Transactions of the Illinois State Academy of Science
(2007), Volume 100, #3&4, pp. 251-257
received 2/28/06
accepted 6/27/07

Demographics of Coyotes (*Canis latrans*) During the Late 1970s and 1990s in Southwestern Illinois

Brian R. Mahan[1] and Emily C. Mahan[2]
[1]Illinois Department of Natural Resources
One Main Event Lane, Suite 140
Sparta, IL 62286
[2]University of Missouri
2319E South Providence Road
Columbia, MO 65203

ABSTRACT

We collected sex, age, and reproductive data from 100 coyotes harvested by fur-takers during the late-1970s and another 200 in the late-1990s from southwestern Illinois. The two samples had nearly identical male-female sex ratios (0.89:1 and 0.87:1, respectively), and neither differed significantly from parity. The percentage of juveniles (<1 year of age) for the 1970s sample (69%) differed significantly from that of the 1990s sample (46%). The high percentage of juveniles in southwestern Illinois during the late-1970s affected breeding rates. Among adult (>1 year of age) females, breeding rates were 53% and 72% for the 1970s and 1990s samples, respectively. The mean number of placental scars (PS) per breeding female of the 1970s sample (4.0) was lower, but did not differ significantly from that of the 1990s sample (4.9). The number of coyotes in southwestern Illinois, as elsewhere in the state increased during the late-1970s. Twenty years later, the coyote population in this area of the state and statewide had stabilized. During both time periods, the mean PS counts in this region of the state were lower than those reported for coyotes in more northern latitudes of Illinois.

Key words: coyote, *Canis latrans*, age structure, placental scars, reproduction, sex ratio

INTRODUCTION

Coyotes (*Canis latrans*) have always been present in Illinois, but densities were low until the 1970s when the population began to grow rapidly (Hoffmeister 1989, Nelson and Lloyd 2005). During the late-1970s, fur prices and harvest rates of all furbearers, including coyotes, also increased from previous levels. The number of coyote pelts purchased by fur buyers rose from 2,833 in 1975-76 to 9,831 pelts in 1979-80 (Hubert 1976, 1980).

We analyzed and compared the demographics of two samples of coyotes collected in southwestern Illinois: One from the late-1970s, a time of increasing coyote numbers (Hoffmeister 1989, Nelson and Lloyd 2005) and increased harvests (Hubert 1976, 1980),

and the second during the late-1990s, when the population had apparently stabilized (Nelson and Lloyd 2005). The two samples were compared with previous coyote studies in Illinois: Hubert (1978, 1979) and Nelson and Lloyd (2005).

MATERIALS AND METHODS

We collected 36 coyote carcasses from fur buyers in Randolph County, Illinois from December 1976 to January 1977 and another 64 specimens from December 1979 to January 1980. The animals had been harvested by trappers and hunters in Randolph and surrounding counties. During the winters (November - February) of 1997-2001, a second sample of 200 coyotes was obtained from the same fur buyers and from several coyote hunters in Randolph, Monroe, and St. Clair Counties.

We recorded the sex of each specimen and removed the uterus from females. Placental scars (PS) were counted following Gier (1968) and Kennelly (1978), and female reproductive rates and mean PS counts were calculated for each sample.

After boiling for about 20 minutes, the upper canine teeth of each of the 1970s specimens were extracted from the skulls (1976-77) or rostrums which had been removed with a hand saw (1979-80). One canine tooth was sawed off at the gumline using a Dremel™ Roto-drill equipped with a 1-mm thick, 25-mm diameter carborundum disk. (Mention of a product does not imply endorsement by Illinois Department of Natural Resources.) For each of the coyotes collected in 1997-2001, one upper canine was sawed off at the gumline *in situ*.

Each canine tooth crown's maximum pulp cavity width (a) and maximum tooth width (b) was measured with a calibrated binocular dissecting scope, and a pulp cavity width ratio (a/b) was calculated for each specimen. Juveniles (<1 year of age) were separated from adults (>1 year of age) by their relatively larger canine tooth pulp cavity (Knowlton and Whittemore 2001, Nelson and Lloyd 2005, and others).

We used Chi-square (x^2) tests to determine if male-female ratios differed significantly from 1:1 and if our samples' sex and juvenile-adult ratios differed significantly from each other and from those of other Illinois studies. We used a two-tailed *t*-test to find any significant difference between the samples' mean PS counts. A *P*-value ≤ 0.05 was used to determine significance.

RESULTS

Males made up less than half (47%) of both the late-1970s and the late-1990s collections. Neither sample's male-female sex ratio was significantly different from parity; 0.89:1 and 0.87:1 (x^2=0.250 and 0.845), respectively (Table 1). The percentage of juveniles (69%) in the 1970s sample differed significantly from that of the 1997-2001 sample (46%; x^2=21.333).

Breeding rates among adult females were 53% and 72% for the 1970s and 1990s samples, respectively. The mean number of PS per breeding female of the late-1970s sample

(4.0, range 1-6, N=9) did not differ (P=0.186) from the late-1990s sample (4.9, range 1-10, N=39).

DISCUSSION

Hubert (1978, 1979) collected coyote specimens during the late-1970s, and recorded significantly more males than females (Table 1). While our 1970s sample was made during the same time period, our sample's sex ratio did not differ from 1:1 (Table 1). Several coyote researchers have noted balanced sex ratios in lightly harvested coyote populations (Knowlton 1972, Todd, Keith, and Fischer 1981, Windberg 1995). Our results suggest that coyote harvests in southwestern Illinois during the late-1970s were low despite increasing statewide harvest rates (Hubert 1976, 1980).

Hoffmeister (1986) and Nelson and Lloyd (2005) indicated that the statewide coyote population was increasing rapidly in the 1970s. This also occurred in southwestern Illinois at that time and is supported by anecdotal reports of hunters, trappers, fur buyers, and the lay public. Coyote harvest rates in this part of the state were relatively low and slow to increase, however, due to lack of interest and knowledge among fur-takers about trapping and hunting coyotes.

Most coyotes purchased by fur buyers in the area during the late-1970s were from persons who inadvertently took them while trapping or hunting for other species (fur buyers, C. Zanders and H. Schaffner, personal communication). Interest in coyote hunting did not increase markedly in the region until the early- to mid-1980s when individuals began purchasing equipment and dogs used specifically to hunt coyotes (C. Zanders and H. Schaffner and coyote hunters, M. Albert and C. Barlow, personal communication).

We also did not find a significant difference from parity between sexes in our 1990s sample (Table 1). In a mid-1990s statewide study, Nelson and Lloyd (2005) recorded a preponderance of males (Table 1). Specifically, they noted significantly more adult (>2 years of age) males, and reported that their yearling (1-2 years of age) and juvenile age classes showed a balanced sex ratio. They suggested that adult males were more vulnerable to harvest, especially hunting.

To allow direct comparison with our 1990s sample, we combined Nelson and Lloyd's (2005) adult and yearling age classes. The resulting male-female ratio of this combined adult (>1 year of age) age class, 1.26:1, differed significantly from 1:1 (x^2=5.643). Although the number of adult males was slightly higher in our late-1990s sample (more of these coyotes were likely harvested via hunting), in neither of our samples — late-1970s nor late-1990s — did adult males predominate (Table 1). This probably reflects the less intense harvest rates in southwestern Illinois compared to elsewhere in the state during either time period.

Juveniles made up 69% of our late-1970s sample. Subsequent age analysis of 99 of the specimens collected by Hubert (1978, 1979) from the same time period revealed that 75% were juveniles (G. Hubert, unpublished data). Other researchers have recorded more juveniles in samples of coyotes from areas of high harvest rates (Mathwig 1973, Jean and Bergeron 1984, and Anderson, Stoneberg, Newell, and Schladweiler 2001). The high

percentages of juveniles in Hubert's studies of the late-1970s probably resulted in part from increasing harvest rates and an expanding population — high recruitment of young coyotes and/or immigration of young individuals. Harvests of juveniles were high due to their lack of experience with human-caused threats, lack of familiarity of the local habitat, and possibly, exclusion from choice cover by territorial and socially dominant adults (Van Deelen and Gosselink 2006).

In southwestern Illinois, where coyote harvests appear to not have been as intense at the time and slow to increase, the large numbers of juveniles in the sample reflects an expanding population due to high recruitment of young coyotes and/or immigration of young individuals into the area.

By contrast, 20 years later, our collection of 200 coyotes from southwestern Illinois consisted of only 46% juveniles. And, while Nelson and Lloyd (2005) noted 55% juveniles in their mid-1990s statewide study, only 46% of the coyotes they collected from southern Illinois were juveniles, identical to what we found. Windberg (1995) reported that coyote populations near carrying capacity have a lower percentage of juveniles. The results from both Nelson and Lloyd's (2005) study and our late-1990s sample suggest that the Illinois coyote population was stabilizing at that time. This is supported by the nearly level coyote sighting indices from the Illinois Department of Natural Resources' annual Archery Deer Hunter Survey during the same time period (Bluett 2005).

High pregnancy rates among female coyotes in areas with high harvest rates have been reported (Dumond and Villard 2000, Anderson et al. 2001). In our late-1970s sample, a total of 53% of the adult females had PS. This somewhat low pregnancy rate suggests that at the time, coyote harvests in southwestern Illinois were not particularly high.

While Hubert (1978, 1979) reported breeding rates of 10% and 31%, extrapolating from the age data of 99 of his specimens (see above), only 33 of the 132 female coyotes examined by him were adults, and of these, 14 had PS giving a breeding rate of over 42%. Hubert's and our studies' pregnancy rates are still not particularly high when compared to those of other coyote studies (Gier 1968, Knowlton 1972, Jean and Bergeron 1984, Windberg 1995), and are lower than expected given the increasing coyote population during the 1970s.

Younger age classes of coyotes typically have lower ovulation and pregnancy rates (Clark 1972, Kennelly 1978, Todd and Keith 1983, Windberg 1995). The aforementioned high percentages of younger coyotes found in the statewide population, and in southwestern Illinois in particular, during the late-1970s explain the lower pregnancy rates noted by both Hubert (1978, 1979) and us. High recruitment of juveniles and immigration of young coyotes into the state from areas of higher coyote concentrations at that time is likely a major factor for such an increase in the population which occurred in the 1970s. The higher numbers of young coyotes depressed the population's reproductive rates.

Knowlton (1972) and Windberg (1995) stated that coyote populations at or near carrying capacity have low breeding rates. While the juvenile-adult percentages of our late-1990s sample suggested that the coyote population in southwestern Illinois was at or near carrying capacity, we noted a pregnancy rate of over 70%. Nelson and Lloyd (2005) found a

breeding rate of 57% among the females in their statewide study involving a much larger sample. The relationship between the abundance of food to greater coyote pregnancy rates has been well documented (Gier 1968, Clark 1972, Todd and Keith 1983, and others). The high breeding rate noted in our late-1990s sample from southwestern Illinois suggests that food availability, related to the increasingly mild winters at the time (unpublished data), was not a problem for female coyotes during the reproductive seasons sampled.

Windberg (1995) felt that reduction of coyote populations via harvesting releases internal social constraints that stimulate compensatory population growth. During their mid-1990s statewide study, Nelson and Lloyd (2005) attributed the high breeding rate they found to food availability and high levels of exploitation. In southwestern Illinois during the 1990s, it appears that food availability, somewhat higher harvest rates, and possibly coyote social factors resulted in high pregnancy rates.

Larger litter sizes among female coyotes in areas of high harvest rates have been reported (Knowlton 1972, Anderson et al. 2001). While Hubert (1978, 1979) recorded mean PS counts of 6.8 and 6.9 per breeding female during the late-1970s, we noted a mean PS count of only 4.0 in our 1970s sample. Again, this suggests that relatively lower harvest rates occurred in southwestern Illinois at the time as compared to elsewhere in the state. Areas of lower coyote harvest rates often have lower litter sizes (Windberg 1995).

The mean PS count of our late-1990s sample (4.9 PS per breeding female) was slightly higher, possibly as a result of a greater percentage of adult females, but was not significantly different from that of our late-1970s sample. The figure is identical to that found by Nelson and Lloyd (2005) in their mid-1990s statewide study.

In his original study, Lloyd (1998) found no significant difference among the mean PS counts for female coyotes from northern, central, and southern Illinois. He felt, however, that the results suggested a positive latitudinal trend — greater mean PS counts in the north, lesser in the south. The mean PS counts from both of our southwestern Illinois samples were lower than that reported by Hubert (1978, 1979) and by Lloyd (1998), respectively, for coyotes collected from more northern Illinois latitudes, lending support for his theory.

SUMMARY

Based on our results, coyote harvests in southwestern Illinois during the late-1970s, appear to have been lower than expected given the increasing statewide harvest rates at the time. The increasing coyote numbers statewide during that time increased the percentage of juveniles within the population. This, in turn, resulted in somewhat lower female coyote reproductive measures. In the late-1990s, coyote harvests in southwestern Illinois, while lower than other parts of the state, were great enough to affect the population's reproductive rates. At this time, the coyote population in southwestern Illinois had apparently stabilized.

ACKNOWLEDGMENTS

This study was funded in part by Federal Aid in Wildlife Projects W-49-R and W-99-R, the U.S. Fish and Wildlife Service, and the Illinois Department of Natural Resources, cooperating. We thank fur buyers G. Napier, H. Schaffner, C. Zanders, G. Zanders, and R. Zanders and several coyote hunters, especially M. Albert and C. Barlow who donated specimens, and R. D. Bluett, G. F. Hubert, Jr., T. Nelson, and P. McDonald for their reviews of the manuscript.

LITERATURE CITED

Anderson, N., R. Stoneberg, J. Newell, and P. Schladweiler. 2001. Effect of predator control on coyote age structure, weight, and reproduction. Intermountain J. Sciences, 7:93-108.

Bluett, B. 2005. 2004 Archery Deer Hunter Survey. Illinois Department of Natural Resources, Wildlife Diversity Program Note 05-5, Springfield, Illinois, USA.

Clark, F. W. 1972. Influence of jackrabbit density on coyote population change. J. Wildl. Manage., 36:343-356.

Dumond, M., and M.-A. Villard. 2000. Demography and body condition of coyotes (*Canis latrans*) in eastern New Brunswick. Can. J. Zool., 79:399-406.

Gier, H. T. 1968. Coyotes in Kansas. Kansas State College Agricultural Experiment Station Bulletin 393.

Hoffmeister, D. F. 1989. Mammals of Illinois. University of Illinois Press, Urbana, Illinois, USA.

Hubert, G. F., Jr. 1976. Fur Harvest Survey, 1975-76. Illinois Department of Conservation, Federal Aid Project Report, W-49-R-24-3, Springfield, Illinois, USA.

Hubert, G. F., Jr. 1978. Population trends and characteristics: Canid investigations. Illinois Department of Conservation, Federal Aid Project W-49-R-25-11, Springfield, Illinois, USA.

Hubert, G. F., Jr. 1979. Population trends and characteristics: Canid investigations. Illinois Department of Conservation, Federal Aid Project W-49-R-26-11, Springfield, Illinois, USA.

Hubert, G. F., Jr. 1980. Fur Harvest Survey, 1979-80. Illinois Department of Conservation, Federal Aid Project Report, W-49-R-27-3, Springfield, Illinois, USA.

Jean, Y., and J.-M. Bergeron. 1984. Productivity of coyotes (*Canis latrans*) from southern Quebec. Can. J. Zool., 62:2240-2243.

Kennelly, J. J. 1978. Coyote reproduction. Pages 73-93 *in* M. Bekoff, editor. Coyotes: Biology, behavior and management. Academic Press, New York, New York, USA.

Knowlton, F. F. 1972. Preliminary interpretations of coyote population mechanics with some management implications. J. Wildl. Manage., 36:369-382.

Knowlton, F. F., and S. L. Whittemore. 2001. Pulp cavity-tooth width ratios from known-age and wild-caught coyotes determined by radiograph. Wildl. Soc. Bull., 29:239-244.

Lloyd, D. M. 1998. Demographics and condition of Illinois' coyotes. Thesis, Eastern Illinois University, Charleston, Illinois, USA.

Mathwig, H. J. 1973. Food and population characteristics of Iowa coyotes. Iowa St. J. Research, 47:167-189.

Nelson, T. A., and D. M. Lloyd. 2005. Demographics and condition of coyotes in Illinois. Amer. Mid. Nat., 153:418-427.

Todd, A. W., and L. B. Keith. 1983. Coyote demography during a snowshoe hare decline in Alberta. J. Wildl. Manage., 47:394-404.

Todd, A. W., L. B. Keith, and C. A. Fischer. 1981. Population ecology of coyotes during a fluctuation of snowshoe hares. J. Wildl. Manage., 45:629-640.

Van Deelen, T. R., and T. E. Gosselink. 2006. Coyote survival in a row-crop agricultural landscape. Can. J. Zool., 84:1630-1636.

Windberg, L. A. 1995. Demography of a high-density coyote population. Can. J. Zool., 73:942-954.

Table 1. Sex ratios of Illinois coyotes.

Study	Males	Females	Sex Ratio (M:F)
Late-1970s sample[a]	**47**	**53**	**0.89:1**
Adults	14	17	0.82:1
Juveniles	33	36	0.92:1
Late-1990s sample[a]	**93**	**107**	**0.87:1**
Adults	54	55	0.98:1
Juveniles	39	52	0.75:1
Hubert (1978, 1979)	**231**	**186**	**1.25:1**[c]
Nelson and Lloyd (2005)	**520**	**457**	**1.13:1**[c]
Adults[b]	247	196	1.27:1[c]
Juveniles	273	261	1.04:1

[a] present study

[b] >1 year of age; see text for explanation

[c] x^2 test, significantly different from 1:1, $P \leq 0.05$