

# SURVIVAL AND CAUSE-SPECIFIC MORTALITY OF ADULT BOBCATS IN CENTRAL MISSISSIPPI

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**Abstract:** Precise and unbiased estimates of survival and mortality patterns are requisite to understand population dynamics of bobcats (*Lynx rufus*) within temperate ecosystems. Although previous research has examined bobcat survival, most studies have been short term (<5 yr) and provided limited information on sex- and season-specific mortality rates. We determined annual and seasonal survival rates of 68 radiomarked bobcats during 1989–97 in central Mississippi. Annual survival ( $S$ ) did not differ between males ( $S = 0.75$ ,  $SE = 0.13$ ) and females ( $S = 0.84$ ,  $SE = 0.09$ ), nor did survival vary among years. Legal harvest (incidental take) accounted for most (45%) bobcat deaths. Males were more likely to be harvested than females, with all hunting mortality occurring during the fall–winter white-tailed deer (*Odocoileus virginianus*) hunting seasons. Females were more likely to experience mortality during parturition–young-rearing periods than were males. Probability of incidental harvest for females was correlated with crepuscular movement rates and distances moved during diurnal periods. We suggest movement patterns and differences in breeding behavior influence incidental harvest of bobcats, and hence annual and season survival.

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Information on long-term annual and seasonal survival and mortality patterns is required to thoroughly understand dynamics of bobcat populations. Previous estimates of bobcat survival have been based on techniques such as carcass collections, trapper or hunter harvest, age structure, and tag return data (Crowe 1975, Bailey 1981, Blankenship and Swank 1981). Although individual-based survival and cause-specific mortality rates have been reported in northern sections of this species' geographic range (Fuller et al. 1985), information identifying causal mechanisms related to annual and seasonal mortality patterns is limited.

Previous research has indicated that human-related forms of mortality, primarily trapping and hunting, account for a large portion of bobcat deaths (Fuller et al. 1985, Knick 1990). However, recent decreases in commercial trapping, coupled with changes in land-use practices, have created conditions conducive to increasing bobcat populations in many areas. Even in the absence of commercial demand and targeted exploitation, bobcats are often incidentally harvested; however, the magnitude of this

incidental harvest on mortality and survival patterns is unclear. Thus, our objectives were (1) estimate annual and seasonal survival rates, (2) identify sex-specific differences in seasonal and annual survival rates, (3) estimate cause-specific mortality for adult male and female bobcats, and (4) identify potential causal mechanisms related to harvest susceptibility for a bobcat population in central Mississippi from 1989 to 1997.

## STUDY AREA

This research was conducted on the 14,410-ha Tallahala Wildlife Management Area (TWMA), a 4,900-ha area owned by Georgia-Pacific Corporation (GP) adjacent to TWMA, and surrounding private lands in sections of Jasper, Newton, Scott, and Smith counties, Mississippi. The TWMA contained 30% mature bottomland hardwood forests, 37% mature pine (*Pinus* spp.) forests, 17% mixed pine–hardwood forests, and 11% in 1–15-year-old loblolly pine (*P. taeda*) plantations. A tornado bisected TWMA in 1992, altering approximately 1,000 ha of mature pine and hardwood forests; most (90%) of the damaged area was replanted to loblolly pine. The GP was managed primarily for wood fiber production, with 90% of the area

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composed of 1–35-year-old loblolly pine plantations, and the remaining 10% in Streamside Management Zones (SMZs) along creek drainages. The study area contained 1 primary and 1 secondary paved road; remaining roads were maintained gravel roads. Topography was gently to moderately rolling, with 0–20% slope. Climate was mild, with a mean annual temperature of 20°C and mean annual precipitation of 152 cm.

## METHODS

### Bobcat Capture and Radiotelemetry

We captured bobcats with Number 3 and 1.5 Victor soft-catch foot-hold traps (Woodstream, Lititz, Pennsylvania, USA) from 10 January to 15 August 1989, and from 4 January to 5 March, 1990–97. Captured bobcats were netted and anesthetized with ketamine hydrochloride (Ketaset Veterinary Products, Fort Dodge Laboratories, Fort Dodge, Iowa, USA) at 15 mg/kg of estimated body mass. Each bobcat was weighed, standard body measurements were taken, and each then given a unique ear tattoo. We fitted each adult bobcat with a 175–225-g mortality-sensitive radiotransmitter (Advanced Telemetry Systems, Isanti, Minnesota, USA). Juvenile bobcats were not fitted with radiotransmitters because of concerns with indeterminate growth of bobcats and auspices of the Mississippi State University Institutional Animal Care and Use Committee. Drugged bobcats were placed in portable pet kennels, monitored to facilitate recovery, and then released at the capture site the following morning. We conducted research under Mississippi State University Institutional Animal Care and Use Committee Protocol 93-032.

Bobcats were located by triangulation (White and Garrott 1990) from permanent radiotelemetry stations ( $n = 480$ )  $\geq 3$  times/week from 1 January to 15 August and  $\geq 2$  times/week during other periods. In most instances, distance from observer to bobcat was  $\leq 1.0$  km. When a mortality signal was detected, bobcats were located immediately to determine cause of death. Bobcats recovered intact were necropsied at the Mississippi State University College of Veterinary Medicine. Bobcats were classified as killed by incidental harvest, vehicle collision, natural causes (e.g., feline panleukopenia, predation), or unknown factors. If carcasses were scavenged or disturbed, cause of death was classified as

unknown. If the exact date of death was unknown, death date was designated at the midpoint between the last known live telemetry location and date when death was confirmed.

We hypothesized that movement patterns would influence harvest susceptibility during fall–winter hunting seasons. Thus, concurrent with monitoring survival, we examined hourly and daily movement patterns of adult bobcats (12 M, 20 F;  $n = 32$ ) from 1993 through 1997. We used sequential radiotelemetry throughout the diel period to document bobcat movement patterns. Monitoring sessions lasted from 3 to 4 hr, with bobcat-specific locations recorded at  $\leq 1$  hr intervals (range = 3–10 bobcats/session). Radiotelemetry accuracy for a single bearing averaged  $\pm 7.9^\circ$ . Mean distances moved between consecutive locations and meters moved per hour were determined for the fall–winter hunting seasons by sex and year. Distances moved and movement rates were separated into 3 periods (diurnal, crepuscular, nocturnal) within the diel period. Periods were defined as crepuscular (0400–0800, 1600–2000), diurnal (0800–1600), and nocturnal (2000–0400).

### Survival and Mortality Analyses

We used the nonparametric Kaplan-Meier approach, generalized to the staggered-entry case, to estimate survival rates by year, sex, and season (Pollock *et al.* 1989). We assumed survival times for each bobcat were independent and that trapping, handling, and radiomarking did not affect survival. We tested hypotheses concerning differences in survival between sexes, and among years and seasons via the generalized chi-square hypothesis testing procedures outlined by Sauer and Williams (1989) in program CONTRAST (Hines and Sauer 1989). We used a hierarchical testing system to examine differences in annual survival between sexes and across years. We tested differences in annual survival between sexes by constructing contrast vectors with linear contrasts in program CONTRAST. We examined differences in survival between sexes and among seasons by controlling for year effects via contrast vectors and testing survival between groups (sexes or between seasons). We hypothesized that seasonal survival and temporal mortality patterns would differ between sexes across seasons, as breeding and parental care responsibilities could influence survival. Thus, we examined sex-specific

survival across seasons to test potential differences in temporal survival.

Cause-specific mortality was defined as the probability of a bobcat dying during a given interval from a given mortality agent in the presence of other competing mortality agents. We used the Heisey-Fuller method to estimate cause-specific mortality rates (Heisey and Fuller 1985a). In addition to the assumptions of the Kaplan-Meier approach, the Heisey-Fuller (1985a) method assumes constant daily survival within a period. Although the Heisey-Fuller approach (Heisey and Fuller 1985a) assumes the exact date of death is known (i.e., daily relocation), the model is robust to relocation intervals as great as 10 days.

Bobcats were entered into the survival model the day following capture. Four bobcats believed to have died from capture injuries were excluded. Bobcats with radiotransmitter failures were censored on the last day of observation (Vangilder and Sheriff 1990). If subsequently recaptured, these bobcats were reentered into the model the day following recapture. Radio-marked bobcats recaptured prior to radiotransmitter failure were censored the day of capture and reentered into the model the day following capture.

We divided each year into biological seasons: (1) breeding-gestation (1 Feb-31 May), (2) parturition-young-rearing (1 Jun-30 Sep), and (3) fall-winter (1 Oct-31 Jan). Biological seasons were delineated via reproductive and physiological information from captive bobcats at Mississippi State University (Stys and Leopold 1993). We used a log-likelihood ratio model to test for effects of year, season, and sex. The full model contained 9 years (1989-97), 3 seasons, and 2 sexes. Reduced models were developed to examine differences in mortality agents between sexes and among years and season by collapsing categories of interest. We examined differential probabilities of incidental harvest by testing male and female harvest rates during fall-winter via program CONTRAST (Hines and Sauer 1989).

Statistical comparisons between full and reduced models were made via the absolute value of the difference between the  $2 \times$  log-likelihood for each model (Heisey and Fuller 1985b, Vangilder and Kurzejeski 1995). Degrees of freedom for this chi-square goodness-of-fit approximation is the difference between full model degrees of freedom and reduced model degrees

of freedom. We tested for differences in cause-specific mortality rates between sexes with a generalized chi-square hypothesis test (Hines and Sauer 1989).

### Relations to Harvest

We used correlation analysis to examine relations between hunter effort (public use) and probability of incidental harvest. As bobcat harvest was legal during sport hunting season, we hypothesized that increased hunter effort would correspondingly increase bobcat susceptibility to harvest. Hunting with the aid of hounds, both for white-tailed deer and raccoons (*Procyon lotor*), occurred on portions of the study area.

Hunter effort was defined as the number of hunter-days recorded on the study area from 1 October to 31 January, coinciding with the opening and closing of white-tailed deer hunting seasons. Deer hunter effort was determined via mandatory check stations distributed throughout the study area. We also hypothesized that higher levels of human-induced disturbance (i.e., traffic, hunting) would increase probabilities of bobcats succumbing to human-induced mortalities (incidental harvest, vehicle collision). Thus, we pooled human-induced mortalities and tested relations between hunter effort and probability of mortality from human-related factors.

We used mean movement distances (m) and rates (m/hr) by bobcats during diurnal and crepuscular periods to examine relations between movement and sex-specific susceptibility to incidental harvest. Although legal, furbearer trapping (e.g., for bobcats, coyotes [*Canis latrans*], gray fox [*Urocyon cinereoargenteus*]) via foothold or snare traps did not occur during the study; thus, we did not use nocturnal movement patterns in analyses, as bobcats were not susceptible to incidental harvest from hunters during nocturnal periods. A mean movement distance and rate were correlated to a probability of incidental harvest from 1 October to 31 January for each year, 1993-97. We used *t*-tests to examine differences in movement distances and rates between sexes. All tests were performed at  $\alpha = 0.05$ .

### RESULTS

We used 68 bobcats (28 M, 40 F) with 54,698 radio days to estimate survival and cause-specific mortality from 1 January 1989 to 31 January 1998. Of 31 known bobcat mortalities,

Table 1. Annual survival rates via the Kaplan-Meier staggered-entry approach for adult bobcats on Tallahala Wildlife Management Area, Georgia-Pacific Corporation, and surrounding private lands, Mississippi, 1989–97.

Year	<i>n</i>	Survival rate ( <i>S</i> )	SE
1989	6	0.84	0.10
1990	11	0.90	0.08
1991	11	0.72	0.11
1992	14	0.82	0.10
1993	25	0.79	0.09
1994	24	0.80	0.07
1995	28	0.84	0.07
1996	29	0.72	0.08
1997	27	0.74	0.09
Mean	68	0.80	0.09

causes of death were as follows: 14 (45%) were incidental harvest (shot), 10 (32%) were unknown, 4 (13%) were to vehicle collisions, 2 (6%) to other bobcats, and 1 (4%) to feline pancytopenia. Two of 10 (20%) unknown deaths (both were females) occurred during parturition–young-rearing. Although both females were recovered immediately after mortality signals were detected, postmortem decomposition prevented necropsy. Half of unknown deaths occurred during fall–winter; thus, incidental harvest was potentially causal. However, our conservative determination of cause of death, confounded by mild to exceptionally warm fall temperatures, resulted in assigning these deaths as unknown.

Fourteen bobcats (21%) experienced radio failures during the study and were not recaptured. Female bobcats were monitored for a mean of 872 days (range = 4–2,506), whereas males were monitored for a mean of 681 days (range = 9–2,795).

### Annual Survival

Mean annual survival was 0.75 for males (range = 0.62–1.00) and 0.84 (range = 0.44–1.00) for females. Annual survival did not differ between sexes during the 9 years ( $\chi^2_1 = 1.78$ ,  $P = 0.182$ ), nor did annual survival differ among years ( $\chi^2_8 = 3.91$ ,  $P = 0.865$ ; Table 1).

### Seasonal Survival

As survival did not differ between sexes or among years, we constructed contrast vectors to control for year and sex effects and tested survival among seasons. Survival did not differ between the breeding–gestation ( $S = 0.98$ , range

= 0.82–1.0) and parturition–young-rearing periods ( $S = 0.95$ , range = 0.67–1.0;  $\chi^2_1 = 1.83$ ,  $P = 0.176$ ) or between the parturition–young-rearing and fall–winter periods ( $S = 0.86$ , range = 0.67–1.0;  $\chi^2_1 = 0.012$ ,  $P = 0.915$ ). However, survival was lower in the breeding–gestation periods than fall–winter ( $\chi^2_1 = 15.17$ ,  $P < 0.001$ ).

### Sex-Specific Seasonal Survival

Survival during breeding–gestation ( $\chi^2_1 = 2.8$ ,  $P = 0.09$ ) and fall–winter ( $\chi^2_1 = 3.21$ ,  $P = 0.073$ ) did not differ between sexes, although both tests approached significance, with males having lower survival. However, survival during parturition–young-rearing differed between sexes ( $\chi^2_1 = 5.46$ ,  $P = 0.019$ ), with females ( $S = 0.92$ , range = 0.67–1.0) having lower survival relative to males ( $S = 0.99$ , range = 0.89–1.0).

### Cause-Specific Mortality

The distribution of mortalities did not differ across years ( $\chi^2_{192} = 68.5$ ,  $P = 1.00$ ). Thus, a reduced model was developed by collapsing years while maintaining 3 seasons and 2 sexes. By comparing subsequent reduced models to the reduced model with years collapsed, differences between sexes approached significance ( $\chi^2_{12} = 19.9$ ,  $P = 0.069$ ), whereas mortalities differed across seasons ( $\chi^2_{16} = 50.1$ ,  $P < 0.001$ ). As examining sex-specific harvest probabilities was desirable, we used the reduced model with 3 seasons and 2 sexes to estimate cause-specific mortality. Males experienced higher probabilities of incidental harvest than females ( $\chi^2_1 = 6.43$ ,  $P = 0.011$ ), whereas only females died from vehicle collisions (Table 2).

To test the hypothesis that breeding and parental care behaviors influenced mortality patterns, we created a reduced model by pooling all mortality agents during breeding–gestation and parturition–young-rearing. We then tested overall mortality rates between sexes during these seasons. Females were more likely to experience mortalities during parturition–young-rearing ( $\chi^2_1 = 4.12$ ,  $P = 0.042$ ) than males. However, males and females were equally likely to experience mortalities during breeding–gestation ( $\chi^2_1 = 0.057$ ,  $P = 0.812$ ).

### Relations to Harvest

Using fall–winter harvest probabilities and hunter effort by year, we detected no relations between deer hunter effort and incidental harvest probabilities for females ( $r = 0.715$ ,  $P =$

Table 2. Mortality interval rates ( $M$ ), by season, for adult bobcats on Tallahala Wildlife Management Area and Georgia-Pacific Corporation lands, Mississippi, 1989–97.

Season	Mortality agent	Males		Females	
		$M$	SE	$M$	SE
Breeding– gestation <sup>a</sup>	Incidental harvest	0.000	0.000	0.000	0.000
	Vehicle	0.000	0.000	0.019	0.014
	Natural	0.018	0.017	0.000	0.000
	Unknown factors	0.018	0.017	0.009	0.009
Parturition– young-rearing <sup>b</sup>	Incidental harvest	0.000	0.000	0.000	0.000
	Vehicle	0.000	0.000	0.000	0.000
	Natural	0.000	0.000	0.020	0.014
	Unknown factors	0.002	0.002	0.020	0.014
Fall–winter <sup>c</sup>	Incidental harvest	0.189	0.054	0.043	0.021
	Vehicle	0.000	0.000	0.022	0.015
	Natural	0.000	0.000	0.000	0.000
	Unknown factors	0.076	0.036	0.022	0.015

<sup>a</sup> 1 February–31 May.

<sup>b</sup> 1 June–30 September.

<sup>c</sup> 1 October–31 January.

0.110,  $n = 5$ ) or males ( $r = 0.135$ ,  $P = 0.799$ ,  $n = 5$ ). Probability of mortality from human-related factors (incidental harvest, vehicle collision) was not correlated to hunter effort for males ( $r = 0.135$ ,  $P = 0.799$ ,  $n = 5$ ) but was for females ( $r = 0.820$ ,  $P = 0.046$ ,  $n = 5$ ).

Mean distance moved between consecutive locations in diurnal periods during fall–winter was 444 m for males and 312 m for females. Distances moved between consecutive locations in diurnal periods did not differ between sexes ( $t_8 = -1.58$ ,  $P = 0.153$ ). Movement rates during diurnal periods averaged 450 m/hr for males and 369 m/hr for females, and movement rates did not differ between sexes ( $t_8 = -0.72$ ,  $P = 0.492$ ).

During crepuscular periods, distances moved between consecutive locations averaged 541 m for males and 368 m for females. Distances moved between consecutive locations did not differ between sexes ( $t_7 = -1.68$ ,  $P = 0.136$ ). Movement rates during crepuscular periods averaged 489 m/hr for males and 446 m/hr for females and did not differ between sexes ( $t_7 = -0.35$ ,  $P = 0.736$ ). Probability of incidental harvest was correlated with crepuscular distances moved ( $r = 0.880$ ,  $P = 0.049$ ,  $n = 5$ ) and movement rates ( $r = 0.866$ ,  $P = 0.058$ ,  $n = 5$ ) for females. We also detected correlations between diurnal distances moved and probability of incidental harvest for females ( $r = 0.863$ ,  $P = 0.054$ ,  $n = 5$ ), although no correlation was detected between movement rate and probability of harvest ( $r = 0.778$ ,  $P = 0.121$ ,  $n = 5$ ). For males, we detected no relations between cre-

puscular distances moved ( $r = -0.728$ ,  $P = 0.272$ ,  $n = 4$ ) or movement rates ( $r = -0.719$ ,  $P = 0.280$ ,  $n = 4$ ) and probability of harvest, nor were diurnal distances moved ( $r = 0.437$ ,  $P = 0.462$ ,  $n = 4$ ) or movement rates ( $r = 0.423$ ,  $P = 0.478$ ,  $n = 4$ ) correlated with probability of incidental harvest.

## DISCUSSION

Annual survival rates of adult bobcats (range = 0.44–1.00) in our study were slightly higher than those reported by Rolley (1983) in Oklahoma (range = 0.56–0.66) and Hamilton (1982) in Missouri ( $\bar{x} = 0.57$ , ad and juv). Similarly, survival rates were higher than those reported in Arkansas ( $\bar{x} = 0.62$ ; Rucker and Tumlison 1985) and in northern areas of bobcat range ( $\bar{x} = 0.67$  [Crowe 1975];  $\bar{x} = 0.61$  and 0.19 on 2 study areas [Fuller et al. 1985]). Although incidental harvest accounted for substantial proportions of bobcat deaths, legal trapping pressure was absent, resulting in differences in causes of mortality between this study and others. However, temporal patterns in mortality were similar, with peak exploitation of bobcat populations occurring during trapping–hunting seasons (Crowe 1975, Fuller et al. 1985).

The difference between male and female annual survival was negligible for bobcats on our study area, which differs from previous studies. In exploited populations, male survival is generally lower than females (Fritts and Sealander 1978). However, exploitation rates were lower in this study relative to other studies, with the exception of Bailey (1974). Because of physio-

logical demands placed on solitary female felids, such as those required for lactation and kitten rearing, we hypothesized that female survival during parturition–young-rearing might be lower than for males. Our data supported this hypothesis, indicating that parental care responsibilities may influence female survival and subsequent fitness.

For solitary carnivores where females raise young, as with the bobcat, reproductive success is closely related to availability of food resources (Kitchener 1991), if survival rates and fitness of females are to be high. For smaller felids, including bobcats, energetic requirements of females during lactation may increase by 2–3 times (Kitchener 1991). For example, lactating cheetahs (*Acinonyx jubatus*) spend considerably more time hunting, requiring nearly double their normal food intake (Caro 1994). Females typically display hunting behavior that maximizes opportunities to secure resources for reproduction and survival (Sandell 1989), and they may often exhibit greater movement rates (Lancia et al. 1986) and diel activity during lactation and kitten rearing (Emmons 1988). Thus, lower female survival in our study during parturition–young-rearing may be a direct consequence of parental care responsibilities, influenced by increased energetic requirements relative to males.

Male bobcats on our study area have larger home ranges (Edwards 1996, Lovell 1996) and core use areas (Conner and Leopold 1993, Plowman 1997) than do females. Male bobcats also exhibit greater movement rates and distances than do females (Bailey 1974), particularly during fall–winter, coinciding with fall white-tailed deer hunting seasons and early breeding opportunities on our study area (Sullivan 1995, Edwards 1996). Given these differential life-history characteristics, we hypothesized that male bobcats would be more susceptible to incidental harvest, and that male movement patterns would be correlated to probability of incidental harvest. Our data rejected the hypothesis that no sex-specific differences existed in incidental harvest probability, indicating that male bobcats had higher probabilities of incidental harvest, and although not statistically different, lower survival rates during fall–winter relative to females.

Within the literature, many speculations exist regarding the influence of male movements, presumably during early breeding periods, on

harvest susceptibility (Anderson 1987). We detected no correlations between male movement patterns or hunter effort and susceptibility to incidental harvest. Sullivan (1995) determined that male bobcats were more active during diurnal periods in winter on our study area, a behavior that could increase the probability of incidental harvest. Thus, we are unsure why no correlations existed between movement patterns and harvest susceptibility. Perhaps characteristics such as a male's location within his home range or habitat use patterns during diurnal periods influenced incidental harvest susceptibility. We encourage others to consider examining these potential hypotheses by using long-term datasets. Although our data failed to support contentions that male movements influence harvest, we did observe positive correlations between probability of mortality and female movements, as well as public use on incidental harvest of females.

We observed a relation between female movement patterns and susceptibility to incidental harvest, which suggested susceptibility increased during years with higher mean movement distances and rates. Similarly, we found relations between hunter effort on our study area and susceptibility of incidental harvest for females, although neither of these correlations indicate cause and effect. Bailey (1981) suggested the level of human disturbance may influence home range size, although home range may be a function of several factors, including habitat quality (Conner and Leopold 1993) and bobcat density (Griffith and Fendley 1986). Female bobcats locate home ranges to ensure sufficient resources for their survival and survival of their kittens (Anderson 1987), and they must hunt their home ranges more intensively, which requires large amounts of prey from smaller areas relative to males (Bailey 1981). If higher movement rates indicate increased hunting activity, our data suggest females hunting extensively within their home range are more susceptible to mortality from human-related factors. However, the relations between prey availability, hunting patterns, and subsequent susceptibility to harvest on our study area are unknown.

We realize potential biases exist in examining hunter harvest of bobcats, particularly in a research project involving radiotelemetry. From 1989 to 1991, we discouraged hunters from harvesting bobcats, as perceived populations and

numbers of radiocollared bobcats were relatively low. In 1992, as sample sizes and population levels increased, hunters began to harvest bobcats. Thus, research activities may have initially reduced bobcat mortalities from incidental harvest. Further, although bobcats were legal for harvest, some hunters may have been hesitant to harvest a radiocollared bobcat. Given these possibilities, our estimates of harvest mortality are likely conservative.

We acknowledge that sample sizes during the early years of our study were low, particularly in the context of examining survival and cause-specific mortality. Bobcat density on our study area prior to 1992 (0.095 bobcats/km<sup>2</sup>; Conner et al. 1992) was lower than densities reported in Florida (Guenther 1980) and Louisiana (Hall and Newsom 1976). However, given the density estimates by Conner et al. (1992), we monitored a large proportion of the bobcat population across the study area. As survival did not differ across years, we believe our estimates of survival and cause-specific mortality are not hampered by sample size constraints prior to 1992.

### MANAGEMENT IMPLICATIONS

In the absence of legal trapping, incidental harvest was the dominant cause of mortality. Managers should consider the potential magnitude of incidental harvest when implementing harvest limits on bobcat populations. Our data indicate male bobcats are more susceptible to incidental harvest than females. However, female mortality appears to increase during kitten-rearing periods, likely a function of parental care responsibilities.

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