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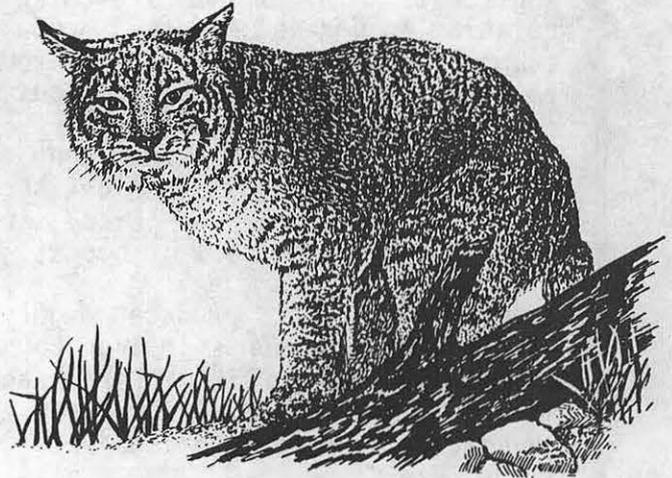
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**BOBCAT HARVEST AND POPULATION
TRENDS IN WISCONSIN, 1973-81**

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**DEPARTMENT OF NATURAL RESOURCES
RESEARCH**

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ABSTRACT

Bobcat harvest and population trends were analyzed using registration forms, questionnaires to hunters and trappers, and winter track counts. Registration totals showed no prolonged trends from 1973-81 on a statewide basis, except for a major decline within the North Central District beginning in 1977. Registration information indicated sex ratios differed significantly in relation to harvest method. Proportionately more females were taken by trapping and other methods compared to hunting. However, the accuracy of sex ratio data is questionable without carefully examining skinned carcasses.

Questionnaire data also showed no major trends in bobcat abundance, although hunters' and trappers' opinions suggested there was a slight increase for 1979-81. Over an 8-year period, trappers took 45% of their bobcats incidental to coyote trapping, 49% in bobcat sets, and 6% in other types of sets.

Winter track counts produced highly variable results that correlated poorly with harvests. Counts in Iron County showed no major trends, but in Oneida County a decline in track abundance corresponded to a decline in harvest beginning in 1977. Cover types at track locations showed bobcats generally favor lowland conifers.

Considering all data sources, the statewide population was judged to be relatively stable from 1973-81. Recommendations include: 1) continue the current monitoring program, which now includes collecting age and reproductive data from carcasses; and 2) maintain conservative season structures that have produced an average annual harvest of 200 or fewer bobcats.

INTRODUCTION

Bobcats were unprotected in Wisconsin until 1970, and through 1964 the Wisconsin Conservation Department paid a \$5 bounty. Increasing concern about the population status of the bobcat plus the desire to elevate it to game animal status led to the establishment of a 5 1/2-month season in 1970. The season was progressively shortened over the years to the current 2-month period (Table 1). In 1980, a seasonal bag limit of 1 bobcat was set, hunters and trappers were required to apply for possession tags prior to the season opening, and bobcats were protected south of State Highway 64.

The objective of this study was to develop a system for monitoring statewide bobcat population trends and test track count surveys to determine bobcat abundance. A preliminary study in 1973-74 examined bobcat distribution, relative numbers, and habitat conditions (Creed and Ashbrenner 1976). The project staff analyzed bounty and registration records, hunter-trapper questionnaires, and bobcat harvests relative to forest types and snowshoe hare abundance. At that time, we concluded that bobcats were secure in Wisconsin, but we recommended additional research on population status.

In 1976, we began an accelerated effort to test track count surveys and questionnaires, and analyze registration data. This report covers the 1976-82 activities, but earlier data are often incorporated (Creed and Ashbrenner 1976; Klepinger et al. 1979). Corrections in harvest data are included where delinquent registration reports have been received.

METHODS

Registration

Since October 1973, all bobcats taken in Wisconsin must be registered and tagged at a Department of Natural Resources field station or by a conservation warden. Registration data includes location (by county and deer management unit), method and date of kill, sex of animal, and names of hunters and trappers. These data were summarized annually and evaluated for changes and trends.

Questionnaires

Questionnaires were sent to people using dogs or traps to harvest bobcats. (Appendix A and B). They were asked where they hunted or trapped, the number of days they hunted or trapped, and their opinions on bobcat population trends. Hunters and trappers replied to questionnaires at an annual rate of 70-80%.

Track Counts

In eastern Oneida and western Iron counties, road transects ranging from 6-43 miles long were located in areas considered to be good bobcat range, with plentiful conifer and alder swamps. The next morning following a snowfall ending by 6 p.m. of the previous day, two observers drove transects with a 4-wheel drive vehicle or snowmobile. They recorded tracks of three predators--bobcats, coyotes, and fishers--and documented locations by odometer readings and cover type.

Certain variables prevented count-to-count standardization of transect length. Miles on individual counts of the same transect varied according to weather conditions and drivability. Snow plowing and new snowfalls sometimes covered tracks, so that counts had to be terminated before total transect lengths were completed.

RESULTS AND DISCUSSION

Population Trends

Data from registration, questionnaires and track counts suggest the statewide bobcat population has remained relatively stable during 1973-81. Bobcat registrations averaged 208 annually from 1973 through 1981, ranging from 90 in 1980 to 296 in 1973 (Table 2).^{*} Analyses of registrations showed no prolonged trends on a statewide basis, but in the North Central District (Fig. 1) a significant decline ($\chi^2 = 14.05$, $P < 0.05$) began in 1977, and recovery to the 1973-76 level has not yet occurred. Subjective interpretation of registration data suggests that bobcat populations in both the Northwest District and the upper portion of the Lake Michigan District are as high or higher than in the early 1970's.

^{*}In this report 1973 refers to the 1973-74 season, 1974 refers to the 1974-75 season, etc. However, beginning in 1980 the seasons were shortened and did not span two calendar years.

Questionnaire responses on perception of population change (Appendix) showed opinions varied significantly from year to year ($P < 0.05$, Fig. 2). Overall, responses suggested no major trends in bobcat abundance, although a slight increase was suggested for the 1979-81 period. On the questionnaire, trends in bobcats run-per-day by hunters' dogs generally matched trends indicated by hunters' opinions on bobcat abundance (Fig. 3). The correlation of the number of hunters replying that bobcats were "more abundant" with the mean numbers of bobcats run per day was significant ($r = 0.76$, $P < 0.05$).

Bobcat track counts in Deer Management Units 28 (Iron County) and 38 (Oneida County) were highly variable from year to year (Table 3), and, in general, correlated poorly with harvests. (A regression calculated for tracks versus harvests showed extremely low predictive value, although the equation was significant, i.e. $P < 0.05$ as shown in Fig. 4.) In Iron County, no definite trends were indicated, but Oneida County track counts showed a major drop-off in 1977, corresponding with a severe decline in bobcat harvests at that time. We believe the decline in bobcat harvests and tracks in eastern Oneida County was caused, in part, by a major loss in habitat quality following a severe spruce budworm outbreak in the 1970's. Following the outbreak, large-scale clear cutting of forests reduced the prime bobcat range in this area.

In 1978, wildlife management personnel extended track counts to 17 northern counties by setting up two 10-mile transects in each county. Results over a 5-year period showed bobcat tracks low in numbers and frequency, averaging 0.34 tracks/10-mile transect and 19% occurrence (Rusch 1982). The low sampling intensity, combined with a sparse bobcat population, precluded any statistical tests. However, combining these data with other indices led us to believe the population was relatively stable during the period of study.

Of the indexes used, the bobcats-run-per-day statistic appeared to be especially useful for detecting major population trends. (In theory, at least, it provides a numerical index to hunters' relative success in locating bobcats.) Track counts showed the most variability and correlated poorly with registration results.

Harvest

From 1973-81, 1,874 bobcats were harvested and registered in Wisconsin. Throughout this period, more bobcats were harvested in the Northwest District than in any other region.

From 1973 through 1981, the top bobcat harvest counties were: Douglas (178), Price (169), Sawyer (154), Marinette (151), Langlade (138), Oneida (131), Forest (124), Taylor (120), Burnett (101), and Lincoln (93). (See Table 4.) Distribution of the 9-year cumulative harvest within deer management units is shown in Fig. 5.

Hunting vs. Trapping. During the 9-year period (1973-81), the number of bobcats taken by hunters with dogs was fairly even with the number taken by trappers (Table 5). Differences among years, however, were significant ($P < 0.05$). We believe changes in annual ratios were caused principally by weather conditions. However, opportunities for hunters have diminished in recent years due to shortening of the season to 3 months in 1978 and then to 2

months in 1980. Shortening the end of the season has a greater impact on hunters than trappers, because when adequate tracking snow arrives late, hunters using dogs have few chances to hunt bobcats. Over an 8-year period (1973-74, 1976-81), trappers reported taking 45% of their bobcats incidental to coyote trapping, 49% in sets made for bobcats, and 6% in other types of sets (Table 6).

Effect of Bag Limit. The number of bobcats taken by individual trappers and hunters was compiled for the three years before the 1-cat bag limit was imposed. These numbers showed 46% of the total bobcat harvest was registered by hunters and trappers taking 2 or more (Table 7). Based on this distribution, a 1-cat limit might reduce the take. Whether this did occur is not clear because groups of hunters and families may share tags. Although illegal, this means that if more than 1 cat is taken, the excess is registered under the name of somebody else in the family or group.

Effect of Season Length. The 2-month season since 1980 has undoubtedly helped to hold the harvest to 200 or less. Frequency of bobcats taken by week were compared for a 4 1/2-month season in 1973 versus a 2-month season in 1981 (Table 8). Some stockpiling of carcasses may have occurred in most years resulting in unusually high numbers being registered near the end of the open season.

During longer seasons, many bobcats were taken in February when pre-mating behavior causes more movement. In all years, hunters using dogs were most successful when snow on the ground permitted good tracking. Trappers began taking bobcats earlier in the fall when coyote trapping was at its peak. Shorter seasons have reduced the number of hunting days reported (Table 9).

Sex Ratios. Through the first nine years of bobcat registration, observed sex ratios (by harvest method) were: hunting with dogs--0.85 males: 1 female; trapping--0.58 males: 1 female; and "other"--0.32 males: 1 female (Table 10). Chi-square analysis showed the overall sex ratio was dependent on harvest method ($P < 0.05$), but did not differ significantly by year. These observed sex ratios should not be accepted at face value, though, since sex determinations at registration stations commonly differ from those obtained through careful examination of skinned carcasses (Berg 1979; Henderson 1979).

McCord and Cardoza (1982) analyzed sex ratios from several states and concluded that skewed ratios are not caused by differences in male or female vulnerability in relation to time of year, season, or harvest method. Our data indicates that trappers tend to take more females, but this can only be corroborated by careful examination of skinned carcasses to determine sex of the animal. We do know that some hunters using dogs select male cats, which are generally the largest cats.

COVER TYPES

During the study, cover types were noted for 59 sets of tracks. Lowland conifers predominated, even though roads in our study areas ran primarily through uplands. Lowland cover types are shown, along with the number of times a set of tracks was found with that type: Swamp conifers (mixtures of cedar, balsam fir, and spruce), 28; speckled alder, 4; and fir alone, 2. Upland type use showed: aspen, 13; paper birch, 5; balsam fir, 4; and northern hardwoods, 3. These observations on cover types were similar to those in a Minnesota report based on intensive monitoring of radio-marked bobcats (Berg 1979).

Bobcat habitat within the primary range appears to be quite secure except near highly developed lake regions. Conifer types in the north are increasing in acreage (Spencer and Thorne 1972), a trend that should generally favor bobcats.

RESEARCH AND MANAGEMENT CONSIDERATIONS

The broad program goal for bobcat management in Wisconsin is to "maintain bobcat populations and distribution at 1975-80 average levels while continuing to provide hunting and trapping opportunities" (Wis. Dep. Nat. Resour. 1979). Management consists of: (1) monitoring population trends through registration, hunter-trapper questionnaires, and track counts; and (2) providing protection through restrictive seasons to maintain populations near the mid-1970's level. Currently, the broad program goal is being met.

During the 1982 season, the Wisconsin Cooperative Wildlife Research Unit began an expanded monitoring program to collect bobcat carcasses to determine age, sex, and reproductive history. This effort should be continued*, along with questionnaires to successful hunters and trappers, and track counts for several mammals, including bobcats.

McCord and Cardoza (1982) outlined a comprehensive research need as follows: "The single greatest research need appears to be long-term, intensive studies of a bobcat or lynx population with known sex and age structure, reproductive activities, home ranges, habitat use, food habits, trends in prey species, and interactions with other predators. With these factors known and monitored in the population, different indexing methods such as scent stations or track transects should be applied to evaluate their sensitivity and perhaps develop methods to evaluate density from different indices. The area should then be subjected to varying harvest levels to evaluate the impact of harvest on reproduction, sex and age structure, home range establishment, etc."

Such a research program would be costly, and all of the information listed by McCord and Cardoza is not required for safe management of Wisconsin's bobcat population. However, a regional approach in the upper Midwest could develop a research program with shared costs and shared information, resulting in more precise management of the species.

*As of the 1983 season, the Wisconsin Department of Natural Resources has begun to collect carcasses to determine age, sex, and reproductive history.

Until an expanded research program is in place, we recommend that the average annual harvest be held to about 200 or fewer. Currently, the 2-month season and 1-bobcat bag limit are accomplishing this. If interest in hunting and trapping increases significantly, additional harvest restrictions may be needed.*

*Further information on bobcats can be found in the 1982 Wisconsin Bobcat Harvest Summary available from the Bureau of Wildlife Management, Dept. of Natural Resources, P.O. Box 7921, Madison, WI 53707.

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TABLE 1. Wisconsin bobcat hunting and trapping season history, 1970-82.

Year	Area Open	Season Dates	Season Length (Days)	Bag Limit
1970	Statewide	12 Sep-28 Feb	170	No limit
1971	Statewide	11 Sep-28 Feb	171	No limit
1972	Statewide	14 Oct-28 Feb	138	No limit
1973*	Statewide	13 Oct-28 Feb	139	No limit
1974	Statewide	12 Oct-28 Feb	140	No limit
1975	Statewide	18 Oct-28 Feb	134	No limit
1976	Statewide	16 Oct-28 Feb	136	No limit
1977	Statewide	15 Oct-28 Feb	137	No limit
1978	Statewide	4 Nov-31 Jan	89	No limit
1979	Statewide	3 Nov-31 Jan	90	No limit
1980	Above Hwy. 64	1 Nov-31 Dec	61	1/season
1981	Above Hwy. 64	31 Oct-31 Dec	62	1/season
1982	Above Hwy. 64	30 Oct-31 Dec	63	1/season

*Mandatory registration required from 1973-82.

TABLE 2. Bobcats harvested and registered, by Department of Natural Resources district, 1973-81.*

District	1973	1974	1975	1976	1977	1978	1979	1980	1981
Northwest	134	100	109	129	98	172	80	53	134
North Central	122	96	88	106	38	24	27	17	40
Lake Michigan	35	22	22	47	36	43	35	20	33
West Central	5	2	4	0	0	0	2	0	1
Total	296	220	223	282	172	239	144	90	208

* District totals corrected to reflect current district configurations.

TABLE 3. Bobcat track counts in Deer Management Unit 28 (Iron County) and Deer Management Unit 38 (Oneida County), 1976-81.

Year	Unit 28 (Iron County)			Unit 38 (Oneida County)		
	Miles of Transect	Tracks	Tracks/ 100 Miles	Miles of Transect	Tracks	Tracks/ 100 Miles
1976	176.1	9	5.1	187.8	11	5.9
1977	139.4	11	7.9	139.4	1	0.7
1978	80.7	4	5.0	144.8	0	0.0
1979	147.4	3	2.0	171.4	3	1.8
1980	126.6	7	5.5	108.3	2	1.8
1981	42.5	1	2.4	150.9	0	0.0
Total	712.7	35	4.7 (Avg.)	902.6	17	1.7 (Avg.)

TABLE 4. Bobcats harvested, by county, 1973-81.

County	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total
Adams							1			1
Ashland	9	3	4	13	6	16	2	2	5	60
Barron	1	2	2		2		1			8
Bayfield	2	2	5	5	4	10	1	2	6	37
Burnett	13	7	17	19	7	14	13	3	8	101
Chippewa	5	2	1				1		1	10
Douglas	15	12	8	27	21	51	19	4	21	178
Dunn			1							1
Florence		1	2	2	6	1	1	4	6	23
Forest	18	25	16	30	10	1	9	3	12	124
Iron	3	2	2	16	8	8	1	2	4	46
Jackson			2				1			3
Juneau	1									1
Langlade	24	21	27	25	10	10	7	6	8	138
Lincoln	21	21	16	15	7	6	2	2	3	93
Marathon	10	2	3	5	1	1	1			23
Marinette	7	6	7	20	27	27	26	13	18	151
Menominee	1		2	1						4
Oconto	7	6	7	15	1	3	5	3	9	56
Oneida	37	18	16	25	6	3	6	6	14	131
Polk		2			7	8				19
Portage		3			1					4
Price	32	16	18	17	6	16	15	13	36	169
Rusk	17	11	10	5	9	4	6	2	7	71
Sawyer	15	15	18	17	14	30	10	9	26	154
Shawano	19	8	4	9	2	10	3			55
Taylor	18	26	14	6	10	12	8	13	13	120
Vilas	11	6	8	6	3	3	1		3	41
Washburn	9	2	11	4	4	3	4	3	6	46
Waupaca	1									1
Waushara		1				1				2
Winnebago						1				1
Wood			2							2
Total	296	220	223	282	172	239	144	90	208	1,874

TABLE 5. Bobcats harvested, by method, 1973-81.

Year	Hunted With Dogs (%)	Trapped (%)	Other Methods* (%)
1973	118 (40)	134 (45)	44 (15)
1974	121 (55)	76 (35)	23 (10)
1975	133 (60)	60 (27)	30 (13)
1976	121 (43)	134 (48)	27 (10)
1977	78 (45)	68 (40)	26 (15)
1978	82 (34)	135 (56)	22 (9)
1979	44 (31)	75 (52)	25 (17)
1980	24 (27)	52 (58)	14 (16)
1981	86 (41)	104 (50)	18 (9)
Total	807 (43)	838 (45)	229 (12)

*Bagged incidentally while hunting other game, shot as nuisances, picked up as road kills, etc.

TABLE 6. Number of bobcats trapped, by method, 1973-81.

Year	Incidental to Coyote Trapping	Sets Made for Bobcats	Other	Total Bobcats
1973	49	36	7	92
1974	18	21	4	43
1975		No Data	-	-
1976	34	35	5	74
1977	26	21	2	49
1978	28	29	2	59
1979	21	22	2	45
1980	7	21	1	29
1981	30	43	5	78
Total	213	228	28	469
Percent of Total	45	49	6	

TABLE 7. Bobcats registered by individuals, 1977, 1978, and 1979 seasons combined.

Registrants	Bobcats Registered								Total Individuals
	1	2	3	4	5	6	7	8	
Hunters Using Dogs	85	16	17	3	2	1	1		125
Trappers	147	32	12	3	1		1	1	197
Other*	67	3							70
Total	299	102	87	24	15	6	14	8	

*Bagged incidentally while hunting other game, shot as nuisances, picked up as road kills, etc.

TABLE 8. Bobcats bagged by week during a 4 1/2-month season in 1973 compared to 2-month season in 1981.

Dates	Hunted With Dogs	Trapped	Other Methods*	Total	Cumulative Harvest	
					Number	Percent
<u>4 1/2-Month Season</u>						
<u>In 1973</u>						
13 Oct-19 Oct		4	1	5	5	2
20 Oct-26 Oct		5		5	10	3
27 Oct- 2 Nov		4		4	14	5
3 Nov- 9 Nov	1	6	2	9	23	8
10 Nov-16 Nov		5	1	6	29	10
17 Nov-23 Nov		1	6	7	36	12
24 Nov-30 Nov	1	2	1	4	40	14
1 Dec- 7 Dec		10	1	11	51	17
8 Dec-14 Dec		4	1	5	56	19
15 Dec-21 Dec	10	5		15	71	24
22 Dec-28 Dec	16	3	2	21	92	31
29 Dec- 4 Jan	5	10	4	19	111	38
5 Jan-11 Jan	5	9	2	16	127	43
12 Jan-18 Jan	5	5	5	15	142	48
19 Jan-25 Jan	12	10	3	25	167	57
26 Jan- 1 Feb	8	11	2	21	188	64
2 Feb- 8 Feb	11	7	3	21	209	71
9 Feb-15 Feb	11	9	4	24	233	80
16 Feb-22 Feb	10	9	3	22	255	87
23 Feb-28 Feb	20	15	3	38	293	100
Total	115	134	44	293**	293	

**Incomplete data for 3 cats.

2-Month Season In 1981

31 Oct- 6 Nov		17	1	18	18	9
7 Nov-13 Nov		12	1	13	31	15
14 Nov-20 Nov		12		12	43	21
21 Nov-27 Nov		6	4	10	53	26
28 Nov- 4 Dec	2	6	6	14	67	33
5 Dec-11 Dec	10	8	1	19	86	42
12 Dec-18 Dec	12	15	2	29	115	56
19 Dec-25 Dec	12	10		22	137	67
26 Dec-31 Dec	48	18	3	69	206	100
Total	84	104	18	206**	206	

**Incomplete data for 2 cats.

*Bagged incidentally while hunting other game, shot as nuisances, picked up as road kills, etc.

TABLE 9. Mean number of days hunted in relation to season length, 1973-81.

Year	Season Length (Days)	Mean Number of Days Hunted
1973	139	13.0
1974	140	12.8
1975	134	No Data
1976	136	14.8
1977	137	13.9
1978	89	10.7
1979	90	8.9
1980	61	4.6
1981	62	7.2

TABLE 10. Sex of bobcats, by harvest method, 1973-81.

Year	Hunted with Dogs		Trapped		Other Method		All Methods		Sex Not Identified
	Male	Female	Male	Female	Male	Female	Male	Female	
1973	62	56	48	83	9	34	119	173	4
1974	58	63	27	47	6	17	91	127	2
1975	48	84	20	40	8	22	76	146	1
1976	54	67	52	79	4	22	110	168	4
1977	43	35	28	40	5	21	76	96	
1978	35	47	40	94	5	16	80	157	2
1979	21	23	28	47	10	15	59	85	
1980	11	13	21	30	2	12	34	55	1
1981	39	47	41	63	6	12	86	122	
Total	371	435	305	523	55	171	731	1,129	14
Percent	46	54	37	63	24	76	39	61	

DNR FIELD DISTRICTS AND AREAS

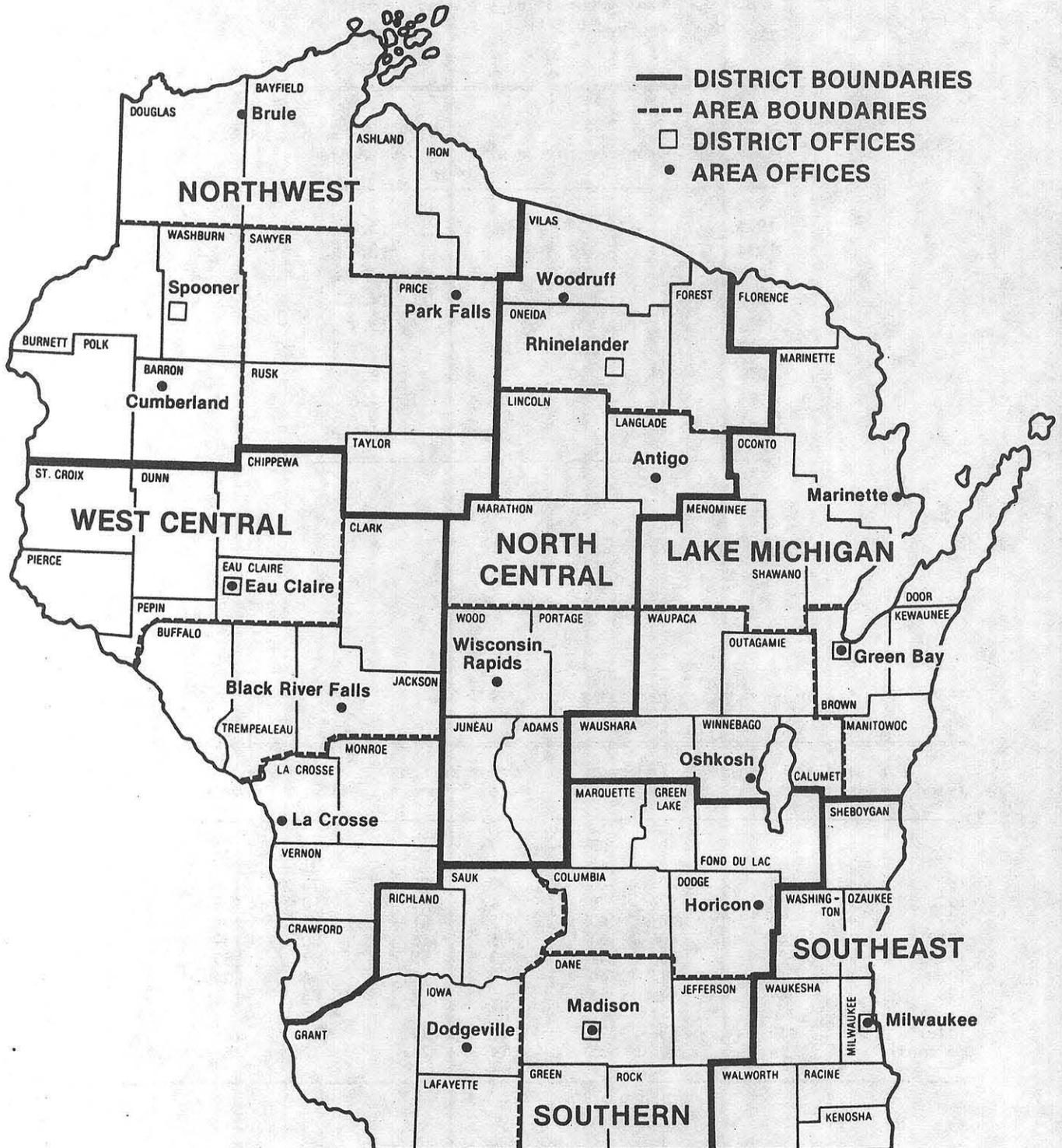


FIGURE 1. Administrative districts and counties used to compile bobcat harvest information.

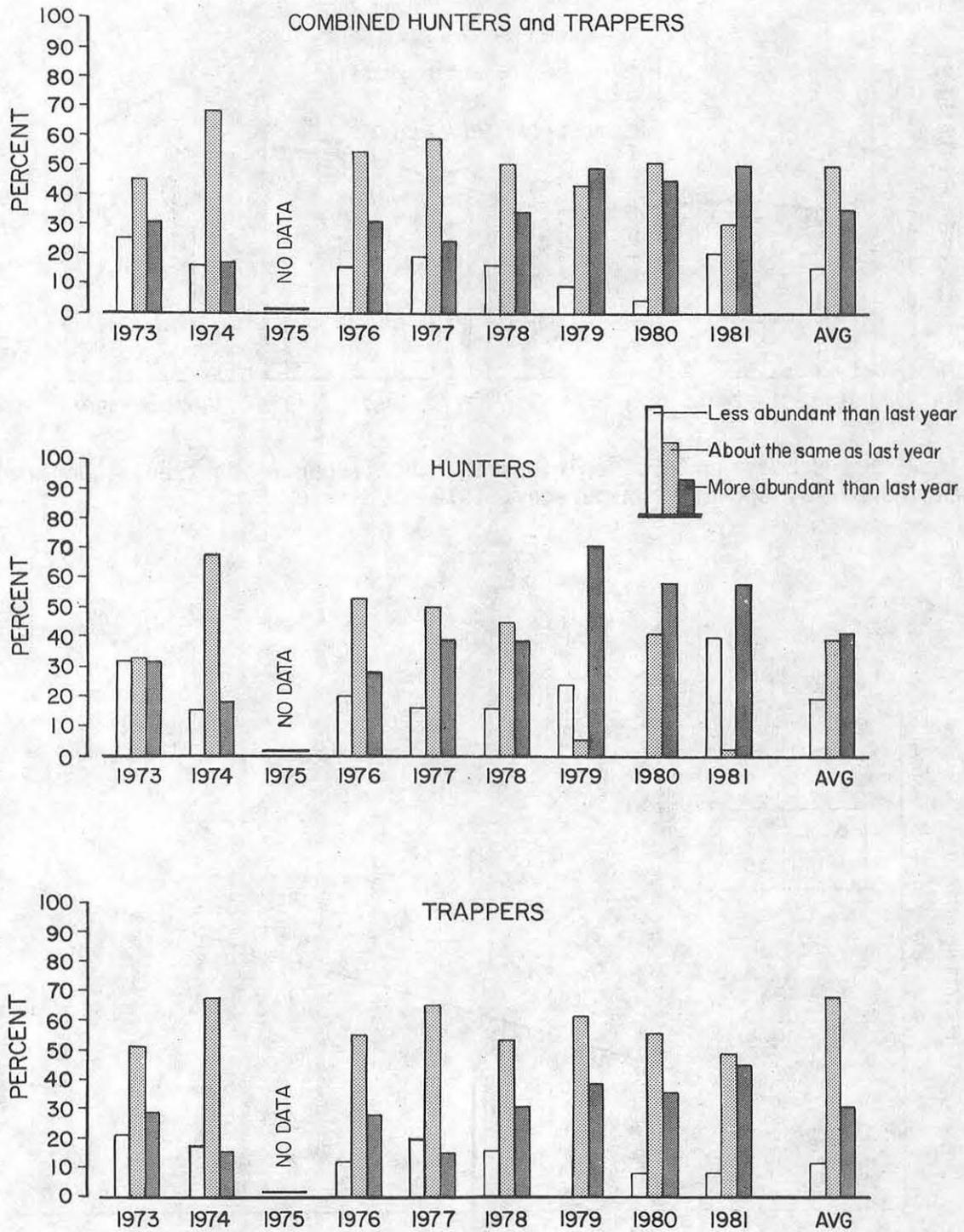


FIGURE 2. Questionnaire responses of hunters and trappers in relation to bobcat population trends, 1973-81.

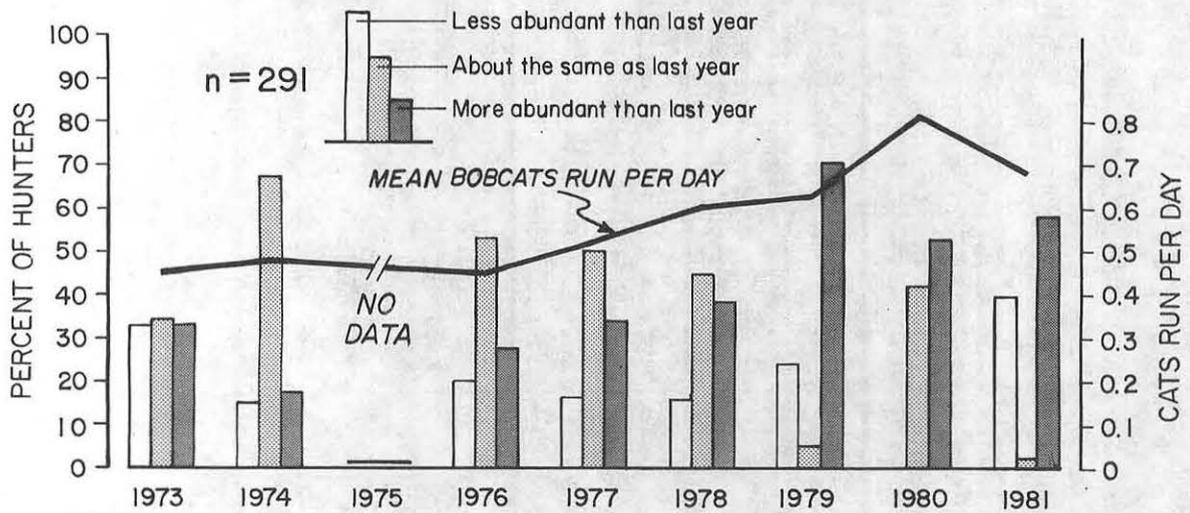


FIGURE 3. Bobcat hunters' opinions on bobcat population trends compared to mean number of bobcats run-per-day, 1973-81.

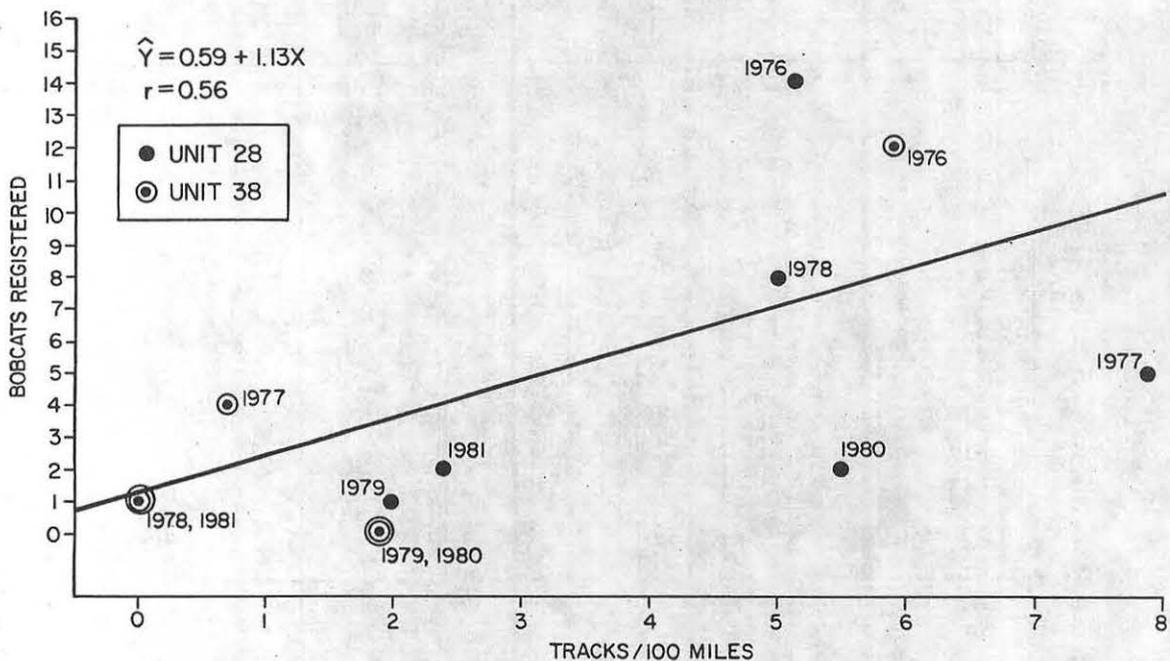


FIGURE 4. Regression showing bobcats registered in Deer Management Units 28 and 38 vs mean tracks/100 miles, 1976-81.

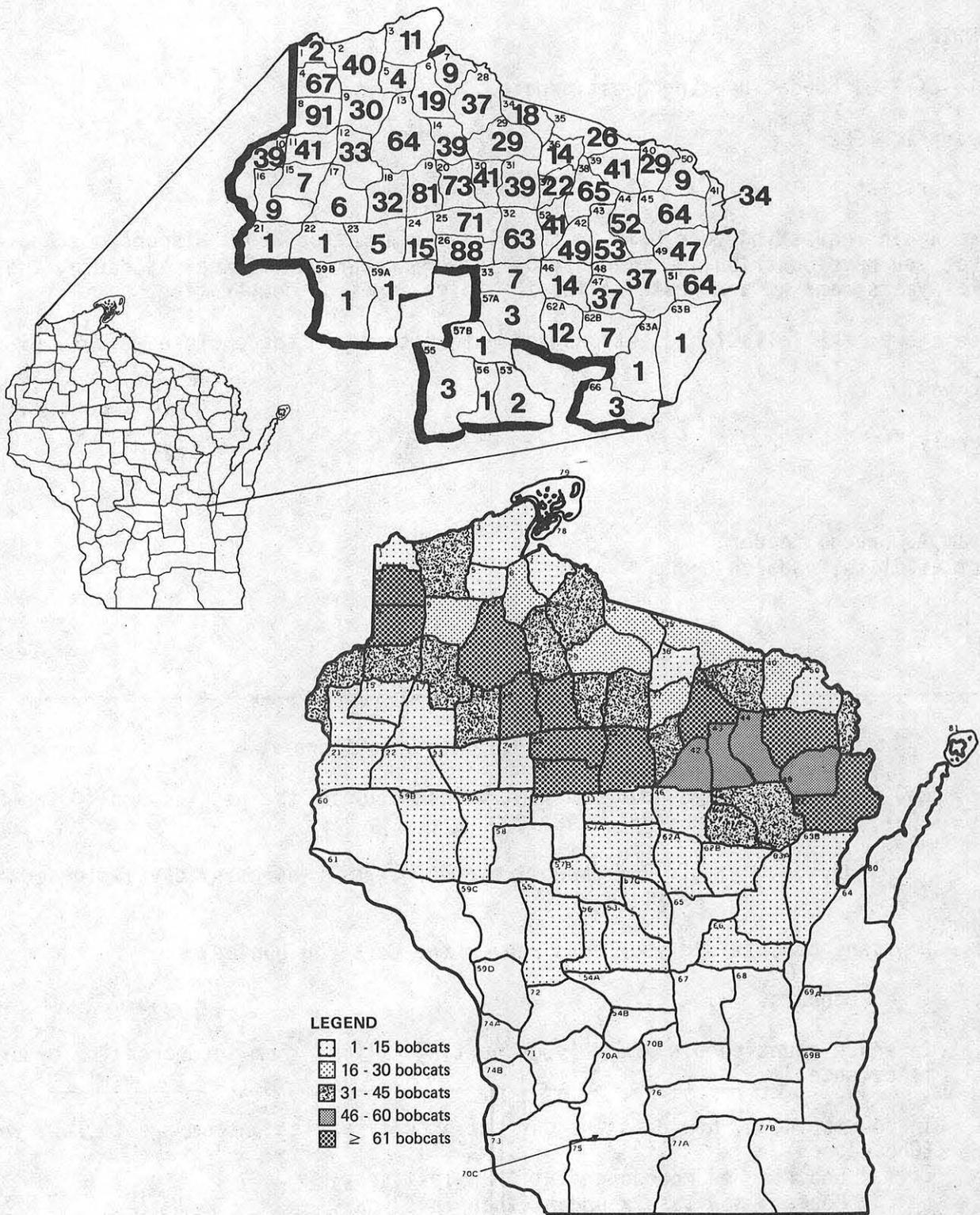


FIGURE 5. Cumulative harvest of bobcats by deer management unit, 1973-81.*

*Out of 1,874 bobcats, unit locations for 28 were unknown.

APPENDIX A

Sample of 1981 bobcat hunting questionnaire.

February 1, 1982

Dear Sportsman:

We are again requesting your help in compiling information about Wisconsin's bobcats. Many of you have contributed immensely by answering our questionnaires during the past several years, and we are grateful for this high level of cooperation.

Please answer the following questions and return to me in the enclosed envelope.

Thank you.

Sincerely,

William A. Creed, Leader
Forest Wildlife Research Group

WAC:ck
Enc.

1981 Bobcat Hunting Questionnaire

1. How many times (days) did you hunt bobcats during the past season (October 31, 1981, through December 31, 1981)?
_____ days. (If you cannot remember exactly how many days, please make an estimate.)
2. How many bobcats did your dogs run on the days you hunted?
_____ bobcats.
3. In which counties did you do your hunting? (List them in decreasing order of importance.) _____
4. In your opinion, how does the current bobcat population compare to last year? (Check one)
() Bobcats now more abundant than last year.
() Bobcats now less abundant than last year.
() Bobcats about the same as last year.
() No opinion.
5. Did you see any Canada Lynx tracks during the past year? (Circle one)
Yes No If yes, in which counties? _____
6. Please add any comments you would like to offer regarding bobcat populations and regulations. (Use back if more space is needed.)

APPENDIX B

Sample of 1981 bobcat trapping questionnaire.

February 1, 1982

Dear Sportsman:

We are again requesting your help in compiling information about Wisconsin's bobcats. Many of you have contributed immensely by answering our questionnaires during the past several years, and we are grateful for this high level of cooperation.

Please answer the following questions and return to me in the enclosed envelope.

Thank you.

Sincerely,

William A. Creed, Leader
Forest Wildlife Research Group

WAC:ck
Enc.

1981 Bobcat Trapping Questionnaire

1. How did you trap your bobcat this past season? (Check one)
 Incidental to coyote or fox trapping.
 In trap set specifically for bobcats.
 Other (describe) _____
2. How many days did you trap during the past season? _____ days.
3. For how many days did you have traps set specifically for bobcats? _____ days.
4. In which counties did you trap? _____
5. In your opinion, how does the current bobcat population compare to last year? (Check one)
 Bobcats now more abundant than last year.
 Bobcats now less abundant than last year.
 Bobcats about the same as last year.
 No opinion.
6. Did you see any Canada Lynx tracks during the past year? (Circle one)
Yes No. If yes, in which counties? _____
7. Please add any comments you would like to offer regarding bobcat populations and regulations. (Use back if more space is needed.)

ACKNOWLEDGEMENTS

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