REPRODUCTIVE ECOLOGY OF BOBCATS AND LYNX IN WESTERN MONTANA

by

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ABSTRACT

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Reproductive ecology of the bobcat (Lynx rufus) and lynx (Lynx lynx) was studied in western Montana from 1982 through 1984. Home ranges averaged 111.4 km^2 for male bobcats and 61.5 km^2 for females. Adult lynx home range sizes averaged 122.0 km^2 for males and 43.1 km^2 for females. Distance between consecutive locations differed significantly between denning and non-denning female bobcats. Juvenile ranges averaged 222.1 km^2 for three female bobcats. Dispersal was documented in two juvenile bobcats and an adult lynx. Placental scar counts indicated an average bobcat litter size of 2.69 and an average lynx litter size of 2.75. Corpora lutea counts indicated ovulation rates of 4.16 for bobcats and 4.28 for lynx. Both yearling bobcats and lynx implanted embryos. Pregnancy rate of yearling bobcats (39.4%) was significantly lower than that of adults (89.6%), and fluctuated greatly between harvest seasons. Lynx pregnancy rate was also lower for yearlings (44.4%) than adults (100.0%). Corpora lutea counts were significantly lower for yearling bobcats ($\bar{x}$ = 3.62) than adults ($\bar{x}$ = 4.48). Over half (55.7%) of yearling bobcats with corpora lutea present had no placental scars versus 9.6% in adults. No significant differences were detected between litter sizes or ovulation rates for bobcats harvested in eastern or western Montana. Bobcat litter sizes and ovulation rates were significantly different between years and age groups. Bobcat breeding season lasted from mid-February through mid-April and kittens were born from early May to early July. Three wild litters located between 1982 and 1984 averaged 2.7 kittens. Bobcats used steep, rocky areas in association with Douglas-fir (Pseudotsuga menziesii) for den sites, selecting hidden microsites within caves, spaces between boulders, hollow logs, or abandoned mine shafts. Den sites were often located near active secondary roads. Past disturbance, such as mining or logging activity, did not appear to influence den site selection. Kittens were not mobile until about 8 weeks of age, when more extensive (> 2 km) movements began.

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INTRODUCTION

This report covers the second phase of research on a project initiated in 1980. The first phase, on habitat use, home range, and seasonal movements of bobcats (Lynx rufus) was completed by Smith (1984). This second phase of research involves the reproductive biology and ecology of the bobcat and lynx (Lynx lynx).

Bobcats were not actively managed as furbearers by most states until the mid-1970's, when increased market demand and trapping pressure resulted in an elevated status for the species. The higher market values followed from the Convention on International Trade for Endangered Species of Wild Flora and Fauna (1973) which imposed an import/export ban on exotic spotted cat pelts. Pelt prices for bobcats soared during this time, and the U. S. Endangered Species Scientific Authority restricted export of this and other species until adequate data on status and trend could be obtained. The state of Montana, and all other states containing bobcat populations, were mandated by the Authority, in accordance with the Convention, to initiate studies on bobcat populations. In 1977, reclassification of the bobcat from predator to furbearer status in Montana allowed management biologists to properly manage bobcats. Information on recruitment and denning requirements is essential for such improved management of this species.

This attention has caused a dramatic increase in the amount of research done on bobcats in recent years. In 1979, the first bobcat research conference was held at Front Royal, Virginia (Blum and Escherich 1979) and since that time studies of bobcat biology have continued. In the 1970's and the early 1980's, research on lynx biology also increased (Nava 1970, Nellis et al. 1972, Berrie 1973, Stewart 1973, Brand et al. 1976, Keith et al. 1977, Brand and Keith 1979, Ward 1983, Parker et al. 1983, O'Connor 1984, Stephenson 1983, 1984).

Until recently, very few studies on bobcat reproduction had been published. The earliest works, by Seton (1929) and Grinnell et al. (1937) were largely anecdotal. Duke (1949, 1954) suggested that bobcats were polyestrous based on ovarian histology studies. Research on aspects of reproduction in the western United States has been completed in Idaho (Bailey 1972, 1974, 1979), Texas (Blankenship 1979, Blankenship and Swank 1979), Oklahoma (Rolley 1983, 1985), Kansas (Johnson and Holloran 1985), Wyoming (Crowe 1974, 1975), Utah (Gashwiler et al. 1961), and Washington (Sweeney 1978, Brittell et al. 1979, Knick et al. 1985). Studies specific to bobcat reproduction have been completed in the northern coniferous forests of Minnesota (Berg 1979), Michigan (Erickson 1955, Hoppe 1979), and Nova Scotia (Parker and Smith 1983). In Montana, Knowles (1981) and Smith (1984) refer to certain aspects of bobcat denning ecology. At present, ongoing research on denning ecology, breeding biology, and kitten survival and dispersal is being conducted in Colorado (Jackson 1984), and Idaho (Knick, pers. comm.).

The study was designed primarily to provide comparable data on bobcat and lynx reproductive ecology and biology.

Specific objectives were to:

1. Document bobcat and lynx breeding and denning ecology and determine:

   a) timing of breeding and denning seasons
   b) denning habitat
   c) litter size
   d) kitten survival and dispersal
   e) denning female activity patterns
   f) minimum successful breeding age
   g) differences between breeding and non-breeding female movements, home ranges, and activity patterns
   h) home range size and movements

2. Analyze carcass data from harvested cats to determine:

   a) litter size
   b) ovulation rates
   c) age at first breeding
   d) pregnancy rates
   e) differences in litter size and ovulation rates between years, regions, and age groups.

STUDY AREAS

Three geographically separate study areas were included in this study, including portions of the Garnet, Mission, and Cabinet mountain ranges in western Montana; difficulties involved in capturing an adequate sample of bobcats dictated the need for a widespread trapping program over a relatively large area. Smith (1984) conducted the first phase of this research on habitat use, movements, and home range size. The study areas used in Smith's study were similar, but the Fish Creek drainage was dropped before my study began in 1983 and the Mission Mountains were added in early 1984.

Faunal composition for the three study areas was typical for western Montana, and was partially listed by Smith (1984). Of special note, however, was the occurrence of wolverines (*Gulo gulo*), fishers (*Martes pennanti*), and wolves (*Canis lupus*) in the Garnet Range study area. The presence of each species was confirmed either through tracking, trapping, or sighting. Grizzly bears (*Ursus arctos*) occur in the Mission and Cabinet study areas, and have been reported in the Garnets (Nielsen, personal comm.).

The following study area descriptions closely follow Smith (1984) and Servheen (1981). Each area is characterized separately due to variations in topography, vegetation, and climate. Weather station data provided by the National Climatic Data Center (U. S. Department of Commerce 1983, 1984) are used to describe climatic conditions.

Garnet Range

This study area includes the entire Garnet Range as well as the drainages directly south of Clinton (Fig. 1). Bobcats were trapped primarily in the Brock Creek drainage near Garrison, and the Schwarz Creek area near Clinton. Lynx were captured in the Chamberlain Meadows area, on Lubrecht Experimental Forest in the western Garnets.

The Garnet Mountains are typified by cool, moist winters and hot, dry summers (Scott 1978, Smith 1984). Weather data collected from stations in nearby Deer Lodge, Drummond, Potomac, and Ovando indicated that winters were generally warmer and drier than in normal years, with mean temperatures averaging -9.3° C in January 1983 and -10.3° C in January 1984. Total precipitation for January was 2.0 cm in 1983 and 1.7 cm in 1984 for all reporting stations. The summer of 1983 was more moist than usual, with precipitation totalling 6.8 cm, and temperatures averaging 18.6° C in August. In 1984, conditions were drier, with temperatures averaging 17.6° C, and precipitation totaling 4.4 cm during August.

The Garnet Range is characterized by relatively moderate, rolling topography, with gentle to moderate slopes (15-30%) dissected by steep (40-60%) limestone canyon areas along drainages; elevations range between 1159 and 2288 m. Talus slopes and rock outcrops occur throughout the study area, particularly along the northern and southern edges.

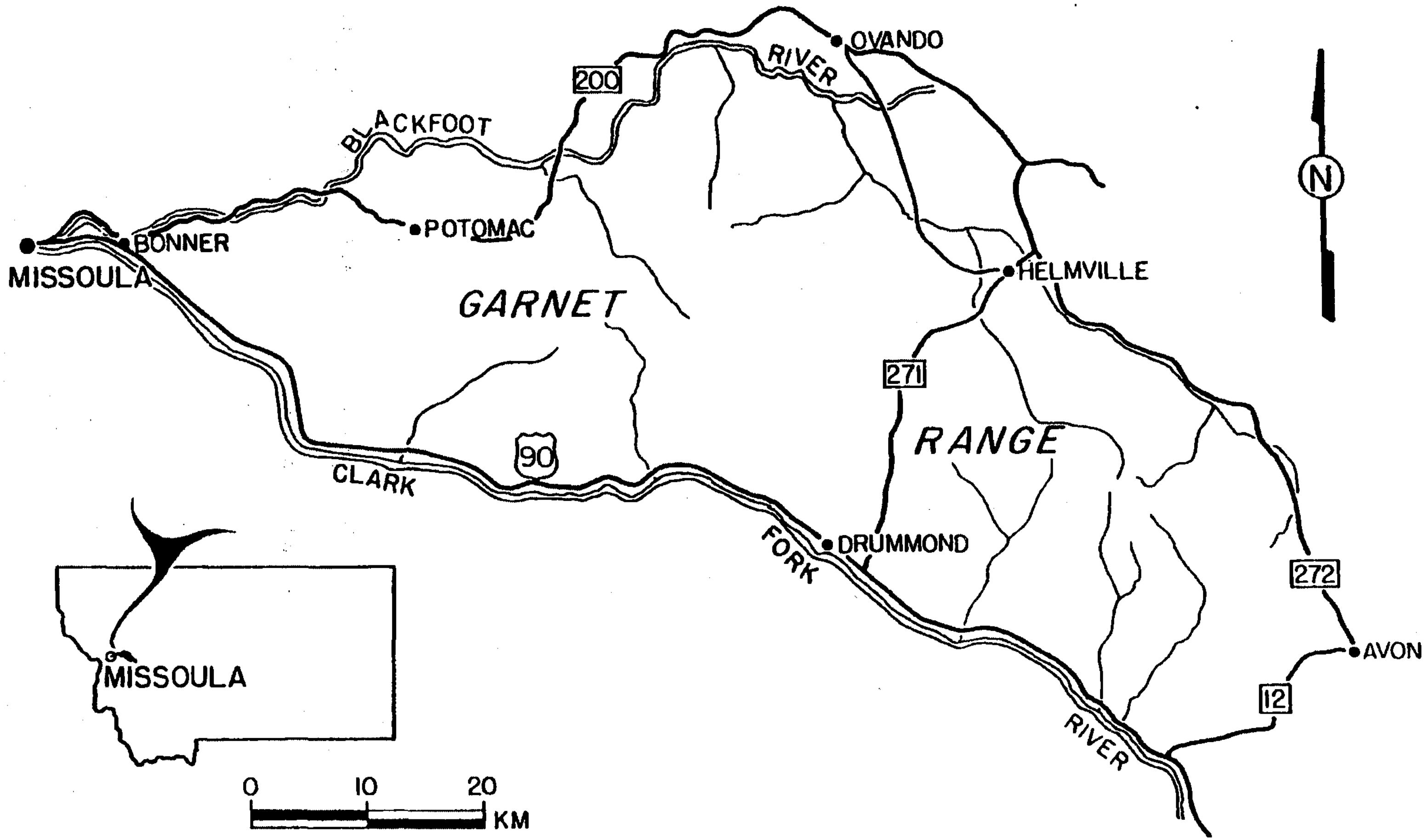

Fig. 1. The Garnet Range study area.

The majority of the Garnet Mountains are covered by coniferous forests; habitat types are typical of those found in western Montana, and occur primarily within the *Abies lasiocarpa* , *Pinus ponderosa*, and *Pseudotsuga menziesii* climax series (Pfister et al. 1977). Ponderosa pine (*Pinus ponderosa*), western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), and Douglas-fir (*Pseudotsuga menziesii*) are the major coniferous tree species at lower elevations; subalpine areas are dominated by lodgepole pine, Englemann spruce (*Picea engelmanni*) and subalpine fir (*Abies lasiocarpa*) . Major deciduous trees and shrubs include quaking aspen (*Populus tremuloides*), redosier dogwood (*Cornus stolonifera*), willows (*Salix* spp.), and black cottonwood (*Populus trichocarpus*).

Cabinet Range

The Cabinet Range study area centers around Thompson Falls, in northwestern Montana (Fig. 2). Bobcats were trapped within a 25 km radius of town. Lynx were trapped in the west fork of Fishtrap Creek, approximately 45 km east of town.

A strong Pacific maritime influence (Brown 1974, Smith 1984) creates the mildest weather conditions found in Montana. This is due primarily to the northwest-southeast alignment of mountain ranges (Brown 1974, Tilton 1977, and Smith 1984). Summers are generally hot and dry; fall, winter and spring are normally cool and wet. Weather data were collected from stations at nearby Thompson Falls and Trout Creek, and

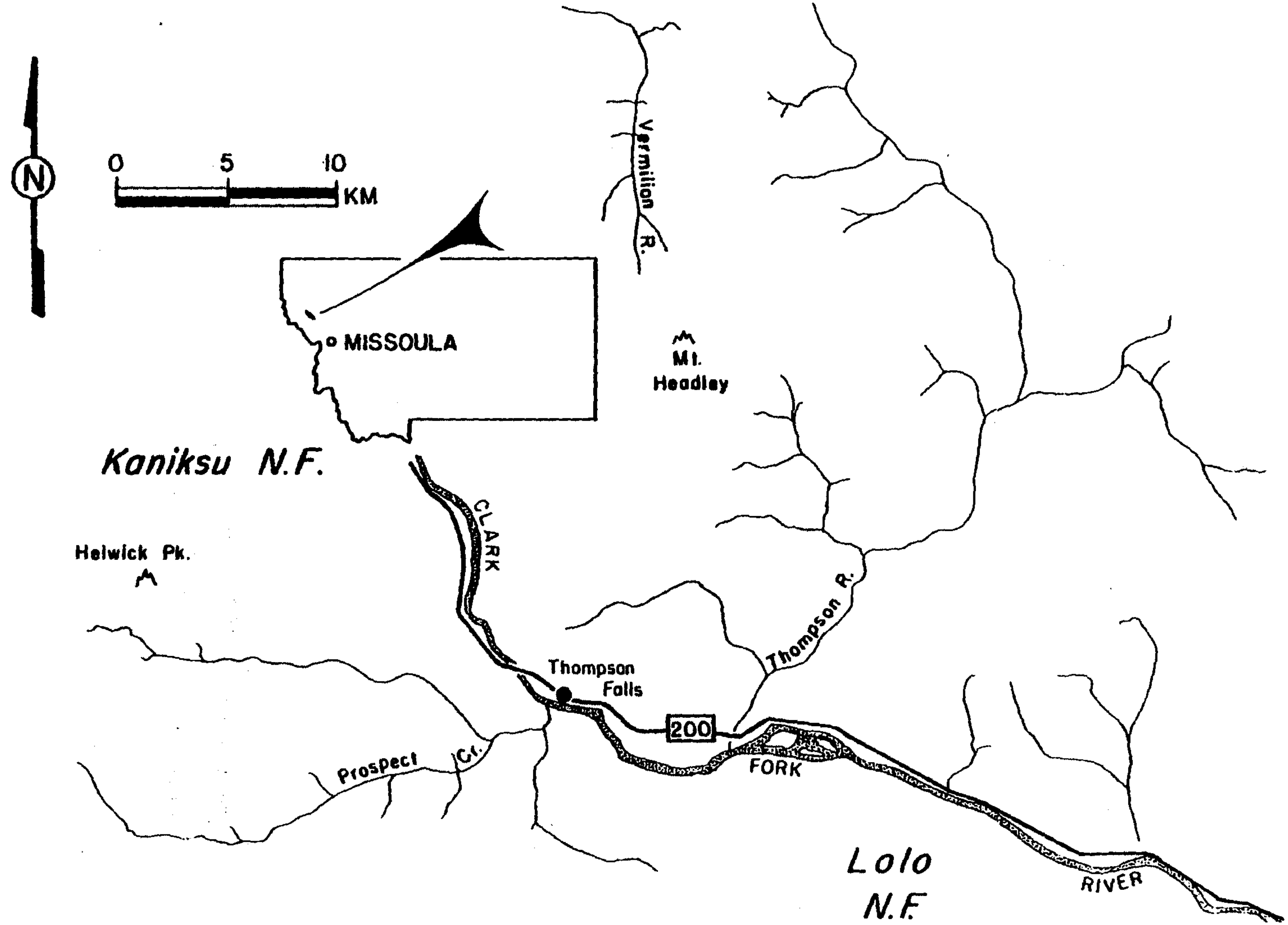

Fig. 2. The Cabinet Range study area.

were averaged to provide the following summary. The winter of 1983 was generally mild and wet, with a mean temperature of 0.2° C and total precipitation of 9.1 cm in January. January of 1984 was slightly colder and drier, with an average temperature of -1.9°C and total precipitation of 5.1 cm. August 1983 was hot and wet, with a mean temperature of 20.4° C and 3.2 cm of measurable precipitation. In 1984, conditions were drier, with only 1.4 cm of precipitation recorded in August; the average temperature during this period was 20.2° C. Further climatological information is provided by Brown (1974).

The terrain along the Thompson River and the Clark Fork River is extremely steep and rugged, with many slopes exceeding 60 percent. Elevations range from 732 m in valley bottoms to peaks over 2135 m high, often in less than 2.4 km. The Clark Fork Valley is characterized by rocky slopes and extensive scree along the east side of the river between Thompson Falls and Plains. The Thompson River is characterized by similar steep, rugged topography. Generally, however, the Thompson River drainage is characterized by more extensive coniferous forest cover than is the Clark Fork drainage. West of Thompson Falls, the Clear Creek, Prospect Creek, and the Dry Creek drainages are characterized by more gentle, rolling topography with fewer extensive rock outcrops, except in the upper Clear Creek and Cherry Creek drainages. The Fishtrap Creek area is characterized by moderate, rolling topography in the lower reaches, and by steep, rugged alpine ridge systems in the headwaters of the West Fork.

Vegetative characteristics are described for the Clark Fork Valley by Brown (1974) and Tilton (1977). Forest habitat types generally conform to the _Pseudotsuga menziesii_, _Abies lasiocarpa_, _Pinus ponderosa_, _Thuja plicata_, _Tsuga_ spp., and _Abies grandis_ climax series (Pfister et al. 1977). Species typical of the Pacific coast include western red cedar (_Thuja plicata_), grand fir (_Abies grandis_), western hemlock (_Tsuga heterophylla_), mountain hemlock (_Tsuga mertensiana_), and western yew (_Taxus brevifolia_).

Mission Range

This study area (Fig. 3) is situated along the western front of the Mission Mountains east of Ronan, and is essentially composed of the home range of a single instrumented adult female bobcat (F70). Lost Creek delineates a rough northern boundary; Eagle Pass Creek represents the southernmost extent of the known movements of this bobcat. The main Mission Mountain divide demarcates the eastern perimeter, and the flat and forested foreland area west of the foothills and east of Montana Highway 93 serves as a rough western boundary. This study area lies within the Flathead Indian Reservation; areas above 1300 m are administered as wilderness by the Confederated Salish and Kootenai Tribes.

Weather data were collected from stations in nearby Polson and Saint Ignatius. Winter temperatures averaged -2.0°C for January; the mean summer temperature averaged 20.1° C during August, the hottest

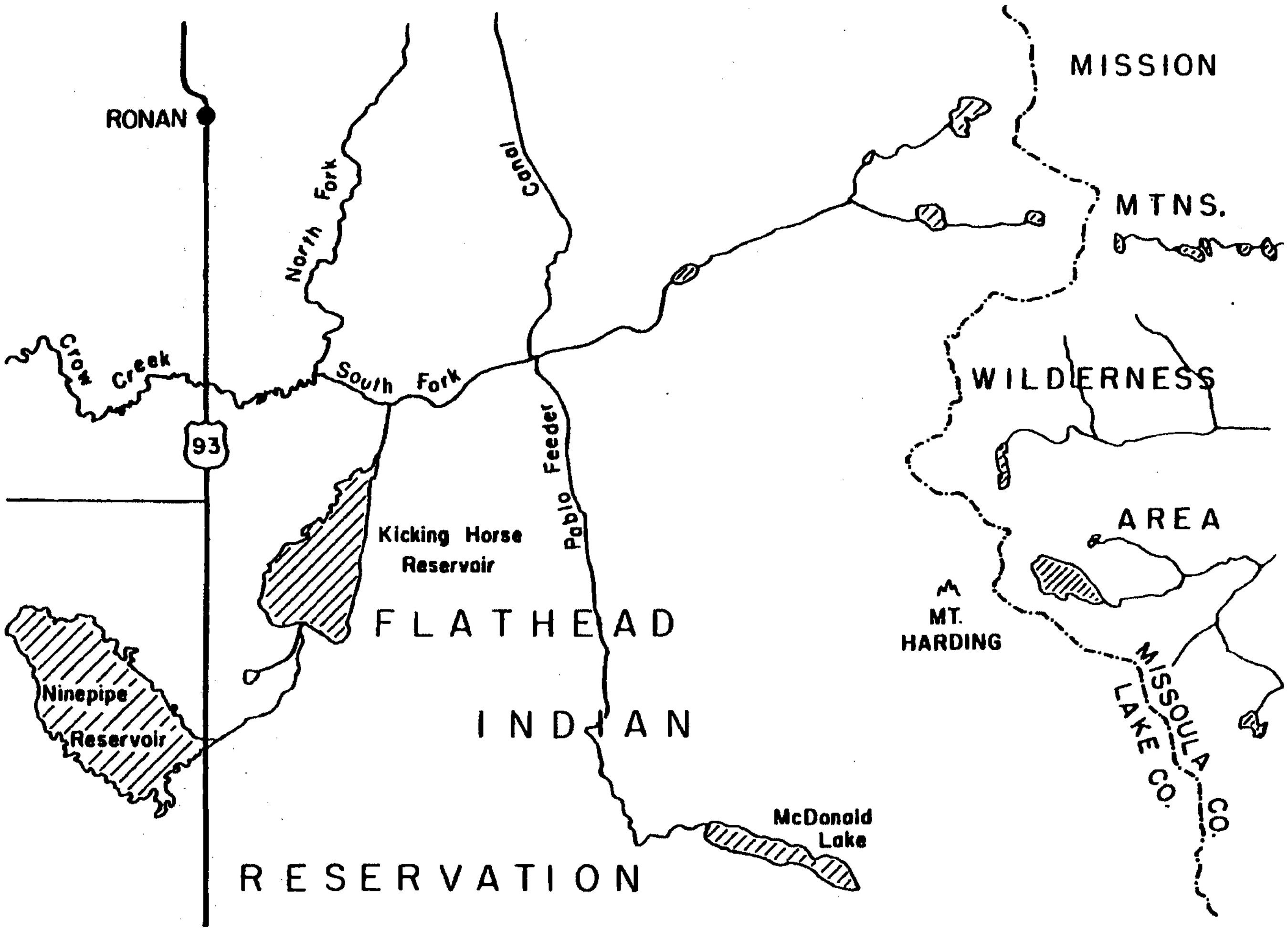

Fig. 3. The Mission Range study area.

month. Total precipitation for January was 1.2 cm; in August total rainfall measured 4.2 cm.

The Mission Mountains are characterized by steep and abrupt relief, with vertical rises of more than 600 m in less than 1 km being common. Elevations range from 1000 m in the lower west slope to over 2400 m along the Mission Divide. Drainages are relatively steep and paralleled by steep rocky slopes in their upper reaches.

Vegetation is typical of that found in northwestern Montana; major habitat types occur within the *Pseudotsuga menziesii*, *Picea* spp., *Thuja plicata*, and *Abies lasiocarpa* series (Pfister et al. 1977). Dominant tree species include subalpine fir, spruce (*Picea* spp.), Douglas- fir, western larch, and lodgepole pine. In the lower portions of drainages, western cedar (*Thuja plicata*) and aspen are common.

METHODS

Trapping was conducted during the periods 1 December 1982 to 19 April 1983 and 1 December 1983 to 31 March 1984 by contracted trappers, volunteer field assistants, and myself. Study animals were captured using wire-mesh live-traps designed and described by Karpowitz and Flinders (1979) and modified by Smith (1984). Traps were set primarily at known bobcat and lynx crossings, near rocky outcrops, and in areas of high lagomorph concentrations. Fresh deer, beaver, snowshoe hare, or porcupine carcasses were used as bait. Commercial gland scent and urine were used as lure, and hanging attractants made from strips of hide and foil were suspended at highly visible locations near each trap. Conifer boughs provided camouflage, shelter, and insulation for traps. Traps were checked every 1 to 3 days, depending on conditions and the length of the trapline.

Ketamine hydrochloride was used as an immobilant; the standard dosage was 22 mg/kg body weight, and drug was injected either by hand-held syringes or projectile darts fired from a pneumatic dart gun. Body weight and measurements, physical condition, and other data were recorded for each cat. Sex and approximate ages of captured animals were determined; they were then eartagged with plastic Rototags and radio-instrumented. Lightweight radio-collars (127 g) were assembled using 2.54 cm PVC pipe containers and one- or two-stage transmitters

(Wildlife Materials, Inc.) powered by lithium batteries. Expected transmitter life was 1 to 2 years. Collars were color-coded for identification purposes; frequencies ranged from 150.000 to 151.999 Mhz.

Bobcats and lynx were radio-located from the ground and air to determine home ranges and movements. Locations were plotted on U. S. Geological Survey 7.5 and 15 minute maps and referenced using Universal Transverse Mercator (UTM) grid coordinates. UTM's were divided into 100 X 100 m units. Aerial locations were made from a Cessna 185 with fixed H-style antennae mounted on wing-struts, or from a Piper PA-18 Super Cub fitted with a rotating, belly-mounted Yagi antenna. Flights were made on a bi-weekly basis whenever possible throughout the year. Gaps in location data were primarily due to poor flying conditions or budgetary constraints. Ground locations were made irregularly during the winter trapping season to determine presence of kittens and breeding season activity. Ground telemetry was used during the spring and summer denning season to facilitate den location, and to monitor activities of denning females. Ground locations were usually determined through triangulation from two or more points; extreme signal bounce often prevented accurate locations.

Home range size and movements were determined using the HOME computer program (Harestad 1981) as modified by Mark Haroldson and Robert Klaver at the University of Montana. The minimum-area method (Stickel 1954, Southwood 1966), was employed in home range calculations.

Straight line distances between successive locations were also calculated. Annual home ranges were calculated for calendar years, and total home ranges include all known locations for individual animals. The summer season is defined as the period from 1 June through 31 August.

Den sites were located through radio-telemetry during spring and summer. General information concerning litter size, kitten age, and den characteristics were collected with each initial visit. After the denning season, in late August and early September, these den sites were again visited and detailed measurements were made of physical characteristics, habitat type (modified from Pfister et al. 1977), distance between consecutive dens, and related parameters. A 0.5 X 0.5 m coverboard was used to determine distance to obscurity at den sites. On-site slope measurements were taken with an inclinometer and cover density readings were measured with a spherical densiometer. Denning habitat was compared to available habitat using a non-mapping technique (Marcum and Loftsgaarden 1980). Topographic maps were used to determine physical features within the known home ranges of denning female bobcats; measured parameters included slope, elevation, aspect, and distances to roads and disturbances. For this analysis, denning season roughly corresponds to the calendar summer (June 1 through August 31).

Carcasses were obtained by the Montana Department of Fish, Wildlife, and Parks from December of 1979 through March 1983. During the 1979-1980 season, carcasses were collected from sportsmen on a voluntary basis. During the following years, trappers and hunters surrendered bobcat and lynx carcasses as part of a mandatory pelt tagging program. Ages were determined through sectioning of canine teeth, which were extracted and classified as deciduous or permanent (Crowe 1972). Animals less than 1 year of age had either open root canals or deciduous teeth. Adults had permanent teeth with closed root canals, and ages were estimated by counting cementum-layer annuli (Matson Inc.). Reproductive tracts were cleared in alcohol solution and wintergreen; they were then examined directly, without staining. Uterine horns were split and placental scars counted to determine litter sizes. Ovaries were fixed, sliced, and corpora counted to determine ovulation rates. Corpora were separated into two categories similar to Crowe (1975). Large, yellowish corpora were classified as corpora lutea associated with the season of collection, and smaller, darker corpora were considered corpora albicantia from previous seasons.

Reproductive data were analyzed across age groups, years, and regions. For this analysis, adults were defined as animals older than 2.5 years. Years were delineated by harvest seasons, and the two regions, western and eastern Montana, were roughly divided by the Rocky Mountain Continental Divide. Pregnancy rates were determined as the percentage of females with placental scars.

Data were analyzed using the SPSSX (Nie et al. 1984) statistical programs package. The subprograms ANOVA (multivariate analysis of variance), ONEWAY (one-way analysis of variance), and NPAR TESTS

(Chi-square) were used on the carcass data, and NPAR tests (Kolmogorov-Smirnov two-sample test) was used to determine differences between non-denning and denning bobcat movements during the summer season. The 1022 data management system provided further summary statistics. Hypotheses were tested at a significance level of $P < 0.05$, unless otherwise stated. Throughout the text, means are stated with their standard deviations.

RESULTS

Trapping and monitoring

Trapping

Twenty three bobcats and 7 lynx were captured during the 1983 and 1984 trapping seasons (Table 1). Five additional study animals, including three bobcats (F105, F111, and M109) and two lynx (M103 and F110), were originally instrumented during 1980-82 (Smith 1984), and all but one were re-instrumented. Seventeen bobcats (4 males and 13 females) and all lynx were radio-instrumented. Five males were ear-tagged and released without transmitters due to budgetary constraints.

Monitoring

More than 490 locations were obtained for 31 study animals from late December 1982 through March 1985. Tracking intervals ranged from 12 days to 25 months. Partial or total transmitter failure resulted in the loss of data from 10 animals, and one bobcat slipped its radio-collar. Seven bobcats, including one ear-tagged individual, were killed by humans, and two more died of natural causes. As of June 1985, eight bobcats, including two (F98 and F99) re-instrumented in the spring of 1985, still had active transmitters.

Table 1. Data on bobcats and lynx captured or monitored between December 1982 and March 1985 in three western Montana study areas.

Tag Number	Date of Capture	Study[a] Area	Age[b]	Wt. (kg)	Number of[c] Locations	Last Contact	Fate[d]
Bobcats							
F3	1/29/82	C	J	4.1	26 (61)	12/22/83	TF
F114	12/28/82	C	A	8.2	35	12/22/83	TF
F26	4/17/83	G	A	7.9	23	12/19/84	K
F45	2/7/83	C	J	4.5	1	2/7/83	TF
F105	1/26/81	C	A	8.4	10	10/9/82	TF
(RI)[e]	12/2/83	C	A	6.8	41	3/5/85	S
F93	12/6/83	C	J	3.2	21	1/15/85	S
F94	12/15/83	C	A	6.8	15	3/5/85	S
F95	12/14/83	C	J	4.5	6	12/10/84	K
F96	12/15/83	C	J	4.5	1	12/15/83	TF
F58	1/24/84	C	A	6.4	19	3/4/85	S
F98	2/22/84	G	A	5.9			
(RI)	2/12/85	G	A	8.6	21	2/12/85	S
F99	2/26/84	G	A	8.2		6/15/84	SC
(RI)	2/14/85	G	A	8.0	8	2/14/85	S
F70	3/6/84	M	A	6.4	23	12/21/85	S
F111	3/31/82	G	J	6.4	21	11/23/83	TF
(RI)	3/21/84	G	A	7.3	44	11/6/84	TF
M116	1/25/83	C	A	12.2	5	9/28/83	TF
M117	1/27/83	G	A	13.2			
(RI)	3/21/84	G	A	10.9	32	1/18/85	S
M5	3/2/83	C	A	9.1	2	7/22/83	TF
M59	12/22/83	C	J	4.8	2	1/3/83	K
M109	3/26/82	G	A	10.9			
(M100) (R)[e]	3/5/84	G	A	12.3	11 (28)	4/18/84	TF
M54 (ET)[e]	3/6/84	C	J	5.0	2	12/28/84	K
M56 (ET)	2/20/84	C	A	11.8	1	-	U
M97 (ET)	2/18/84	C	A	8.2	1	-	U
M62 (ET)	3/12/84	C	A	8.6	1	-	U
M63 (ET)	3/14/84	C	A	9.5	1	-	U
Lynx							
F115	1/12/83	C	A	8.2	40	11/8/84	K
F110	4/1/82	G	A	8.2			
(RI)	3/4/83	G	A	8.2	33 (59)	12/12/83	TF
M44	2/3/83	C	A	10.0	9	1/5/85	K
M103	1/12/81	G	A	10.4			
(RI)	2/4/83	G	A	10.5	24	1/7/84	K
M118	2/4/83	G	A	10.9	8	5/11/83	TF
M119	2/4/83	G	J	4.5	7	5/11/83	D
M120	2/20/83	G	J	4.5	6	5/11/83	D

a/ G = Garnet Range, C = Cabinet Range, M = Mission Range.
b/ J = juvenile, A = adult.
c/ Total number of locations, including those before 1983, indicated in parenthesis.
d/ TF = transmitter failure, K = shot or trapped, S = survived and transmitter functional, SC = slipped collar, U = unknown, D = natural mortality.
e/ RI = recaptured and re-instrumented, R = recaptured only, ET = ear-tagged only.

Home range size, movements, and dispersal

Home range

Figures 4 through 6 show bobcat home range sizes within individual study areas based on 358 locations for 13 (3 males and 10 females) adults (Tables 2 and 3), and 1 juvenile female bobcat (Table 4). Lynx were located 127 times and home range size or area of use was estimated for five adult lynx (three males and two females) and two juvenile male lynx monitored between 1983 and 1984 in the Cabinet and Garnet Range study areas (Table 5). Data collected by Smith (1984) during the first phase of the study are included for comparison and continuity.

Annual home range sizes averaged 79.0 km^2 (55.0 - 119.5 km^2) for adult male bobcats and 58.6 km^2 (16.8 - 127.2 km^2) for adult females. Total home range sizes were slightly larger, with estimates of 111.4 km^2 (70.9 - 172.8 km^2) for adult male bobcats and 61.5 km^2 (16.8 - 127.2 km^2) for adult females. Both annual and total bobcat home ranges were consistently larger for adult males than adult females. Summer home ranges were not calculated for male bobcats due to insufficient sample size. Annual home range sizes of lynx averaged 122.0 km^2 (47.3 - 246.1 km^2) for adult males; female home ranges were smaller, averaging 43.1 km^2 (11.0 - 32.3 km^2) (Table 5). Total lynx home ranges were larger, and averaged 232.7 km^2 (47.3 - 246.1 km^2) for males and 55.5 km^2 (43.9 - 70.9 km^2) for females. Summer seasonal home ranges continued this trend, with male lynx averaging 44.2 km^2 (13.0 - 78.7 km^2) and

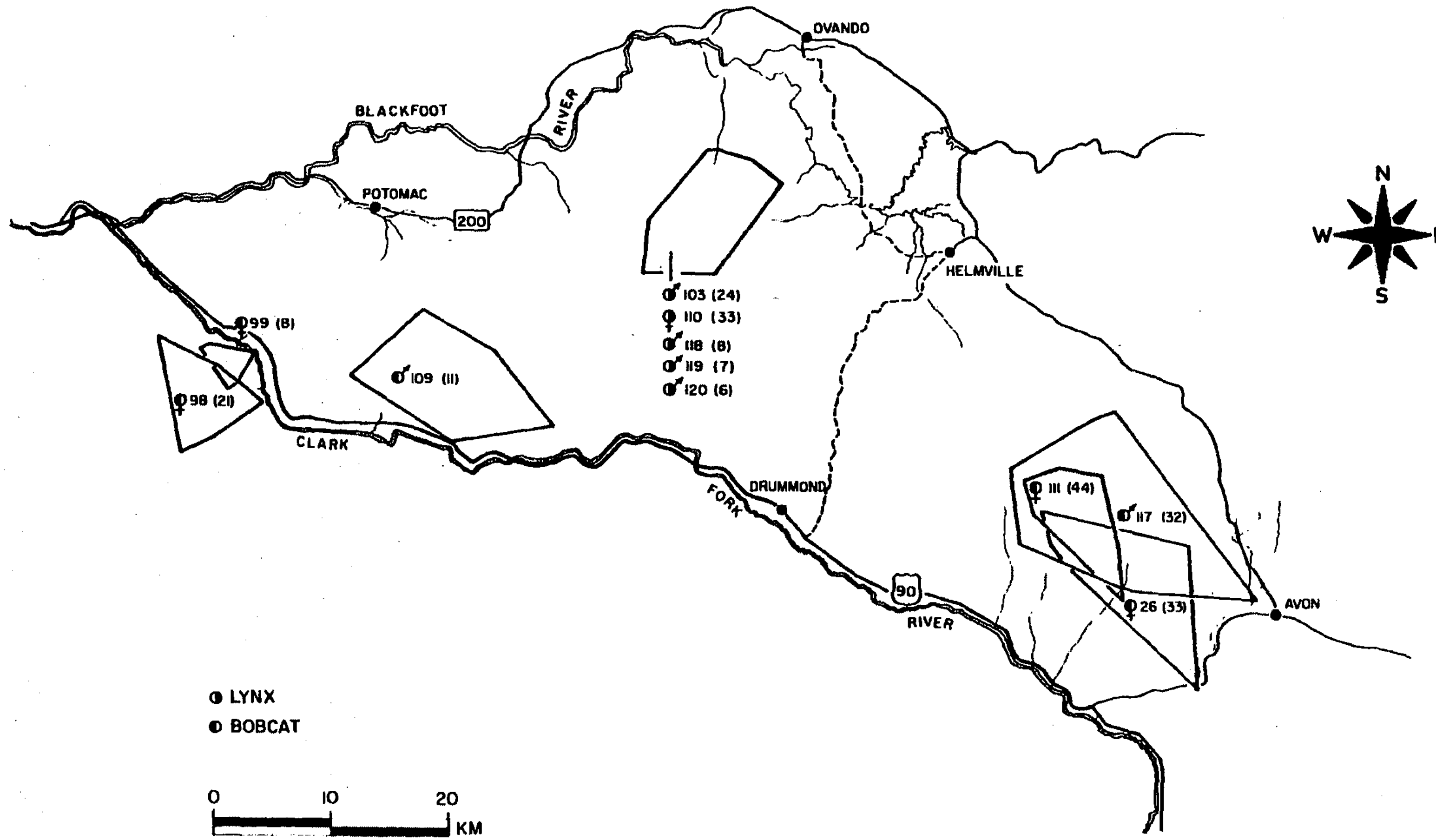

Fig. 4. Home ranges of instrumented bobcats and lynx in the Garnet Range study area, December 1982 through March 1985.

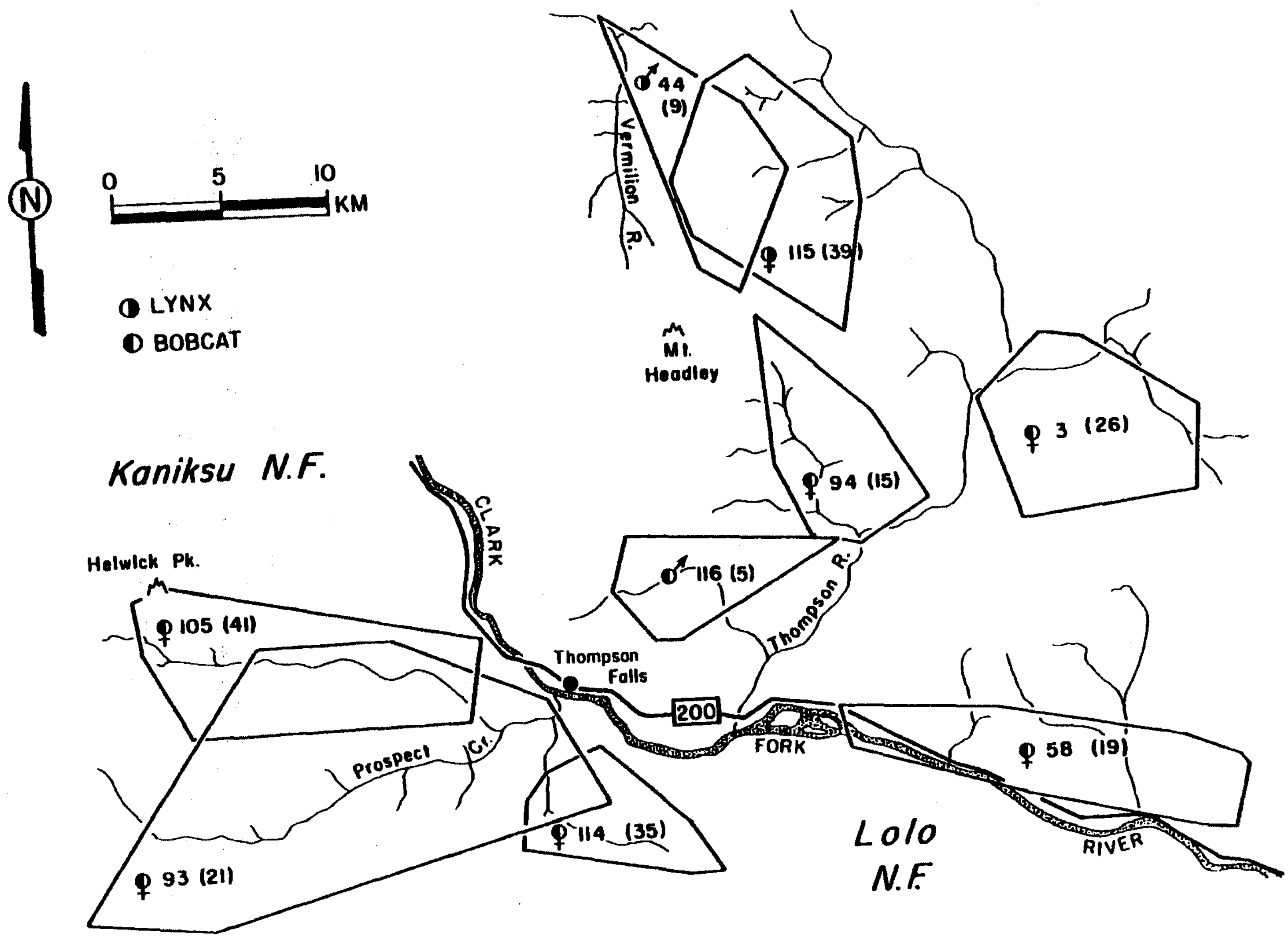

Fig. 5. Home ranges of instrumented bobcats and lynx in the Cabinet Range study area, western Montana, December 1982 through March 1985.

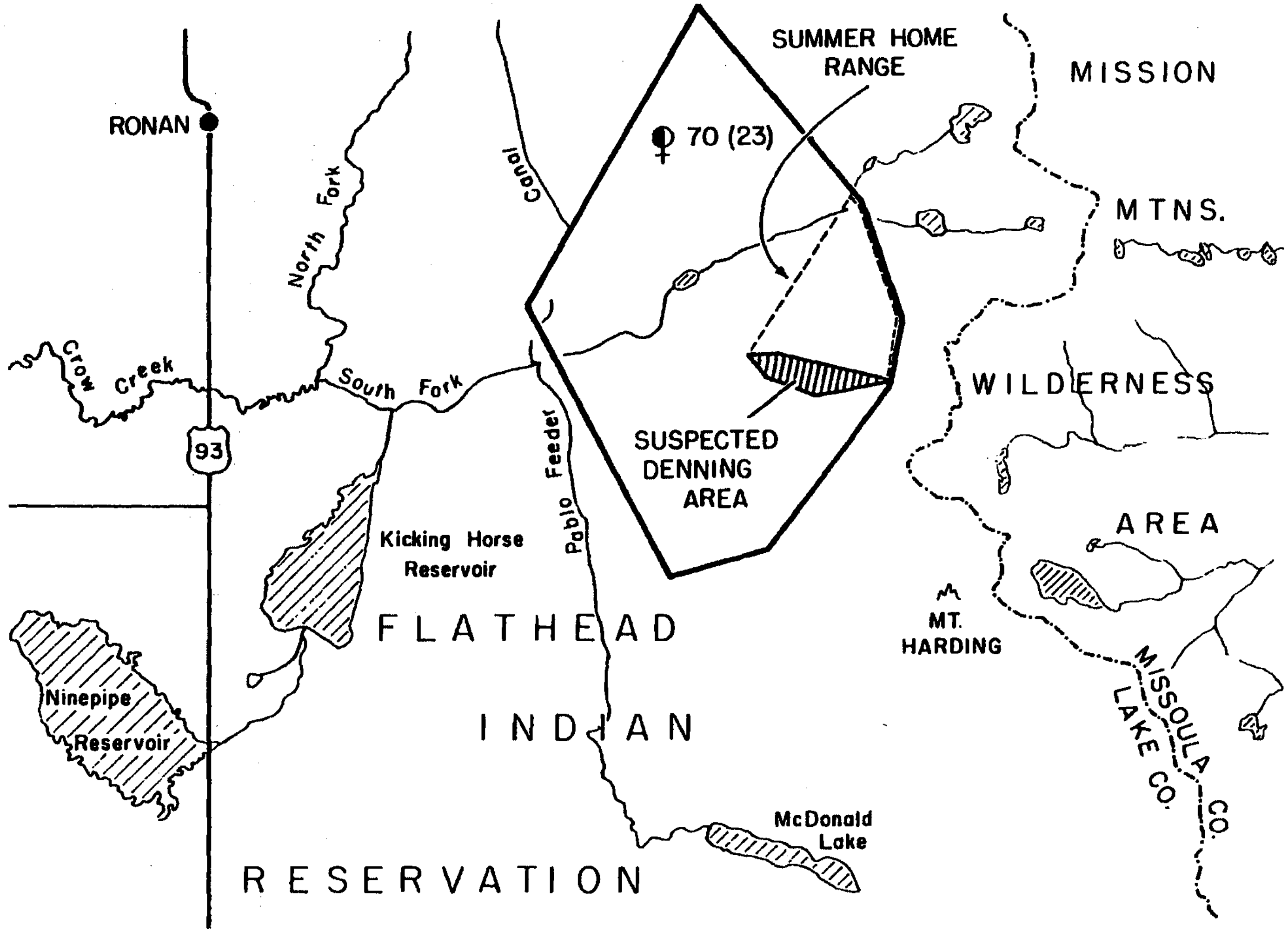

Fig. 6. Home range of F70 between March and December 1984 in the Mission Range study area.

female lynx 18.3 km^2 (11.0 - 32.3 km^2). Seasonal ranges were not determined for winter, spring, or fall because of low sample size ($\leq$ 5). Despite intensive efforts, no lynx dens were located, and presence of kittens was not confirmed for any of the three adult female lynx monitored between 1982 and 1984.

Comparisons were made between home range estimates for denning and non-denning adult female bobcats (Table 2). Presence or absence of kittens was confirmed by observation at den sites or through snow-tracking in early winter. The status of one bobcat (F94) was not determined, but indirect evidence indicated that she probably denned during the 1984 season. This bobcat was extremely difficult to locate during the summer, and had produced at least one kitten (F95) the previous season. Mean summer home range size for denning females was 14.0 km^2 (3.3 - 22.4 km^2); non-denning female summer ranges were 1.6 times larger, averaging 22.2 km^2 (7.8 - 31.9 km^2). No differences were observed between annual or total home ranges between these groups, with mean annual ranges of 59.8 km^2 and 57.4 km^2, and mean total ranges of 59.8 km^2 and 62.9 km^2 for non-denning and denning females.

Little information was obtained on home range overlap. The total home range of male bobcat M117 encompassed that of two adult female bobcats (F26 and F111) during 1982 and 1983 (Fig. 7). One bobcat, F26, apparently shifted its home range, although only a few locations were obtained after the first year due to partial transmitter failure. In 1984, the arithmetic mean center (Harestad 1981) of F26's home range

Table 2. Summer denning season and total home range sizes (km^2) for non-denning and denning adult female bobcats in western Montana, 1980-85.

Tag[a] Number	Age	Year	Summer[b]	Annual	Total
Non-denning females					
F3	2	1983	27.7 (14)	62.6 (26)	62.6 (26)
F114	2	1983	31.9 (19)	43.6 (35)	43.6 (35)
F105	5 +	1984	17.6 (20)	81.8 (41)	81.8 (51)
F58	2	1984	7.8 (8)[c]	61.8 (19)	61.8 (19)
F98	2	1984	14.1 (7)[c]	38.4 (21)	38.4 (21)
Mean	-	-	22.2 (68)	59.8 (142)	59.8 (142)
Denning females					
F52	2 +	1982	14.7 (12)	127.2 (29)	127.2 (29)
F108	2 +	1982	22.4 (27)	59.4 (36)	59.4 (36)
F26	2 +	1983	8.6 (14)	16.8 (18)	
		1984	NC[d] (2)	17.5 (5)	81.8 (23)
F111	3	1984	12.4 (32)	43.5 (44)	43.5 (44)
F70	3 +	1984	3.3 (11)	21.6 (24)	21.6 (24)
F99	3 +	1984	NC (4)	7.4 (8)[c]	7.4 (8)[c]
F94[e]	3 +	1984	NC (4)	42.3 (15)	42.3 (15)
Mean	-	-	13.9 (96)	57.4 (171)	62.9 (171)
Total					
Mean	-	-	17.3 (164)	58.5 (313)	61.5 (313)

a/ Age during summer denning period (June 1 thru August 31).
b/ Number of locations, n, indicated in parentheses.
c/ Represents area used and not home range.
d/ NC = not calculated.
e/ This bobcat had a kitten previous season (F95) and was assumed to be denning although this was not confirmed.

Table 3. Total home range sizes (km^2) for adult male bobcats , western Montana, 1981-85.

Tag[a] Number	Year	Annual	Total
M116	1983	30.1 (5)[b]	30.1 (5)[b]
M117	1983	89.3 (16)	
	1984-85	119.5 (16)	172.8 (32)
M109	1982	55.0 (17)	
	1983-84	71.3 (11)	97.9 (28)
M102	1981	70.9 (39)	70.9 (39)
Mean	-	79.0 (99)	111.4 (99)

a/ The longest "annual" period was 425 days.
b/ Sample too small for home range calculation.

Table 4. Total area of use (km^2) for juvenile female bobcats, western Montana, 1982-85.

Tag Number	Year	Summer	Annual	Total
F111	1982	45.9 (9)	147.8 (21)	147.8 (21)
F107	1982	107.4 (6)	478.8 (9)	478.8 (9)
F93	1983	NL[a]	NC[b] (4)	
	1984	1.0 (8)	124.6 (16)	
	1985	NL	NC (2)	188.1 (22)
Mean	-	46.4 (23)	204.5 (46)	222.1 (52)

a/NL = Not located during this period.
b/NC = Not calculated.

Table 5. Summer and total home range sizes (km2) for lynx in western Montana, 1981-85.

Tag[a] Number	Age	Year	Summer	Annual	Total
Females					
F112	2 +	1982	11.0 (10)	43.9 (28)	43.9 (28)
F110	3 +	1982	14.3 (10)	48.7 (28)	
		1983	4.9 (21)	16.1 (33)	50.9 (59)
F115	3 +	1983	32.3 (28)	62.3 (37)	
		1984	NL[b]	NC (2)	70.9 (39)
Mean	-	-	18.3 (69)	43.1 (126)	55.5 (126)
Males					
M104	2 +	1981	78.7 (7)	246.1 (33)	246.1 (33)
M103	2 +	1981	43.4 (7)	167.0 (34)	
		1982	38.6 (8)	52.6 (26)	
		1983-84	13.0 (6)	52.4 (24)	201.3 (83)
M44	2 +	1983-85	8.2 (4)[c]	47.3 (8)	47.3 (9)
M118	2 +	1983[c]	NL	15.7 (8)	15.7 (8)
M119	1	1983[c]	NL	3.7 (7)	3.7 (7)
M120	1	1983[c]	NL	7.8 (6)	7.8 (6)
Mean	-	-	44.3 (28)	122.0 (124)	232.7 (125)

a/ Age during first year of capture.
b/ NC = Not calculated, NL = Not located during this period.
c/ Number represents area of use, rather than home range size.

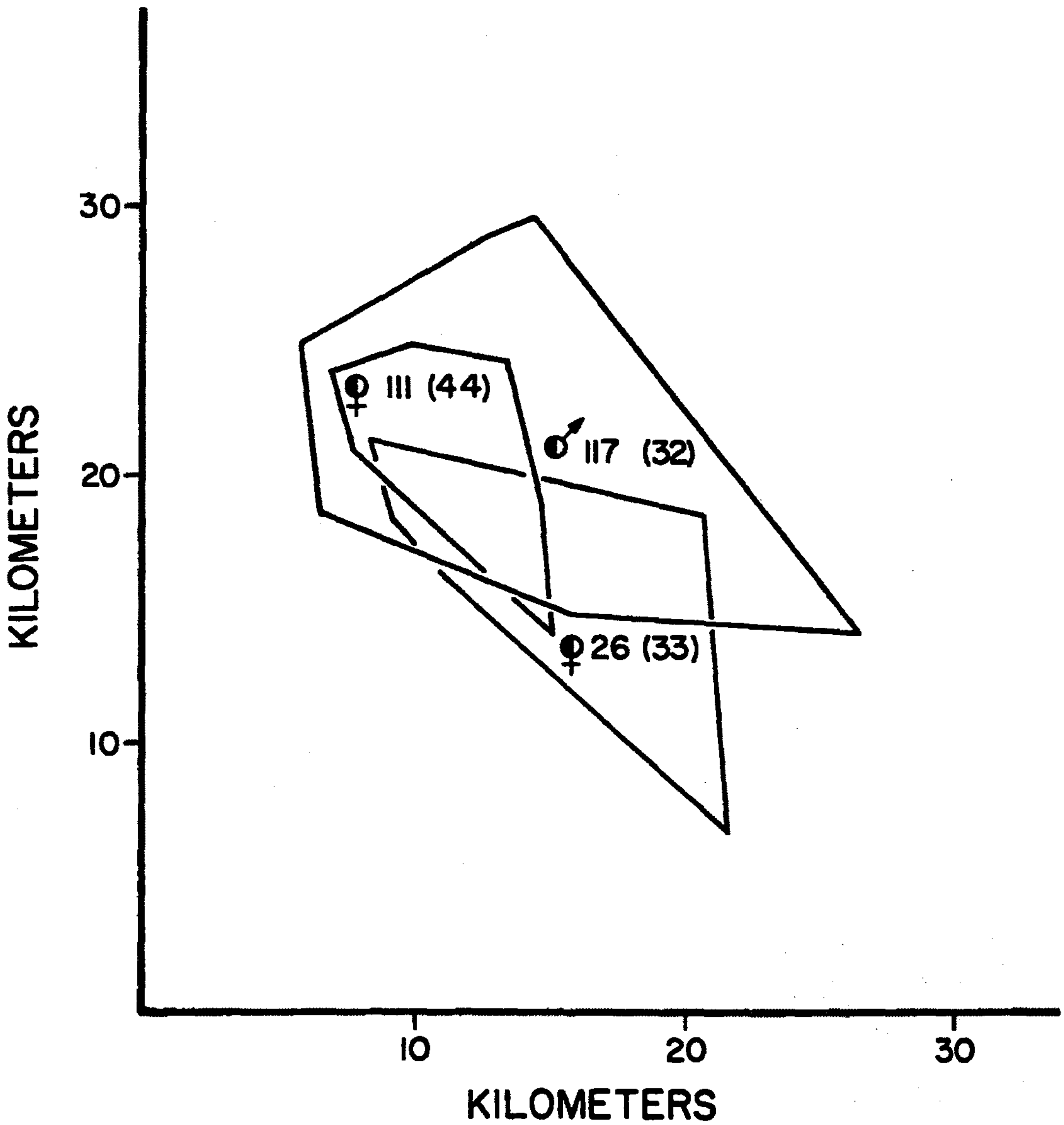

Fig. 7. Home ranges of adult bobcats M117, F26, and F111 in the eastern portion of the Garnet Range study area, January 1983 to March 1985.

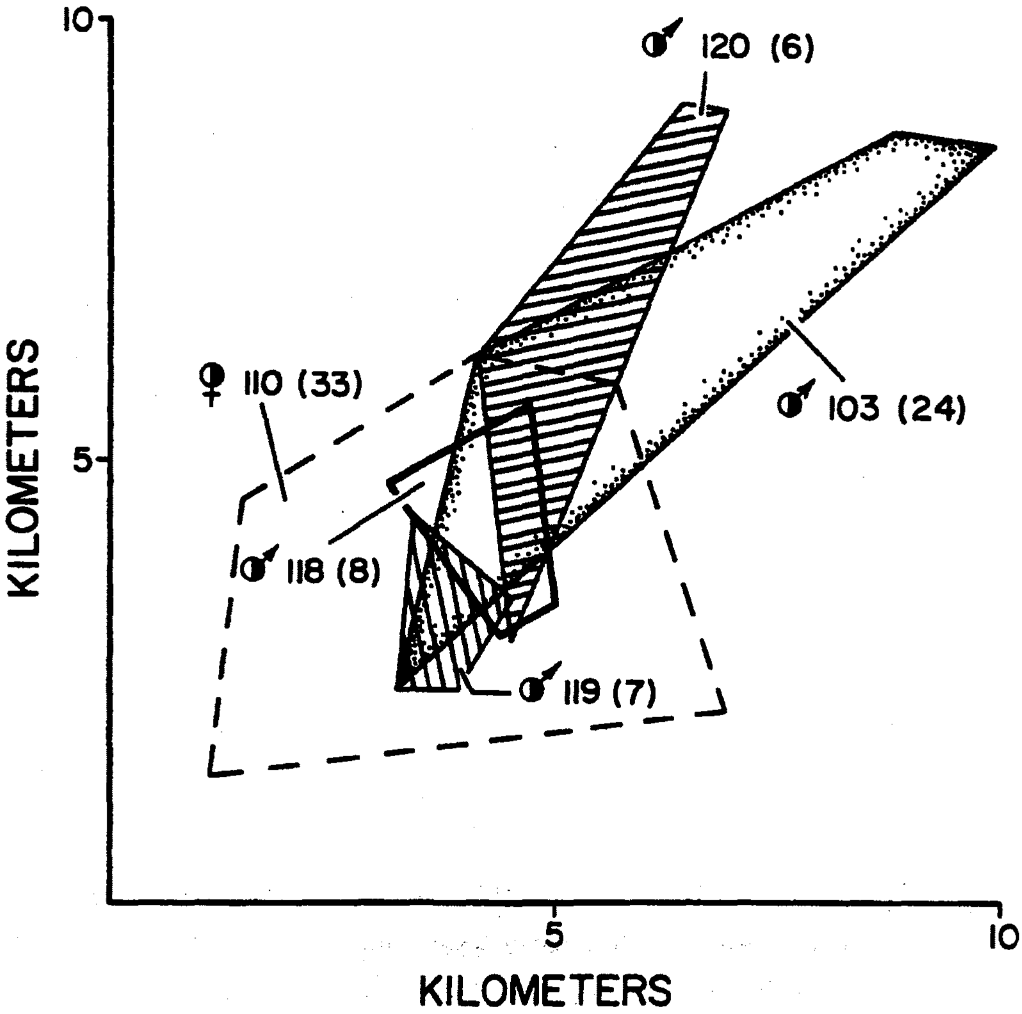

Fig. 8. Home ranges of lynx M103 and F110, and areas of use of M118, M119, and M120 from January 1983 to January 1984 in the Chamberlain mountain area, western Garnet Range study area.

moved 9.8 km southeast from its 1983 position.

Adult and juvenile lynx of both sexes displayed extensive overlap between January 1983 and January 1984 in the western Garnet range (Fig. 8). Adult lynx M103 and F110 were monitored during this entire period, and their ranges partially overlapped, particularly in the Chamberlain meadows area. The other three lynx, adult M118 and juveniles M119 and M120, were captured or radio-located in this same general area from January through May 1983. No additional locations were obtained for these animals; M119 and M120 died of natural causes, and M118 either emigrated or its transmitter failed. A small concentration of snowshoe hares occurred in this area during the winter months. The total home ranges of an adult male and female lynx instrumented in the Cabinet Range also exhibited extensive overlap (Fig. 6). No specific prey concentrations were noted in this area, however.

Juvenile ranges were considered areas of use rather than actual home ranges. Two bobcats used in this comparison were monitored during the first phase of this study. One bobcat, F111, was originally radio-collared in 1982 as a juvenile, and later re-instrumented as an adult. Bobcat F107 was trapped during its second winter, and F93 was still travelling with a functional transmitter in March of 1985. Annual juvenile ranges varied from 124.6 km^2 to 478.8 km^2 ($\bar{x}$ = 204.5 km^2); total estimates ranged from 147 km^2 to 478.8 km^2 ($\bar{x}$ = 222.1 km^2, Table 4). As with adults, only summer home ranges were calculated. These ranges also varied considerably, with a range of 1.0 km^2 to 107.4 km^2, with an average of 46.4 km^2 for all three animals.

Movements

Distances between consecutive locations were compared between denning and non-denning adult female bobcats during the summer denning season (Table 6). A sample of five non-denning and five denning bobcats was used in this analysis. Three of the non-denning bobcats were determined to be 2 years old, and two others (F114 and F105) were adults. All of the denning females were adults, and one (F52) may have been 2 years old during the denning season. Average distances between successive locations less than 15 days apart were compared. Non-denning females averaged between 1.55 km to 3.64 km between locations, with a group average of 2.51 km. Parturient females ranged from 0.70 km to 2.40 km, with a group mean of only 1.23 km. The difference between these means was statistically significant ($P < 0.001$, Kolmogorov-Smirnov two-sample test).

Dispersal

Dispersal distances differed widely. One male kitten (M54), ear-tagged in early 1984 near the confluence of the Thompson and Clark Fork Rivers, was harvested by a trapper in December 1984 at the mouth of Westerman Creek, near Lolo, MT, an airline distance of 115 km (Fig. 9). One instrumented female kitten (F95) traveled from the West Fork of the

Table 6. Average distances (km) between consecutive radio-locations (<14 days) for denning and non-denning female bobcats (June 1-August 31, 1982-84).

Tag Number	Average[a] Distance	Standard Deviation	Number of Locations	Range
Non-denning				
114	3.64	2.20	18	0.00 to 8.13
58	1.55	1.40	6	0.00 to 3.11
3	2.52	2.10	13	0.00 to 7.43
98	3.33	3.23	6	0.00 to 9.43
105	1.60	1.71	20	0.00 to 6.13
Total	2.51	2.20	63	0.00 to 9.43
Denning				
26	0.71	0.62	13	0.00 to 1.65
111	0.70	1.32	31	0.00 to 5.40
108	2.23	2.61	16	0.00 to 6.60
52	2.40	1.82	11	0.00 to 4.72
70	0.80	0.68	10	0.00 to 2.20
Total	1.23	1.73	91	0.00 to 6.60

a/ Groups different at $P < 0.001$ (Kolmogorov-Smirnov two sample test)

Thompson River in late December 1983 to a trapsite at the mouth of Ward Creek, near Interstate 90 west of St. Regis, MT, a distance of 37.3 km (Fig. 9). A juvenile male (M59) bobcat captured near the mouth of the Thompson River drainage was found shot 11 days later near the Clark Fork River, 7.5 km from its original capture site. A female kitten (F93) tagged with its mother (F105) in December 1983 dispersed 9.4 km from the center of its natal home range by June 1984 (Fig. 6).

Female lynx F115 made a long-distance dispersal of 325 km from the West Fork of Fishtrap Creek to the vicinity of Radium Hot Springs, British Columbia (Fig. 9). This lynx was last located on 25 April 1984, within the limits of its normal home range, and was caught by a trapper in the Rocky Mountain Trench of southeastern B. C. in November 1984. A male lynx (M118) may have dispersed 36 km from the Chamberlain mountain area north to the vicinity of Seeley Lake, MT, although evidence is circumstantial; a radio-collared lynx was reported crossing a road near there in the fall of 1983, and M118 was the only Chamberlain lynx not accounted for during that period. In 1982, another male lynx (M104) dispersed 96.5 km from the Chamberlain area to near Lolo, MT, where it was harvested (documented by Smith 1984:41).

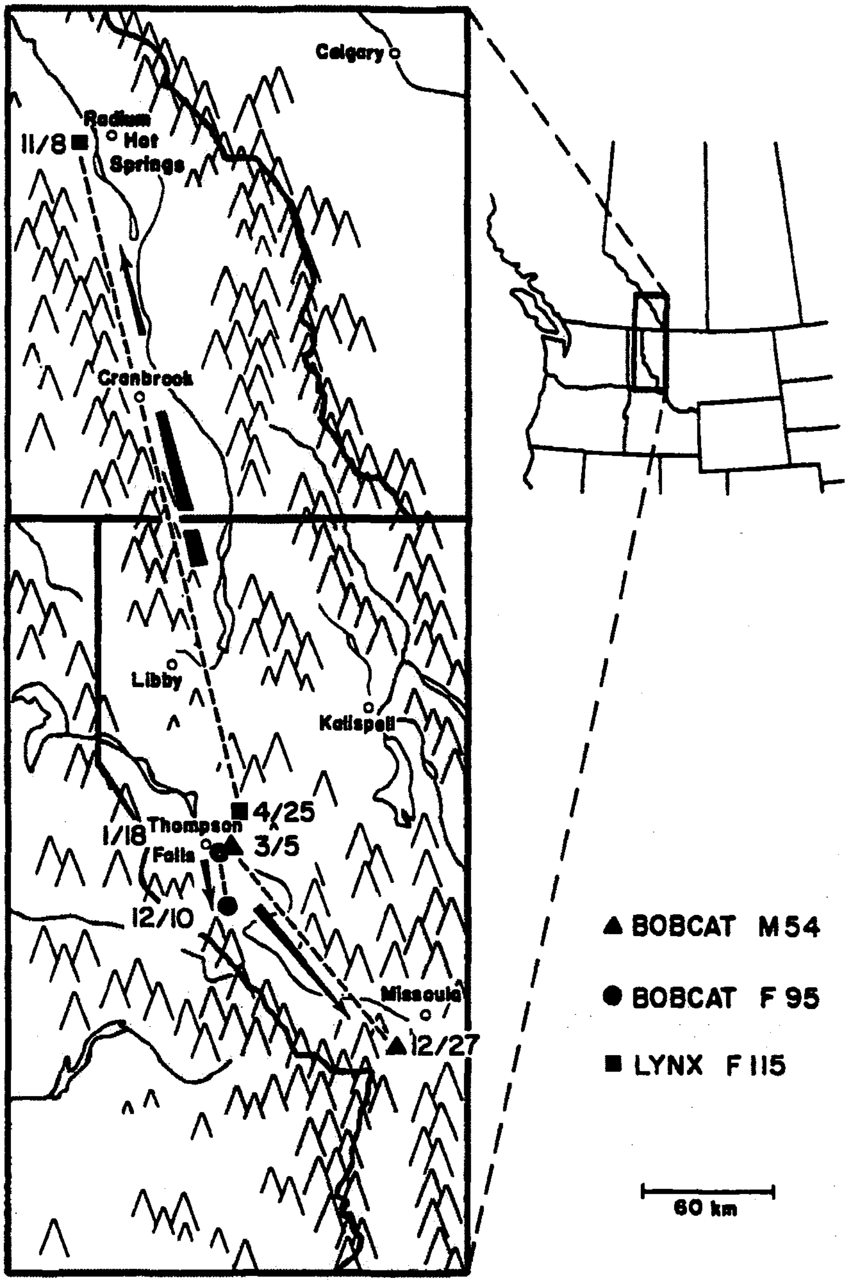

Fig. 9. Long-distance dispersal for two juvenile bobcats and one adult lynx from the Thompson Falls area, western Montana, 1984.

Reproduction

Carcass data

Reproductive data collected from a sample of 688 female bobcat carcasses were statistically analyzed. These bobcats ranged in age from 0.5 to 14.5 years, with 67.9% (n = 467) between 0.5 and 2.5 years of age. Bobcats $\geq$ 2.5 years were considered adults, and those $\geq$ 4.5 years were combined into one age group. Kittens (6-9 months) comprised 15.0% (n = 103) of this sample, and no placental scars or corpora were found in their reproductive tracts. Only yearling and adult bobcats (n = 585) were used for comparisons between regions, years, and ages. The number of available uterine horns for bobcats 1.5 years old or older varied between years, with 160 (27.4%) for 1980-81, 178 (30.4%) for 1981-82, and 247 (42.2%) for 1982-83. Seventy-three percent of yearling or older bobcats came from eastern Montana (n = 424); the remaining 161 carcasses were from western Montana.

In utero bobcat litter sizes ranged from one to six (Table 7); the most frequently observed litter sizes were two (34.4%) and three (35.6%). Yearlings had a much higher incidence (25.3%) of single placental scars than older animals. Only 16.0% of yearlings and 21.1% adults had litters of four or more. One yearling and one older adult (> 4.5 years) had six placental scars.

The total yearling pregnancy rate was lower than that of older age classes (X^2 = 26.28, df = 3, P < 0.001), and accounted for all

Table 7. Frequency distribution (%) of bobcat placental scars for yearlings and adult bobcats with placental scars, 1980-83.

N Placental Scars	AGE: Yearlings (N = 87)	AGE: Adults (N = 326)	Total (N = 413)
1	25.3	5.8	9.9
2	29.9	35.6	34.4
3	28.7	37.4	35.6
4	12.6	19.0	17.7
5	2.3	1.8	1.9
6	1.1	0.3	0.5

variability between age categories for bobcats (Table 8). Yearling pregnancy rates also differed significantly between harvest seasons ($X^2 = 23.026$, df = 2, $P < 0.001$). Only 16.7% of yearling females implanted embryos in 1980-81; this rate increased to 58.3% in 1981-82 and decreased to 39.4% in 1982-83 (Table 8). If yearlings were excluded, variation between seasons ($X^2 = 0.208$, df = 2, $P = 0.901$) or age classes ($X^2 = 0.76$, df = 2, $P = 0.69$) was not significant. Differences in pregnancy rates between regions were negligible for all age classes ($X^2 = 0.03$, df = 1, $P = 0.87$).

The overall mean bobcat litter size was 2.69 $\pm$ 0.97 (n = 413, Table 9). Two-way ANOVA showed that litter sizes were significantly different between years ($P = 0.002$) and ages ($P = 0.004$, Table 9). Regional samples did not differ significantly ($P = 0.20$, one-way ANOVA) and were therefore combined. Mean _in utero_ litter sizes varied significantly ($P = 0.012$, one-way ANOVA) between yearlings ($\bar{X} = 2.40 \pm 1.14$) and adults ($\bar{X} = 2.76 \pm 0.91$) when years were combined (Table 9 and Fig. 10). Average litter sizes in 1981-82 (2.68 $\pm$ 0.99) and 1982-83 (2.83 $\pm$ 0.98) were significantly greater than in 1980-81 (2.45 $\pm$ 0.88) when all age classes were considered ($P < 0.001$, one-way ANOVA). This variability remained even when yearlings were excluded. During the 1980-81 season, one-way ANOVA indicated that the mean placental scar count (1.90 $\pm$ 0.88) for yearlings differed from that of adults (2.52 $\pm$ 0.89, $P = 0.06$), and in 1982-83 the difference between the yearling mean (2.34 $\pm$ 1.04) and the adult mean (2.95 $\pm$ 0.94) was pronounced ($P = 0.003$). In contrast,

Table 8. Annual variation in age-specific pregnancy rates (%) for Montana bobcats, 1980-83.[a,b]

AGE	YEARS 1980-81 % (n)	1981-82 % (n)	1982-83 % (n)	All Years % (n)
1.5	16.7 (10)	58.3 (42)	39.3 (35)	39.4 (87)
2.5	87.9 (29)	81.8 (36)	83.3 (55)	83.9 (120)
3.5	88.2 (17)	100.0 (21)	90.3 (28)	94.3 (66)
4.5 +	86.0 (43)	100.0 (40)	93.4 (57)	92.7 (140)
Adults (2.5 +)	87.0 (89)	93.2 (97)	88.8 (140)	89.6 (326)
ALL (1.5 +)	79.9 (99)	82.7 (139)	79.9 (175)	81.2 (413)

a/Yearling pregnancy rate was significantly lower than that of adults ($X^2 = 26.28$, df = 3, $P < 0.001$) for all seasons.

b/Yearling pregnancy rate fluctuated significantly between seasons ($X^2 = 23.03$, df = 2, $P < 0.001$).

Table 9. *In utero* litter size by age-group for bobcats with placental scars, Montana, 1980-83.[a]

AGE	YEAR											
	1980-81[c]			1981-82			1982-83[d]			All Years		
	N[b]	$\bar{x}$	s.d.	N	$\bar{x}$	s.d.	N	$\bar{x}$	s.d.	N	$\bar{x}$	s.d.
1.5	10	1.90	0.88	42	2.57	1.25	35	2.34	1.03	87	2.40	1.14
2.5	29	2.53	0.95	36	2.81	0.92	55	2.91	0.87	120	2.78	0.90
3.5	17	2.53	0.88	21	2.33	0.73	28	2.96	1.20	66	2.65	1.02
4.5 +	43	2.51	0.83	40	2.85	0.92	57	2.98	0.87	140	2.80	0.86
Adults (2.5 +)	89	2.52	0.87	97	2.72	0.80	140	2.95	0.94	326	2.76	0.91
Total (1.5 +)	99	2.45	0.88	139	2.68	0.99	175	2.83	0.98	413	2.69	0.97

a/ Litter size was significantly different between years (P = 0.002, two-way ANOVA) and age-groups (P = 0.004, two-way ANOVA), but not regions (P = 0.20, one-way ANOVA).
b/ N sets of uterine horns
c/ Significant difference (P = 0.06, one-way ANOVA) between age-groups.
d/ Significant difference (P = 0.003, one-way ANOVA) between age-groups.

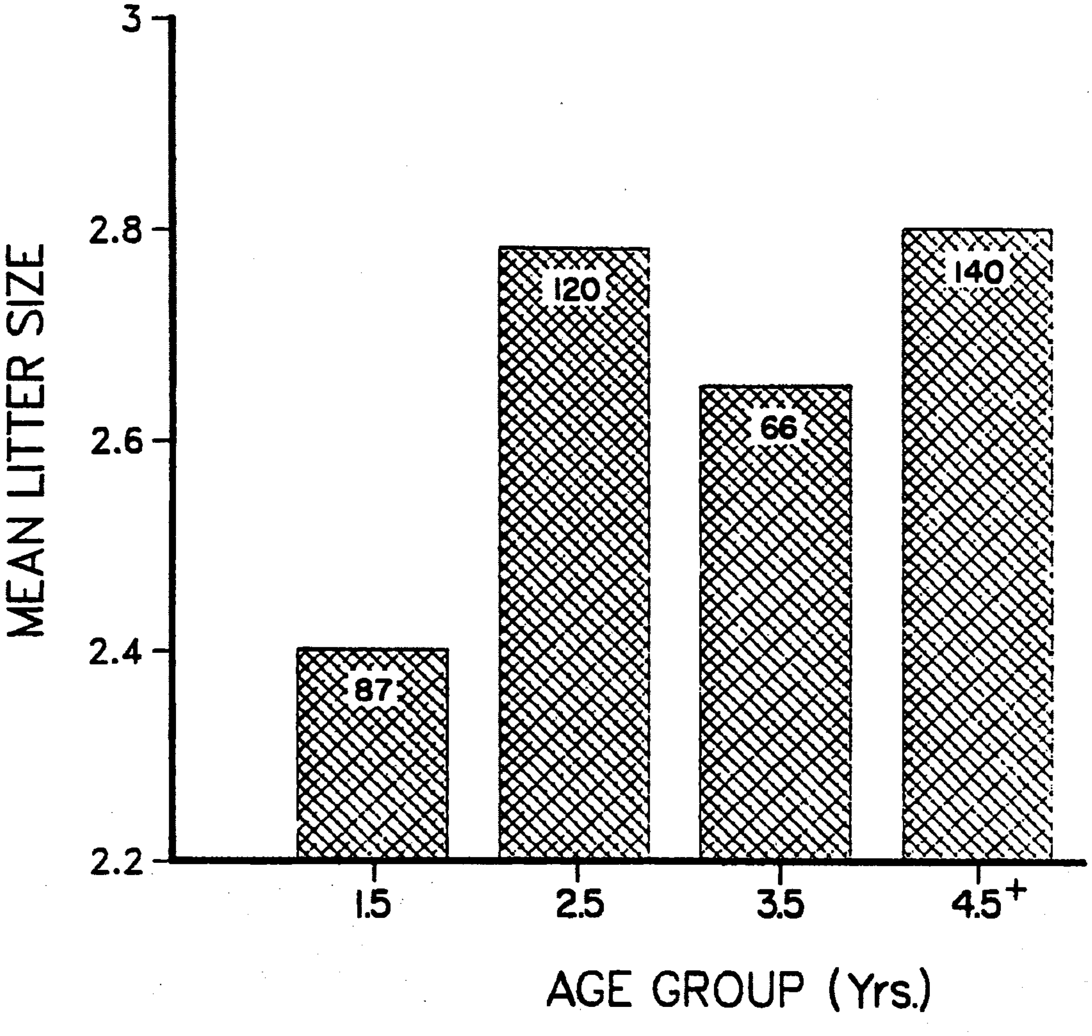

Fig. 10. Bobcat placental scar counts by age group, 1980-83.

Table 10. Frequency distribution (%) of corpora lutea counts by age-group for bobcats with corpora lutea, Montana, 1980-83 (n = 566, range 1-11).

N Corpora Lutea	AGE Yearlings (n = 220)	AGE Adults (n = 359)	Total (n = 579)
1	3.4	0.9	1.8
2	16.8	8.7	11.7
3	26.3	19.6	22.1
4	22.5	23.3	23.0
5	17.2	22.4	20.5
6 +	13.9	25.2	21.0

no significant differences were found between age groups ($P = 0.67$) during 1981-82 (Table 9).

Corpora lutea provided information on ovulation rates, and were distinguished from older, accumulated corpora albicantia of previous seasons. Most (95.0%) yearlings, and virtually all (99.2%) females over 2 years of age ovulated; kitten ovaries contained no corpora lutea. Tracts of 13 bobcats (2.2%), including 11 yearlings and two older adults, contained no fresh corpora lutea or placental scars. Corpora lutea counts ranged from 1 to 11 ($n = 566$), with most bobcats (65.6%) producing 3 to 5 eggs per ovulation (Table 10). The most frequently observed numbers of corpora lutea in yearling ovaries were 3 (26.3%) and 4 (22.5%); adult counts were higher, with 4 (23.3%) and 5 (22.4%) being the most common. For the total sample, including yearlings, counts of corpora lutea averaged 4.16 eggs per ovulation (Table 11). Yearling corpora lutea counts averaged 3.62 ($n = 220$), and adults averaged 4.48 ($n = 359$). More than half (55.7%) of all yearlings with corpora lutea did not have placental scars; only 9.6% of all adult bobcats had corpora lutea without corresponding placental scars, and the majority of these (63.8%) were 2.5 years of age.

Bobcat corpora lutea counts were significantly different between years and age groups (Two-way ANOVA, $P < 0.001$) (Table 11). No differences between regions were found ($P = 0.33$, one-way ANOVA). Corpora lutea counts fluctuated greatly between all seasons ($P < 0.001$, one-way ANOVA), with the lowest ovulation rates occurring

Table 11. Average corpora lutea counts by age-group for all bobcats, Montana, 1980-83.[a]

	YEAR											
	1980-81[c]			1981-82[d]			1982-83[e]			All Years		
AGE	N[b]	$\bar{x}$	s.d.	N	$\bar{x}$	s.d.	N	$\bar{x}$	s.d.	N	$\bar{x}$	s.d.
1.5	60	3.05	1.70	72	3.97	1.77	88	3.73	1.56	220	3.62	1.70
2.5	33	4.33	1.88	43	4.95	1.89	65	4.82	1.53	141	4.74	1.74
3.5	17	4.18	1.84	22	4.45	1.77	31	4.48	1.34	70	4.40	1.59
4.5 +	49	3.91	1.93	40	4.58	1.43	59	4.36	1.34	149	4.24	1.60
Adults (2.5 +)	99	4.10	1.86	105	4.70	1.70	155	4.57	1.43	359	4.48	1.65
Total (1.5 +)	159	3.70	1.87	177	4.41	1.76	243	4.27	1.53	579	4.16	1.72

a/ Corpora lutea counts were significantly different between years ($P < 0.001$, two-way ANOVA) and age-groups ($P < 0.001$, two-way ANOVA), but not regions ($P = 0.33$, one-way ANOVA).
b/ N sets of ovaries.
c/ Significant difference ($P = 0.001$, one-way ANOVA) between age-groups.
d/ Significant difference ($P = 0.013$, one-way ANOVA) between age-groups.
e/ Significant difference ($P < 0.001$, one-way ANOVA) between age-groups.

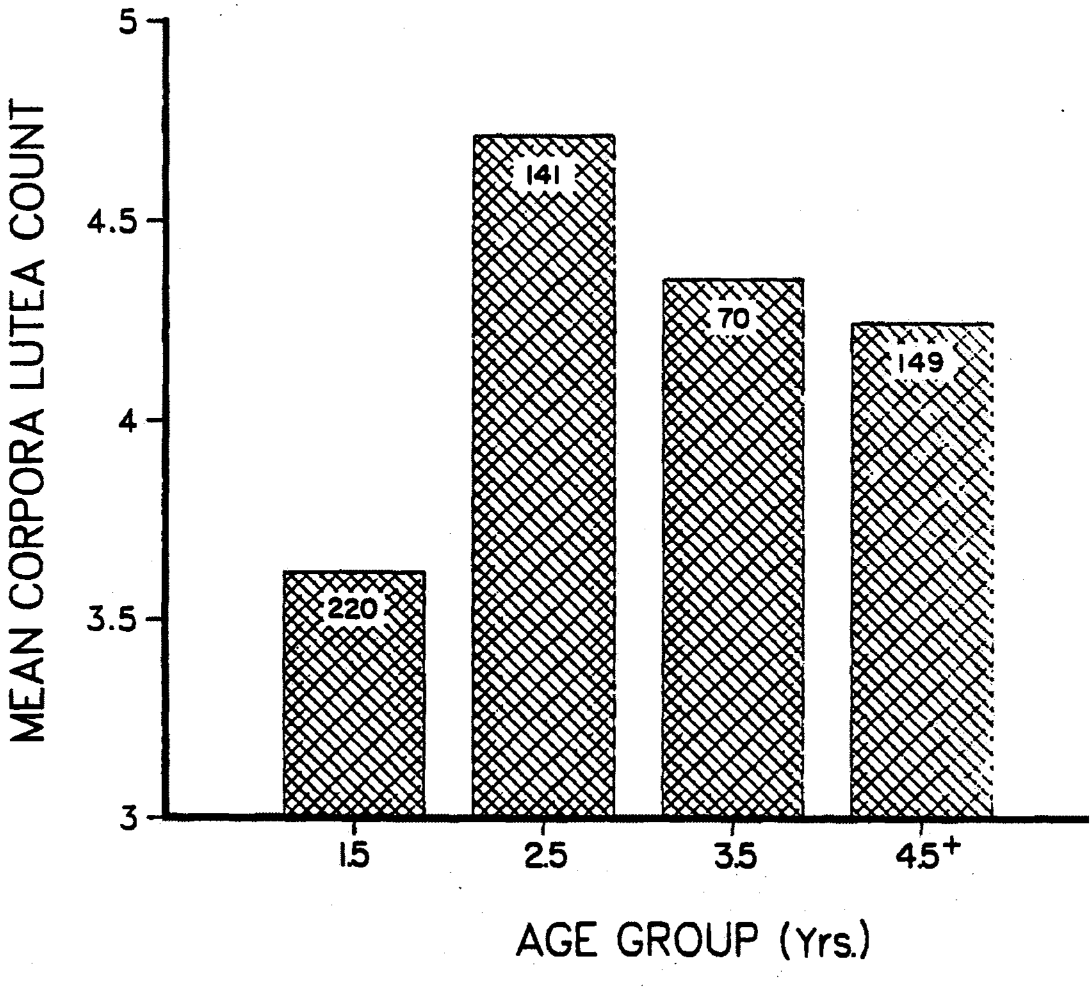

Fig. 11. Bobcat corpora lutea counts by age group, 1980-83.

during 1980-81. When all seasons were considered, first-year females produced fewer corpora lutea than adults (Fig. 11) ($P < 0.001$, one-way ANOVA); within seasons, this trend did not vary, with yearling corpora lutea counts lower than adults in 1980-81 ($P = 0.001$, one-way ANOVA), 1982-82 ($P = 0.013$), and 1982-83 ($P < 0.001$). For all seasons, the average number of corpora lutea was higher ($P = 0.03$, one-way ANOVA) for 2.5 year-olds (4.74 ± 1.74) than those in the $4.5 +$ age group (4.24 ± 1.60).

Twenty known-age female lynx carcasses, ranging from 0.5 to 9.5 years of age, were available for analysis, with 76.2% ($n = 16$) ≤ 2.5 years. Two lynx kittens (9.5%) had no placental scars or corpora lutea. Eighty percent ($n = 16$) of these lynx were harvested west of the Continental Divide. Average litter size for all lynx was 2.75 ± 1.48, with a range of one to five. Four yearlings had a mean litter size of 1.75 ± 0.96 with a range of one to three; mean litter size for adults was 3.25 ± 1.49. Overall corpora lutea counts averaged 4.28 ± 2.05, ranging from two to nine. Nine yearlings averaged 3.22 ± 0.97, ranging from two to five; nine adults averaged 5.33 ± 2.35 corpora lutea with a range of two to nine. Pregnancy rate for all ages was 70.6%; only 44.4% ($n = 9$) of yearling uteri contained placental scars versus 100% in adults ($n = 8$).

Table 12. Characteristics of kittens and den sites located in the Garnet Mountains, Montana, 1982-1984.

Date	Number of Kittens	Kitten Age (weeks)	Canopy Cover (%)	Distance to Obscurity (m)	Number of Entrances	Number[a] of Chambers	Dimensions (m): Chamber[a] Depth	Dimensions (m): Entrance (Width by Height)	Den[b] Type	Habitat Type
F108										
6/5/82	c	Unk	0.0	6.6	1	1	NM[d]	2.5 x 1.6	1	PSME/scree
F52										
7/15/82	3	2-3	13.0	NM	1[e]	1[e]	-	-	2	PSME/scree
F26										
6/21/83	3	3	11.3	1.4	2	1	0.7	0.1 x 0.4	3	PSME/scree
7/11/83	1 +	6	0.0	NM	-	-	-	-	4	PSME/scree
7/19/83	1 +	7	9.5	3.0	1	1	2.0	0.2 x 0.2	5	PSME/rock
7/20/83	1 +	7	17.5	9.0	2	3	2.9	0.4 x 1.2	5	PSME/rock
8/8-15/83[f]	1 +	9-10	NM	NM	-	-	-	-	6	PSME/rock
F111										
5/31/84	2	1	71.5	12.0	1	1	1.7	0.1 x 0.5	1	PSME/scree
6/18/83	2	3	9.5	22.5	1	1	2.5	0.2 x 0.3	5	PSME/rock
7/15/83	1 +	7	0.0	18.7	3 +	5	1.4	0.2 x 0.5	4	PSME/scree
7/25-31/83[f]	1 +	8-9	NM	NM	-	-	-	-	6	PSME/scree
F99										
6/17/84	c	Unk	16.0	17.4	1	1	2.5	0.5 x 1.1	5	PSME/rock
Mean	2.7[g]	-	14.8	11.3	1.4	1.7	2.0	0.5 0.7	-	-
Std. Dev.	0.6		20.9	7.7	0.7	1.4	0.8	0.9 0.5		

a/ Minimum estimate
b/ Den type: 1 = downfall timber, 2 = mine shaft, 3 = pile of rocks on limestone outcrop, 4 = interstices of boulders in talus, 5 = rock cave, 6 = actual den not observed.
c/ Kittens not observed.
d/ NM = Not measured.
e/ Open den.
f/ Den not visited.
g/ Mean initial litter size.

Breeding season chronology

Breeding season appeared to commence in mid-February. Snow-tracking indicated that M117 and an unknown female (probably F26) were traveling together on 17 February 1984 in the East Brock Creek drainage of the eastern Garnets. On 19 February 1984, two sets of adult bobcat tracks were encountered along a road within the range of F03 in the Cabinet Range study area. Unfortunately, F03's transmitter had failed by this time and her presence in the area was impossible to confirm; however, the close association between the bobcats suggested that they were a mated pair. Male bobcat M117 travelled approximately 13.0 km during the night of 11-12 March 1984 from the vicinity of Shearing Plant Gulch to the Anderson Mine in the East Brock Creek drainage. This movement seemed unusually long for an overnight movement; he appeared to be moving between the home ranges of F26 and F111. On 21 March 1984, M117 and F111 were captured in a double set in the Anderson Mine area, and were probably a breeding pair. F111 gave birth to kittens around 24 May 1984, and this interval may have approximated the gestation period.

Breeding continued until at least the first two weeks of April. In 1983, tracks of a female bobcat were located in the general vicinity of M117 on 7 April. A female bobcat was captured 12 days later within 200 m of this spot and marked as F26. This female had three kittens during the first week of June 1983 and M117 probably sired this litter. M117 was the probable father of at least two litters in the eastern Garnet

Range area during the two seasons.

Denning ecology

Six female bobcats denned during the summers of 1982-84. Four female bobcats (F52, F108, F26, and F111) denned in the eastern Garnet mountains during this period, and kittens were confirmed for all but one (F108) (Fig. 12). No dens were found for a female bobcat (F70) that denned in the Mission Range in 1984, but kittens were confirmed through snow-tracking that winter. Bobcat F99 slipped its collar in a suspected den south of Clinton in early June 1984.

Kittens were observed at seven natal dens (after Bailey 1979). Two additional natal dens and two auxillary denning areas where kittens were not observed were also included in this analysis (Table 12). Two dens were in cavities formed by dead, fallen trees on talus slopes. Two other sites were located in the interstices of large boulders in boulder field/talus slope situations, where spaces between rocks provided unlimited hiding cover. Four dens were in rock fissures or caves, and one was in a small pile of rocks on a limestone outcrop. The abandoned Anderson mine, in the eastern Garnets, was a particularly attractive natal denning area for three female bobcats (Figs. 12, 13, and 14), although two bobcats seemed to use only natural structures within the area for kitten rearing. The other female used a partially collapsed mine shaft as a den. Two denning areas were were located late in the season, but were not visited. Both sites were on steep, rocky hill

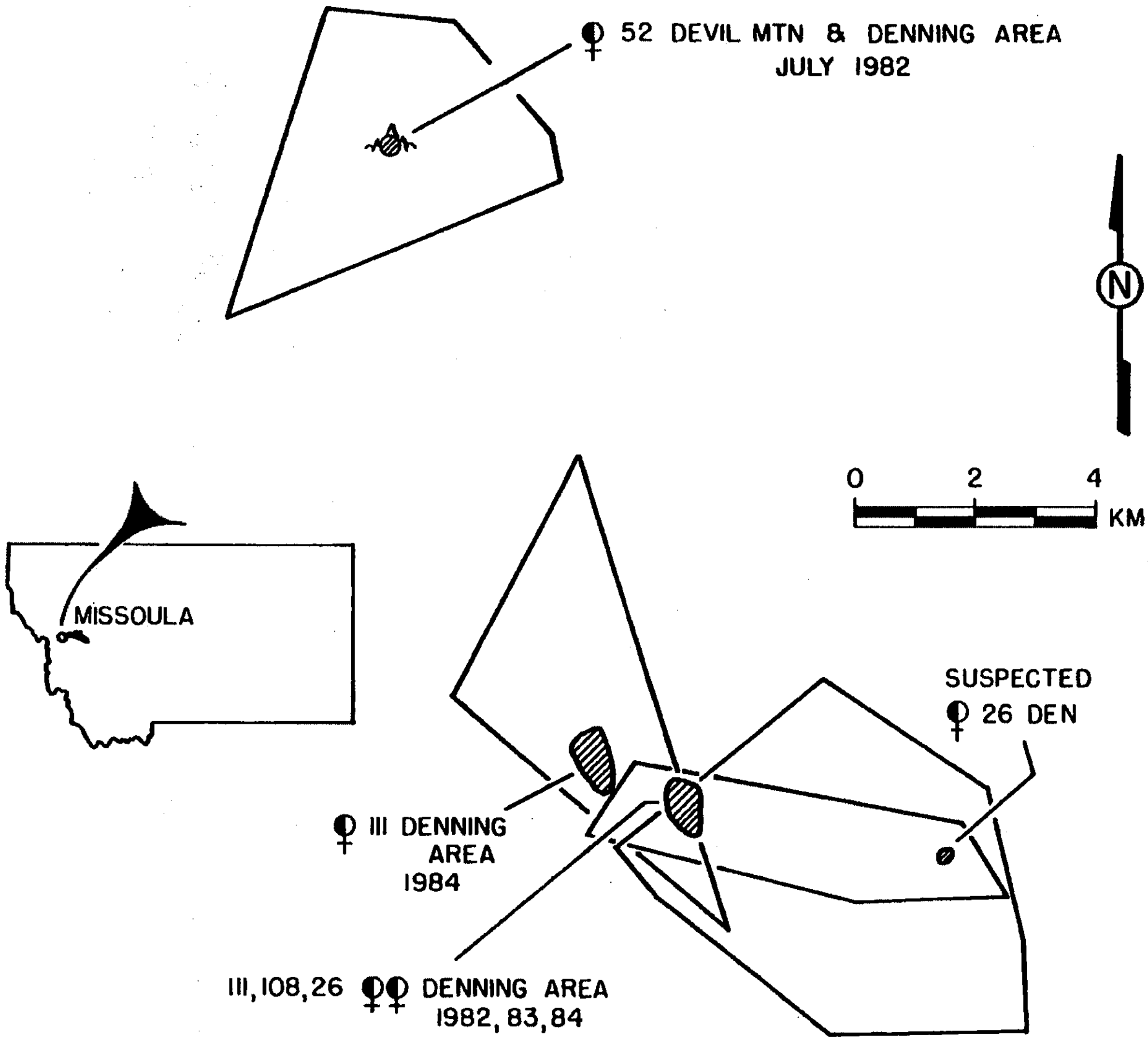

Fig. 12. Juxtaposition of summer home ranges and denning areas for four denning female bobcats in the eastern Garnet range, 1982-84.

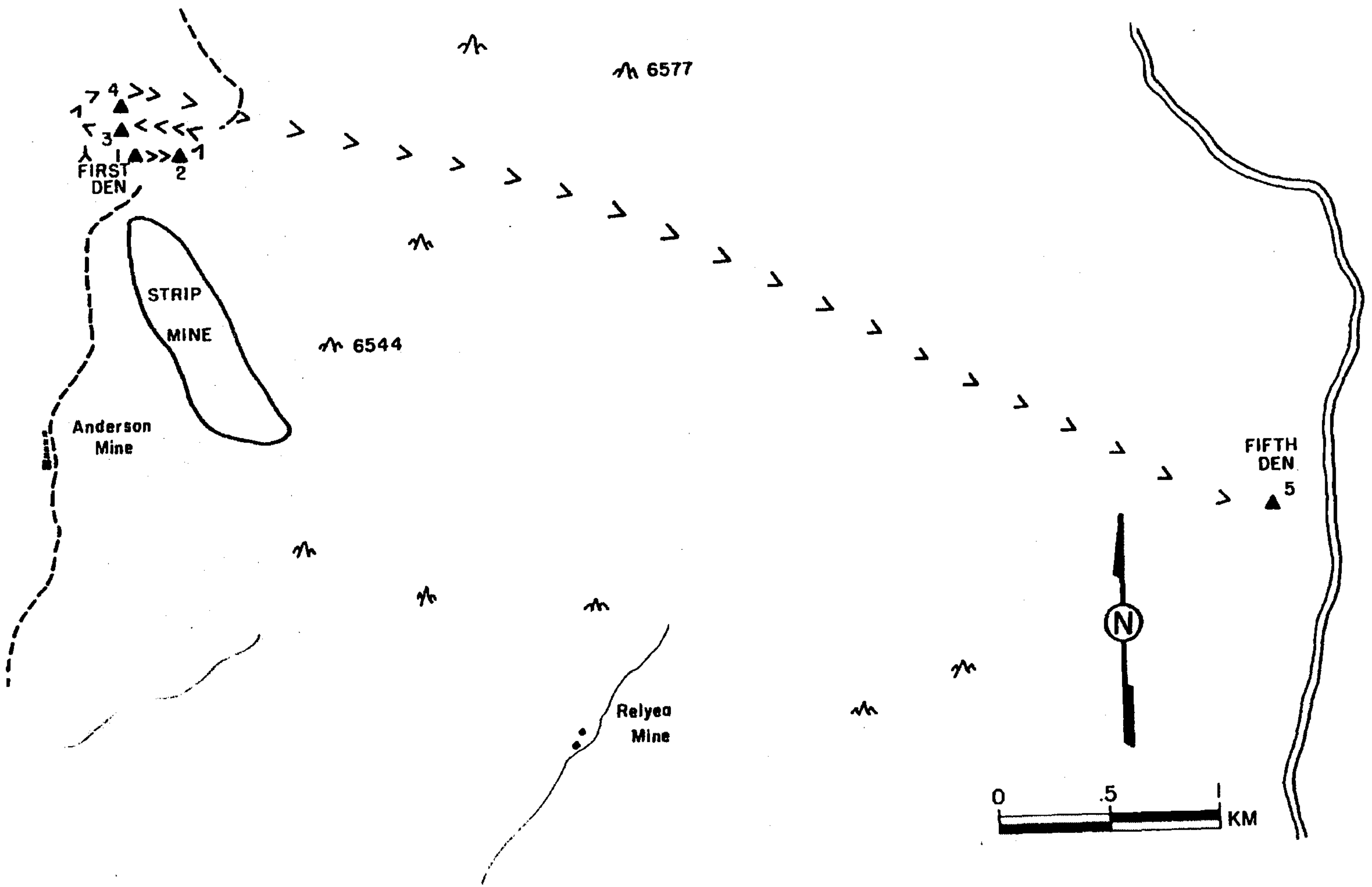

Fig. 13. Sequence of denning activity for adult female F26 during 1983 denning season, eastern Garnet study area.

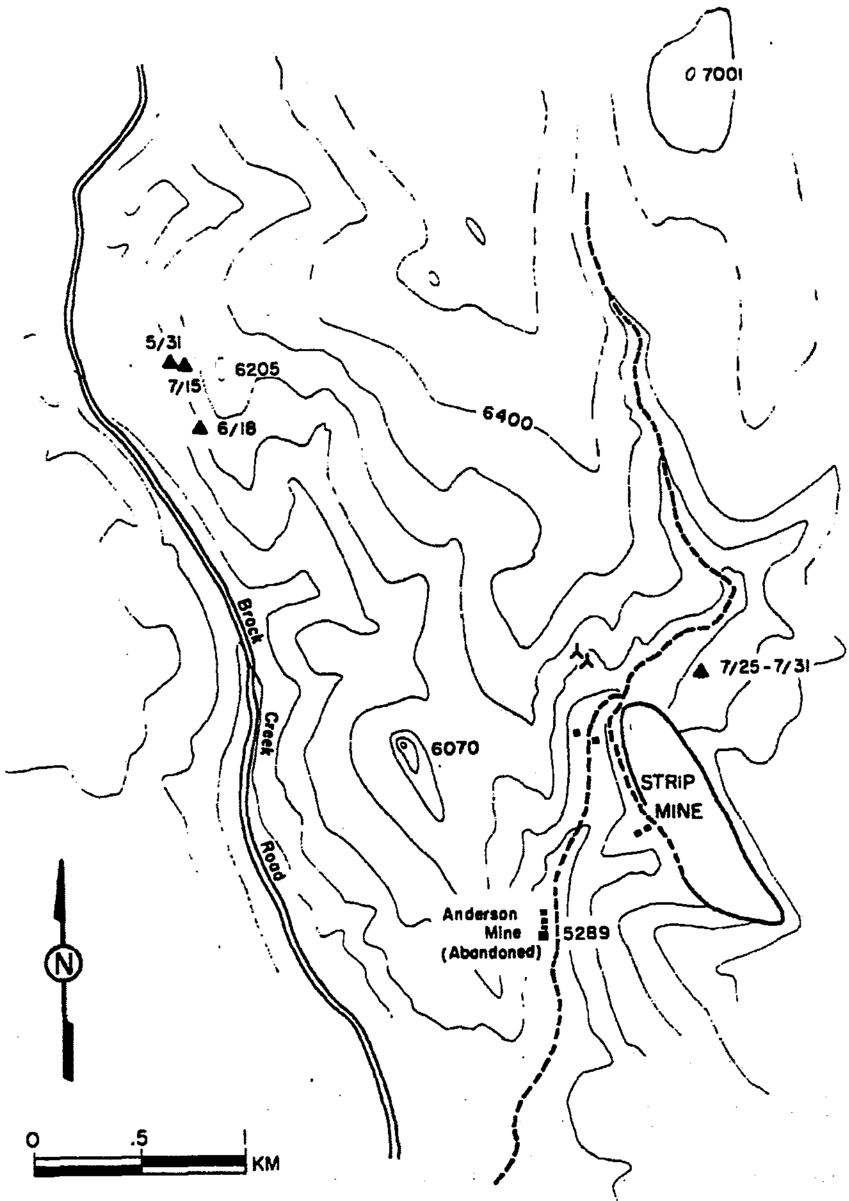

Fig. 14. Sequence of denning activity for adult female F111 during 1984 denning season, eastern Garnet study area.

sides in association with Douglas-fir; one of these was near or within a limestone outcrop.

Most dens were in association with rock, including the mine shaft, caves, and spaces between boulders or small rocks. Number of entrances varied from one to three ($\bar{x}$ = 1.4 $\pm$ 0.7), and entrance dimensions ranged from 0.1 m wide and 0.4 m high to 2.5 m wide and 1.6 m high; average width was 0.5 $\pm$ 0.9 m and average height was 0.7 $\pm$ 0.5 m (Table 12). Five of these dens had single entrances, with dimensions ranging from 0.2 m wide by 0.2 m high for one narrow fissure to 1.6 m by 2.6 m for the gaping mouth of the collapsed shaft. Two dens had at least two or more entrances, and main entrances ranged in size from 0.2 m wide and 0.4 m high for a small rock pile to 0.4 m wide by 1.2 m for a large, multi-chambered crevice. One den in a talus/boulder field had at least three possible entrances. It was difficult to define "entrances" for the rotten log dens, due to the configuration of each. One of these consisted of a small pocket formed under the trunk of a fallen tree on a talus slope, and the other was formed as a small and shallow triangular bed at the conjunction of three rotting logs under a small stand of Douglas-fir on a talus slope.

The mine shaft was considered too unstable and dangerous for detailed exploration, but the depth and number of chambers were recorded for dens in natural rock formations. The number of chambers ranged from one to five, and averaged 1.7 $\pm$ 1.4 chambers/den. Many dens were quite narrow and relatively deep, more chambers probably existed, and those measured may have been much deeper than I could detect. Therefore, these measurements are only minimum estimates for chamber number and depth. Seven dens (77.8%) had only one detectable chamber, and these varied in depth from 0.7 to 2.5 m. These dens were generally in rock or downfall timber. Two (22.2%) multi-chambered dens were found in rocky substrates, ranging in depth from 0.8 to 1.4 m.

Average distances to 90% obscurity ranged from 1.4 to 22.5 m, with an average of 11.3 ± 7.7 m for all measured dens; seven of eight measured dens were totally obscured in at least one direction. Of these, two were totally obscured in two directions, and one was totally obscured from the human eye in three of the four cardinal compass directions. The mine shaft was visible in all directions with distances ranging from 1.5 to 10.7 m, and it is probable that its main protective feature was its extensive underground network of hiding places rather than its visibility at ground level. The least visible den was on a steep and abrupt rock outcrop, was totally obscured in three of four directions. Its average visibility was 1.4 m and had the shortest distance to obscurity (5.8 m) in a single direction. The most visible den was a rock cave on a relatively open talus/rock slope. An average distance to obscurity of 22.5 m greatly overestimates the actual visibility of this den; in fact, the entrance was relatively small (0.2 by 0.3 m), and was nearly missed during the initial search because it was at ground level and obscured by vegetation. The greatest distance measured in a single direction (45.7 m) was for a den in a boulder field, and the second greatest distance (30.5 m) was for a birth den located in a log cavity on the same talus/boulder slope. In each of these cases, visibility was again greatly over-estimated.

All dens were found in association with the Pseudotsuga menziesii (PSME) habitat series (Pfister et al. 1977) in combination with either scree or solid rock. Canopy coverage was highly variable, ranging from 0.0% to 71.5% ($\bar{x}$ = 14.8 ± 20.9%). Seven (70.0%) of 10 dens measured for this parameter had at least some tree cover.

Dens ranged in elevation from 1706.9 to 2048.2 m, averaging 1828.8 ± 104.2 m (Table 13). Dens were found on west, northwest, east, southeast, and southwest slopes. Slope averaged 38.2 ± 13.4% (12.0-56.0%). Most (63.6%) den sites were located at mid-slope, and the remaining dens (36.4%) were on lower slopes (Table 13).

Habitat availability and use were compared within the total home ranges of bobcats F52, F108, F26, and F111 in the eastern Garnet study area (Tables 14 and 15). No statistical analyses could be performed on these data because of low sample sizes. Two bobcats (F26 and F111) accounted for nine (81.8%) of 11 dens and denning areas used in the analysis, and thus sample was not truly independent.

Use of moderate (25 to 50%) and steep (27.0%) slopes exceeded that available (Table 14). Likewise, dens occurred less frequently on slopes < 25% than were generally available (Table 14). Use of aspects varied, and strong preferences for particular aspects were not obvious. Den sites tended to be located more on middle slopes and lower slopes than available, and these were the only slope positions utilized (Table 14). Most den sites were located between 1751 and 2000 m elevations, and use of these elevations was higher than available. Use of areas under 1750 m elevation was less than that available, and use of elevations > 2000 m was proportional to availability (Table 14).

Distances of den sites to sources of past and active disturbances were compared (Table 15). Denning bobcats selected sites close to secondary roads (0.0 to 0.5 km) roughly in proportion to their availability, but tended to prefer areas 1.6 to 2.0 km from ungated, actively-used secondary roads (Table 15). Distances to active secondary roads averaged 1.3 ± 0.7 km, and ranged from 0.3 to 2.0 km. Distances to past mining activity varied from 0.0 km for two bobcats that denned within the abandoned Anderson mine area to 12.6 km for one bobcat that denned in a relatively remote area of the eastern Garnets. More remote sites were used as well, with areas 1.6 to 2.0 km receiving relatively greater use and sites > 2.1 km receiving less use than available. Denning areas did not occur near active mining operations, with distances ranging from 2.4 to 14.5 km ($\bar{x} = 4.9 \pm 3.4$ km) (Table 15). All dens were at least 2.4 km from the nearest permanent settlement, and the greatest distance was 13.1 km ($\bar{x} = 5.5 \pm 3.3$ km). All den sites were in areas > 2.1 km from permanent human settlement, roughly proportionate to the expected frequency of occurrence for this parameter (Table 15).

Adult-juvenile relationships

Denning season commenced during early May, with female bobcat F99 displaying denning behavior in the Greenough Creek drainage south of Clinton as early as 10 May. Only three litters were observed during the three seasons that females were monitored. Three kittens were born to F52, and were about two weeks old when found by Smith (1984:39) on 17 July 1982. On 21 June 1983, I found a litter of three three-week old kittens born to bobcat F26. I also found two one-week old kittens belonging to bobcat F111 on 31 May 1984. This small sample gave an average of 2.67 kittens/litter (Table 12). A fourth female (F108), also monitored by Smith (1984), was obviously denning in an abandoned mine shaft, although presence of kittens was never confirmed. In 1984, female bobcat F70 denned in the Mission Range study area (Fig. 6), but presence of kittens was not confirmed until that December. One additional female bobcat (F99) denned south of Clinton but slipped its collar in the den before kittens could be found.

Denning female bobcats tended to vary time spent at individual den sites. Both bobcats F52 and F108 spent prolonged periods at single den sites. F52 spent at least 19 days from 17 July to 5 August 1982 at an open den in downfall timber and scree in a relatively remote area, and an abandoned mine shaft was used by F108 continuously for at least 53 days from 5 June 1982 to 27 July 1982. During 1983, F26 used the same abandoned mining area utilized by F108 the previous summer. She moved her den at least three times from 21 June to 20 July (Fig. 13). These

Table 13. Topographic and habitat parameters for bobcat den sites in the eastern Garnet mountains, 1982-84.

					Distance (km)			
Date of Location	Elevation (m)	Aspect	Slope (%)	Slope Position	Secondary Road	Past Mining	Present Mining	Settlement
F108								
6/5/82	1706.9	West	24.0	Lower	1.6	0.0	2.4	2.4
F52								
7/15/82	2048.2	Northwest	40.0	Mid-slope	1.9	12.6	14.5	13.1
F26								
6/21/83	1997.1	Southeast	36.0	Lower	2.0	0.0	3.6	3.4
7/11/83	1743.5	Southeast	12.0	Lower	1.8	0.0	2.7	3.2
7/19/83	1842.2	Southeast	32.0	Mid-slope	1.7	0.0	3.4	3.5
7/20/83	1842.2	Southeast	32.0	Mid-slope	1.7	0.0	3.4	3.5
8/8-8/15/83	1767.8	East	56.0	Mid-slope	0.3	4.6	3.0	3.6
F111								
5/31/84	1789.2	Southwest	48.0	Mid-slope	0.5	2.2	5.7	8.0
6/18/84	1780.0	Southwest	56.0	Mid-slope	0.3	2.0	5.3	7.7
7/15/84	1810.5	Southwest	48.0	Mid-slope	0.5	2.2	5.7	8.0
7/25-7/31/84	1789.1	West	36.0	Lower slope	1.8	0.2	4.5	4.2
Mean	1828.8	-	38.2	-	1.3	2.2	4.9	5.5
Std. dev.	104.2	-	13.4	-	0.7	3.8	3.4	3.3

movements varied from 224 to 361 m between consecutive dens and may have been the direct result of disturbance by myself and my field assistants. On 8 August, F26 was located 4.6 km east of her original denning area, and at this time her kittens were between 9 and 10 weeks old (Table 12 and Fig. 13). She remained in this general area until 27 August, the last time she was located during the denning season. After denning season, F26's transmitter lost its antenna, and only a few locations were obtained before she was killed in December 1984. This bobcat shifted her home range during 1984, and may have denned that summer in a network of mine shafts in the Gravelly Mountain area, 7.0 km east of the Anderson Mine. From about 24 May to 15 July, F111 used a timbered-scree slope as a denning area, and three den sites were located (Fig. 14). F111 apparently made several small shifts between individual den sites during this period along 300 m of a moderately steep southwest-facing slope. In late July she shifted 2.6 km east to the abandoned mine used by F26 and F108 during previous denning seasons (Fig. 14). By late August the family became increasingly mobile and probably had shifted to using auxillary den sites.

Between 12 June and 31 July 1984, F111 was monitored for 24 hour periods to determine activity patterns associated with denning. Time spent at the den or away hunting was variable, but generally, F111 spent most of her time at the den site between about 1000-1600 hours and did most of her hunting between 0400-1000 and 1600-2000 hours. Limited night tracking revealed variable activity; the bobcat spent the entire

Table 14. Availability and use of habitat parameters for F111, F26, F108, and F52 den sites in the eastern Garnet Mountain Range, 1982-1984.

Parameter	% Availability	% Den Use
Slope (%)		
< 25 Percent	70.2	18.2 (2)
25 to 50 percent	27.0	63.6 (7)
51 to 75 percent	2.8	18.2 (2)
Aspect		
North	7.5	-
Northeast	18.3	-
East	5.6	9.1 (1)
Southeast	15.5	36.4 (4)
South	5.2	-
Southwest	20.6	27.3 (3)
West	9.5	18.2 (2)
Northwest	13.9	9.1 (1)
Flat	4.0	-
Slope position		
Ridge top	7.9	-
Upper slope	36.1	-
Mid-slope	32.5	72.7 (8)
Lower slope	18.7	27.3 (3)
Stream bottom	4.0	-
Flat	0.8	-
Elevation		
1250 to 1500 m	2.8	-
1501 to 1750 m	29.8	18.2 (2)
1751 to 2000 m	56.0	72.7 (8)
2001 to 2250 m	11.0	9.1 (1)
2251 to 2500 m	0.4	-

night of 15-16 June hunting away from her den, and the entire night of 7-8 July at the den. Radio-telemetry often indicated short (< 200 m) trips away from the den. This type of activity was also noted for F26 the previous season. Non-denning females tended to rotate between different resting areas continuously day to day, and never keyed into specific spots, although some apparently preferred loafing areas were occasionally revisited. In this respect, non-parturient females resembled males in their activities.

Kitten survival was difficult to document. No information was obtained for either F52 or F108 after the 1982 denning season. The fate of F52 and her kittens is unknown due to transmitter failure that fall. F108 was harvested in December 1982, and the trapper reported kitten tracks around the trap site. Of three kittens observed on 21 June 1983, only one was confirmed by 20 July for F26 in the Anderson mine area (Table 12). The fate of the other kittens is unknown, although one kitten observed on 21 June was in relatively poor condition and its chances of survival seemed low. A female and kitten bobcat visited a trap site placed in the immediate vicinity of F26's denning area on 11 February 1984, but they were not caught and identity was therefore not confirmed. Bobcat F111 was caught in the same trap 6 weeks later, and this pair could have been either adult and an acompanying juvenile. In September 1984, recent droppings of a juvenile bobcat were found at one of F26's daybeds within the old natal denning area; this bobcat may have been one of F26's kittens. F111 and her two kittens were observed at close range on 31 May and 18 June 1984, but only one seven-week old kitten was found on the boulder-strewn slope near the birth den on 15 July. However, the other kitten easily could have escaped detection on the rocky slope. After 15 July, no further contact was made with these kittens and their fate remains unknown. F111's transmitter apparently failed after October 1984. At least one and probably two kittens were travelling with F70 in the Mission Range study area on 22 December 1984. No dens were located for this animal despite intensive efforts by a field assistant.

A female kitten (F93) was instrumented in December 1983 along with its mother (F105) and its dispersal range was documented (Figs. 10 and 15). On 21 December 1983, aerial location indicated they were separated by only 0.6 km. Both bobcats were captured at the same trap site in early January 1984. It is not clear if a 9.5 km separation between the 9 January capture of F105 and the 12 January capture of F93 indicated spatial separation of these individuals or simultaneous movement by the pair. Severe signal bounce prevented accurate location of either individual by ground telemetry on 29 February 1984, but general locations indicated they were separated by at least 5 km in the Clear Creek drainage. On 25 April 1984, these bobcats were located from the air in the Clear Creek drainage and were 8.6 km apart. F93 was not located again until 17 July in the Crow Creek Drainage, outside its natal range, a distance of 13.1 km from its last location and 9.4 km from the arithmetic mean center of F105's total home range. From July

Table 15. Availability and use of disturbance habitat parameters for F111, F26, F52, and F108 den sites in the eastern Garnet Mountain Range, 1982-1984.

Distance to Disturbance type	% Availability	% Den Use
Active Secondary Road		
0.0 to 0.5 km	42.1	36.4 (4)
0.6 to 1.0 km	28.6	-
1.1 to 1.5 km	15.1	-
1.6 to 2.0 km	6.7	63.6 (7)
2.1 km or more	7.5	-
Human Habitation		
0.0 to 0.5 km	-	-
0.6 to 1.0 km	1.2	-
1.1 to 1.5 km	2.0	-
1.6 to 2.0 km	1.6	-
2.1 km or more	95.2	100.0 (11)
Past Mining Activity		
0.0 to 0.5 km	0.8	54.5 (6)
0.6 to 1.0 km	2.8	-
1.1 to 1.5 km	2.4	-
1.6 to 2.0 km	4.8	9.1 (1)
2.1 km or more	89.3	36.4 (4)
Present Mining Activity		
0.0 to 0.5 km	3.2	-
0.6 to 1.0 km	1.6	-
1.1 to 1.5 km	4.8	-
1.6 to 2.0 km	2.8	-
2.1 km or more	87.7	100.0 (11)

1984 through March 1985, F93 (by now a yearling) remained primarily along the Prospect Creek corridor outside the known range of F105. On 3 October it was located on the ridge separating the Clear Creek and Prospect Creek drainages, within the known home range of F105. On this date adult and juvenile were 9.2 km apart. F93 was observed on 15 January 1983 in a small cave in a rock outcrop 1.2 km southwest of the Thompson Falls dam. She appeared to be in good condition. In March 1985, F93 was located 1.2 km northwest of Clark Mountain, near the center of adult female F114's 1983 home range. F114's transmitter failed in late 1983 and her status from that time is unknown.

Bobcat F105 was at least 5 years old during the 1984 denning season, and did not raise kittens. F105 suffered an injury during the 1980-81 trapping season and lost most of one hind foot. During 1983-84 she was a frequent visitor to live-traps, and apparently relied heavily on bait for sustenance. I found one of her day beds on a rock outcrop in the Clear Creek drainage in July, and the area immediately around the bed was covered with scats. Examination of several scats indicated that this animal had been subsisting largely on a vegetarian diet. It appeared that this bobcat was stressed and if it had produced a litter earlier in the season, the kittens did not survive. This bobcat was snow-tracked in December 1984, and flushed from a loafing den under the roots of a fallen tree. No kittens were found.

Two male lynx kittens, M119 and M120, died of possible malnutrition during the early spring of 1983. Both kittens were frequent visitors to live-traps in the Chamberlain area between January and March, and the bait may have been their major source of food. The undisturbed skeletal remains of M119 were found in September 1983, 4.4 km from its original capture site. Lynx M120 was found 3.1 km from its original point of capture, and only the skull, strips of hide, a few bones, and a chewed-up radio-collar were located. It was impossible to tell if M120 had been killed by predators or if it had died of starvation and then been scavenged.

DISCUSSION

Home ranges of bobcats in western Montana are among the largest reported; estimates range from less than 1.0 km^2 for adult females in California (Lembeck and Gould 1979) to over 200 km^2 for adult males in Maine (Litvaitis et al. 1983). Bobcats in mountainous, forested regions tend to have larger home ranges than those in other areas (Kitchings and Story 1978, 1979, 1984, Marston 1942, Berg 1979, Smith 1984, Litvaitis et al. 1983). Kitchings and Story (1978) found that relatively low numbers of rabbits (*Sylvilagus floridanus*) and cotton rats (*Sigmodon hispidus*) in mountainous eastern Tennessee probably caused bobcats to travel farther in search of prey than in lowland areas of the southeastern United States. Rolley (1983) postulated that relatively large home ranges for bobcats in Oklahoma may have been due to either low prey densities or high harvest pressure, or a combination of both. My informal observations indicate that snowshoe hare (*Lepus americanus*) and cottontail rabbits (*Sylvilagus nuttallii*) were not abundant in any of my study areas, and probably explain the large home range sizes and relatively low densities of bobcats in western Montana.

Large home ranges for Montana lynx may be similarly explained; Mech (1980) believed that large (51 to 243 km^2) home ranges of colonizing lynx in northeastern Minnesota were the result of low prey densities. Ward (1983) found that, as snowshoe hare numbers decreased, lynx home range sizes increased and home range overlap declined. Koehler et al. (1979) found that one adult male lynx monitored from March through October 1977 in western Montana had a home range of 36 km^2, and concentrated its activities in young, densely stocked stands of lodgepole pine where snowshoe hares were most abundant. During 1981-84, lynx in the Chamberlain area frequented similar habitat, although snowshoe hares appeared to be declining, which may explain these large home range estimates. The large extent of inter- and intrasexual overlap of home ranges or use areas in the Chamberlain area may be explained by the existence of small, localized, hare populations.

Adult male bobcats tended to have larger home ranges than adult females in this study, as has been reported in most other studies (Marshall and Jenkins 1966, Marshall 1969, Bailey 1972, 1974, Hall 1973, Hall and Newsom 1978, Kitchings and Story 1978, 1979, 1984, Brittell et al. 1979, Rolley 1985, and others). Large areas of use have been reported for juvenile bobcats elsewhere, with Kitchings and Story (1984) reporting a range from 6.3 to 228.7 km^2 in eastern Tennessee. Adult male lynx also had larger home ranges than females in this study, as was in northeastern Minnesota (Mech 1980).

During the denning season, adult females known or strongly suspected to have been raising kittens displayed more restricted movements than non-parturient females. Similar results were reported by Bailey (1972) in southeastern Idaho. Distances between consecutive locations in my study reflect gross activity of bobcats over longer periods of time, rather than daily movement patterns. Little information was collected on daily movements due to restrictions created by topography.

Decreased prey base and/or high lynx densities probably cause long-distance movements of lynx, which ranged from 103 to 720 km in other studies (Saunders 1963, Nellis and Keith 1969, Mech 1977, Ward 1983). The movement of adult female lynx F115 from Thompson Falls to Radium Hot Springs, B. C. may have reflected lowered prey base, as might the dispersal of adult male lynx M104 from Chamberlain Mountain to Lolo, MT (Smith 1984). Lynx were known to be concentrated in the Chamberlain area, and relatively high densities of these lynx in this area might have also contributed to M104's long movement. Bailey and Bangs (1983) reported that, during the low phase of the lynx cycle, core populations exist in relatively inaccessible refugia, and as populations grow, dispersals take place from these areas.

Juvenile bobcats seemed to be transient animals seeking new ranges, such as has been reported by Bailey (1972) and Kitchings and Story (1984). The long-distance movement by juvenile male bobcat M54 is similar to that reported by Knick and Bailey (in press) in southeastern Idaho. Lynx F115 and bobcat M54 were in good condition when trapped, and the lynx lost only 2.2 kg between its capture in 1983 and harvest almost two years later. Knick and Bailey reported that two marked bobcats were in an emaciated condition when they were harvested 158 and 182 km from their respective initial capture points. Kitchings and

Story (1984) postulated that relatively short dispersals of two male bobcat kittens may have been a response to deficiency of prey within their natal area.

An overall average litter size of 2.69 for Montana bobcats, derived from carcass data and field observations, is well within the range of reported averages (2.5 to 3.2) in other studies (Table 16). One bobcat produced six litters over the course of six seasons in Florida, with an average of 3.3 kittens/litter (Winegarner and Winegarner 1982). Mean litter size was lower for yearlings than adults, as in other studies (Sweeney 1978, Parker and Smith 1983, Knick et al. 1985, Johnson and Holloran 1985, and Rolley 1985). Fritts and Sealander (1978) stated that placental scar counts did not account for stillbirths or uterine losses, but were more reliable indicators of actual litter size than corpora counts.

Very little information exists on lynx litter sizes. A small sample of Newfoundland lynx had 1 to 6 implanted embryos, with an average litter size of 2.92 (Saunders 1961). Parker et al. (1983) found that decreased snowshoe hare densities suppressed lynx recruitment in Nova Scotia. O'Connor (1984) found that high lynx litter sizes correlated closely with peaks in snowshoe hare abundance. In Alaska, Nava (1970) stated that, during periods of high snowshoe hare densities, average litter size for all females was 2.5; yearlings had lower mean litter sizes ($\bar{x}$ = 2.2) than adults ($\bar{x}$ = 4.6), much as in Montana.

Table 16. Summary of bobcat reproductive information by author and locality, 1929-1985.

Author	Year	Locality	Mean Litter size	Mean C.L.[a] counts
Seton	1929	North America	3	-
Grinnell et al.	1937	California	2	-
Pollack	1949/ 1950	Massachussetts & New Hampshire	2	-
Erickson	1955	Michigan	2.6	3.6 (Y) 5.5 (A)
Young	1958	Utah	2	-
Gashwiler et al.	1961	Utah	3.3	4.8
Bailey	1972	Idaho	2.8	-
Hall	1973	Louisiana	-	3.3
Crowe	1975	Wyoming	2.8	4.6
Sweeney	1978	Washington	2.6	3.73 (Y) 6.06 (A) 5.38 (T)
Fritts and Sealander	1978	Arkansas	2.5	-
Bailey	1979	Idaho	2.7	4.6 (Y) 4.9 (T)
Berg	1979	Minnesota	3.2	5.9 (Y) 9.5 (A)
Brittell et al.	1979	Washington	2.6	-
Hoppe	1979	Michigan	3.1	4.6
Blankenship & Swank	1979	Texas	2.7	-
Parker and Smith	1983	Nova Scotia	2.4	-
Jackson	1984	Colorado	2.8	-
Rolley	1983/ 1985	Oklahoma	2.6	-
Johnson and Holloran	1985	Kansas	2.8	-

a/ Y = yearling, A = adult, T = all age classes

Our bobcat corpora counts (4.16 ova/season) agree closely with those reported in the literature, when attempts were made to distinguish recent corpora lutea from corpora albicantia of previous seasons (Table 16). It is now generally accepted that bobcats are polycyclic ovulators (Duke 1949, Crowe 1975, Fritts and Sealander 1978, Winegarner and Winegarner 1982). Fritts and Sealander (1978) state that corpora counts over-estimated litter size of Arkansas bobcats by 59.5% (2.5 kittens/litter vs. 4.2 ova/season); this study reports similar results, with litter size being 64.2% of that estimated by corpora lutea counts (2.69 kittens/litter vs. 4.16 ova/season). These higher corpora counts may be indirect evidence for multiple estrus cycles. Yearling corpora lutea counts were consistently lower than those of adults in this study, as has been the case in other studies (Erickson 1955, Sweeney 1978, and Bailey 1979). Lower yearling corpora lutea counts indicated either 1) yearlings only cycled once their first season, or 2) corpora albicantia of previous ovulations were mistaken for recent corpora lutea in the laboratory, due to the intergradation of color and size between them (Provost et al. 1973). Corpora albicantia (or corpora rubra) from previous seasons accumulate as female bobcats get older (Duke 1949, Pollack 1950, Erickson 1955, Nelson 1971, Crowe 1975, Sweeney 1978, Berg 1979, Hoppe 1979, and Johnson and Holloran 1985). In this study, corpora albicantia were not quantified, although this same trend was observed.

Female bobcats in Montana apparently become sexually mature their first spring, although the yearling and 2-year old cohorts were less productive than older animals. Yearlings had lower pregnancy rates than adults in Washington (Brittell et al. 1979), Kansas (Johnson and Holloran 1985), and Oklahoma (Rolley 1985); in addition, Parker and Smith (1983) showed that 2-year old females had lower pregnancy rates than older bobcats in Nova Scotia. Our field data support this, with only one of four (25.0%) 2-year old bobcats confirmed denning during the normal denning season. Rolley (1985) stated that age of first breeding is greatly influenced by prey availability. Stewart Fraser, who has raised several bobcats for over 10 years, reported that none of his known-age bobcats from western Montana successfully produced litters until their third summer.

Research on lynx showed that productivity of yearling lynx varied with availability of snowshoe hares (Nava 1970, Brand et al. 1976, Brand and Keith 1979, O'Connor 1984). Age of sexual maturity in Montana lynx was similar to that reported elsewhere (Saunders 1961, Nava 1970, O'Connor 1984). Pregnancy rates in lynx vary with availability of prey (O'Connor 1984); the relatively low yearling pregnancy rate in Montana may reflect low prey availability during the 1980-83 seasons.

Reproductive potential of Montana bobcats was virtually the same for populations east and west of the Continental Divide, and therefore any differences in population recruitment must be linked with environmental factors after young were born. Fluctuations in productivity between harvest seasons may reflect corresponding variability in prey-base (Rolley 1985) or related climatic factors.

Breeding and birthing seasons were variable, with most breeding in the northern and western United States occurring from mid-February to mid-April with a definite peak in March (Young 1958, Crowe 1975, Sweeney 1978, and Brittell et al. 1979). Most births occur from mid-April to mid-July with a peak in mid-May (Seton 1929, Grinnell et al. 1937, Duke 1954, Pollack 1950, Gashwiler et al. 1961, Jackson 1984, Sweeney 1978, Brittell et al. 1979, Berg 1979, and Blankenship and Swank 1979); my field data showed that western Montana bobcats conform to this trend. Erickson (1955) reported a slightly earlier season in Michigan, and researchers in the southeastern United States report earlier and longer breeding seasons, usually ranging from December or January to March or April (Nelson 1971, Fritts and Sealander 1978). Denning seasons are correspondingly earlier in these areas, with births occurring from February through May (Fritts and Sealander 1978, Kitchings and Story 1978). Some researchers state that breeding seasons may begin in September (Duke 1954, Sheldon 1959, Provost et al. 1973, Hall 1973, and Blankenship and Swank 1979). Earlier breeders occasionally produce second litters late in the season (Jackson 1984, Winegarner and Winegarner 1982). Female bobcats in their first reproductive season may produce kittens later in the breeding season (Erickson 1955, Crowe 1975, Fritts and Sealander 1978, and Winegarner and Winegarner 1982). During this study, a 2-year old female bobcat (F52) produced a late litter in

July 1982, and this was probably her first litter. I suspected that one sedentary two-year old female bobcat (F03) had kittens as late as October, but snow-tracking in December did not reveal denning activity or presence of kittens.

Kunc (1970) stated that the European lynx (Lynx lynx) mate in mid to late March, and give birth in late May or early June. Nava (1970) reported that Alaskan lynx breed in late March or early April, and give birth in June. Montana lynx probably have similar breeding and denning seasons, but this was not confirmed.

Very little information is available on denning behavior or habitat requirements of parturient female bobcats. Natural shelters in rock or rotting logs appear to be the most preferred sites for bobcat dens, although a variety of different sites, including man-made structures, are used (Seton 1929, Rollings 1945, Young 1958, Pollack 1949, Gashwiler et al. 1961, Bailey 1979, Knowles 1981, and Smith 1984). In this study, bobcats seemed to use areas that, although often close to human activities, were relatively undisturbed. Caves within rock outcrops or abandoned mine shafts provided excellent security for young kittens. Spaces between rocks on scree slopes offered unlimited hiding cover, and rotten logs on such slopes, with some canopy coverage, were ideal spots for dens. Bailey (1979) reported similar findings in southeastern Idaho, where bobcats preferred natural rocky areas, but also used abandoned structures such as nuclear cooling towers or sheds to rear kittens. Gashwiler et al. (1961) and Pollack (1949) both reported instances where caves were used as dens; Bailey (1979) stated that natural, potential den sites in his sagebrush plains study area were determined by the distribution of ancient volcanoes, lava tubes and outcrops. Kitchings and Story (1984) found dens under stumps in areas of past hardwood logging, and one den was located under brush at the edge of a powerline right-of-way. In Montana, bobcats tended to favor sites within areas that feature several possible alternate hiding spots for young kittens, and thus rocky areas, with an interspersion of downfall timber were ideal. Disturbed surfaces, such as those encountered in strip mines, did not deter bobcats, although all dens I found in such an abandoned mine were in natural settings. An abandoned mine shaft in this same area provided virtually limitless shelter and protection for the offspring of one bobcat monitored by Smith (1984).

Microsite selection seemed to be the over-riding factor in choosing den sites, Bobcats will den near sources of human activity, such as moderately-used secondary roads, if an area provides hiding cover. Den sites were generally well hidden, even on sites that were relatively exposed, and were difficult to detect without the aid of telemetry. Rocky, rugged areas tended to occur in areas with steeper slopes at higher elevations, and explains preference for these areas by denning bobcats. Distances between dens varied from 50 m to 4.6 km, similar to that reported for auxillary dens in southeastern Idaho (Bailey 1979).

Activity patterns associated with denning are difficult to monitor, and only a few studies have attempted to do so (Kitchings and Story

1978, Griffith et al. 1981, Kitchings and Story 1984). I found that one female bobcat (F111) displayed largely crepuscular movement patterns, with peaks of activity between 0400 and 1000 hours and 1600-2000, similar to what Griffith et al. (1981) found for adult female bobcats during all seasons.

Although precautions were made to minimize disturbance during searches for dens, researcher activity may have influenced natal den shifts in some cases. In 1984, radio-telemetry indicated that F111 was moving her den from site to site during June and July, even when not disturbed. Kitchings and Story (1978) support my observation that denning females often tend to have several temporary dens within a general denning area. Bailey (1979) found that individual female bobcats used one natal den and up to five auxillary dens during the course of a denning season.

Kittens are helpless at birth, and depend upon maternal care during their first 3 months of life. My limited data indicated that 9-10 week old kittens were able to travel with their mothers. Dispersal of kittens appeared to coincide with the onset of breeding season. One female-kitten pair in my study stayed together at least until mid-February, and another mother-young pair (F105-F93) split up when the kitten was probably about 10 months old, in March. Griffith et al. (1983) found that subadult bobcats disperse in March, and Kitchings and Story (1984) stated that two sibling male kittens dispersed from their natal range during the spring, and had established areas of use outside their mothers by summer.

Some studies support the idea that kitten survival is directly linked to prey availability (Bailey 1972, Nellis et al. 1972, Brand and Keith 1979, and Blankenship and Swank 1979). My limited observations on the apparent low survival of kittens in western Montana, as well as large home range sizes for adults of both sexes, indicated that low prey-base was probably a limiting factor, although empirical data were lacking. Low prey numbers adversely affect survival of lynx kittens (Nava 1970, Berrie 1972, Nellis et al. 1972, Brand et al. 1976, Brand and Keith 1979), and the apparent starvation of two lynx kittens in this study demonstrated this.

MANAGEMENT IMPLICATIONS

1. Bobcats require relatively undisturbed microsites for den sites, although these sites may be adjacent to "passive" sources of human disturbance, such as secondary roads. Human disturbance at bobcat dens may adversely affect kitten survival, and should be minimized. Abandoned mine shafts provide excellent denning cover for bobcats, and provisions should be made to allow bobcat access if shafts are sealed to prevent human trespass. Rocky areas are preferred for kitten-rearing, and should be protected.

2. Reproductive success is probably closely tied to nutrition, and future research should focus on food habits, prey availability, and the use of prey population data as an index to bobcat productivity.

3. Long-distance dispersal may indicate high cat densities and/or low prey availability. Managers can expect dispersers to find and colonize areas with low cat densities.

4. Low reproductive rates warrant conservative harvest strategies which reduce take of female bobcats. A later January-February season may help skew harvests towards males and thereby reduce female mortality. Kitten survival may also be enhanced if early season female mortality is reduced.

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