigs	9.3	2.7
Sheep	1.6	T
Livestock, undetermined	0.8	0.1
Other mammals	(20.3)	(3.2)
Raccoon (*Procyon lotor*)	2.8	1.6
Fox squirrel (*Sciurus niger*)	2.0	0.7
Muskrat (*Ondatra zibethicus*)	0.8	0.5
Coyote (*Canis latrans*)	2.4	T
Shrew (*Blarina* and *Sorex*)	0.8	0.1
Woodchuck (*Marmota monax*)	0.4	0.1
Pocket gopher (*Geomys bursarius*)	0.4	0.1
Opossum (*Didelphis marsupialis*)	0.4	T
Striped skunk (*Mephitus mephitus*)	0.4	T
House cat (*Felis domesticus*)	0.4	T
Mammal, undetermined	10.2	0.1

[a]( ) indicates totals for each major category.

Table 8. (Continued)

Food Item	Percentage Occurrence	Percentage Volume
Birds	(32.5)	(4.4)
Chicken (Gallus gallus)	3.3	1.5
Bobwhite (Colinus virginianus)	1.2	0.9
Meadowlark (Sturnella magna)	2.0	0.2
Eggshell, undetermined	5.3	0.3
Bird, undetermined	21.5	1.4
Invertebrates	(37.4)	(1.4)
Grasshoppers	15.0	1.1
June beetles	1.2	T
Other beetles	7.7	T
Insect, undetermined	11.0	0.2
Maggots	1.2	T
Ticks	2.0	T
Crayfish	0.8	T
Snails	1.2	T
Crickets	0.4	T
Reptiles	(1.2)	(T)
Lizards (Six-lined racerunner)	0.4	T
Snakes, undetermined	0.8	T
Miscellaneous	(8.1)	(0.8)
Sand, gravel	5.7	0.2
Manure	0.4	0.2
Tinfoil	0.4	T
Plastic	0.4	T
Pan cover	0.4	0.1
Debris, undetermined	0.8	0.4

Table 9. Monthly variations in foods found in coyote scats collected summers 1971-1974 and a comparison with winter stomach contents

Food Item	Percentage Volume			
	June (112)[a]	July (66)	August (68)	Winter (stomachs)
Rabbits	(36.9)[b]	(47.9)	(11.7)	(51.0)
Cottontail (_Sylvilagus floridanus_)	36.9	47.9	11.7	51.0
Livestock	(17.7)	(8.8)	(6.3)	(25.5)
Cattle	14.1	6.2	4.7	10.2
Pigs	3.6	2.6	1.6	8.1
Sheep	T	-	-	7.3
Livestock, undetermined	-	-	T	-
Mice	(20.1)	(19.2)	(19.1)	12.3
Meadow voles (_Microtus_ sp.)	18.8	14.5	18.4	10.2
Deer mouse (_Peromyscus_ sp.)	0.6	0.5	0.7	0.3
Harvest mouse (_R. megalotis_)	-	0.4	T	0.2
House mouse (_Mus musculus_)	-	-	-	T
Mouse, undetermined	0.7	3.8	T	1.7
Other mammals	(2.5)	(1.8)	(5.8)	(8.0)
Raccoon (_Procyon lotor_)	0.7	1.8	2.9	2.6
Fox squirrel (_Sciurus niger_)	1.4	-	0.6	2.7
Muskrat (_Ondatra zibethicus_)	-	-	1.8	0.1
White-tailed deer (_O. virginianus_)	-	-	-	2.6
Coyote (_Canis latrans_)	T	T	T	T
Woodchuck (_Marmota monax_)	0.2	-	-	-
Pocket gopher (_Geomys bursarius_)	-	-	0.2	-
Opossum (_Didelphis marsupialis_)	-	T	-	-

[a]( ) indicates sample sizes.

[b]( ) indicates total for each major category.

Table 9. (Continued)

Food Item	Percentage Volume			
	June (112)[a]	July (66)	August (68)	Winter (stomachs)
Striped skunk (*Mephitus mephitus*)	-	-	T	-
House cat (*Felis domesticus*)	-	-	T	-
Shrew (*Blarina* and *Sorex*)	0.2	-	T	T
Mink or weasel (*Mustela* sp.)	-	-	-	T
Mammal, undetermined	T	T	0.3	0.1
Plants	(18.2)	(15.5)	(47.0)	(0.3)
Mulberry (*Morus* sp.)	15.9	11.8	18.3	-
Wild plum (*Prunus americana*)	-	0.4	19.3	-
Chokecherry (*Prunus virginiana*)	-	-	3.0	-
Corn (*Zea mays*)	T	0.6	4.7	T
Grass	2.0	2.4	1.4	T
Gooseberry (*Ribes* sp.)	-	0.4	-	-
Oats (*Avena sativa*)	-	T	0.3	T
Sticktight	-	T	-	-
Hazelnut (*Corylus americana*)	T	-	-	-
Bark and twigs	0.3	-	-	0.2
Juniper (*Juniperous virginiana*)	T	T	T	-
Alfalfa (*Medicago sativa*)	T	-	-	-
Wild grape (*Vitis riparia*)	-	-	T	-
Straw	-	-	-	T
Carrot (*garbage*)	-	-	-	T
Leaves, undetermined	T	T	-	-
Seeds, undetermined	T	T	T	-
Plant material, undetermined	T	T	-	-
Birds	(4.0)	(4.9)	(4.9)	(0.9)
Chicken (Gallus gallus)	0.4	1.7	3.1	1.9
Pheasant (Phasianus colchicus)	-	-	-	T

Table 9. (Continued)

Food Item	Percentage Volume June (112)[a]	July (66)	August (68)	Winter (stomachs)
Bobwhite (Colinus virginianus)	1.5	0.9	-	T
Meadowlark (Sturnella magna)	T	0.6	-	-
Eggshell, undetermined	0.9	T	0.3	-
Bird, undetermined	1.2	1.7	1.5	0.8
Reptiles	-	(T)	(T)	-
Lizard (Six-lined racerunner)	-	-	T	-
Snake, undetermined	-	T	-	-
Invertebrates	(0.9)	(0.9)	(4.1)	-
Grasshoppers	T	0.5	3.9	-
June beetles (Phyllophaga sp.)	0.1	-	-	-
Other beetles	T	0.1	T	-
Insect, undetermined	0.1	0.3	0.2	-
Maggots	T	-	T	-
Ticks (Dermacenter sp.)	T	T	T	-
Crayfish (Cambarus sp.)	T	-	T	-
Snails	T	0.1	T	-
Crickets	-	T	-	-
Miscellaneous	(0.6)	(1.0)	(1.1)	(0.2)
Sand, gravel	0.4	-	T	T
Manure	-	0.5	-	-
Tinfoil	T	-	-	-
Plastic	-	T	-	-
Cloth	-	0.5	-	T
Tape	-	-	-	T
Fence barb	-	-	-	T
Lead short	-	-	-	T
Debris, undetermined	0.2	-	1.1	-

Rabbits occurred in 68.2 percent of the scats, and birds and plants each occurred in 63.6 percent. Insects, fox squirrel, and miscellaneous debris were also found.

Eighteen stomachs were saved by hunters during the summers of 1973-1974 and were subsequently analyzed (Table 10). These stomachs, in most cases, were from coyotes that the hunters believed were killing livestock. Rabbits, livestock, and miscellaneous mammals were the most important food items in these stomachs. The occurrence of sheep in these stomachs was approximately 17 times greater than that observed in summer scats and 6 times more than that in winter stomachs. Mice, birds, plants, and invertebrates also were present in the diet.

Movements and Mortality

Tagging at dens

During the period 1972-1974, 99 coyotes (including two adult females) were tagged at den sites in southcentral Iowa, mainly in Decatur county. At 15 dens from which the entire litter was believed to have been captured, the average litter size was 6.1 pups, including two dens containing two litters each. Those 15 dens were of the following types: 9 in dirt-banks, 3 in bulldozed piles of trees, 1 in a pond dam, 1 in a terrace, and 1 under tree roots. In addition, several other dens were located,chiefly in bulldozed tree piles, from which pups could not be removed. Average litter sizes for 1972, 1973, and 1974, respectively, were 5.25, 5.75, and 6.90 pups per litter. Sample sizes in each year were small.

Table 10. Contents of 18 stomachs collected during summer and spring from coyotes allegedly killing sheep

Food Item	Percentage	
	Occurrence	Volume
Rabbits	(66.7)[a]	(49.9)
Cottontail (*Sylvilagus floridanus*)	66.7	49.9
Livestock	(77.8)	(22.0)
Cattle	38.9	12.1
Sheep	27.8	9.5
Pigs	5.6	0.4
Livestock, undetermined	5.6	T
Mice	(22.2)	(7.5)
Voles (*Microtus* sp.)	16.7	6.6
Deer mouse (*Peromyscus* sp.)	5.6	0.9
Mouse, undetermined	5.6	T
Other mammals	(22.2)	(19.7)
Fox squirrel (*Sciurus niger*)	5.6	18.6
Opossum (*Didelphis marsupialis*)	5.6	0.9
Muskrat (*Ondatra zibethicus*)	5.6	0.3
Coyote (*Canis latrans*)	5.6	T
Birds	(22.2)	(0.6)
Chicken (*Gallus gallus*)	5.6	T
Meadowlark (*Sturnella magna*)	5.6	0.4
Eggshell	5.6	0.2
Bird, undetermined	5.6	T
Plants	(88.9)	(0.3)
Grass	77.8	0.3
Seeds	22.2	T
Corn (*Zea mays*)	5.6	T
Oats (*Avena sativa*)	5.6	T
Plant, undetermined	11.1	T
Invertebrates	(50.0)	(T)
Beetles	16.7	T
Crickets	5.6	T
Grasshoppers	5.6	T
Insect, undetermined	33.3	T
Crayfish (*Cambarus* sp.)	5.6	T

[a]( ) indicates totals for each major category.

Trapping

A total of 34 coyotes (19 males and 15 females) were captured with steel traps during the summers of 1973 and 1974 in 827 trap-nights. Three of the trapped coyotes were adults at the time of capture and the remaining 31 were juveniles. In 1973, the capture rate was 4.9 coyotes per 100 trap-nights and in 1974 was 3.4 coyotes per 100 trap-nights ($\bar{x}$ for both years = 4.1). One coyote was recaptured two days after its initial capture approximately 50 yards from the first capture site in 1973. Of 34 trapped coyotes, one juvenile female died in a trap during very hot weather and five juvenile coyotes suffered severe injuries from the traps resulting in broken bones. Four of these injured animals were captured by their rear feet and the fifth was a very young juvenile caught in a trap set for an adult. To date, two of the five injured coyotes have been recovered.

In addition to the 34 coyotes, the following animals were also captured in traps: 20 raccoons (Procyon lotor), 2 gray foxes (Urocyon cinereoargenteus), 1 red fox (Vulpes fulva), 3 badgers (Taxidea taxus), 14 opossums (Didelphis marsupialis), 1 striped skunk (Mephitus mephitus), 5 house cats (Felis domesticus), 18 cottontail rabbits (Sylvilagus floridanus), 2 fox squirrels (Sciurus niger), 3 brown thrashers (Toxostoma rufum), 1 yellow-shafter flicker (Colaptes auratus), and 1 bluejay (Cyanocitta cristata). No dogs were caught during either summer.

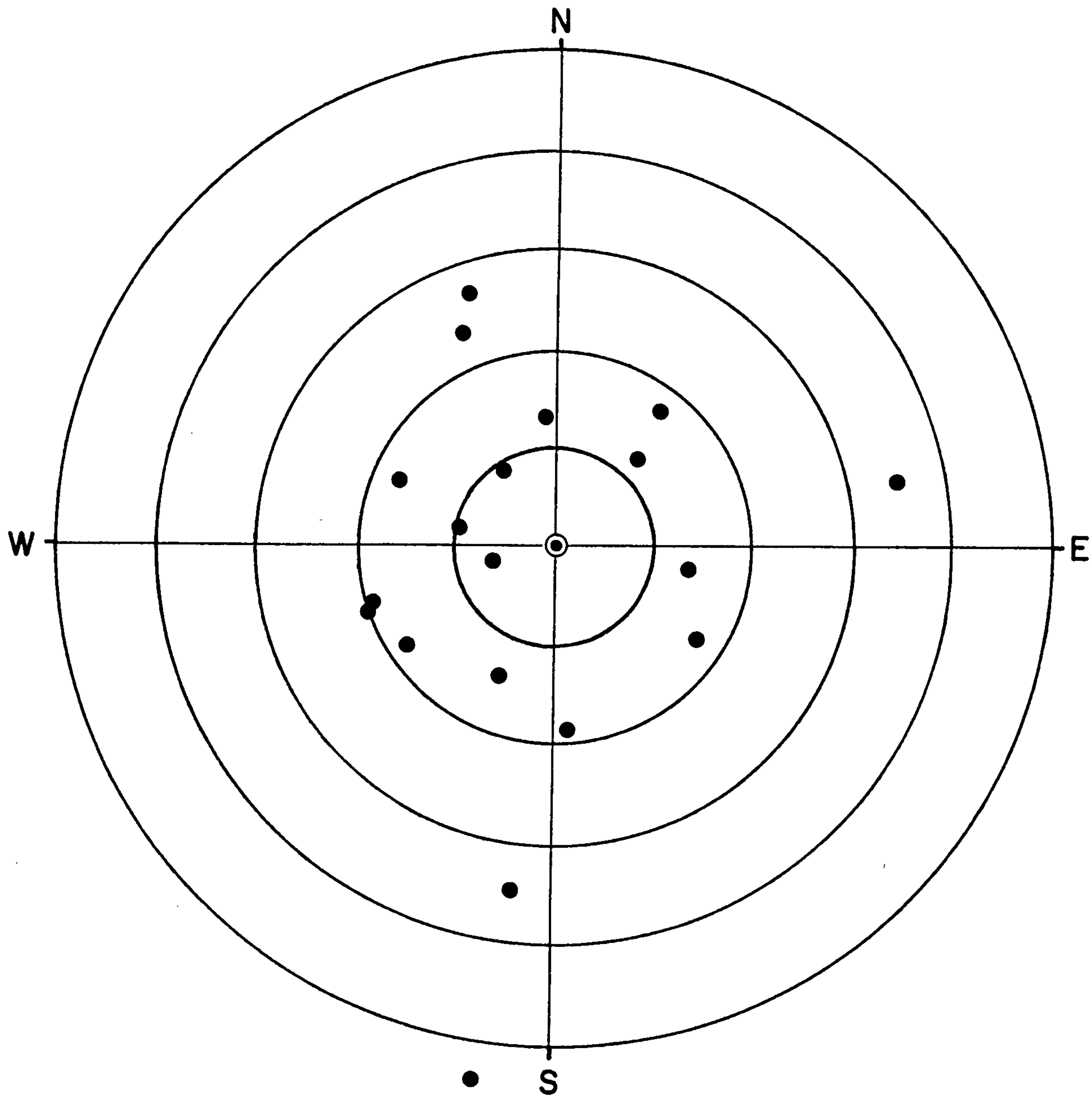
Activity centers, similar to the activity areas reported at rendezvous sites of wolves (Joslin 1967), were frequently located during summer trapping activities. These areas were easily recognized by the flattened vegetation, worn areas, and diggings, usually surrounded by several well-worn trails. On 35 occasions during the two summers of field work, searches were made for coyotes which had responded to the siren. Activity centers were located between 0.05 and 0.75 miles (0.08 and 1.21 km) from the point at which the siren was sounded on 26 of the 35 searches (Appendix A). On the nine other occasions, coyotes responded to the siren but no concentration of sign could be found. At eight of the located activity centers, trapping attempts were unsuccessful.

Movements

To date, 34 of 132 tagged coyotes have been recovered (Appendix B), representing a 25.8 percent recovery rate. In addition, two tagged pups were killed at dens by farmers but the numbers were not recorded, and two other coyotes were reported to have lost both ear-tags. The mean recovery distance for all coyotes was 24.5 miles (s.e. = 4.49). The mean distances of 26.1 miles (42 km) for males and 22.7 miles (36.5 km) for females did not differ significantly. Of the 19 animals recovered more than 10 miles (16.1 km) from the initial tagging site, 11 males were recovered at a mean distance of 38.8 miles (62.4 km) and eight females averaged 41.1 miles (66.1 km).

The direction traveled by individuals dispersing over 10 miles (16.1 km) (Fig. 13) did not show a significant directional tendency, but a net westward movement ($X^2 = 2.58$, $P<0.12$) was suggested. Most

Fig. 13. Direction and distance moved by coyotes dispersing over 10 miles (16.1 km) from the point of tagging. Interval between concentric circles equals 20 miles (32.2 km)


N
W
E
S

tag returns were received during the period November-March. For animals recovered in their first year of life, the peak recovery for females was earlier than that for males (Fig. 14). Dispersal apparently began sometime in November, based on observed recovery distances and timing for juvenile coyotes recovered during their first year of life (Fig. 15).

Recovery distances for coyotes tagged at dens, as opposed to those that were trapped, were not significantly different. Movements of 14 trapped coyotes ranged from 0 to 107 miles ($\bar{x}$ = 21.3) and movements of 20 coyotes tagged at dens ranged from 0 to 70 miles ($\bar{x}$ = 23.6). Recovery rates for pups tagged at dens were, in general, lower than those for the older animals that were trapped (Table 11). The recovery rate, based on the returns from the first year following tagging, declined over the three-year period for pups tagged at dens, but remained relatively constant for the two years of trapping data. Overall, the mean recovery rate of 33.3 percent for trapped animals returned in the first year following tagging was approximately 1.7 times greater than the 19.2 percent value for pups tagged at dens. Return rates for the three types of tags used are summarized in Table 12. The distribution of tag recoveries did not decline geometrically with distance, but was skewed toward longer distances (Fig. 16).

Mortality causes for all recovered coyotes included: shot, 55.9 percent; trapped, 23.5 percent; road-killed, 11.8 percent, and snared, 2.9 percent. Of 14 trapped coyotes that were later recovered, four (28.6 percent) were trapped again at the time of their recovery. This

Fig. 14. Monthly distribution of tag recoveries

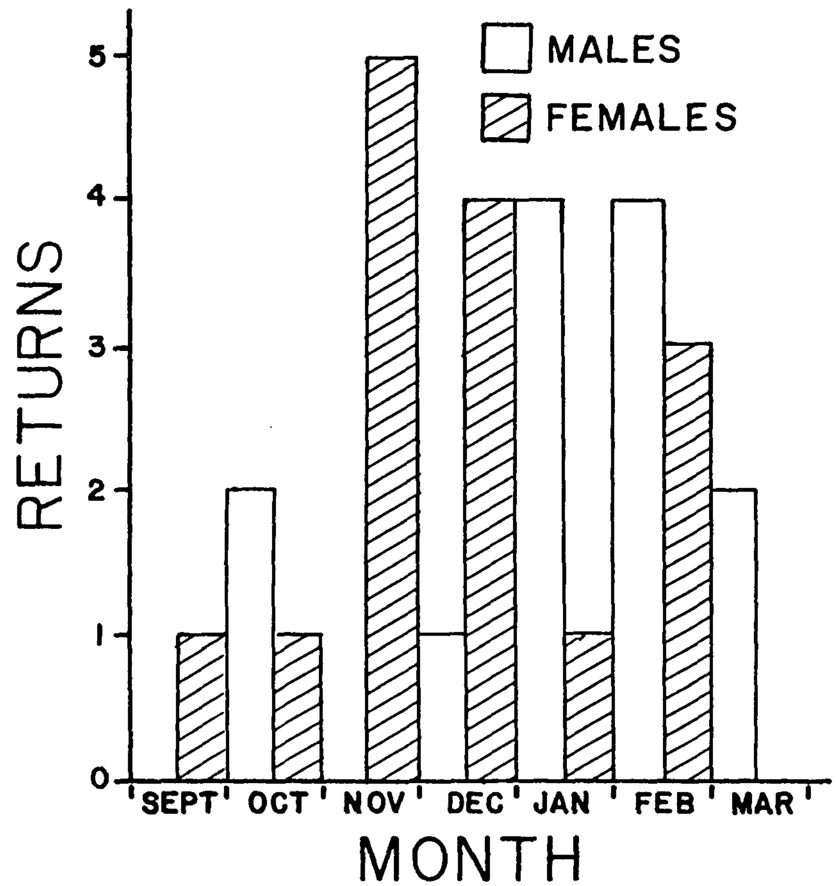
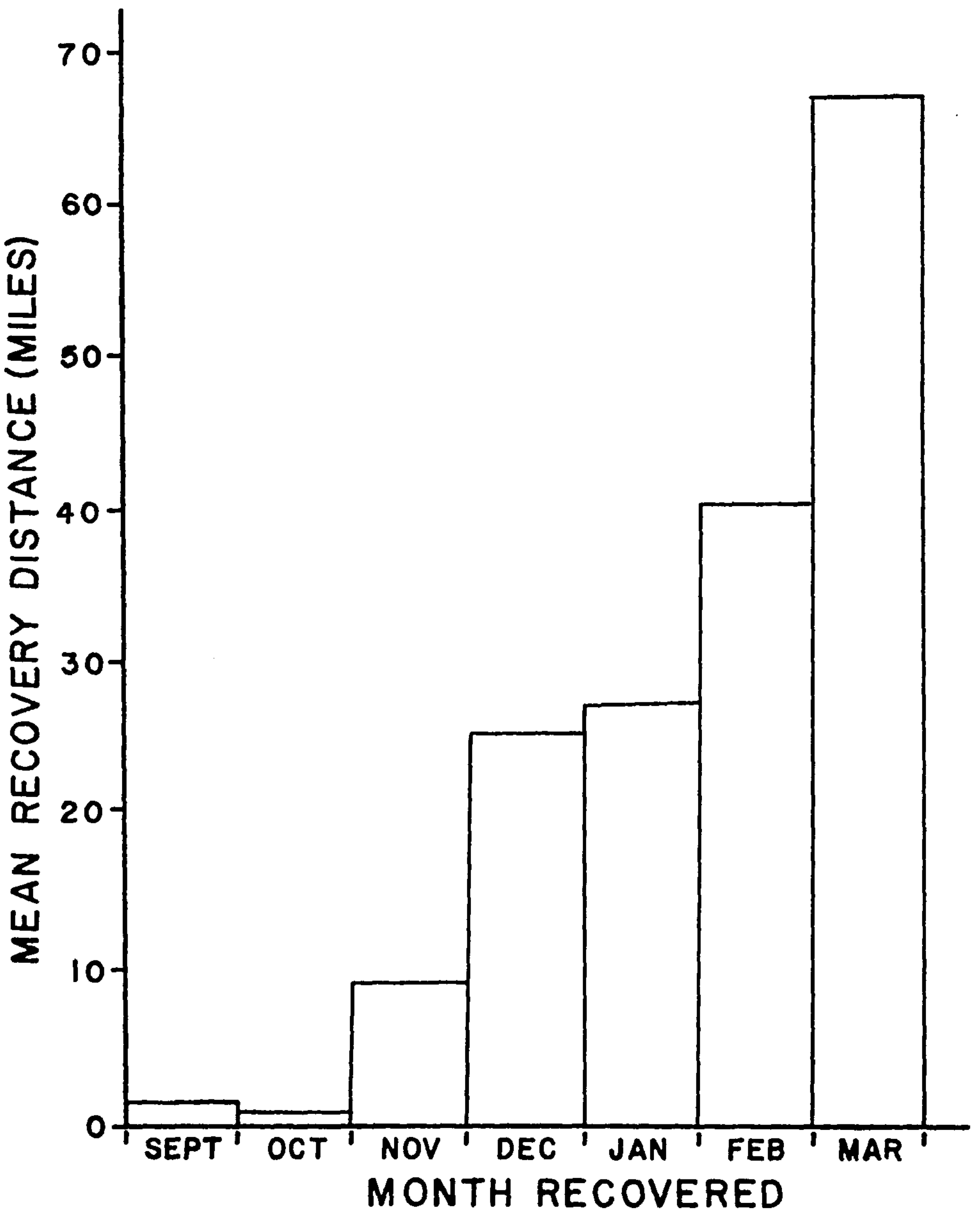

MALES
FEMALES
RETURNS
0
1
2
3
4
5
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
MONTH

Fig. 15. Recovery distances in relation to time of year for coyotes in their first year of life



MEAN RECOVERY DISTANCE (MILES)
70
60
50
40
30
20
10
0
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
MONTH RECOVERED

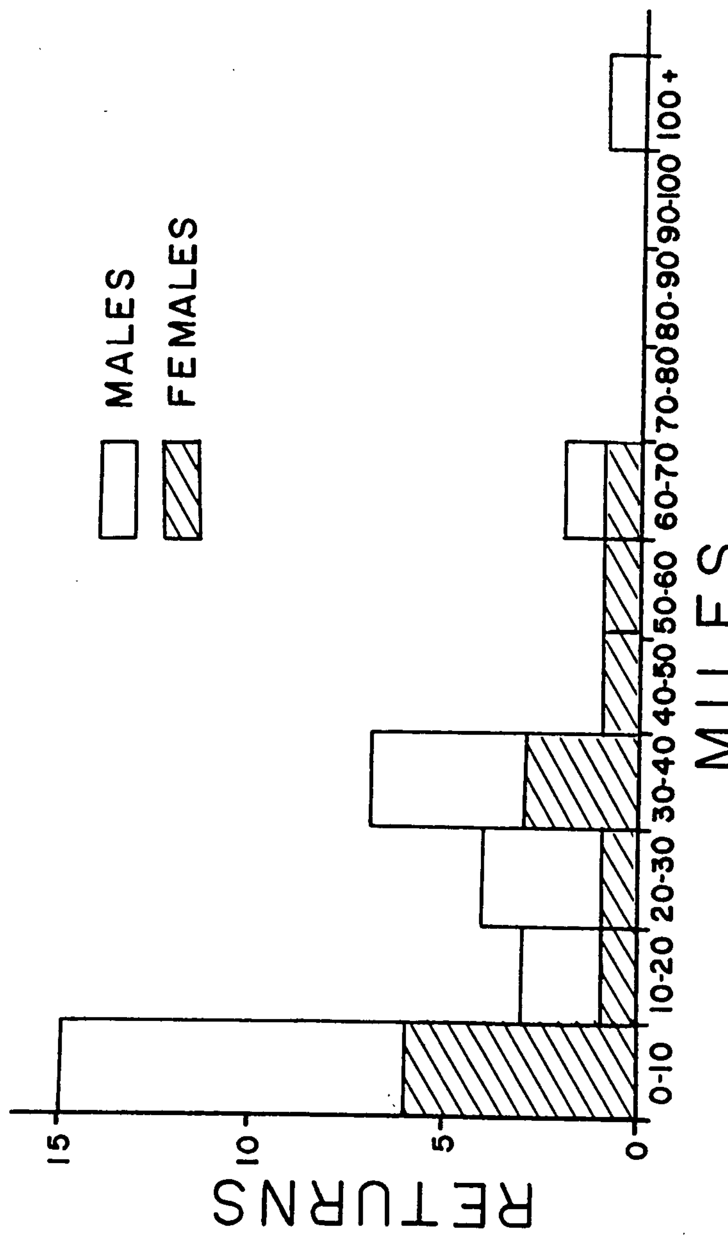
Table 11. Recovery rates for coyotes killed during their first year after tagging

Year	Denning			Trapping		
	Tagged	Recovered	Percent	Tagged	Recovered	Percent
1972	24	9	37.5	-	-	-
1973	27	5	18.5	19	6	31.5
1974	48	6	12.5	14	5	35.7
Total	99	19	19.2	33	11	33.3

Table 12. Recovery rates for type of tag used

Type of tag	Number tagged	Number recovered	Recovery rate (%)
Metal button	76	17	22.4
Metal band	21	1	4.8
Plastic	42	17	40.5

Fig. 16. Frequency distribution of tag recoveries as a function of distance from tagging site



MALES
FEMALES
RETURNS
0
5
10
15
MILES
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
100+

included one juvenile male that was trapped twice in three days in July of 1973 and was subsequently trapped seven months later at a distance of 107 miles (172 km). Of the 20 recoveries of pups tagged at dens, four (20 percent) were trapped at the time of their recovery.

DISCUSSION

Population Structure

The two methods used to estimate survivorship in this study were each subject to possible sources of error. The regression estimate is biased positively when a few individuals are present in the upper age-classes (Eberhardt 1971), as was the case with some of the data in this study. The Chapman-Robson method, although more precise, requires that more assumptions be met before the estimate is valid. The two estimates were similar, at least relatively, suggesting that the possible biases, if present, were not masking the relationships. The similarity of the estimates for the three years indicates that the assumption of a stable age distribution was, at least approximately, fulfilled.

The mean survival rate of 60.9 percent for Iowa coyotes compares favorably with values calculated from data presented by Knowlton (1972) of 59.3, 71.9 and 69.9 percent for Texas, New Mexico, and Arizona, respectively. Mathwig's (1973) data gave a value of 40.5 percent survival when calculated by the Chapman-Robson method, but it was not consistent with the assumption of constant survivorship between age-classes. The life-table data from that study suggested that two-year-old animals had higher survival than other age-classes. Nellis and Keith (unpublished ms.) estimated mortality from recoveries of marked animals at 36 to 42 percent (58 to 64 percent survival) near Rochester in central Alberta.

The data for Iowa appears to be fairly typical of an exploited coyote population, with a survivorship between the extremes reported in other studies. The reason that observed survival in this study was higher than that found by Mathwig (1973) is not clear. It is interesting to note that in New Mexico and Arizona, which had the highest survival rates and presumably the lowest exploitation, the number of juvenile animals was consistent with the rest of the data. This adds further support to the hypothesis that juvenile coyotes may be more susceptible to some forms of human-caused mortality than are older animals, as has been reported in Alberta (Wetmore et al. 1970).

The differential survival between males and females noted in the present study has not been reported previously. The major difference between the age structures of the two sexes was the absence of females in the upper age-classes. The reason for a lower longevity in females is not clear but it may be related to greater reproductive stress in this sex throughout its lifetime.

The preponderance of males in the winter sex ratio was in agreement with the findings of several other studies (Robinson and Cummings 1951; Young and Jackson 1951; Gier 1968; Hawthorne 1971; Mathwig 1973; Nellis and Keith, unpublished ms.). Wetmore et al. (1970) and Knowlton (1972) found a greater ratio of females in areas where exploitation was intense and a greater ratio of males in areas under less intense harvest. The predominance of males in the first age-class implies either an uneven sex ratio at birth or some type of sex-specific mortality of juvenile females. Competition of female pups with larger (and presumably more aggressive) male littermates could be a contributing factor to the uneven sex ratio.

The mean weights of 29.6 and 25.1 pounds (13.4 and 11.4 kg) for male and female coyotes in this study are comparable with values of 30 and 25 pounds (13.6 and 11.3 kg) for males and females in Minnesota (Chesness 1973) and with the 31 and 26 pound (14.1 and 11.8 kg) averages for Kansas (Gier 1968). Weights of Iowa coyotes were greater than the 24 and 21 pounds (10.9 and 9.5 kg) reported for coyotes in California (Hawthorne 1971) but less than the 34.8 and 30.2 pound (15.8 and 13.7 kg) values for coyote-like canids in Maine (Richens and Hugie 1974).

Population Density

Siren index

The results of the 1973-1974 siren surveys were promising enough to warrant further research, but the technique should be evaluated for accuracy over a period of several years. The accuracy of the technique could be improved by increasing the number of stations per county and by surveying the maximum number of counties that is practical. The approach, however, would depend on the specific objectives of a survey.

If the objective was to estimate the difference in response between years as a whole, then it would be most advantageous to increase the number of counties surveyed. If, on the other hand, the objective was to detect differences between years at an individual county level, then it would be desirable to increase the number of stations per county and to decrease the number of counties, if necessary.

The costs of equipment and labor for the siren survey are also important considerations in determining the applicability of the technique. An electronic siren plus speaker currently costs approximately $200 and each route requires approximately 2.5 man-hours per night, or a total of 10 hours. Some disadvantages to the siren survey include: only one route can be surveyed at a time by a single individual; a relatively small amount of data is obtained per unit effort; and public reaction is sometimes adverse to the sounding of a siren after dark.

Advantages to the siren survey include a probable reduction in observer bias because coyote and dog vocalizations are relatively easy to distinguish, and a high response rate which should tend to somewhat reduce variability. The key consideration in deciding upon an index for practical use, however, is the accuracy of that index in monitoring density changes in the population. At this time, this consideration cannot be evaluated for the siren index because the available data does not cover a sufficiently long period of time.

Scent-post surveys

Scent-post surveys could offer some potential advantages over the siren survey, if they should prove to be accurate. These advantages include: several surveys may be run simultaneously by a single observer;

all work can be completed during normal working hours; larger quantities of data can be obtained with less effort; and public reaction is generally more favorable. However, observer biases may decrease the validity of the data if inexperienced personnel are used to identify tracks because coyote and dog tracks are not always easy to distinguish. Also, low visitation rates may tend to increase the variability of the estimate.

Livestock Losses

Domestic animal claims

Data collected from domestic animal claims was not obtained objectively but represented the judgments of individuals who were experiencing livestock losses. This information demonstrates how livestock growers view their losses.

Perhaps most noteworthy is that, despite claims by some sheep raisers, dogs appear to be doing more damage to sheep flocks in Iowa than coyotes, although recent information indicates that the coyote problem may be increasing. Since 1970, claims of alleged sheep losses to dogs have decreased at about the same rate that reported losses to coyotes have increased. This may be accurate but it also is suggestive of the possibility that coyotes are now being blamed for losses that were previously being attributed to dogs.

The seasonal pattern of reported sheep kills was probably directly related to availability of sheep. The summer peak of coyote kills roughly encompassed the time that sheep are normally grazed on open pasture. Feedlot confinement conditions probably had a large influence on the observed December peak in reported dog kills because a dog could easily kill a large number of sheep in a short period of time in that situation.

Few reliable figures are available on sheep losses to predators in the United States. Reynolds and Gustad (1971), using mail questionnaires, estimated sheep losses to predators at 5.3 percent of the total sheep inventory (cited in Advisory Committee on Predator Control 1972). Early et al. (1974a) also used mail questionnaires to arrive at figures of three and four percent losses of lambs and ewes, respectively, to predators in Idaho. Gier (1968) reported that maximum losses of three percent of the total sheep production in some counties in Kansas were attributable to coyotes, based on information from the annual farm census. Evanson (1967) felt that most estimates of sheep losses to predators were exaggerated and estimated that sheep losses to mammalian predators are normally in the vicinity of one percent. The estimates for Iowa are between the extremes listed above, averaging 0.8 percent for coyotes and 2.0 percent for dogs, with 0.3 percent attributed to either coyotes or dogs.

Food habits

Food habits analyses may not be strictly comparable for summer and winter, since one was based on scat contents and the other on stomach contents. However, the higher incidence of sheep in winter was the opposite of the reported trend in domestic animal claims.

The reason for this is not clear but may be related to relatively low densities of coyotes in winter, resulting in a higher incidence of sheep even though the total occurrence might actually be lower.

It was usually difficult or impossible to identify a food item as carrion, although eight stomachs (six of them from summer) contained dry hard hide, hooves, bones, or maggot-infested meat which indicated that they were from carrion. Cattle carrion was abundant on the study area at most times of the year and particularly in winter and spring. It is believed that nearly all of the cattle and most of the pigs found in the diet were probably taken as carrion. This is based both on the known availability of carrion and on informal interviews with cattle raisers who indicated that their losses to coyotes were either minor or nonexistent.

The amount of livestock found in the diet of coyotes in the present study was higher than in several other studies in the central United States. The 25.5 percent (by volume) figure for livestock in this study compares with 10.9 percent livestock and 12.8 percent carrion (mainly cattle and pig) in north-central Missouri (Korschgen 1973); 25.4 percent carrion (including livestock) in Kansas (Tiemeier 1955); 14.0 percent livestock in Iowa in 1971-1972 (Mathwig 1973); and 12.5 percent livestock in Nebraska (Fichter et al. 1955). Gipson (1974) found a low incidence of cattle and hogs but a high incidence of poultry in coyotes in Arkansas.

The proportion of livestock and carrion found in Missouri coyotes increased between the collections of 1957 and 1973 (Korschgen 1957, 1973). A similar trend may partially explain the greater amount of livestock in this study in comparison to that found by Mathwig (1973) and could be due to increased availability of cattle carcasses with increased cattle production and higher rendering costs.

Movements

Gier (1968) reported that juvenile coyotes make up a disproportionately large part of the kill early in the season, indicating a greater vulnerability to hunting. Most tag returns of juvenile animals in the present study have come from mid to late-winter but it is not known what proportion of the total kill they represented. The apparent greater recovery of juvenile females earlier in the year than males suggests a possible greater vulnerability of females to hunting which may be related to an earlier onset of dispersal in female coyotes.

The overall mean capture rate of 4.1 coyotes per 100 trap nights in the present study was substantially greater than the values of 1.04 for California (Hawthorne 1971), 0.91 for Minnesota (Chesness 1972), 0.59 for Alberta (Nellis 1968), 0.60 for Iowa in 1971-1972 (Mathwig 1973), and 0.57 for Utah-Idaho (Clark 1972). The reason for the higher success in the present study was probably because trapping was done intensively in relatively small areas for short periods of time and the traps were moved to new locations often.

The 25.8 percent tag recovery rate for this study, to date, was lower than the 48.1 percent rate in Wyoming (Garlough 1940), 41.5 percent in Yellowstone Park (Robinson and Cummings 1951), and 35.7 percent for California (Hawthorne 1971). Nellis and Keith (unpublished ms.[1]) reported an overall recovery rate of 39 percent in Alberta, representing a rate of 22 percent for pups tagged at dens and 56 percent for adult coyotes, compared to values of 20.2 percent for pups tagged at dens and 42.4 percent for older animals in this study. The difference in recovery rates for the two age groups was probably due to higher tag losses and greater mortality in the younger age group.

The apparent onset of dispersal in November in Iowa is similar to findings in Minnesota (Chesness and Bremicker 1974) and in Texas (Knowlton 1972) but it was slightly later than the reported dates for Yellowstone Park (Robinson and Cummings 1951) and Alberta (Nellis and Keith, unpublished ms.). The maximum distance of 107 miles (172.2 km) moved by a coyote in this study is comparable to figures of 100 miles (160.9 km) in Wyoming (Garlough 1940), 115 miles (185 km) in Montana (Robinson and Cummings 1951), 87 miles (140 km) in California (Hawthorne 1971), and 96 miles (154.5 km) in Alberta (Nellis and Keith, unpublished ms.).

Based on a limited number of returns from adult animals, juveniles tended to move much greater distances than did adults. This is

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[1]Manuscript provided by Carl H. Nellis, Idaho Department of Fish and Game, Garden City, Idaho.

consistent with findings in other studies (Robinson and Cummings 1951; Hawthorne 1971; Chesness and Bremicker 1974). The mean distance of 25.9 miles (41.7 km) for juvenile coyotes in this study is comparable to the 26.8 mile (43.1 km) mean reported by Garlough (1940) but is much greater than the 10.5 miles (16.9 km) reported for Yellowstone (Robinson and Grand 1958) and 9.1 miles (14.6 km) for central Alberta (Nellis and Keith, unpublished ms.). The probable reason for the differences between these studies appears to be that the latter two studies were conducted on relatively well-defined areas and many of the recoveries were made by the researchers themselves; whereas the present study and that of Garlough (1940) were carried out over a larger area and most returns were supplied by individuals not directly associated with the study. The observed skewed distribution of dispersal distances in the present study is consistent with the hypothesis of an innate dispersal tendency proposed by Howard (1960).

The slight but statistically insignificant greater movement by males in this study was the opposite of that reported by Robinson and Grand (1958), Knowlton (1972), and Nellis and Keith (unpublished ms.) who found that females traveled greater distances. Hawthorne (1971) observed no significant difference in the movements of males or females. Phillips et al. (1972) reported substantially greater movements by male red foxes than by females.

The apparent directional tendency of dispersal movements noted in this study has also been reported in Minnesota (Chesness and Bremicker 1974) and in Alberta (Nellis and Keith, unpublished ms.). The most plausible explanation for the apparent westward tendency in Iowa would seem to be differential hunting pressure. Coyotes generally decrease in abundance from west to east across the southern part of the state and the hunting pressure seems to decline accordingly in the easterly direction. Therefore, a tagged coyote dispersing west would probably encounter greater hunting pressure and be more likely to be returned as a data point.

Data on reproductive incidence in this study was not accurate for the entire population because collections were obtained somewhat before the peak of the breeding season. Calculation of the replacement rate, R_0, (Slobodkin 1961) for the observed mortality regime and litter sizes suggests that at least 45 percent of the juvenile females must be breeding if the population is maintaining itself. This is probably a valid assumption, since Iowa coyote populations appear to be increasing. Other workers have reported that the average incidence of breeding in yearling females is from 10 to 70 percent in Kansas (Gier 1968), 49 to 70 percent under favorable conditions in Utah-Idaho (Clark 1972), and 14 percent under unfavorable food conditions in Alberta (Nellis and Keith, unpublished ms.).

MANAGEMENT IMPLICATIONS

Although alleged sheep losses to coyotes and dogs accounted for only about three percent of total annual sheep production, these losses were not distributed equally among all sheep growers on the study area. Some individuals suffered high losses and certain flocks seemed to be located in traditional problem areas. In situations such as these, intensive control in a local area might be desirable. Any attempts to reduce populations in local areas, however, would require nearly continual control efforts each year. The great dispersal ability possessed by coyotes precludes the possibility of eradicating them in a local area for any significant period of time because each fall and winter there would be a new ingress of individuals from surrounding areas.

Normal hunting mortality in Iowa may not be additive to natural mortality, but may partially replace natural mortality. This is indicated by the fact that survival under high exploitation in Iowa is not much lower than that in the relatively unexploited populations reported on by Knowlton (1972). Hunting mortality in the spring, however, probably is nearly additive to natural mortality and would be the most effective means of bringing about a general population reduction. Bounties apparently are ineffective in causing any significant degree of population control.

In most cases of sheep losses to coyotes in Iowa, general population reduction appears to be the least efficient means of controlling coyote damage. Food habits analysis of coyote stomachs taken in selective control attempts suggest that selective control may be several times more effective at removing coyotes that are eating sheep than is general, nonselective control. In other words, several coyotes would need to be killed indiscriminantly to obtain the same degree of damage control that would be achieved by selectively killing one coyote. Therefore indiscriminant control, except in special cases, is an inefficient use of time, money, and of a valuable natural resource.

Coyotes probably have little detrimental effect on the populations of other game animals with the possible exception of the red fox. Red foxes were plentiful throughout the current range of the coyote in the early 1960's but declined to low levels, apparently as a result of a severe outbreak of mange. What inhibitory effects, if any, the coyote is exerting on red fox populations are not known.

Cottontail rabbits are a staple food item in the coyote's diet in Iowa but, because of their extremely high reproductive potential, rabbit populations are probably not being limited by coyote predation. Ring-necked pheasants and bobwhite quail are occasionally taken by coyotes, but this is probably the result of chance encounters rather than selective feeding.

Changing land-use practices in southern Iowa, particularly the clearing of timber for "pasture-improvement," have probably been beneficial to coyote populations by providing a more optimal interspersion of brushy and open habitat and by creating safe denning sites in bulldozed tree piles. It also appears likely that increased availability of cattle carcasses has greatly increased the winter carrying capacity for coyotes in southern Iowa.

Management Recommendations

Current information indicates that it would be economically infeasible and biologically unsound to attempt to control coyote damage to livestock by general population reduction. However, there does not appear to be sufficient justification to warrant a restricted season on the coyote at this time. The present continuous open season has not resulted in any apparent reduction in the coyote population, yet it allows the elimination of problem coyotes at any time and serves to reduce public concern about rising coyote populations.

Coyote damage to sheep can be controlled or prevented most effectively by practicing good animal husbandry and by selectively controlling problem coyotes, when necessary. Livestock growers should be encouraged to properly dispose of dead livestock. This will aid in removing a major source of food for coyotes and thereby also reduce the possibility of these predators becoming habituated to feeding on livestock.

SUMMARY

Ages were determined for 389 coyotes collected 1973-1975. Survival in 1973 was higher than in the next two years and averaged 60.9 percent for coyotes over one-year of age. Males had significantly higher survival than females in 1973 and 1975. The winter sex ratio, determined from the examination of 985 coyotes, significantly favored males (53.2 percent). The siren index for estimation of relative population density declined significantly from 33 percent response in 1973 to 21 percent in 1974. Scent-post index values in four counties ranged from 36 to 105 in 1974.

A total of 3594 livestock loss claims representing 11,958 sheep, 489 cattle, 1288 pigs, and 2354 chickens, geese, and ducks were examined. For all reported sheep losses, 52.9 percent were attributed to dogs and 35.6 percent to coyotes. The proportions of cattle, pigs, and poultry reportedly lost to dogs were also higher than those attributed to coyotes. A mean of 3.1 percent of the total annual sheep production on the study area was allegedly lost to dogs and coyotes. Reported sheep and pig kills were highest in the summer and early fall and reported cattle kills were highest in spring.

Rabbits were the most important single food item in the coyote's diet in both summer and winter. Livestock, most of which was believed to be carrion, made up nearly one-fourth of the winter diet. Stomachs of coyotes collected in selective control attempts contained 6 to 17 times greater occurrence of sheep than those from general summer or

winter collections.

A total of 99 coyotes was tagged at dens and 34 were trapped 1972-1974. A mean of 4.1 coyotes per 100 trap-nights was captured by trapping. To date, 25.8 percent of the tagged coyotes have been recovered at an average distance of 24.5 miles (range = 0 to 107 miles). Dispersal apparently began in November and movements of males and females did not differ significantly. Mortality causes included: shot, 55.9 percent; trapped, 23.5 percent; road-killed, 11.8 percent; and snared, 2.9 percent. Average litter size at dens was 6.1 pups and two of 15 dens contained two litters each. An average of 6.1 corpora lutea of ovulation or mature follicles were found in 103 ovaries examined.

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APPENDIX A: DATA FOR LOCATED ACTIVITY CENTERS AND TRAPPING SUCCESS

County	Estimated distance (miles)	Traps set?	Number captured
Decatur	0.50	Yes	2
Decatur	0.25	Yes	1
Decatur	0.10	Yes	3
Decatur	0.05	Yes	2
Guthrie	0.10	Yes	1
Marion	0.40	Yes	0
Marion	0.40	Yes	0
Marion	0.30	Yes	0
Marion	0.25	Yes	0
Marion	N.L.[1]	No	-
Ringgold	0.75	Yes	3
Ringgold	0.35	Yes	1
Ringgold	0.25	Yes	0
Ringgold	0.10	Yes	2
Ringgold	0.15	Yes	3
Ringgold	0.25	Yes	4
Ringgold	0.30	Yes	1
Ringgold	0.05	Yes	0
Ringgold	N.L.	No	-

[1]N.L. = Not located.

County	Estimated distance (miles)	Traps set?	Number captured
Ringgold	N.L.	No	-
Ringgold	N.L.	Yes	0
Ringgold	N.L.	Yes	0
Wayne	0.25	Yes	2
Wayne	0.40	Yes	1
Wayne	0.15	Yes	1
Wayne	0.10	Yes	2
Wayne	0.10	Yes	1
Wayne	0.40	Yes	1
Lucas	0.25	Yes	0
Lucas	0.45	Yes	0
Davis	0.05	Yes	1
Davis	N.L.	No	-
Appanoose	N.L.	Yes	0
Appanoose	N.L.	No	-
Appanoose	N.L.	No	-

APPENDIX B: GENERAL INFORMATION FOR TAGGED COYOTES RECOVERED IN THIS STUDY

County tagged	Tagging date	Sex	Cause of mortality	Return date	Movement
Decatur	05-13-72	M	shot	01-16-74	5 mi. NW
Decatur	05-13-72	F	shot?	11-20-72	40 mi. SW
Decatur	05-13-72	M	road-kill	10-25-72	1 mi. NE
Decatur	05-13-72	M	trapped	12-04-72	33 mi. SE
Decatur	05-13-72	M	trapped	10-25-72	0.5 mi. --
Decatur	05-13-72	F	shot	11-19-72	1 mi. NW
Decatur	05-20-72	F	trapped	10-25-72	0.5 mi. --
Decatur	05-21-72	M	shot	01-25-73	27 mi. E
Decatur	06-07-72	M	road-kill	03-10-73	28 mi. SW
Decatur	05-03-73	M	shot	?	0 mi. --
Harrison (Missouri)	05-04-73	F	shot	12-10-73	26 mi. N
Harrison (Missouri)	05-04-73	M	shot	01-05-74	18 mi. NW
Harrison (Missouri)	05-04-73	M	shot	01-08-74	33 mi. NW
Decatur	05-05-73	F	shot	12-18-73	19 mi. NW
Ringgold	07-11-73	F	shot	12-29-73	46 mi. NW
Ringgold	07-11-73	M	shot	02-05-75	13 mi. SW
Ringgold	07-13-73	M	shot	02- ?-75	5 mi. NE
Decatur	07-17-73	M	trapped	03-14-74	107 mi. SW
Decatur	07-17-73	F	trapped	01-15-74	36 mi. NE

County tagged	Tagging date	Sex	Cause of mortality	Return date	Movement
Decatur	07-19-73	F	drowned (dogs)	11-30-73	0.5 mi. --
Davis	07-27-73	F	killed by dogs	09-26-73	1.5 mi. SW
Wayne	08-21-73	M	shot	11-15-73	3 mi. SW
Wayne	08-23-73	M	shot	02-20-73	37 mi. S
Decatur	05-09-74	F	trapped	12-19-74	3 mi. SW
Ringgold	05-11-74	M	road-kill	02-09-75	36 mi. SW
Ringgold	05-11-74	F	shot	02-19-75	39 mi. SW
Ringgold	05-11-74	F	shot	02-18-75	69 mi. S
Harrison (Missouri)	05-11-74	M	shot	?	70 mi. NE
Harrison (Missouri)	05-11-74	M	shot	01-05-75	24 mi. NE
Ringgold	07-03-74	M	shot	02- ?-75	5 mi. SW
Ringgold	07-06-74	F	trapped	11-22-74	0.5 mi. S
Ringgold	07-06-74	F	trapped	11-06-74	4 mi. NW
Ringgold	07-18-74	M	snared	02-28-75	0 mi. --
Wayne	08-31-74	F	shot	02-07-75	54 mi. NW

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