State of California
THE RESOURCES AGENCY
Department of Fish and Game

BOBCAT STUDY, SAN DIEGO COUNTY, CALIFORNIA 1/

by

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ABSTRACT

Thirty-one bobcats were trapped 63 times from December, 1976 through June, 1978 in the study area around El Capitan Reservoir, San Diego County, California. All bobcats captured were adults, 20 males and 11 females. Population densities were calculated to range from 1.27 to 1.53 bobcats per square kilometer. Female home range size varied from 0.6 to 4.4 km^2, with the seasonal home range usually less than 1.4 km^2. Established resident females showed no home range overlap with other established resident females. Home range sizes for males varied from 0.88 to 6.4 km^2, but most seasonal home ranges were less than 2.0 km^2. Males showed considerable home range overlap with other males, up to 90% seasonally.

A sex ratio of 1.8 males per female was noted in the relatively unexploited bobcat population in the study area. This compares to a ratio of 0.94 males per female noted in a sample of 60 bobcats harvested in San Diego County. The age structure of bobcats on the El Capitan Reservoir study area was biased towards older individuals while 73% of the trapper harvested bobcats in the county were less than three years old.

Only two of four females appeared to have given birth to kittens in 1977 and while three of three females appeared to have kittens during 1978, no young bobcats were trapped.

The deaths of 13 study animals were documented. Eight of these deaths were naturally caused, three were man caused, and two were study related.

Seasonal weight fluctuations of up to 21% of an individual bobcat's body weight occurred during the course of the study.

1/ Supported by Federal Aid for Endangered, Threatened and Rare Wildlife, Nongame Wildlife Investigations, Project E-W-2, Study IV, Job 1.7 (September, 1978).

RECOMMENDATIONS

1. Conduct a similar study on an exploited bobcat population in San Diego County to determine comparative density, distribution, reproduction, and mortality.

2. Determine the annual rate of harvest for exploited populations.

3. Develop a bobcat management plan for San Diego County based on these results and results from study of an exploited population. With additional study data develop a statewide management plan for bobcat.

4. Simulate and evaluate local overharvesting of a bobcat population.

5. Evaluate the use of home range size of bobcats as the most reliable and easiest method to obtain an indicator of their density.

INTRODUCTION

Considerable public concern is being expressed over the status of the bobcat (Felis rufus) because of the recent escalation in value of bobcat fur and subsequent increase in commercial take of bobcat. This is especially true in San Diego County where the harvest of bobcat by hunters and trappers has been among the highest of all counties in the state since 1970.

Although literature is available concerning the bobcat in North America (Grinnell et al. 1937, Young 1958, Hall and Kelson 1959), only a few studies have addressed bobcat population dynamics (Marshall 1969, Bailey 1972, Crowe 1974, Jones 1976). None of these bobcat studies were performed in habitats comparable to California habitats.

The chaparral habitat near El Cajon, San Diego County, was chosen as a study area because chaparral is prevalent in other southern coastal counties from which large numbers of bobcats have been reported taken recently. This study, concentrating on the population dynamics of the bobcat, was conducted from December, 1976 through June, 1978.

The objectives of this study were to: 1) determine density, home range and interspecific actions among bobcats in a chaparral habitat; 2) determine the sex and age structure and reproductive and mortality rates of a study population; and 3) evaluate the population structure of a harvested population by comparing age and sex structure data with the unharvested study population.

Literature Review

Reported densities of bobcats have ranged from 0.05/km^2 (0.14/mi^2) in Idaho (Bailey 1972) to 2.74/km^2 (7.1/mi^2) in Texas (Brownlee 1977) (Table 1). Reported home range size of bobcats not only varies from location to location but also varies by the sex of the bobcat in some areas. In many instances, reported data are based on small sample sizes and short periods of time during which bobcats were followed. Jones (1976) deduced a home range size of only 2 km^2 (.77 mi^2) for bobcats he studied in Arizona. In Idaho, Bailey (1972) found considerably larger home ranges with male home ranges of 33.5 - 107.9 km^2 (12.9 - 41.5 mi^2), larger than female home ranges of 9.1 - 35.1 km^2 (3.5 - 13.5 mi^2).

Marshall (1969) and Bailey (1972) noted the near exclusivity of home ranges of female bobcats and only slightly more overlap in the home ranges of males. However, Jones (1976) felt that the bobcats he studied did not show this exclusivity though he had little data to substantiate his feelings.

As with most other parameters of population dynamics the noted sex ratio varies from 0.4 males per female in Vermont (Foote 1945) to 1.7 males per female in Arkansas (Fritts and Sealander 1978) (Table 1). Bailey (1972), in his study in Idaho, observed a variable sex ratio dependent upon the age of the bobcats. The ratio was 1 male per female among kittens, 3 males per female among transients, 0.6 males per female among adults, and a total population ratio of 0.9 males per female in an unharvested population.

Average litter size is relatively constant from one population to another, normally between two and three (Table 1). Gashwiler et al. (1961) showed in bobcats in Utah that litter size was frequently less than the number of ova released per female and less than the number of fertilized eggs implanting in the uterus.

Table 1. Previously published parameters of population dynamics of bobcats.

Parameter	Location	Data	Source
DENSITY	Idaho	0.05 bobcats/km^2 (0.14/mi^2)	Bailey 1972
	Minnesota	O.O7/km^2 (O.l8/mi^2)	U.S.F.S. 1942
	Wisconsin	0.09/km^2 (0.23/mi^2)	U.S.F.S. 1942
	Michigan	O.lO/km^2 (0.26/mi^2)	U.S.F.S. 1942
	Arizona	0.28/km^2 (0.73/mi^2)	Jones 1976
	South Carolina	0.58/km^2 (1.5/mi^2)	Marshall 1969
	Texas	0.58-2.74/km^2 (1.5-7.l/mi^2)	Brownlee 1977
HOME RANGE	Arizona	2 km^2	Jones 1976
	South Carolina	2.46-4.64 km2 (0.95-1.79 mi^2)	Marshall & Jenkins 1966
	Northeast U.S.	3.9-14.2 km2	Pollack 1949, 1950 in Jones 1976
	Idaho	females: 9.1-35.1 km^2 (3.5-13.5 mi^2) males: 33.5-107.9 km^2 (12.9-41.5 mi^2)	Bailey 1972
	Minnesota	25-38 km^2	Rollings 1945 in Jones 1976
	Michigan	39-52 km^2	Erickson 1955 in Jones 1976
	Maine	47-104 km^2	Marston 1942 in Jones 1976
SEX RATIO	Vermont	0.4 males/female	Foote 1945
	Idaho	overall: 0.91 males/female adults: 0.6 males/female	Bailey 1972
	Arizona	1 male/female	Jones 1976
	Wyoming	1.01 males/female	Crowe 1974
	Northeast U.S.	1.05 males/female	Pollack 1950
	Washington'	1.07 males/female	Poelker 1977
	Utah	1.11-1.29 males/female	Gashwiler et al. 1961
	Arizona	1.26 males/female	Young 1958
	Nevada	1.57 males/female	Nevada Dept. Fish & Game 1978
	Arkansas	1.7 males/female	Fritts and Sealander 1978
ANNUAL REPRODUCTIVE RATE	Northeast U.S.	2.0 kittens/litter	Pollack 1950
	Arkansas	2.49 embryos/mature adult female	Fritts 1973
	Michigan	2.6 kittens/litter	Erickson 1955
	Wyoming	2.79 young/female	Crowe 1974
	Idaho	2.8 kittens/litter	Bailey 1972
	Utah	4.8 bright yellow corpora lutea/female 3.9 placental scars/female 3.2 embryos/litter 3.5 young/newborn litter	Gashwiler et al. 1961

Known age structures of bobcat populations (Table 2) vary most noticeably in the proportion of the population in the 0-1 age class. In a heavily exploited population in Wyoming, 36% of the population was in the O-l age class (Crowe 1974). This was larger than 17-27% in Nevada's healthy population (Nevada Dept. Fish and Game 1978) and 17.8% in a very lightly exploited population in Arkansas (Fritts and Sealander 1978).

Most state agencies have records of harvest mortality of bobcats. However, rates of natural mortality are conspicuous by their absence in all field studies.

Study Area

The study area was located northeast of El Cajon in the El Capitan Reservoir area (Figure 1). Topography is very steep with two predominant canyons. The San Diego River Canyon runs east to west and joins Chocolate Canyon, which runs south to north, at El Capitan Reservoir. Elevations vary from 182 to 545 m (600 to 1800 ft). Predominant chaparral vegetation includes laurel-leaved sumac (Rhus laurina), wild lilac (Ceanothus, spp.), chamise (Adenostoma fasciculatum), flat-top buckwheat (Eriogonum fasciculatum), and sagebrush (Artemisia, spp.).

The west side of the study area is a semi-rural area. A large poultry ranch dominates the southwest quarter of the study area. Although a large part of the study area is administered by the Cleveland National Forest, access is restricted by steep topography and the owners of adjacent lands. Activities such as hunting, predator calling, and running animals with hounds rarely occur.

Population density estimates of bobcats were calculated within a 6.7 km^2 (2.6 mi^2) portion of the study area having the following boundaries: north boundary - El Monte Park Road to El Capitan Reservoir; east boundary - top of east slope of Chocolate Canyon; south boundary - approximate alignment of highway Interstate 8; west boundary - Dunbar Lane and its northerly projection to El Monte Park Road (Figure 1). This area was chosen because of convenient road access and because all trapping was done within these boundaries after January 1977.

METHODS

Bobcats were trapped using number 2 and number 3 long-spring, and number 2 double-coilspring leg-hold traps. All number 3 traps were offset and padded, and some number 2 traps were padded; the remainder had jaws filed smooth. Scent sets were used from December, 1976 through September, 1977 after which both blind and scent sets were used. Captured bobcats were anesthetized using a combination of Ketaset (approximately 15 mg per kg of body weight) and Acepromazine (approximately 0.8 mg per kg of body weight), and were sexed, weighed, measured, and fitted with a radio collar. Radio collared bobcats subsequently were monitored on an average of 18 days per month and their locations were plotted on topographic maps.

Bobcat skulls were collected from dead study animals and from bobcats taken by commercial trappers throughout San Diego County. Sex and general capture location of each bobcat were noted. Teeth were extracted and the age of each individual determined by the cementum annuli method (Crowe 1972). This was performed by Matson's, Milltown, Montana, using a process developed from that used by Low and Cowan (1963).

Percent of sample in age class

Source	Fritts & Sealander 1978			Nevada Dept. of Fish & Game 1978			Poelker 1977							Crowe 1974		
							Western Washington			Eastern Washington						
Age Class / State	Arkansas			Nevada									Wash.	Wyoming		
	male	female	Tot.	male	female	Tot.	male	female	Tot.	male	female	Tot.	Tot.	male	female	Tot.
0-1	11.5	6.3	17.8	8.8	7.9	16.6	8.1:	5.8	14.0	21.2	12.1	33.3	17.1	18.0	18.0	36.0
1-2	10.3	6.3	16.7	10.6	12.7	23.3	11.6	11.6	23.3	3.0	3.0	6.1	20.5	13.0	14.3	27.3
2-3	10.9	5.7	16.7	23.9	9.4	33.2	9.3	9.9	19.2	15.2	21.2	36.4	22.0	8.7	8.7	17.4
3-4	9.2	6.9	16.1				8.7	7.0	15.7	-	-		13.2	3.7	3.1	6.8
4-5	8.0	2.9	10.9	14.5	6.3	20.8	5.8	4.1	9.9	6.1	3.0	9.1	9.8	1.9	0.6	2.5
5-6	6.3	2.3	8.6				2.9	3.5	6.4	-	3.0	3.0	5.9	0.6	1.9	2.5
6-7	1.7	2.3	4.0				3.5	2.9	6.4	3.0	-	3.0	5.9	0.6	1.2	1.9
7-8	1.1	2.3	3.4					1.7	1.7	-	3.0	3.0	2.0	1.2	0.6	1.9
8-9	0.6	-	0.6					0.6	0.6	-	-		0.5	1.2		1.2
9-10	0.6	1.7	2.3					0.6	0.6	-	-		0.5		1.2	1.2
10-11	0.6.	-	0.6	3.3	2.7	6.0	1.2	0.6	1.7	-	3.0	3.0	2.0	0.6	0.6	1.2
11-12	1.7	-	1.7				-	-	-	-	-				-	-
12-13							-	-	-	-	-				-	-
13-14	0.6	-	0.6								3.0	3.0	0.5		-	-
14-15															-	-
15-16															-	-
			n=174			n=331			n=172			n=33	n=205			n=161

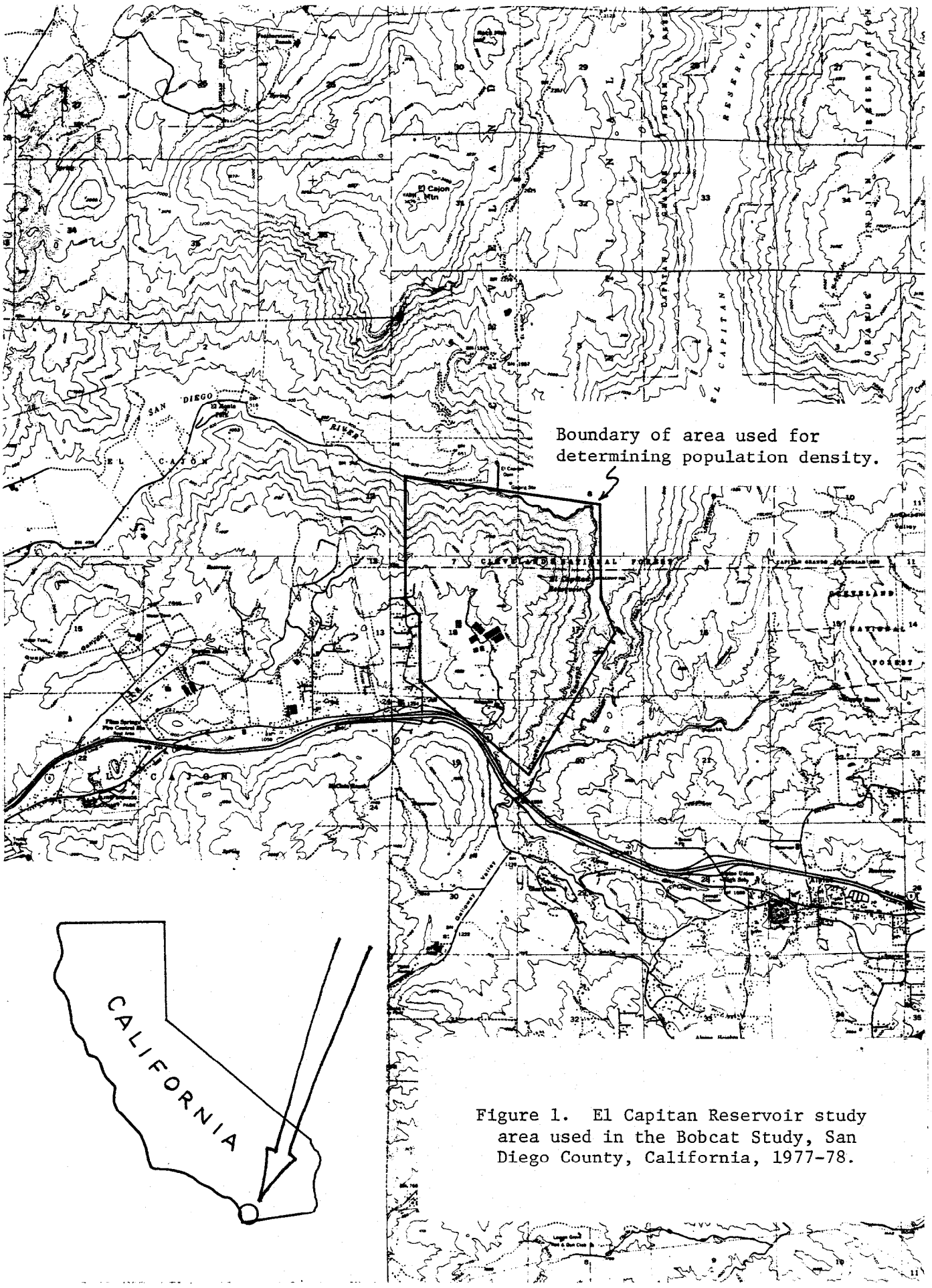


Figure 1. El Capitan Reservoir study area used in the Bobcat Study, San Diego County, California, 1977-78.

RESULTS

Thirty-one different bobcats were trapped from December, 1976 through June 30, 1978 (Figure 2). Commercial trappers caught two animals and study personnel caught 29 cats 61 times in 5,799 trap nights for a catch effort of one animal per 95 trap nights. Fifteen were retrapped including one which was captured eight times and two five times. Females were trapped an average of 1.5 times per individual throughout the course of the study. Males were trapped 61% more often, 2.42 times per individual. During the time corresponding to the commercial trapping season males were only caught 47% more often with an average capture rate of 1.0 and 1.47 for females and males respectively.

Six bobcats (SD-l, SD-2, SD-4, SD-5, SD-6, SD-8) were captured outside the area for which density was calculated. Three (SD-2, SD-4, SD-5) of these were later retrapped within that area. Of these, one (SD-2) was a resident, one (SD-4) was a part-time resident, and one (SD-5) was not a resident of the study area. Of the other three animals captured outside the area used for density calculations, SD-1 seldom came close to the area, SD-6 was released, after treatment for injury, without a radio collar, and SD-8 had originally been taken inside the area.

Due to 15 transmitter failures, radio collars were placed on 27 bobcats 35 times. Transmitter failures occurred from 11 to 139 days after placement on bobcats (Figure 2). Seven inoperative collars were recovered; in each case a broken crystal was the cause of malfunction. Two study bobcats (SD-5, SD-16) had collar failures with two different collars.

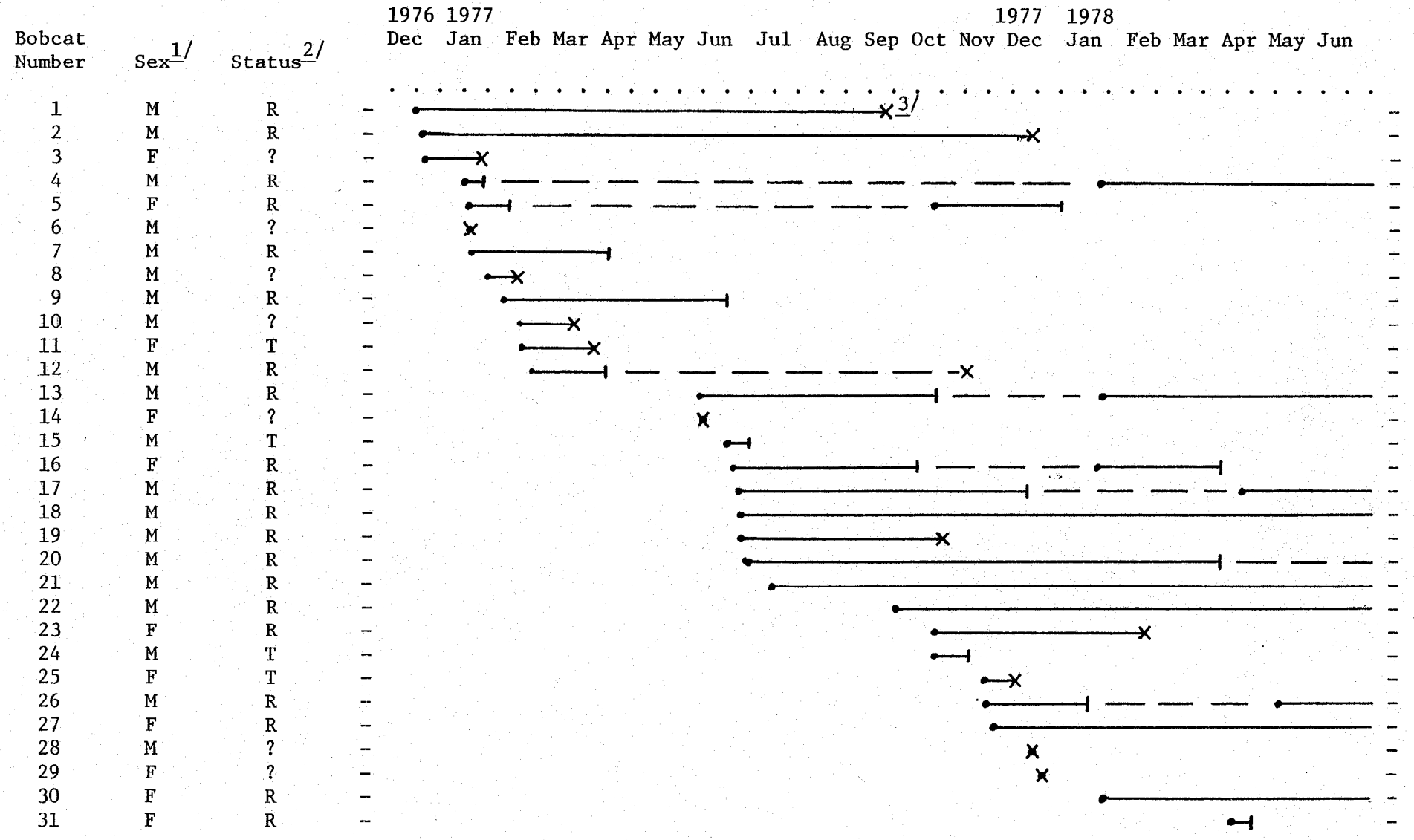
Density

Bobcat density was calculated to be 1.53 bobcats per km^2 (3.94 per mi^2) during November - December 1977, 1.36 bobcats per km2 (3.50 per mi^2) during February - March, 1978, and 1.27 bobcats per km^2 (3.27 per mi^2) during April - May 1978 (Table 3). These calculations are conservative because only captured and marked bobcats were considered, but with one exception. A resident female (SD-31) was suspected to exist early in the study because of the home range pattern of other females. Subsequent trapping and monitoring of this individual's home range confirmed speculation and data from this individual were included in the calculations.

Also, the stated bobcat density does not include transients or young, only the density of the stable population. Transients, by definition are ephemeral, and are not a constant part of the established population. Only four bobcats captured, marked and followed were considered transients after an evaluation of their movements. However, a number of residents had periods when they became transients in other areas. This was especially true of sick and dying individuals.

Density calculations were made by summing: 1) the fraction of time that resident bobcats spent in the area used for density calculations; 2) the fraction of time that peripheral resident bobcats spent in the area used for density calculations; and 3) the best estimate, based on previous data, of that fraction of time spent by resident and peripheral bobcats whose radio collars recently had become inoperative. This summation then was divided by the size of the area used for calculating density.

Figure 2. History of radio-collared bobcats, San Diego County Bobcat Study, 1976-78.



1/ M = male, F = female.
2/ R = resident, T = transient, ? = unknown.
3/ Closed circle denotes capture; X indicates mortality; verticle line indicates radio collar failure. Solid horizontal line denotes bobcat carrying functioning radio collar; dashed line indicates bobcat apparently in study area but carrying nonfunctioning radio collar.

Table 3. Population density of bobcats on El Capitan Reservoir study area, San Diego County, 1977-78.

Time Period	Bobcat and percentage of time each individual spent within area used to calculate density 6.7 km^2 (2.6 mi^2)					Calculated Density
	Residents		Peripheral Residents		Suspected Residents	
	Males	Females	Males	Females	Females	
November - December, 1977	2 - 85% 13-100 17-100 18 - 82 21-100 22 - 94 26 - 81	16-100% 27-100	20 - 54%	23 - 29%	31-100%	1.53/km^2 (3.94/mi^2)
February - March, 1978	13-100% 17-100 18 - 67 21 - 67 22 - 90 26 - 80	16 - 64% 27-100	4 - 53% 20 - 60	30 - 28%	31-100%	1.36/km^2 (3.50/mi^2)
April - May, 1978	13-100% 17-100 18 - 40 20 - 50 21 - 94 22 - 49 26-100	16 - 80% 27-100 31-100	4 - 7%	30 - 30%	--	l.27/km^2 (3.27/mi^2)

Home Range Size and Distribution

Variations in home range size and location existed between all bobcats. The most notable variations were between bobcats of different sexes and between the areas occupied by the same individual on a seasonal basis (Table 4, Figures 3, 4 and 5). Home range size of nine males varied from 0.88 to 6.40 km^2 (0.34 to 2.47 mi^2). On a seasonal basis their home ranges varied from 0.36 to 6.11 km^2 (0.14 to 2.36 mi^2), but 83% of the recorded seasonal home ranges were less than 2.0 km^2 (0.77 mi^2). Four of the seven male bobcats, on which home range size was noted during the breeding season as well as at other times of year, increased their home range during the breeding season (Table 4, Figure 3). This increase in size also implies a change in location of home range (Figure 3).

Males showed a large degree of overlap in home ranges with both other males and females (Table 5, Figure 5). Some males were found within the home range of other males a large percentage of the time. For example, SD-21 was observed in the home range of SD-17 35% of the time in July-August, 1977; 61% of the time in September-October, 1977; 53% of the time in November-December, 1977; and 14% of the time in April-May, 1978. Using only the largest percentage of overlap of one male with another male, the average minimum percent of male-male overlap was calculated to be 28.4% during July-August, 1977; 30% during September-October 1977; 59.7% during November-December, 1977; 57.8% during February-March, 1978; and 31.9% during April-May, 1978. It must be noted these averages are conservative because the calculation method involved only the maximum overlap with one other male and not the overlap with all overlapping males and because there were radio collar failures.

Four different males showed home ranges divided into two distinct regions, one within the area used to calculate density and one outside this area. These regions were from 1.6 to 11 km (1.0 to 6.8 mi) apart. These bobcats seldom were observed between the two areas, though the four bobcats made numerous trips between their dual territories.

Home range size of three female bobcats varied from 0.60 to 4.40 km^2 (0.23 to 1.70 mi^2), with the size of the seasonal home range usually less than 1.40 km^2 (0.54 mi^2) (Table 4). There was a marked seasonal variation in home range size at different times of year with a very noticeable decrease before parturition and slightly thereafter (Figure 4).

In general, females showed no home range overlap with other females (Table 5, Figure 5). However, one female (SD-16) was an exception; she also had the largest home range among the females (Table 4). Despite mostly occupying an area between the home ranges of other females, this female appeared unable to establish as definitive a home range as the other females and overlapped their home ranges. Actions of this individual probably bias the data on the home range size of female bobcats in the study area. Also, she left the immediate study area for 44 days, traveling 13 km (8 mi) to another area, during July, 1977. On returning in September she established a very small home range of 0.47 km^2 (0.18 mi^2) not overlapping with any other females. This was assumed to be representative of parturition, although this was never substantiated.

Sex-Age Structure

Male bobcats definitely dominated the study population (Table 6). Of those bobcats spending more than one-half of their time in the area used for calculating density and for which their resident status was known, there were

Table 4. Home range size of bobcats on El Capitan Reservoir study area, San Diego County, 1977-78.

Bobcat Number	Seasonal Home Range Size (in km^2)							Total Home Range Size Observed
	Feb-Mar 1977	June 1977	July-Aug 1977	Sept-Oct 1977	Nov-Dec 1977	Feb-Mar 1978	Apr-May 1978	
Males -								
2	0.36	0.47	0.73	0.44	0.34			0.88
4						5.05	6.11	6.40
7	0.88							--
13		3.52	1.68	1.58		1.22	1.19	4.07
17			1.32	1.24	1.19		1.30	1.71
18			1.04	1.27	1.89	1.86	0.80[1/]	2.33[1/]
19			1.76	1.37				3.24
20			1.45	1.24	1.58	1.55		1.86
21			1.40	1.94	2.05	5.08	4.17	5.28
22					1.50	1.17	1.01[1/]	1.86[1/]
Females -								
5					1.35			--
16			3.44[1/]	0.47		2.43		4.40[1/]
23					1.22			--
27					0.47	0.36	0.54	0.60
30						1.40	0.75	1.40

1/ A larger home range than indicated was occupied. See text for explanation.

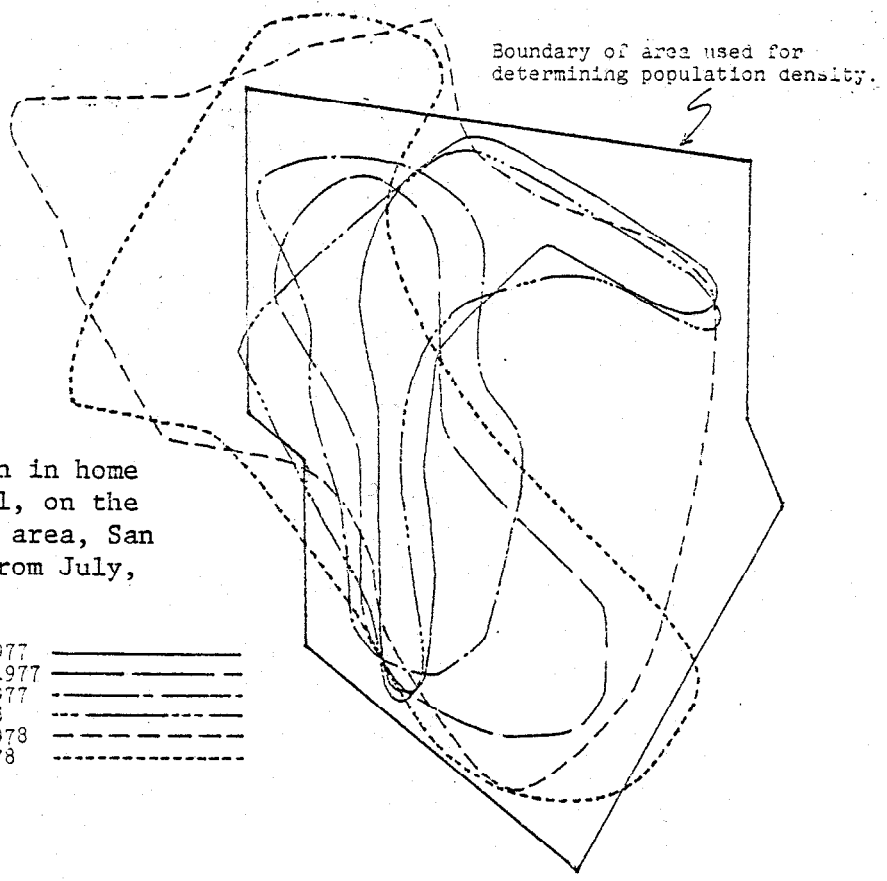


Figure 3. Seasonal variation in home range of male bobcat, SD-21, on the El Capitan Reservoir study area, San Diego County, California from July, 1977 through May, 1978.

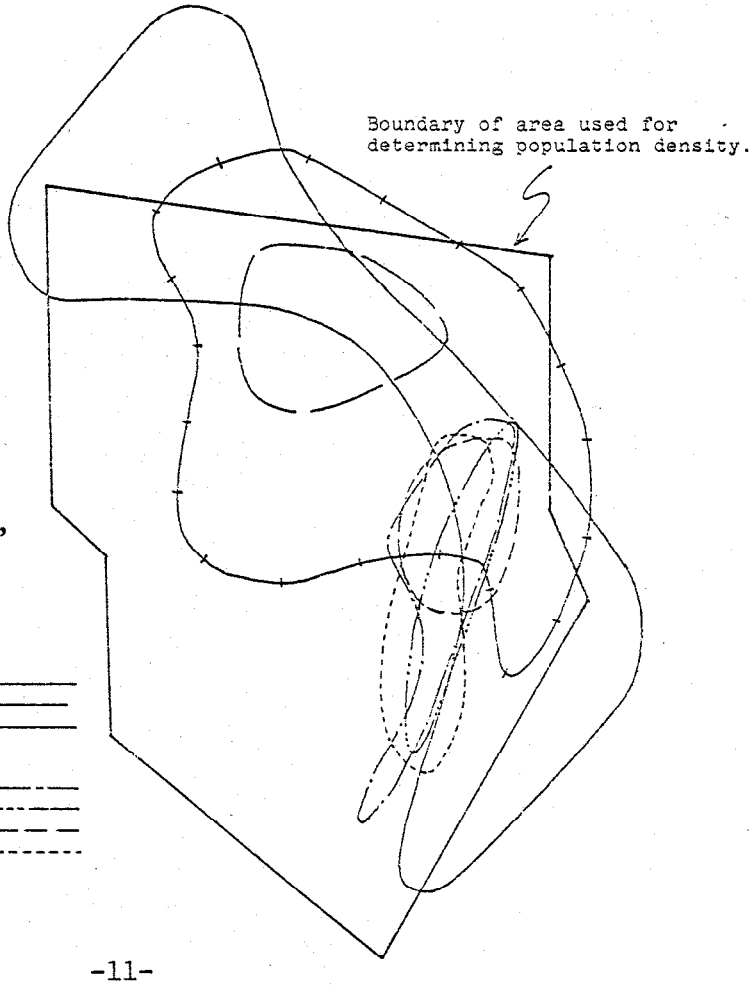


Figure 4. Seasonal variations in the home range of two female bobcats, SD-16 and SD-27, on the El Capitan Reservoir study area, San Diego County, California from July, 1977 through May, 1978.

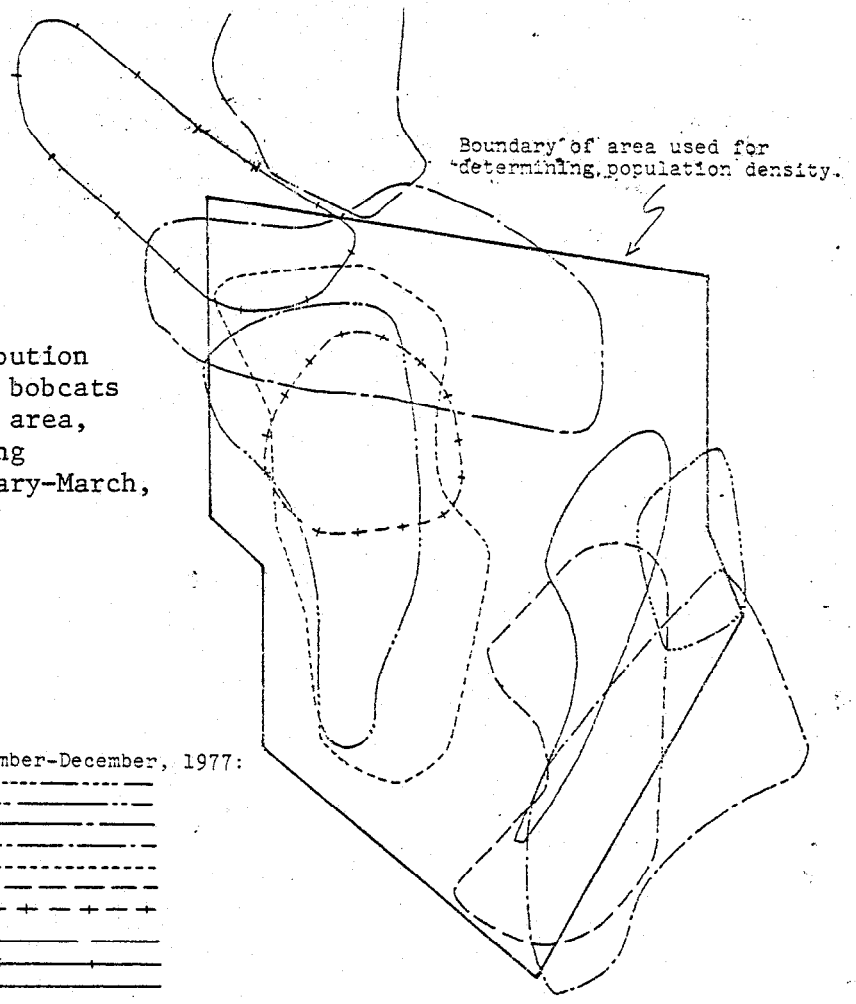
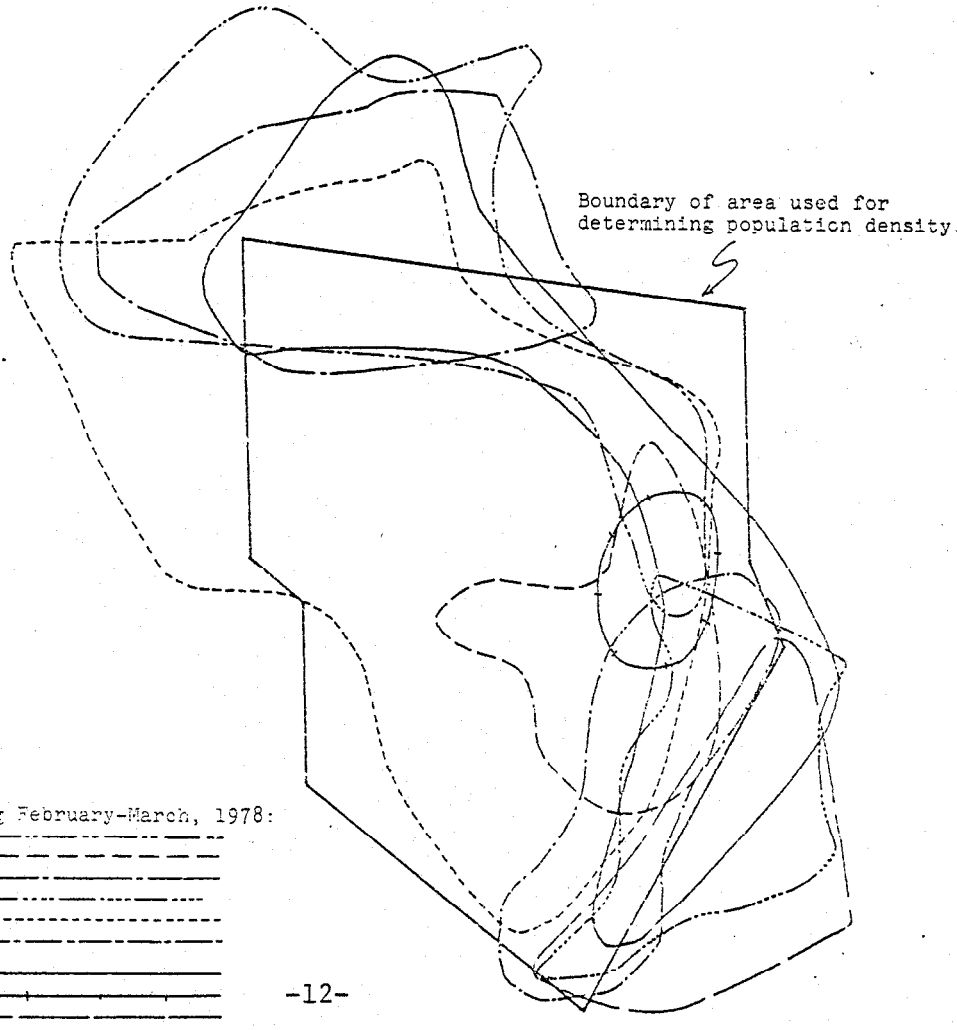


Figure 5. Variations in the distribution of home ranges of male and female bobcats on the El Capitan Reservoir study area, San Diego County, California during November-December, 1977 and February-March, 1978.

Areas used by bobcats during November-December, 1977:

Males SD-2
SD-17
SD-18
SD-20
SD-21
SD-22
SD-26

Females SD-5
SD-23
SD-27



Areas used by bobcats during February-March, 1978:

Males SD-4
SD-13
SD-18
SD-20
SD-21
SD-22

Females SD-15
SD-27
SD-30

Table 5. Percent of overlap of bobcat home ranges on El Capitan Reservoir study area, San Diego County, 1977-78.

Season	Bobcats Overlapping Home Range of Other Bobcats		No. of Obs.	Bobcats Whose Home Range Are Overlapped by Other Bobcats[1/]															
				2	4	13	17	18	19	20	21	22	26	5	16	23	27	30
July - Aug., 1977	2	♂	38	-	-	47[1/]	0	0	0	8	0	-	-	-	-	-	-	-
	13	♂	35	20	-	-	9	0	17	9	9	-	-	-	-	-	-	-
	17	♂	41	0	-	0	-	0	32	0	32	-	-	-	-	-	-	-
	18	♂	35	0	-	0	0	-	0	0	29	-	-	-	-	-	-	-
	19	♂	25	0	-	28	28	0	-	8	16	-	-	-	-	-	-	-
	20	♂	26	0	-	8	0	0	8	-	0	-	-	-	-	-	-	-
	21	♂	23	0	-	4	35	26	4	0	-	-	-	-	-	-	-	-
Sept. - Oct., 1977	2	♂	38	-	-	8	0	0	0	16	0	-	-	-	-	-	-	-
	13	♂	28	7	-	-	4	0	18	7	18	-	-	-	-	-	-	-
	17	♂	30	0	-	0	-	10	23	0	70	-	-	-	-	-	-	-
	18	♂	36	0	-	0	8	-	0	0	3	-	-	-	-	-	-	-
	19	♂	20	0	-	15	15	0	-	0	25	-	-	-	-	-	-	-
	20	♂	26	12	-	4	0	0	0	-	0	-	-	-	-	-	-	-
	21	♂	28	0	-	4	61	4	32	0	-	-	-	-	-	-	-	-
Nov. - Dec., 1977	2	♂	34	-	-	-	0	0	-	79	0	0	0	0	-	0	6	-
	17	♂	37	0	-	-	-	38	-	3	89	3	19	3	-	3	0	-
	18	♂	44	0	-	-	11	-	-	0	32	0	2	2	-	27	0	-
	20	♂	39	18	-	-	0	0	-	-	0	44	0	0	-	0	3	-
	21	♂	43	0	-	-	53	21	-	0	-	0	26	0	-	2	0	-
	22	♂	35	6	-	-	0	0	-	40	0	-	0	0	-	0	34	-
	26	♂	16	0	-	-	50	19	-	0	81	0	-	0	-	0	0	-
	5	♀	52	0	-	-	0	34	-	0	0	4	0	-	-	0	0	-
	23	♀	83	0	-	-	0	28	-	0	10	0	0	0	-	-	0	-
	27	♀	18	6	-	-	0	0	-	6	0	56	0	0	-	0	-	-
Feb. - Mar., 1978	4	♂	49	-	-	18	-	27	-	2	57	4	-	-	33	-	18	0
	13	♂	46	-	15	-	-	0	-	37	78	61	-	-	52	-	43	2
	18	♂	39	-	90	0	-	-	-	0	77	0	-	-	46	-	0	0
	20	♂	48	-	0	8	-	0	-	-	8	54	-	-	25	-	6	85
	21	♂	42	-	33	17	-	14	-	5	-	14	-	-	29	-	7	0
	22	♂	31	-	0	32	-	0	-	35	35	-	-	-	45	-	16	23
	16	♀	45	-	49	13	-	29	-	36	44	20	-	-	-	-	11	29
	27	♀	46	-	28	97	-	0	-	30	96	52	-	-	46	-	-	0
	30	♀	46	-	0	0	-	0	-	85	2	26	-	-	39	-	0	-
Apr. - May, 1978	4	♂	46	-	-	0	0	7	-	-	9	0	4	-	-	-	4	0
	13	♂	47	-	0	-	0	0	-	-	40	68	36	-	-	-	64	6
	17	♂	33	-	0	0	-	6	-	-	21	0	0	-	-	-	0	0
	18	♂	26	-	18	0	11	-	-	-	36	0	0	-	-	-	0	0
	21	♂	43	-	16	5	14	9	-	-	-	16	0	-	-	-	2	9
	22	♂	22	-	0	16	0	0	-	-	16	-	7	-	-	-	7	18
	26	♂	14	-	0	57	0	0	-	-	0	29	-	-	-	-	57	0
	27	♀	47	-	0	72	0	0	-	-	13	19	81	-	-	-	-	0
	30	♀	47	-	0	6	0	0	-	-	21	23	0	-	-	-	0	-

[1/] In July-August, 1977 bobcat SD-2 was observed in home range of bobcat SD-13 on 47% of the occasions SD-2 was located during the stated time period.

Tabie 6. Sex and age classes of bobcats studied in San Diego County, 1977-78. [1/]

Age Class	El Capitan Reservoir Study Area		Commercially Harvested in San Diego County			
			Southeast San Diego County		Countywide Total	
	Males	Females	Males	Females	Males	Females
0-1	0	0	1	9	1	9
1-2	0	1	9	7	9	7
2-3	0	0	6	4	10	8
3-4	1	0	0	2	5	3
4-5	1	1	1	1	2	2
5-6	1	1	0	0	1	0
6-7	1	0	0	0	0	0
7-8	0	2	0	0	0	0
8-9	1	0	0	0	1	1
9-10	0	0	0	0	0	1
Sex Ratios	5[2/]	5[2/]	17	23	29	31
	1	1	0.74	1	0.94	1

1/ Age determined by cementum annuli analysis of' canine teeth.
2/ Sex ratio data only from those bobcats dying and whose teeth were analyzed to detetmine age. Actual sex ratio was 20 males to 11 females (1.82:1). Sex ratio of those bobcats trapped on study area during the commercial trapping season was 17 males to 8 females (2.13:1).

11 males and 5 females (2.1 males:1 female).. This was not substantially different from the sex ratio of 20 males to 11 females (1.8 males:1 female) of all bobcats captured in the study, nor from the sex ratio of 17 males to 8 females (2.1 males:1 female) captured in the study area during that time of year corresponding to the commercial trapping season.

All bobcats in the study population were adults with no young known to have survived and only three bobcats were possibly yearlings when first captured. The old age structure of the population is demonstrated in the mean age class of 5-6 years for those study area bobcats that died and were aged (Table 10).

These age and sex structures are different from those obtained from a harvested population of bobcats (Table 10). The sex ratio shown in the sample of the harvested population is nearly even (0.94 males:1 female) and the mean age class was 2-3 years with more than 73% of the population in the first three age classes.

Reproduction

During 1977, reproduction in the area was believed to be nonexistant. Though the female sample size was small, only two of the four females showed any indication of breeding. No young were caught in the study area which could have been produced in the study area.

Litters were produced by three of three females monitored during the 1978 breeding season. Only one litter, of two kittens, was observed. However, SD-30 was pregnant when trapped in May, 1978 and both SD-30 and SD-31 showed the same reduction in range noted in SD-27 just before parturition and noted by Zezulak (personal communication) just before and after females he was studying at Lava Beds National Monument, Siskiyou County, gave birth. The litter of SD-27 was estimated to have been born on April 1. SD-31 was definitely nursing when trapped in mid-April and the litter probably produced by SD-30 was born during the first part of June. No data were gathered on kitten survival.

Mortality

Thirteen study animals are known to have died during the period from January, 1977 through June, 1978. Two bobcats died from Panleukopenia, two from starvation, and another was attacked and partially eaten by a large felid, most probably a mountain lion (Felis concolor). A male bobcat was found dead after it had degenerated to a weakened condition caused by a 3 cm square (1.2 inch square) leather object obstructing food passage through the stomach. This individual appeared to have been killed by a dog (Canis spp.). Two bobcats were harvested by commercial trappers and one bobcat was shot. A female bobcat was found dead in a trap, with bruising around the neck and shoulders indicating possible predation. One bobcat was euthanized after the trap he was in lodged in heavy brush and broke his leg. Two other study animals succumbed to unknown causes, although there were indications that one may have been killed by a predator.

Weight Fluctuations

Study bobcats captured and weighed more than once showed weight fluctuations; these fluctuations were related either to seasonal variations or to sickness or injury (Table 7). Because of the small sample of females weighed and timing of the study, seasonal weight losses were most dramatic among males and during late fall and early winter of 1977-78. Ten males showed losses of 6 to 21% from their highest recorded weights, usually observed during the May to July period. One male (SD-19) appeared to lose 24% of his body weight but because he was found shot, the loss in may have been due in part to desiccation. Data for SD-2 and SD-8 suggest that this seasonal weight loss may have occurred, though to a lesser degree, during the 1976-77 winter as well as during the 1977-78 winter. However, the normalcy of large seasonal weight fluctuations is unknown as is the involvement of females in this phenomenon.

Diseased and injured bobcats showed weight losses of up to 53% from their recorded maximum weight before death (Table 7). Weight loss was greatest for those individuals dying of Panleukopenia (SD-l) and starvation (SD-2, SD-12, SD-25). SD-21 lost, due to injury, an additional 6% above the 21% he already had lost as a result of seasonal fluctuations, and SD-22 lost 30% of its highest recorded weight when sick. Both of these latter two animals survived, indicating that there may be a limit to the weight loss which can occur where recuperation still is possible.

DISCUSSION

Conservative density estimates of 1.27 to 1.53 bobcats per km^2 (3.27 to 3.94 mi^2) on the El Capitan Reservoir study area are substantially higher than densities previously reported (U. S. Forest Service 1942, Marshall 1969, Bailey 1973, and Jones 1976) except for some densities of 2.74/km^2 reported for parts of Texas (Brownlee 1978). Density estimates on the El Capitan Reservoir study area probably are accurate due to the intensity of trapping effort during the study. These high density figures are even more impressive because there were no transients or young used in calculating density and because of the apparent reduction in population size which occurred during the study.

The sizes of home ranges of bobcats in the El Capitan Reservoir study area are smaller than those previously reported (Marston 1942, Rollings 1945, Pollack 1949, 1950, Erickson 1955, Marshall and Jenkins 1966, Bailey 1973, Jones 1976), especially when equals are compared. In most previous studies bobcats were not followed for the same length of time they were followed in this study. The size of all average bi-monthly home ranges documented in this study are smaller than those home ranges reported in other studies. It appears that there is a definite inverse relationship between bobcat density and home range size - the higher the density, the smaller the home range.

The mutual exclusivity of female home ranges observed in this study agreed with findings by Marshall (1969) and somewhat with Bailey (1972) who found a slight overlapping of home ranges of females, but less overlap than occurred with males. The significant degree of male-male overlap which occurred in this study has not been reported previously. Males were observed, on several occasions, in close proximity to other males. This does not imply that there was no agonistic behavior between individuals. Most males and some females were scarred and had tattered ears, and two males trapped in May, 1978 had fresh and fairly severe cuts on the head. These appeared to be the result of recent encounters with other bobcats.

Table 7. Weight fluctuations in bobcats on El Capitan Reservoir study area, San Diego County, 1977-78.

Bobcat Number	Monthly Weights (kg) 1976 Dec.	1977 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	1977 Dec.	1978 Jan.	Feb.	Mar.	Apr.	May	% Maximum Weight Variation
Seasonal Variations																			
Males																			
4		6.70												5.74					14
8		7.07	6.48																8
13							6.45	5.91						6.31	5.74			6.85	16
17							7.64					6.50	6.48				6.90		15
18							5.00				4.23			4.77					15
19							7.78				5.91								24
20								6.99						6.56					6
21								7.53				5.94	5.48						21[1/]
26												6.34						7.30	13
Females																			
5		4.83									4.89								1
16							5.09							4.60					10
Variations due to disease or starvation																			
Males																			
1	7.76									3.61									53
2	5.77	5.45					6.14			5.00			3.55						42[2/]
12			7.24									3.52							51
22										6.85	4.97[3/]	6.59						7.10	30[3/]
Females																			
25											4.20	2.70							36

1/ SD-21 maximum weight loss, including 12/77 weight of 5.48 kg is 27%. Additional loss believed due to injured foot.
2/ SD-2 underwent seasonal weight fluctuation of 6% during winter 1976-77.
3/ SD-22 was sick during 10/77 but recovered.

Reported sex ratios may be biased towards males because they have larger home ranges than females, especially during the breeding season which often corresponds to part of the commercial trapping season. In this study the reported sex ratio is accurate because of the low possibility that any bobcats in the study area were untrapped. On an average per individual basis, male bobcats were trapped more often than females. However, this was less distinct during -the commercial trapping season than during the remainder of the year.

Sex and age ratios of the bobcats on the El Capitan Reservoir study area are typical of a population with little turnover and recruitment. In San Diego County, the unharvested population had less than 10% in the first two age classes, similar, but less than the 34% observed by Fritts and Sealander (1978). This was substantially less than the 43% observed in the harvested bobcats in San Diego County, and the 38%, 40%, and 63% found in harvested bobcat populations in Washington (Poelker 1977), Nevada (Nevada Dept. Fish & Game 1978) and Wyoming (Crowe 1974) respectively.

The age ratio of individuals in the bobcat population on the El Capitan Reservoir study area probably affected the territorial behavior of the bobcats. If Bailey (1972) is correct in assuming that most transients are sexually immature individuals, the lack of transients in study population is explained by the old age structure.

The sex structure appears to act as an indicator of population exploitation or health just as age structure does. The sex structure of unharvested or lightly harvested populations, such as those studied on the El Capitan Reservoir study area and in Arkansas by Fritts and Sealander (1978), is male dominated and likely biased towards more individuals of older age classes. The resultant population, usually with high relative densities, as is probably shown with most Nevada populations (Nevada Dept. Fish & Game 1978) as well, favors males. Their larger size may allow them to be more competative with other predators and with others of their own species. Females, because they are highly territorial, are limited by their established home range size. Males, may overlap with other males in a fluid system, if food resources are great enough, and also help depress the number of females and new, young individuals which try to enter the population. Until adult male numbers decline in such a population, there may be little chance of the young surviving beyond separation from the female, even when young survive that period of adult care which Bailey (1972) described as critical to survival of the year's reproduction. This condition appears only to occur when food is not more limiting than social pressures. Bailey's population in Idaho probably did not show the male dominated sex structure because the food supply was variable and low and was limiting the bobcat population density.

Because male bobcats have a greater chance of being captured than females, the true reproductive potential of a population is usually higher than that indicated by sex structures derived from seasonal or casual trapping. The differential capture rate between the sexes, and in a promiscuous breeding system, may mitigate, in part, the take by commercial trapping which allows more females to remain in the population.

The poor reproductive effort in 1977 of the female bobcats studied is evidence that, at least in a population with high density, not all females breed all years when they are sexually mature. This invalidates any calculation to determine the present recruitment rates from the number of females present in the population and necessitates gaining knowledge of the actual reproductive effort.

Crowe (1974) suggests that the survival pattern of bobcats follows Pearl's (1928) Type I curve when unexploited and the Type II curve if exploited. Nine instances of natural mortality were observed in a sample of 31 bobcats on the relatively unexploited population in the El Capitan Reservoir study area, a substantially higher rate than reported by Bailey (1972). The individuals, dying of natural mortality on the study area, were all adults. They were of various ages suggesting that a survivorship curve, closer in shape to a Type II curve, is attained by populations with a high density.

The recorded seasonal variations in weights of bobcats indicates that body weight is a poor method of determining the age of adult bobcats which can not be subjected to the cementum annuli technique of aging an individual through its teeth. Seasonal weight losses also indicate that late fall and early winter is a period of high stress for male bobcats in the study area. This is further substantiated by the dates when four bobcats succumbed to disease and starvation and another was observed to be sick.

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Appendix 1

SAN DIEGO COUNTY BOBCAT STUDY
TRAPPING DATA

ID No.	Date First Trapped	Sex	Year of Birth	Maximum Weight (kg) Observed	Neck (cm) Circumf.	Leg Length (cm) Front	Leg Length (cm) Rear	Comments
SD-1	12-17-76	M	1972	7.76	26.7	45.7	52.1	Died-Panleukopenia
SD-2	12-20-76	M	1973	6.14	25.4	43.2	45.7	Died-accidental starvation
SD-3	12-22-76	F	ADULT	4.23	22.2	38.1	40.6	Died-Panleukopenia
SD-4	1-14-77	M	ADULT	6.70	25.4	40.6	45.7	
SD-5	1-16-77	F	ADULT	4.89	22.9	41.9	44.5	
SD-6	1-16-77	M	ADULT	6.90	26.0	44.5	44.5	
SD-7	1-19-77	M	ADULT[1/]	4.97	24.1	40.6	43.2	
SD-8	l-28-77	M	ADULT	7.07	24.1	43.2	48.3	Euthanized-broken leg
SD-9	2-06-77	M	ADULT	6.65	24.8	43.2	43.2	
SD-10	2-15-77	M	ADULT	5.97	22.2	44.5	47.0	Died-unknown
SD-11	2-17-77	F	1975[1/]	3.63	21.0	38.1	43.2	Died-unknown, possible predation
SD-12	2-22-77	M	1969	7.24	25.4	45.7	50.8	Died-starvation
SD-13	6-02-77	M	ADULT	6.85	22.9	43.2	50.8	
SD-14	6-03-77	F	1972	4.83	21.6	41.9	45.7	Died-unknown
SD-15	6-17-77	M	ADULT	6.14	23.5	43.2	48.3	
SD-16	6-20-77	F	ADULT	5.28	22.2	40.6	45.7	
SD-17	6-24-77	M	ADULT	7.64	24.8	45.7	48.3	
SD-18	6-26-77	M	ADULT[1/]	5.00	20.9	43.2	45.7	
SD-19	6-26-77	M	1971	7.78	26.0	45.7	45.7	Died-shotgun wounds
SD-20	7-01-77	M	ADULT	6.99	23.5	45.7	48.3	
SD-21	7-14-77	M	ADULT	7.53	26.0	45.7	45.7	
SD-22	9-27-77	M	ADULT	7.10	24.8	45.7	50.8	
SD-23	10-21-77	F	ADULT	5.00	21.6	40.6	45.7	Died-Felid predation
SD-24	10-21-77	M	ADULT	4.87	20.3	43.2	48.3	
SD-25	11-19-77	F	1970	4.20	19.7	40.6	44.5	Died-starvation
SD-26	11-20-77	M	ADULT	7.30	24.1	45.7	49.5	
SD-27	11-24-77	F	ADULT	5.74	23.5	43.2	47.0	
SD-28	12-17-77	M	1974	6.02				Taken by commercial trapper
SD-29	12-21-77	F	1973	5.28				Taken by commercial trapper
SD-30	l-28-78	F	ADULT	5.28	21.6	40.6	41.9	
SD-31	4-13-78	F	ADULT	5.17	21.6	39.4	43.2	

l/ Possibly yearling when first captured.