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Biology, Ecology and Range of the Bobcat, Lynx Rufus in New York and its Inferred Interactions with Potentially Reintroduced Lynx, Lynx canadensis canadensis in Adirondack Park

Lloyd B. Fox

Rainer H. Brocke

Not For Publication Or Publication Reference

NOTICE OF RESEARCH PROJECT
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Bureau of Sport Fisheries and Wildlife
Division of Federal Aid

SIE NO.
PROJECT NO. Endangered Species Program
STATE New York
JOB NUMBER XII- 6
RESEARCH CLASSIFICATION

JOB TITLE The role of parasites and diseases in the distribution and abundance of bobcats in New York with special reference to the role of domestic cat as a reservoir host.

NAME AND TITLE OF PRINCIPAL INVESTIGATOR
Rainer H. Brocke, Assistant Project Leader

NAME AND ADDRESS OF GAME AND FISH AGENCY
N.Y.S.D.E.C., Bureau of Wildlife, 50 Wolf Road, Albany, New York

JOB DESCRIPTION (Include project and job objectives, procedures, work schedule, location of work and name of technical personnel participating.)

Job Duration: April 1, 1978 to March 31, 1980.

Schedule: Bobcat carcasses will be collected statewide during the 1978-79 and 1979-80 trapping seasons. Intensive data collection on Study Areas I, II and III will be conducted primarily during late summer and early fall of 1978. Some trapping of lagomorphs may be conducted in late winter of 1979. Laboratory analysis will proceed through December, 1979. Final analysis and writing is scheduled for January through March, 1980.

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Location: State University of New York College of Environmental Science and Forestry, Newcomb, New York.

JOB DURATION From:	To:	FEDERAL SHARE	STATE SHARE
April 1, 19 78	March 31, 19 79	$ 9,257	$ 4,629

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BIOLOGY, ECOLOGY AND RANGE OF THE BOBCAT *LYNX RUFUS* IN NEW YORK AND ITS INFERRED INTERACTIONS WITH POTENTIALLY REINTRODUCED LYNX *LYNX CANADENSIS* IN ADIRONDACK PARK

<u>Final Report 1982</u>

Federal Aid Project W-105-R and E-1-3
New York State Department of
Environmental Conservation
Study XII, Jobs 1, 2, 3, 4, 5, 6

<u>Part I, Jobs XII, 1, 2, 3, 4</u>
(Bobcat Biology, Ecology, and Range in New York)
Prepared by Lloyd B. Fox
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<u>Part II, Job XII 5</u>
(Lynx Restoration in Adirondack Park)
Prepared by Rainer H. Brocke, Ph.D.
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(Bobcat Parasites and Diseases in New York)
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This study was supported by the State University of New York, College of Environmental Science and Forestry, and by Federal Aid Project W-105-R and E-1-3, New York, the U.S. Fish and Wildlife Service and New York State Department of Environmental Conservation cooperating.

PART I

BIOLOGY, ECOLOGY AND RANGE OF THE BOBCAT *LYNX RUFUS* IN NEW YORK AND ITS INFERRED INTERACTIONS WITH POTENTIALLY REINTRODUCED LYNX *LYNX CANADENSIS* IN ADIRONDACK PARK

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FINAL REPORT 1982

Federal Aid Project W-105-R
New York State Department of
Environmental Conservation
Study XII, Jobs 1, 2, 3, 4.

This study was supported by the State University of New York, College of Environmental Science and Forestry, and by Federal Aid Projects E-1-3 and W-105-R, New York, the U.S. Fish and Wildlife Service and New York State Department of Environmental Conservation cooperating.

Prepared by: ______________________________

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Mar. 18, 1983
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Approved by: ______________________________ 18 March '83

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Stuart Free, Chief — Date
Bureau of Wildlife

State: New York
Project No: W-105-R

Final Job Completion Report

Job XII - 1,2,3,4

STUDY NUMBER AND TITLE: XII - Biology, Ecology and Range of the Bobcat, *Lynx rufus* in New York and its Inferred Interactions with Potentially Reintroduced Lynx, *Lynx canadensis canadensis* in Adirondack Park.

STUDY OBJECTIVES:

1. To determine and describe the predation ecology, movement patterns, territorial behavior and habitat of bobcats in New York.

2. To determine vital population characteristics and exploitation levels of bobcats in New York.

3. To recommend management alternatives for bobcats in New York on the basis of an information synthesis, range map and model of current bobcat exploitation levels in the region.

4. To make recommendations concerning the feasibility of lynx reintroduction in Adirondack Park based on the inferred level of lynx-bobcat competition and a survey of potential lynx range in the Park.

(1) JOB NO. AND TITLE: XII-1 Predation ecology, territorial behavior, population characteristics and habitat of bobcats in the central Adirondacks and Catskills - an extensive study.

JOB OBJECTIVE: To determine the predation ecology, territorial behavior, population characteristics and habitat of bobcats in the central Adirondacks and Catskills.

(2) JOB NO. AND TITLE: XII-2 Population characteristics, exploitation indices, prey and range of the bobcat in New York - an extensive study.

JOB OBJECTIVE: To measure selected population characteristics, to determine the level of local trapping and hunting pressure affecting bobcats, to describe the species composition of prey and to delineate the range of bobcats in New York.

(3) JOB NO. AND TITLE: XII-3 Estimation of the bobcat population in New York.

JOB OBJECTIVE: To estimate the bobcat population in New York.

(4) JOB NO. AND TITLE: XII-4 Data analysis and recommendations for bobcat management in New York.

JOB OBJECTIVE: To analyze data from intensive and extensive studies and recommend bobcat management alternatives for New York.

NOTE: Abstracts for Jobs XII-1, XII-2, XII-3, and XII-4 are given in the following pages in lieu of standard, brief job completion reports. Data and detail for these reports is contained in the subsequent report entitled: "Biology, Ecology, and Range of the Bobcat, *Lynx rufus* in New York."

(1) JOB NO. AND TITLE: XII-1 Predation ecology, territorial behavior, population characteristics and habitat of bobcats in the central Adirondacks and Catskills - an extensive study.

JOB OBJECTIVE: To determine the predation ecology, territorial behavior, population characteristics and habitat of bobcats in the central Adirondacks and Catskills.

Abstract: The ecology of the bobcat (Lynx rufus) was studied through snow-tracking and radio telemetry of individuals on 4 study areas in New York. This information supplimented data obtained during the necropsy of 247 carcasses collected statewide from October 1976 until April 1980. White-tailed deer (Odocoileus virginianus) and lagomorphs are the principal diet components of New York bobcats, occurring in 32% and 30.2% respectively of the 169 bobcat stomachs that had food items. No significant differences ($P > 0.05$) were detected in the diets of bobcats compared by sex, age, or region. Deer are utilized significantly ($P < 0.001$) more in the winter than during either the summer or fall. Bobcats fed predominately on deer less than one year old (10 of 13) and were known to kill 7 of these animals, 5 with bites to the throat and 2 with bites on the side of the neck at the base of the skull. An index to bobcat condition, which was the ratio (expressed as a percentage) of the dry weight to the fresh weight of the femur marrow, suggests that juveniles and females in the Adirondack undergo a period of negative energy balance during the late winter. The Catskill bobcat femur fat index did not show this trend. The home ranges of telemetered Adirondack bobcats were extremely large; 325.7 ± 61.1 ($\bar{X} \pm SE$) km^2 for 4 males and 86.4 ± 28.6 ($\bar{X} \pm SE$) km^2 for 4 females. The home ranges of 2 adult males in the Catskills was 36.0 ± 28.5 ($\bar{X} \pm SE$) km^2 whereas an adult female had a home range of 31.0 km^2. The minimum estimated diel travel distance of Adirondack male bobcats is 3.03 ± 0.2 km ($\bar{X} \pm SE$) which is significantly greater ($P < 0.001$) than the 0.93 ± 0.1 km^2observed for Catskill male bobcats. Similarly the Adirondack female bobcats were found to travel 2.73 ± 0.2 km which is significantly greater ($P < 0.01$) than the 1.89 ± 0.3 km observed for the Catskill female. Bobcats generally utilized lower elevations within their home range. Various cover types were utilized in excess of their availability within an individual's home range. However, this appears to be individual preference, not species preference within a region. New York bobcats were found to be arrhythmically active 63.2% of the times they were observed.

BACKGROUND: See attached manuscripts

PROCEDURES: See attached manuscripts

FINDINGS: See attached manuscripts

ANALYSIS: See attached manuscripts

RECOMMENDATIONS: This job has been terminated. The attached manuscript will serve as the final report for this job as well as Jobs XII-2, XII-3, and XII-4.

(2) JOB NO. AND TITLE: XII-2 Population characteristics, exploitation indices, prey and range of the bobcat in New York - an intensive study.

JOB OBJECTIVES: To measure selected population characteristics, to determine the level of local trapping and hunting pressure affecting bobcats, to describe the species composition of prey and to delineate the range of bobcats in New York.

Abstract: The bobcat (Lynx rufus) currently occupies over 35,000 km^2 of New York with populated areas occurring in the Adirondack, Catskill and Taconic regions. This species is often harvested incidentally during other hunting or trapping activities. The majority of persons (52.2%, n = 272) who bountied bobcats within Hamilton County during 17 years (1955 to 1971) harvested only a single bobcat during the period. Successful hunters and trappers who submitted bobcat carcasses during the period 1976-80 took 1.18 ± 0.04 bobcats/year. The peak harvest of bobcats in southern New York occurs during the big game season, and most are killed by deer hunters, whereas the peak harvest of bobcats in the northern region occurs at the end of the trapping season and is comprised primarily of trapped animals. The sex ratio of the animals necropsied was 100 males per 84.8 females. The average placental scar counts for yearling, 2 year-olds, and female bobcats 3 years old or more was 1.2, 2.8, and 3.4 respectively. Within an age class no significant difference ($P > 0.05$) in reproductive rate was observed between the northern and southern regions. Juveniles comprised 27.2% of the sample collected from the northern region and 24.3% of the animals from the southern region. Yearlings comprised a significantly greater ($P < 0.05$) portion of the harvest in the southern region (42.6%) than in the northern region (23.3%). The principle diet components of New York bobcats are white-tailed deer (Odocoileus virginianus) and lagomorphs, comprising 32% and 30.2% of the diet respectively as determined from a sample of 169 bobcat stomachs.

BACKGROUND: See attached manuscripts

PROCEDURES: See attached manuscripts

FINDINGS: See attached manuscripts

ANALYSIS: See attached manuscripts

RECOMMENDATIONS: This job has been terminated. The attached manuscripts will serve as the final report for this job as well as for Jobs XII-1, XII-3, and XII-4.

(3) JOB NO. AND TITLE: XII-3 Estimation of the bobcat population in New York.

JOB OBJECTIVES: To estimate the bobcat population in New York.

Abstract: The post dispersal adult segment (> 2 1/2 years old) of the bobcat (Lynx rufus) population in New York was estimated by 3 techniques. The range of bobcats in New York was estimated to be over 35,000 km^2 on the basis of pelt tag data. Bobcat density estimates based on known distributions of telemetered bobcats and the tracks of other bobcats were made at the Central Adirondack Study Area (CASA) and the Western Catskill Study Area (WCSA) during the late winter. Density estimates ranged from 1.93 bobcats/100 km^2 on the CASA to 6.18 bobcats/100 km^2 on the WCSA. Bobcat home ranges calculated with data collected in Job XII-1 were used to estimate the total adult bobcat population of the occupied range based on the assumption of no overlap among members of the same sex and no exclusion between opposite sexes. Post dispersal adult harvest age structure modified by various simulated values of the intrinsic rate of population increase (r) and smoothed with a $\log_e$ linear regression of frequency vs. age was used to estimate adult mortality rates (qx) of 0.13, 0.22, and 0.29 for r values of 0.1, 0.0, and -0.1 respectively. Assuming that the total annual adult deaths were 1.5 times the total annual adults harvested, the model estimates post-dispersal adult population of between 380 and 815 individuals in the state. Estimates by each of the three techniques are conservative approximations. It is safe to say that New York has over 500 adult bobcats by late winter.

BACKGROUND: See attached manuscripts

PROCEDURES: See attached manuscripts

FINDINGS: See attached manuscripts

ANALYSIS: See attached manuscripts

RECOMMENDATIONS: This job has been terminated. The attached manuscripts will serve as the final report for this job as well as for Jobs XII-1, XII-2, and XII-4.

(4) JOB NO. AND TITLE: XII-4 Data analysis and recommendations for bobcat management in New York.

JOB OBJECTIVES: To analyze data from intensive and extensive studies and recommend bobcat management alternatives for New York.

Abstract: Bobcat (Lynx rufus) populations presently occur in the Adirondack, Catskill and Taconic regions of New York. They occupy over 35,000 km^2 of range and apparently have occupied this range since the 1890's. Bobcats are harvested incidentally to other hunting and trapping activities; only a few persons harvest more than one bobcat during a season. This pattern of exploitation appears to be reflected in earlier periods, for example, the period 1955 to 1971 in Hamilton County, even though the bounty record (1955 to 1971) indicates a substantially higher ($P < 0.001$) harvest than the pelt tag record (1977-78 to 1981-82). The coyote fraction of the aggregate harvest of bobcats and coyotes has decreased. The home range size and diel movement patterns of Adirondack bobcats is substantially greater than Catskill bobcats. An extensive (63.2%) and arrhythmic activity pattern probably makes bobcats more vulnerable to big game hunters than most other furbearers. Yearlings outnumbered juvenile bobcats in the age structure of harvested bobcats from southern New York each season from 1977-78 to 1979-80 while the harvest increased during this period. Dispersal aged animals may be over-represented in a highly exploited population. Assuming that the distribution, harvest levels and manner of exploitation remain generally unchanged, it is likely that the immediate future of New York bobcats is secure. Modification of existing management practices may be warranted to optimize the value of the bobcat resource. Such modifications can be tested on a small scale.

BACKGROUND: See attached manuscripts

PROCEDURES: See attached manuscripts

FINDINGS: See attached manuscripts

ANALYSIS: See attached manuscripts

RECOMMENDATIONS: This job has been terminated. The attached manuscripts will serve as the final report for this job as well as for Jobs XII-1, XII-2, and XII-3.

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PART A: PREDATION ECOLOGY, MOVEMENT PATTERNS AND HABITAT OF BOBCATS IN NEW YORK

Abstract: The ecology of the bobcat (Lynx rufus) was studied by snow-tracking and radio telemetry of individuals on 4 study areas in New York. This information supplemented data obtained from the necropsy of 247 carcasses collected statewide between October 1976 and April 1980. White-tailed deer (Odocoileus virginianus) and lagomorphs were the principle diet components of New York bobcats, occurring in 32% and 30.2% respectively of the 169 bobcat stomachs that had food items. No significant differences ($P > 0.05$) were detected in the diets of bobcats compared by age, sex or region. Deer were utilized significantly more ($P < 0.001$) in the winter than during either the summer or fall. Bobcats fed predominately on young-of-the-year deer (10 of 13) and were known to kill 7 of these animals, 5 with bites to the throat and 2 with bites on the side of the neck at the base of the skull. An index to bobcat condition, which was the ratio of the dry weight to the fresh weight of the femur marrow, expressed as a percentage, suggested that juveniles and females in the Adirondacks undergo a period of negative energy balance during the late winter. The Catskill bobcat femur fat index did not show this trend. The mean home range of Adirondack bobcats was extremely large; 325.7 ± 61.1 ($\bar{X} \pm SE$) km^2 for 4 males and 86.4 ± 28.6 ($\bar{X} \pm SE$) km^2 for 4 females. The mean home range of 2 adult males in the Catskills was 36.0 ± 28.5 ($\bar{X} \pm SE$) km^2, whereas an adult female had a home range of 31.0 km^2. The minimum estimated diel travel distance of Adirondack male bobcats was 3.03 ± 0.2 km ($\bar{X} \pm SE$) which was significantly greater ($P < 0.001$) than the 0.93 ± 0.1 km observed for Catskill male bobcats. Similarly, the Adirondack female bobcats were found to travel 2.73 ± 0.2 km which was significantly greater ($P < 0.01$) than the 1.89 ± 0.2 km observed for the Catskill female. Bobcats generally selected lower elevations within their home range. Some cover types were utilized in excess of their availability within an individual's home range. However, this appeared to be individual preference rather than species preference within a region. New York bobcats were found to be arrhythmically active 63.2% of the times they were monitored.

PREFACE

Work conducted on Pittman-Robertson study number W-105-R, Jobs XII 1-4 and the corresponding jobs covered under Endangered Species Project E-1-3 have been consolidated into a single, two part final report. Part A, entitled: "Predation Ecology, Movement Patterns, and Habitat of Bobcats in New York", deals with the objectives of Job XII-1 and the portion of Job XII-2 pertaining to food habits. Part B, entitled: "Population Characteristics, Exploitation Indices, Distribution and Abundance of Bobcats in New York", deals with the objectives in Jobs XII 2 and 3.

Part A of this report has an extensive background section. This was believed to be necessary in view of the warning in M. Dyer's (1979) summary of the bobcat research conference, namely: "I have been concerned about the lack of rigor in the science as I have heard it in the past 3 days. There has been an overly casual attitude and the sloppy use of many concepts, terms, and units of measure. Without rigorous use of these, the backbone of any science, how can we continue to communicate effectively?" The background section contains a review of the literature and redefines terms and concepts which are used throughout the report, but were found to be imprecisely presented in some previously published papers. Data from major published findings have been tabulated using standard units of measurements to allow quick and direct comparisons rather than the customary descriptive approach.

A section designated "Findings and Analysis" has been prepared for Part A. The results of our work are presented first, immediately followed by the analysis, thereby eliminating the redundancy of restating the findings in a separate analysis section.

Management alternatives and recommendations for the bobcat resource in New York, the objective of Job XII-4, are synthesized into a single section entitled: "Recommendations."

The final report was written in this manner to provide a unified document of manageable size. Programs for the computer models used in the analysis, and peripheral data collected during the study are available upon request. It is my sincere wish that this document serve as a base upon which further refinements in our knowledge will be included and from which the management of this fascinating creature will be continually elevated.

ACKNOWLEGEMENTS

This project was accomplished with the cooperation and assistance of numerous individuals, only a portion of whom can be personally recognized in this space. Personnel from all levels of the N.Y.S.D.E.C. cooperated. Collection of carcasses and observation reports were coordinated at D.E.C. by M. Brown, S. Cameron, M. Ermer, M. Hall, R. Henry, L. Myers, B. Penrod, B. Sharick, and G. Will. Conservation officers throughout the state contributed to the project: special recognition is given to E.C.O.s M. Berrio, J. Ponzio, J. Volker, and E. Washburn for their assistance at the Western Catskill Study Area; M. Fey and J. Peck for assistance in western New York; and to the complete crew in Region 5. Wildlife pathologist, W. Stone, trained the author in tooth sectioning techniques, provided lab space and the use of equipment, and offered technical advice on numerous occasions. Assistance with trapping and handling techniques were provided by E. Davies and L. Birchelli. Furbearer specialist, G. Parsons, reviewed preliminary findings and provided insight for analysis of population dynamics.

Field work was assisted by wildlife technicians R. Masters and M. Tracy. In addition, S.U.N.Y. College of Environmental Science and Forestry work study students S. Adamczak Jr., J. Beeman, C. Beseth, E. Brickwedde, D. Kinney and G. Terzi assisted during the summer with trapping, telemetry, and activity monitoring. E.S.F. graduate students J. Fox, G. Goff, K. Gustafson, and J. Okoniewski are gratefully acknowledged for their cooperation in the field and lab and for their thought stimulating comments. The staff of the Huntington Wildlife Forest supported the project in innumerable ways. Directors W. Tierson and Dr. W. Porter encouraged and supported the project.

Access to private property was granted by all except one of the landowners from whom it was requested. Landowners often became enthusiastic participants in the study. For example, G. Ackerly donated over 4 days to guide the author to caves around which he had traditionally seen bobcat tracks, he contacted neighbors to obtain access permission for us, he helped with trapping efforts, and he even provided space in his home freezer for serum samples. The cooperation encompassed landowner conditions from small farms to large estates, and from hunting and fishing club leases to lands closed to all consumptive users. I am deeply indebted to these landowners.

The Catskill Chapter of Fur Takers of America provided funds to purchase additional study animals, and helped clarify some observation and harvest reports; special thanks is given T. Fisher. Members of the N.Y.S. Houndsmen Association assisted in efforts to capture bobcats for the telemetry study; special thanks are given D. Barber, B. Mason, and C. Tousant for the use of their hounds and much insight into the sport of hunting bobcats with hounds. Veterinary services were provided by D.V.M.s E. Becker, R. Lopez and G. Silverstein. The skills of H. Helms, T. Helms, and S. Short in flying small aircraft in all sorts of weather for the telemetry portion of the study are recognized. An essential modification of an APL plotting function was prepared by J. Thorton of the Syracuse University Computing Center.

Advice and encouragement was provided by a thesis committee consisting of Dr.s M. Alexander, D. Behrend, G. Mattfeld and N. Ringler. Dr. R. Brocke served as major advisor and functioned as supervisor and mentor throughout the study.

Primary acknowledgment is given to my wife, Jeanne, for the personal sacrifices she made, for help in all aspects of the work and for support during the disappointing periods of the study.

BACKGROUND

Little justification for a comprehensive study of bobcats in New York occurred prior to the initiation of this study in 1976. From either economic or recreational viewpoints, the bobcat had contributed very little to the state's wildlife resource values. The bobcat has not been a prime species for scientific research in the northeastern U.S.A., partly because it is uncommon. Merriam (1882:42) noted: "The wildcat is, for some reason, an extremely rare animal in the Adirondacks." Few specimens were collected under these conditions whereas bobcats were easily acquired in the south and west where densities were considerably higher (for a summary of the reported densities of bobcat in various regions, see Appendix 1). There has been a lack of research devoted to bobcats in New York, but as the price of bobcat pelts increased during the 1970's, as public sentiment changed towards placing higher aesthetic values on predators, and as the status of the bobcat changed from an unregulated species to a game species, the justification for a comprehensive study developed.

Cursory review of harvest data from bounty records in New York suggested that bobcat populations in some areas of the state had undergone a considerable decline. For example, Connors (1966) reported that the Tug Hill region was a local center of abundance for bobcats and that 98 animals had been bountied in the Tug Hill section of Lewis County during 1963 and 1964. Ten years later, Brocke and Zarnetske (1974) reported interviews with local guides and residents indicating that bobcats were apparently scarce in that area.

Food habits have been the most commonly studied aspect of bobcat predation ecology. Cottontail rabbits (Sylvilagus spp.) and various small mammals have generally been shown to be the most common food items throughout the range of the bobcat except along the northeast fringe of the bobcat's range. Studies conducted by Hamilton and Hunter (1939), Pollack (1951), Westfall (1956), and Stevens (1966) have documented the white-tailed deer (Odocoileus virginianus) to be the most important winter food item of bobcats in the northeast. Interrelationships between food habits and life history patterns have seldom been quantitatively analyzed. Seton (1929) speculated that food availability impacted bobcat home range size and density. Young (1958:49) observed the highest mean bobcat litter size of 3.13 during the year with the greatest small rodent, squirrel, and rabbit abundance whereas the mean litter size throughout the study period was 2.69. Bobcat predation on deer during the winter has been previously described (Marston 1942, Matson 1945) and its impact on deer populations assessed (Foote 1945, Banasiak 1961).

Factors causing a difference in prey utilization have been the topics of numerous speculations. Predator food habits are generally thought to change in response to prey abundance (Holling 1965). Lynx depend less heavily on snowshoe hare (Lepus americanus) and diversify their food habits when hare densities are low (Brand and Keith 1979). Changes in prey density do not always cause predictable changes in bobcat food habits. Jones and Smith (1979) were unable to show a significant change in bobcat food habits between periods that had significantly different lagomorph and rodent density indices. Kitten survival in Idaho has been related to rabbit numbers (Bailey 1974). The findings of Petraborg and Gunvalson (1962) suggest that Minnesota bobcats may suffer winter losses due to starvation.

Bobcat home range size has been found to be extremely variable. Home range sizes as small as 2.6 km^2 and 1.1 km^2 were reported by Miller and Speake (1979) for 6 males and 6 females respectively from southern Alabama, whereas Berg (1979) found the average home range size of 16 males and 6 females from northern Minnesota to be 62 km^2 and 38 km^2 respectively.

There is a lack of standardization in the literature for the terms used to describe movement patterns for bobcats. The terms: "core area", "center of activity", and "intensive use areas" have been applied by different authors to the same phenomena, namely a clumping in the distribution of relocation points. The term "intensive use areas", qualified for each type of activity (if known e.g. resting intensive use area, hunting intensive use area, etc.) is used in this report. Intensive use areas have been reported for three studies of bobcat movement patterns. Hall (1973) reported that 2 of the 3 male bobcats he followed in Louisiana had intensive use areas of 2.2 km^2 and 0.7 km^2 and that the other male had a 2 part home range. The 3 adult females he followed had intensive use areas with an average size of 0.17 km^2 (Hall 1973). Only 5 of 7 males and 4 of 5 females that Miller (1980) telemetered in southern Alabama had intensive use areas, the average of which were 0.15 km^2 and 0.18 km^2 for the males and females respectively. Two adult females telemetered by May (1981) in Maine had intensive use areas that averaged 0.54 km^2.

Distance traveled by bobcats in a 24 hour period has been labeled using similar terms expressing dissimilar concepts. For example, the linear distance between resting sites was termed "daily cruising radius" while the actual length of the trail between these sites was termed "daily hunting range" by Rollings (1942:21), however Erickson (1955:35) referred to the latter of these measures as "daily cruising range." I propose the following 3 terms to describe travel distances: (1) Actual Diel Travel Distance (ADTD) which is a measure of the actual length of route traveled by an individual in a 24 hour period, (2) Estimated Diel Travel Distance (EDTD) which is a measure of the sum of straight line distances between consecutive observed locations obtained at some specified standard interval of time over a 24 hour period, and (3) Minimum Estimated Diel Travel Distance (MEDTD) the linear distance between locations at 24 hour intervals. Travel distances described as ADTD can be measured by snow tracking or in the laboratory (see Kavanau 1971). The most common estimate of diel movement reported in the literature on bobcats is the category MEDTD, variously referred to as daily cruising radius (Rollings 1942:21), cruising radius (Erickson 1955:35), linear distance between consecutive daily radiolocations (Bailey 1974), net distance between daily locations (Kitchings and Story 1978), daily distance moved (Kitchings and Story 1979), and maximum distance between any two points in one day's movements (Guenther 1980).

A common assumption in the older literature appears to be that bobcats are uniformly nocturnal. Telemetry studies and laboratory experiments have revealed that bobcats may be active at any time (Kavanau 1971, Hall 1973, Miller 1980, Guenther 1980, May 1981). Studies that used snow tracking as the means of determining distances traveled and assumed that bobcats were nocturnal may have measured only a portion of the ADTD.

The bobcat is a generalist in regards to the various environmental conditions it is capable of utilizing. The list of habitats where bobcats have been studied includes low elevations in the humid bottomland hardwoods of the southeast (Hall 1973, Jenkins et al. 1979, Buie et al. 1979), conifer plantations of the southeastern coastal plains (Miller 1980), chapparral along the west coast (Lembeck and Gould 1979), conifer forest of the northwest (Brittell et al. 1979), various habitats including some at elevations over 2500 meters within the great plains (Bailey 1974, Blankenship and Swank 1979, Karpowitz and Flinders 1979), desert and shrub-steppe (Brittell et al. 1979, Zegulak and Schwab 1979), oak-hickory forest (Buttrey 1979, Hon 1979, Kitchings and Story 1978, 1979), and northern hardwoods and spruce-fir forest of the northeast and northcentral regions (Rollings 1942, Pollack 1949, Progulske 1952, Erickson 1955, McCord 1974, Berg 1979, May 1980, Maclaughlan 1981).

PROCEDURES

Study Areas

Bobcats were studied in 4 locations in New York, 3 of which were in the Adirondack region and 1 was in the Catskills. The Central Adirondack Study Area (CASA) is located in western Essex and eastern Hamilton counties near the community of Newcomb, NY. This area includes a mixture of state and privately owned lands. The privately owned lands are intensively managed for pulp (both hardwood and conifer) and sawtimber. For example, one 15,000 ha portion has averaged 0.8 and 0.2 tons per acre per year of hardwood and softwood pulp respectively and 0.02 and 0.01 thousand board feet per acre per year of hardwood and softwood sawtimber respectively during the period 1971-1981 (M.J. Tracy 1982, pers. comm.). Hunting, fishing, and trapping privileges are commonly leased to sportsmen groups by forest landowners. Use of state owned lands are restricted with no logging operations permitted; these lands are open to the public for hunting, fishing and trapping. Much of the state owned land had been logged, predominately for white pine (Pinus strobus) and red spruce (Picea rubens) before the land was acquired by the state. The influence of this type of cutting on the resulting stand composition has been shown to substantially reduce the red spruce component (Simon 1979:42).

The forest in the CASA is predominately SAF (Society of American Foresters) forest cover type 25 (i.e. sugar maple-beech-yellow birch) with interspersed areas of SAF forest cover type 33 (i.e. red spruce-balsam fir). The conifer component of the forest is dominant along water courses in wet sites and on mountain tops. The understory is composed of a variety of shrubs and seedlings with witch-hobble (Viburnum alnifolium), striped maple (Acer pennsylvanicum) and beech(Fagus grandifolia) often dominating the less disturbed hardwood understory sites. Raspberry (Rubus spp.) predominates where logging has recently opened the canopy.

The Northwestern Adirondack Study Area (NASA) is located in western Franklin and eastern St. Lawrence counties, in the vicinity of Paul Smiths, NY. This study area is predominately in private ownership, with large estates forming the nucleus of the area. The NASA is generally lower in elevation than the CASA. Hardwoods are scattered at higher elevations, while spruce-fir stands dominate the lower elevations. Fire had been a major factor in the development of the current stands. Numerous openings with bracken fern (Pteridium aguilinum) and blueberry (Vaccinium spp.) have developed since the severe fires at the turn of the century. Speckled alder (Alnum rugosa) thickets and swales border the numerous small streams of the area.

The Western Adirondack Study Area (WASA) is located in western Hamilton and eastern Herkimer counties in the vicinity of the Moose River Recreational Area, south of the village of Inlet, NY. Extensive cutting and salvage operations occurred in this area after a hurricane in 1950. Much of this land was subsequently acquired by the state. Dickinson and Severinghaus (1969) provide a brief history of the area. Bobcat hunting with hounds has been common on this area since the mid 1950's. An extensive network of groomed snowmobile trails provides easy access for these hunters.

The Western Catskill Study Area (WCSA) located in eastern Delaware and northwestern Ulster counties in the vicinity of the community of Margaretville, NY includes a mixture of forested areas and farm land. The forested lands are predominately hardwoods but with a greater diversity of species than the Adirondack study areas. Northern red oak (Quercus rubra), black cherry (Prunus serotina) and American basswood (Tilia americana) are common. Much of the land had once been cleared for farming or grazing. Recently abandoned farmland and pastures are dominated by hardhack (Spiraea tomentosa) and hawthorn (Crataegus spp.). Red maple (Acer rubrum) and white ash (Fraxinus americana) are common in areas that have been abandoned longer. Stone fences, a common feature of the wooded hillsides, are an indication of the extent of former clearings. Dairy farms are common, active farms generally occur in the valley bottoms or flat areas of the upland. Rock out-croppings with numerous ground dens and caves, are located at the higher elevations of the area.

Predation Ecology

Indices of abundance were obtained for the 3 most common categories of prey utilized by bobcats in the northeast; namely deer, lagomorphs, and small mammals. The number of adult male deer harvested per 100 km^2 of deer range was used as a regional deer population index. This index is useful in comparing annual trend of deer populations within a region, however comparisons between regions are hampered because of regionally different harvest pressure.

Snowshoe hare and small mammal populations were monitored only at the CASA. Snowshoe hare populations had been monitored at the CASA since 1970. Approximately 66 ha were intensively trapped during March 1978 in an effort to enumerate all hares. Pellet counts were made on this tract and used to estimate hare population densities.

Small mammal populations were monitored annually by snap trapping during July. Representative habitat types were sampled using 2 or more trap lines per type. A total of 10 trap stations spaced 15 meters apart were located along each trap line. Trap stations were permanently marked for use each year from 1977 through 1980. Three Victor mouse traps baited with peanut butter were spaced 1 meter apart at each station (spruce slopes, logged spruce-fir flats, unlogged spruce-fir flats, commercial clearcuts, wet meadows, unlogged mature northern hardwood and logged mixed hardwood-conifer forest were sampled for a total of 1920 trap-nights annually). The small mammal population index, expressed as the catch per 100 trap nights, was selected so as to provide information that could be compared with previous small mammal studies in the CASA.

Bobcat food habits were studied by analyzing stomach contents of harvested bobcats and scats collected in the field. Personnel from the New York State Department of Environmental Conservation (DEC) and the Adirondack Ecological Center (AEC) routinely picked up bobcat carcasses from hunters, trappers, and taxidermists throughout the state. Carcasses were kept frozen until they were necropsied at the AEC. Scats and stomach contents were washed, sorted, weighed and analyzed according to the procedures of Korschgen (1971). Prey were identified macroscopically whenever possible. A reference collection of teeth, bones, hair and feathers was developed to identify most of the prey species. Prey remains consisting of only mammal hairs were identified with the aid of published guides and keys (e.g. Mayer 1952, Stains 1958, Adorjan and Kolensky 1969, Moore et al. 1974). Bait and debris obviously ingested by trapped bobcats were not considered food items.

Bobcat winter predatory behavior was inferred from snow tracking bobcats during the winters of 1977-78 through 1979-80. Telemetered bobcats were generally backtracked to reduce disturbance. A reduction in the daily movement patterns of telemetered bobcats was observed to be associated with feeding upon deer. Hence, monitoring telemetered bobcats increased the chances of locating this prey item.

Age and physical condition characteristics of deer killed or fed upon by bobcats was quantified in an effort to shed light on the predatory behavior of bobcats on their most important (based on previous food habits studies in the Northeast) food category. Tooth wear and replacement was used to estimate deer age (Severinghaus 1949). A condition index, the percent dry matter of oven dried marrow samples, was assigned to deer (Nieland 1970). The same condition index technique was appled to bobcat carcasses.

The year was divided into 4 periods to analyze seasonal changes in bobcat behavior. These periods are defined as follows: fall is the period from September 1 through November 30; winter is the period from December 1 through March 31; spring is the period from April 1 through May 31; and summer is the period June 1 through August 31. Differences occur in phenology between the Adirondack and Catskill regions. Season dates were selected after data were collected. Few data were collected in the WCSA during transition periods between seasons. A compromise on the dates of seasons favoring Adirondack phenology was made

Movement Patterns

Bobcats were captured in leg hold traps, confined in a tangle net, and immobilized with ketamine hydrochloride (Hime 1974, Mach and Siwe 1977). During the open season, cooperation of private trappers under special permit was enlisted to live trap bobcats for telemetry. Project personnel generally removed trapped bobcats from cooperator's traps; cooperators were paid $200 per bobcat. An upper molar was extracted to aid in age determination. Standard body measurements and the weight of each study animal was recorded. All bobcats used in the telemetry study were released at the site of their capture.

Movement patterns of bobcats were studied using standard radio-telemetry techniques (Masters 1978, Cochran 1980). Three types of transmitter packages were used; the average weight was 225 g and they transmitted between 150 and 152 MHZ. Transmitter model SB-2 was powered with a lithium battery and had an expected life of 18 months (AVM Instrument Co., Champaign, IL). Transmitter model LT43-2M-LD was powered with a lithium battery, had an expected life of 12-18 months, and had a motion sensitive switch, whereas transmitter model RS100-2TM-6X was solar powered and had a life expectancy of 5 years (Telemetry Systems, Milwaukee, WI). An AVM model LA12 receiver, yagi antenna and hand held compass were used to determine the azimuth bearing.

Telemetry locations were assigned Universal Transverse Mercator (UTM) coordinates. Generally 3 or more azimuth readings with angle separations greater than 30° were obtained for each telemetry location. Subjective judgement was used to reject azimuth readings in areas where false signal peaks were common. U.S.G.S. topographic maps (1:24,000 or 1:56,000 scale) were used as base maps for field work. The center point, expressed in UTM coordinates of the polygon formed by the intersecting azimuth readings was estimated to the nearest 0.1 km.

UTM coordinates for each bobcat were chronologically ordered in vectors and analyzed with a system of computerized home range models written in APL. The programs (i.e. APL functions and subfunctions) allow a user numerous options to tailor an output for specific purposes.

Various approaches were used in this study to measure and analyze movement patterns. The subject is complex as Sanderson (1966) observed, namely; "No one technique for determining location and no one technique for analyzing data give the best answer for all species and all situations". From the variety of techniques available, 4 were selected. The convex polygon (Mohr 1947) was chosen because it has been used extensively and serves as a basis for comparisons between our findings and published findings. Elliptical home range models were selected to provide unbiased estimates of area with regards to sample size (Jennrich and Turner 1969) and non-circular orientation of the home range (Sokal and Rohlf 1969:528). A harmonic mean home range model (Dixon and Chapman 1980) was selected because it is useful in describing intensive use areas and a bivariate normal distribution of data is not a required assumption.

The irregular convex polygon program, IRPOLY, sequentially obtains the coordinates of the outside points of the data using the law of cosines. The area of this, or any polygon whose coordinates are known, can then be calculated with the program AREA, which computes the area of a traverse by coordinates (Bouchard 1947:166).

The program SOKAL calculates the area of ellipses as described by Sokal and Rohlf (1969:528) and Jennrich and Turner (1969). For plotting purposes, 40 points are calculated on the 95% confidence ellipse of the data point distribution. Associated with this program are 4 statistical options to test the hypothesis that the distribution of original data is bivariate normal.

The program HM1 computes harmonic mean measures of an animals's home range. Grid size can be standardized for all individuals or specified differently for each individual. Isopleth values can be calculated for the percentage of the data points to be included within a home range or arbitrary isopleth values can be specified. HM1 includes options to perform the other home range programs and it creates an output matrix that can be used as an input to plotting programs capable of producing scaled axis overlays up to 76.2 by 635 cm in size.

A bobcat was considered active if the amplitude of its transmitter signal varied (for standard transmitters) or if the pulse interval changed (for transmitters with motion sensitive switches). Activity was recorded each time an azimuth reading was taken. Continuous monitoring of signal variation was periodically done with an Esterline-Angus (424A milli-amp) strip chart recorder. The signal from the external meter jack of the receiver was pre-amplified through 1 channel of a D.C. powered stereo amplifier prior to input on the recorder. Fifteen minute time intervals were the units of an observation. Each day was divided into 4 periods (i.e. night, dawn, day and dusk). Dawn and dusk were established as the 4 hour period centered on sunrise and sunset respectively.

Habitat Analysis

Three habitat classification systems were used to determine if telemetered bobcats utilized their home ranges at random. A tracing of an individual's home range was overlayed onto habitat maps. The boundaries of the habitats were traced and the habitat at each location for the bobcat was recorded, thus providing an observed frequency. Data points that occurred on habitat boundary lines were alternatively placed in adjacent categories. Each habitat type traced on paper was cut out and the total area of each habitat type was weighed with a Metler H20 analytical balance. An expected frequency was calculated by multiplying the total number of telemetry locations for the animal's home range by the fraction of the total weight that each habitat category within the home range comprised. Chi square goodnes of fit analysis was performed to determine if utilization was random.

Land Use and Natural Resource Inventory of New York State (LUNR) maps were purchased from the Resource Information Laboratory at Cornell University. The 1968 LUNR inventory is the only known data base derived from aerial photographs that includes the entire state. The system was chosen for its potential to aid in comparisons between regions. LUNR habitat types occurring within the study areas are described in Appendix 4.

The elevation at each telemetry location was estimated to the nearest 6 m (20 ft.). Each home range was divided into elevational zones specific for the area, such that an expected frequency of observation greater than 5 was obtained in the least prevalent zone.

A forest cover type and logging history habitat map of the CASA was initially developed for a deer movements study in Pittman-Robertson Project W-105-R, Job VI-5. This map was expanded to include the home ranges of bobcats in the CASA. Twenty one habitat categories were classified on this map, 15 were forested lands and 6 were non-forested or partially forested lands. The dominant tree canopy component of the forest categories was classified into 5 types, namely: softwood (S) where conifer species comprised at least 85% of the stand; softwood-hardwood (Sh) where the stand is basically coniferous with scattered deciduous trees that constitute between 15-40% of the stand; mixedwood (M) where conifer and deciduous components are evenly represented (i.e. 40-60% of the stand); hardwood-softwood (Hs) where the stand is basically deciduous with scattered conifer trees that constitute between 15-40% of the stand; and hardwood (H) where deciduous species comprised at least 85% of the stand. Each of these 5 types were further categorized in 3 stem sizes based on recent logging activities, namely: large pole-sawtimber (L) where stands had not been logged or less than 50% of the basal area removed and the trees were generally greater than 15m in height; small pole-sapling (S) where stands had not been logged or less than 50% of the basal area removed and the trees were generally less than 15m in height; and cut (CL) where stands had noticeable recent logging activity (i.e. 50% or more of the basal area had been removed since 1953). An example of the forested lands category designation is ShCL, denoting a softwood-hardwood area that had been logged. The 6 non-forested land categories were classified as: marsh (M) where wetlands had perennial vegetation; water (W) for lakes or ponds; open (O) for fields, pastures, gravel pits, etc.; softwood broken (SB) for areas that had not been recently logged but had space between scattered conifer crown; hardwood broken (HB) for areas that had not been recently logged but had space between scattered deciduous crowns; and mixed broken (MB) for areas that had not been recently logged but had space between the crowns of the mixed stand of conifer and deciduous species.

Means are presented with plus or minus one standard error. Comparisons of means have been made with Student's "t" test adapted for equal or unequal variance depending upon the sample variances. Chi-square tests were used to compare frequency distributions (goodness of fit) and to compare observed and expected relationship (contingency tables with Yate's corrections). Analysis of variance was performed using Statistical Analysis System (SAS) algorithms (PROC GLM or PROC ANOVA). An α level of 0.05 was chosen as the determinant of significance throughout this study. Lower probabilities of chance outcome are provided when appropriate.

FINDINGS AND ANALYSIS

Predation Ecology

Twenty four species of mammals and birds were identified in a sample of 169 bobcat stomachs (Table 1). Graphic representation of the diet of bobcats expressed as the percent by weight of stomach contents of male, female, and juvenile bobcats from the northern (Adirondack) and southern (Catskill and Taconic) areas of the state is presented in Figure 1. A comparison of these diets based on frequency of occurrence was unable to detect significant differences. Seasonal utilization of the various food categories, based on analysis of 85 scats and 169 stomachs, indicated that deer was significantly more prevalent ($P < 0.001$) in the diet during the winter than during either the summer or fall (Table 2).

White-tailed deer is the most important overall food item of New York bobcats. It was found in 32% of the stomachs, it comprised 35.7% of the total weight, and it was the most prevalent category in 3 of the 4 years stomachs were examined. This utilization was anticipated as deer had been reported as the most prevalent food item in other studies conducted in the northeast and north-central region (Hamilton and Hunter 1939, Westfall 1956, Erickson 1955, Progulske 1952). Although deer was not the primary food item reported by Pollack (1951), it occurred at the same rate (32%) in his sample ($n = 208$) as it did in this study.

Table 1. Food items in 169 bobcat stomachs collected in New York from 1976 to 1980.

Food Item	Frequency	% Weight	% Occurrence
Deer (*Odocoileus virginianus*)	54	35.7	32.0
Cottontail (*Sylivalagus* spp)	15	16.1	8.9
Snowshoe hare (*Lepus americanus*)	20	9.3	11.8
Leporidae	16	1.3	9.5
Sub-total Lagomorphs	51	26.7	30.2
Tree squirrel (*Sciurus spp*)	8	4.3	4.7
Red squirrel (*Tamiasciurus hudsonicus*)	9	2.0	5.3
Chipmunk (*Tamias striatus*)	4	1.4	2.4
Flying squirrel (*Glaucomys spp*)	4	0.7	2.4
Sub-total Squirrels	25	8.5	14.8
Red backed vole (*Cleithrionomys gapperi*)	10	0.3	5.9
Deer mice (*Peromyscus* spp)	8	1.12	4.7
Meadow vole (*Microtus pennsylvanicus*)	7	0.8	4.1
Southern bog lemming (*Synaptomys cooperi*)	1		0.6
Muridae	1		0.6
Microtinae	13	7.7	0.3
Unidentified mouse or vole	4	0.1	
Sub-total Mice and Voles	41	2.8	24.3
Muskrat (*Ondatra zibethicus*)	11	7.9	6.5
Beaver (*Castor canadensis*)	3	3.7	1.8
Porcupine (*Erethizon dorsatum*)	1	0.8	0.6
Woodchuck (*Marmota monax*)	1	0.4	0.6
Sub-total Other Rodents	16	12.8	9.5

Table 1. (cont.)

	Frequency	% Weight	% Occurrence
Raccoon (*Procyon lotor*)	6	7.3	3.6
House cat	2	0.3	1.2
Unidentified carnivore	2	0.4	1.2
Sub-total Carnivores	10		
Short-tailed shrew (*Blarina brevicauda*)	5	0.3	3.0
Unidentified shrew	9	0.1	5.3
Sub-total Shrews	14	0.4	
Unidentified Mammal	3		1.8
Ruffed grouse (*Bonasa umbellus*)	6	1.8	3.6
Domestic duck	2	1.3	1.2
Blue jay (*Cyanocitla cristata*)	2	1.1	1.2
Chicken	2	0.4	1.2
Pheasant (*Phasianus colchicus*)	1	0.5	0.6
Unidentified bird	7		4.1
Sub-total Birds	20		11.8
Grass	24	0.2	14.2
Insects	1		0.6

Figure 1. The percent by weight of stomach contents of male, female, and juvenile bobcats from the Adirondack (1976-1980) and combined Catskill-Taconic (1977-1980) regions of New York.

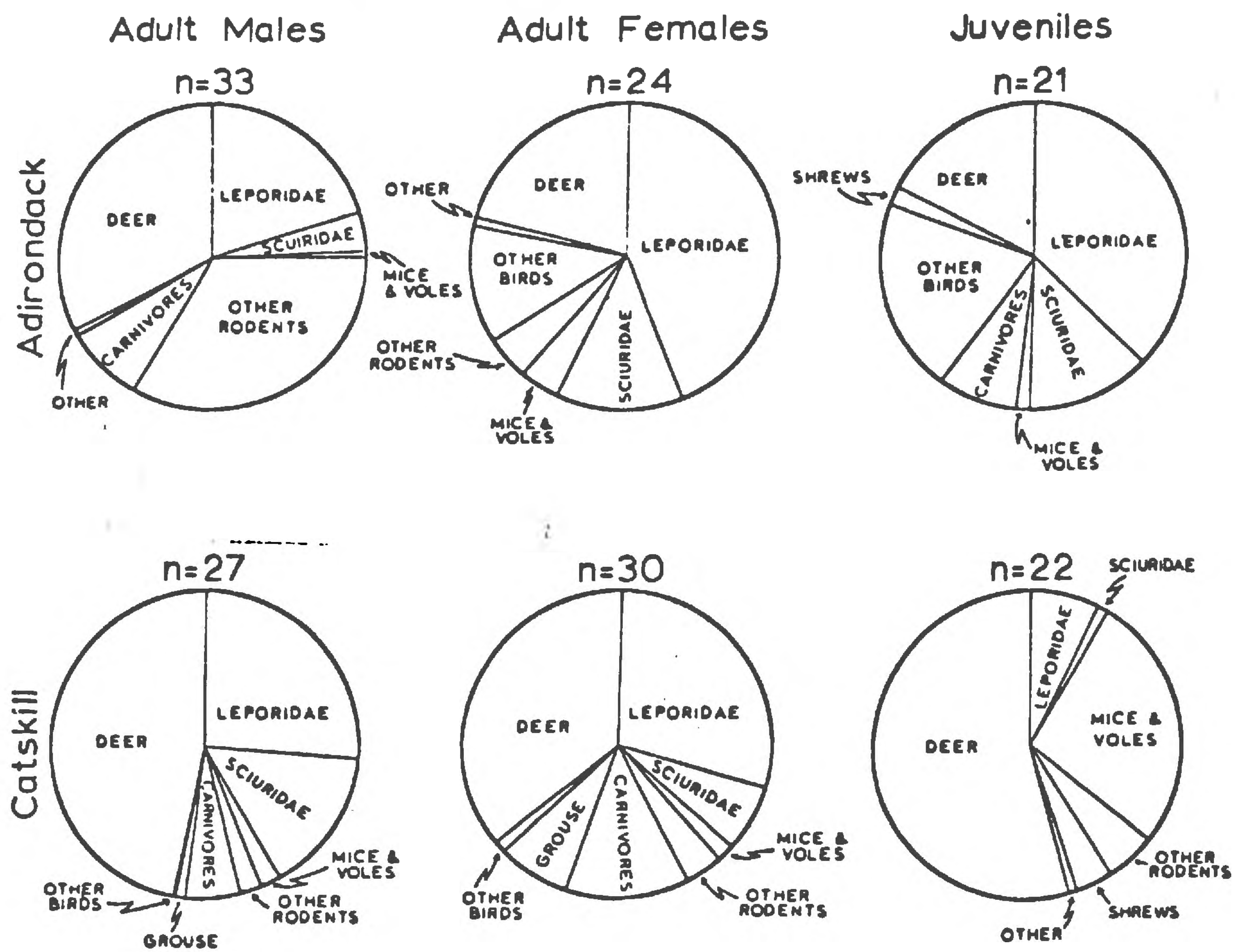

Adult Males
Adult Females
Juveniles
Adirondack
n=33
DEER
LEPORIDAE
SCUIRIDAE
MICE & VOLES
OTHER RODENTS
CARNIVORES
OTHER
n=24
DEER
OTHER
LEPORIDAE
OTHER BIRDS
SCIURIDAE
OTHER RODENTS
MICE & VOLES
n=21
SHREWS
DEER
LEPORIDAE
OTHER BIRDS
CARNIVORES
SCIURIDAE
MICE & VOLES
Catskill
n=27
DEER
LEPORIDAE
SCIURIDAE
CARNIVORES
MICE & VOLES
OTHER RODENTS
OTHER BIRDS
GROUSE
n=30
DEER
LEPORIDAE
SCIURIDAE
GROUSE
CARNIVORES
MICE & VOLES
OTHER RODENTS
OTHER BIRDS
n=22
SCIURIDAE
LEPORIDAE
MICE & VOLES
DEER
OTHER RODENTS
SHREWS
OTHER

Table 2. The percent occurrence of food items utilized seasonally by New York bobcats.

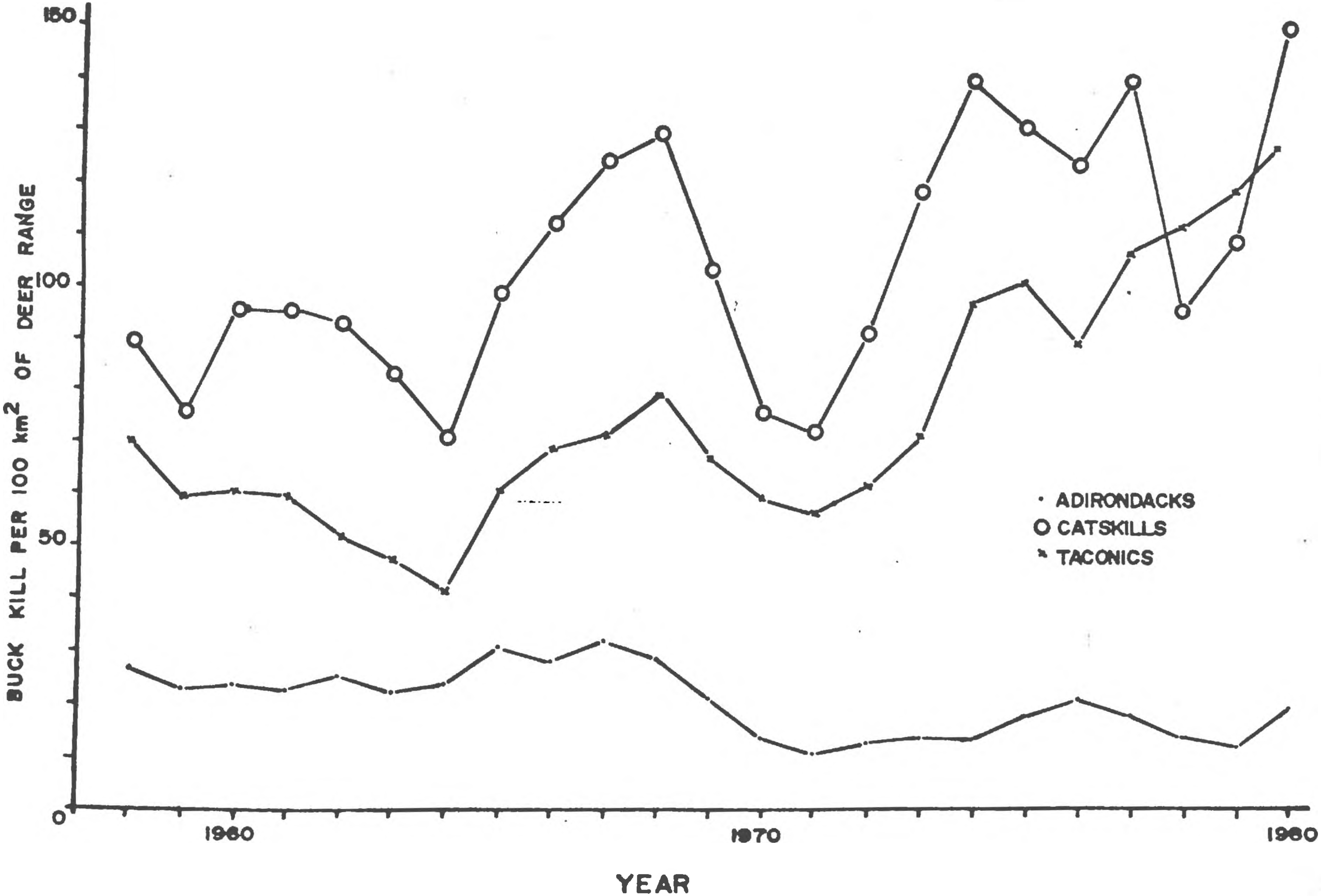
Food Categories	Summer (N = 22)	Fall (N = 122)	Winter (N = 93)
Deer	22.7	29.5	72.0
Lagomorphs	40.9	33.6	19.4
Squirrels	22.7	18.0	2.2
Mice and voles	22.7	25.4	8.6
Other rodents	9.1	10.7	2.2
Carnivores	4.5	2.5	4.3
Shrews	4.5	9.0	3.2
Grouse		2.5	1.1
Other birds	4.5	7.4	6.3
Misc.	4.5	0.8	1.1
Grass	4.5	14.8	3.2
Unknown		0.8	

Bobcat stomachs from the Adirondacks contained deer about as often (25.6%) as those from the Catskill and Taconic regions (37.1%). However, similar prevalence should be compared referenced to deer abundance. Deer density estimates from the Huntington Wildlife Forest (in the CASA) indicate that the pre-hunting season deer densities expressed in deer per km^2 were 3.1, 4.3, and 5.8 in 1978, 1980, and 1981 respectively, and had ranged from 1.9 to 10.4 in 1971 and 1966 respectively (Behrend et al. 1970, Sage and Weber 1982). Figure 2 shows an index (adult bucks killed per 100 km^2 of deer range) to deer populations. This index can not be compared directly between regions because of differences in harvest pressure, however the figure shows a legal harvest of adult bucks from the Catskill and from the Taconic that exceed the pre-hunting season density estimates of deer in the Adirondacks.

Few bobcat food habits studies have attempted to concurrently quantify the abundance of deer. South Texas bobcat stomachs (n = 51) contained 24.3% deer by volume in 1971 when cottontail rabbits and cotton rat (Sigmodon hispidus) populations were low but no deer was detected in 74 stomachs during 1972 when these alternative prey were abundant, even though the density of deer was approximately the same each year at 12.4 deer/km^2 (Beason and Moore 1977).

Deer accounted for 50% of the food items visited or fed upon and 56% of the prey items unsuccessfully attacked. Bobcat attempts to prey on deer were easier to detect than attempts on smaller species. Seven of the 17 deer carcasses visited by bobcats were determined to have been killed by bobcats whereas the extent of utilization of the other 10 carcasses precluded precise determination of the cause of death. The throat area was the focus of attack on 5 of the 7 deer killed by bobcats, and the other 2 deer were killed as a result of bites to the side of the neck at the base of the skull. Associated

Figure 2. Trends in deer population indices for three regional bobcat populations.


BUCK KILL PER 100 km² OF DEER RANGE
150
100
50
0
1960
1970
1980
YEAR
ADIRONDACKS
CATSKILLS
TACONICS

with the bites were minor facial lacerations caused by bobcat claws, especially near the nose.

The throat appears to be the focus of attack when felids tackle large prey. Bobcats have previously been known to attack the throat area when attempting to kill deer (Newsom 1930, Marston 1942, Matson 1948). Leyhausen (1979:115) observed several species of cats that killed prey with throat bites but stated: "The species which tend to a throat bite are all capable of killing with a nape bite as well." He qualified this observation by explaining that prey size and local traditions are the 2 factors that determine the various hunting and killing methods employed by the big cats (Leyhausen 1979:153). Lions (Pantherea leo) have been observed to kill small prey with bites on the back of the neck whereas large prey were generally attacked in the throat area (Schaller 1972:262-265). Large prey (22 cattle and buffalo) attacked by tiger (Panthera tigris) were always killed with throat bites (Schaller 1967:296). Schaller (1967:296) stated: "The throat hold as used by the tiger may be a special adaptation for dealing with large prey." This appears to be true for bobcat predation on deer. One deer killed with neck bites did considerable struggling before it was subdued.

The length of time that an undisturbed bobcat feeds on a deer carcass appears to depend primarily on winter weather and snow conditions, but may also be influenced by fat reserves of the bobcat and alternative prey availability. Telemetered bobcats restricted their movements to the area near deer carcasses (n = 7) an average of 12.6 ± 2.9 days during the winter of 1978-79. Bobcats trailed in the WASA killed deer (n = 4) and visited deer carcasses (n = 5) during the winter of 1977-78, however they did not restrict their movements to the vicinity of these carcasses during the period of observation when travel tended to be easy on crusted snow.

Bobcats were observed to cache deer at the location where the deer died. They generally cached deer by covering them with snow, leaves, and/or deer hair. Wet leaves were used to cover a deer carcass cached in a small stream. This deer is believed to have fallen into the stream when it died. The only observation of a bobcat moving a portion of a deer occurred at the edge of a talus slope. The front leg of this deer was found in a rock crevice approximately 10m from the carcass.

Seventeen deer carcasses were visited by bobcats. Age, sex, and physical condition was recorded from some of these carcasses. The deer were generally young, 10 were young of the year, 1 was a yearling, and 2 were adults. Three of the deer were males and 6 were females. The femur fat index of 6 deer was 63.2 ± 5.1, a value reflecting good physical condition. Bobcats killed some deer early in the winter (Jan. 4, 1979) when deer were in good physical condition.

Rabbits and hares occurred in 30.2% of the bobcat stomachs. Lagomorphs were the most important food category in the summer (40.9%) and fall (33.6%) periods. Lagomorphs were more frequently utilized in the Adirondack region (40.0%) than in the Catskill and Taconic regions (25.8%) but this difference was significant only at a low level ($P < 0.10$).

Cottontail rabbits do not occur in most of the Adirondack range of the bobcat whereas they are fairly numerous in most of the Catskill range of the bobcat. Predation was recorded 3 times on cottontail rabbits in the WCSA but no attempts were observed on snowshoe hare, even though hare sign was common, especially at higher elevations in that area. Bobcats in Massachussetts also appeared to utilize cottontail rabbits more than snowshoe hare (Pollack 1951).

The utilization of hares and rabbits by bobcats in New York was significantly less ($P < 0.05$) than the 60.1% level reported by Pollack (1951), but similar to the 22% level reported by Hamilton and Hunter (1939), Foote (1958) and Westfall (1956).

Snowshoe hare prey is generally available throughout the CASA. An estimated snowshoe hare population of 50 individuals on 66 ha (i.e. 76 hares/km^2) was determined by removing 42 individuals from the population between March 9, 1978 and March 26, 1978 and identifying an additional 8 individuals remaining in the area during 3 subsequent track searches. A mean pellet count of 30 ± 5.2 was obtained for 10 m^2 subsamples with 10 replications on this area after the snow melted. Pellet counts were taken on 6 mountain ranges and a mean March density of 70.1 ± 13.7 hares/km^2 was obtained. During the period 1970-74, Brocke (1974) determined the hare density of a site within the CASA to be 29.7 ± 2.5 hares/km^2 and observed that the pre-breeding hare population on the area was relatively stable. Central Adirondack snowshoe hare populations have among the lowest reproductive rates recorded, but high adult survival rates and high population densities in some locations (Brocke 1977). These populations do not fluctuate in numbers as is characteristic of hare populations in more northern regions (Keith 1963). Thus hares are an important stable prey base in the Adirondacks.

Mice and voles were found in 22.7%, 25.4%, and 8.6% respectively of the summer, fall, and winter samples of scats and stomach contents (Table 2), but these prey constituted only 2.6% of the stomach contents total weight. Catskill and Taconic juvenile bobcats utilized mice and voles significantly ($P < 0.05$) more than Adirondack juvenile bobcats. Southern red-backed vole (Clethrionomys gapperi) were identified in 10 of the 169 bobcat stomachs examined, whereas 8 individuals had eaten Peromyscus and 7 individuals had eaten meadow voles (Microtus pennsylvanicus). Although mice and voles are not extensively used by bobcats in New York, individual bobcats may feed upon them intensively. For example, a juvenile female bobcat taken in Washington County had a 116g mass of Peromyscus in her stomach that contained no fewer than 10 individual mice based on skulls. This bobcat had also consumed a short-tailed shrew (Blarina brevicauda). The percent occurrence of mice and voles in the New York sample is similar to that reported in other northeast and northcentral studies but lower than the occurrence reported in the southeast and west (Appendix 2).

Small mammal population trends at the Huntington Wildlife Forest as reflected by the catch/effort index, are presented in Table 3. This summary indicates dramatic population changes from year to year. The highest index of 21.94 small mammals/100 trap nights was recorded in 1977, whereas the lowest index of 1.04 small mammals/100 trap nights was recorded in 1962. Changes in this index may not be linearly related to population changes (Patric 1958).

From 1977 through 1980, 1080 small mammals were captured in 11,520 trap nights of effort at the Huntington Wildlife Forest. Annual changes in the small mammal index among 7 cover types is presented in Table 4. The variability in small mammal populations was significantly influenced by both year and cover type ($P < 0.0001$). There was a significant difference in the index each year ($P < 0.05$). The spruce slope (SL) and mature northern hardwood (HL and ML) cover types had the 2 highest small mammal indices of 20.6 ± 7.2 and 16.1 ± 4.0 respectively during the 4 year interval, whereas the average for the other 5 cover types was only 6.8 ± 1.5.

The species composition of the small mammal population, as presented in Table 5 showed some spectacular annual shifts. Direct comparisons between species are not valid because of the unknown magnitude of differential trap vulnerability, however comparisons of the annual index of a species between years are useful. For example, southern red-backed voles were captured at a rate of 13.13/100 trap nights and comprised 61.2% of the small mammals (n = 619)

Table 3. Historical trends in the small mammal catch per 100 trap-nights of effort at the Huntington Wildlife Forest.

Year	Trap Nights	Catch per 100 trap nights
1940[a]	3650	7.42
1941[a]	6000	8.07
1946[a]	120	12.50
1948[a]	540	15.93
1951[a]	5970	12.09
1952[a]	6120	13.82
1953[a]	8100	18.94
1954[a]	6300	12.78
1955[a]	6300	2.60
1956[a]	6300	3.44
1958[b]	4800	3.13
1959[b]	4800	21.88
1960[b]	4800	3.13
1961[b]	4800	17.71
1962[b]	4800	1.04
1963[b]	4800	17.71
1964[b]	4800	7.29
1965[b]	4800	12.50
1966[b]	4800	5.21
1967[b]	4800	11.35
1977[c]	2160	21.94
1978[c]	2160	3.84
1979[c]	2340	6.24
1980[c]	2160	10.28
1981[c]	2220	8.29

[a] First three days of trapping each year by Huntington Wildlife Forest Staff (Patric 1958).

[b] Four consecutive trap days, interpolated from graph. Unpubl. report at Huntington Wildlife Forest.

[c] First three days of trapping each year; data collected during this study.

Table 4. Annual changes in the small mammal catch per 100 trap-nights in various cover types.

Cover type	Year 1977	1978	1979	1980
Mature northern hardwoods (HL-ML)[a]	26.56	7.40	13.85	16.67
Mixed and conifer hardwood (MCL&ShCL)[b]	13.89	2.78	2.08	10.14
Spruce slope (SL)[c]	39.58	5.83	14.17	22.92
Unlogged conifer lowlands (SS)[c]	19.58	5.00	1.67	7.08
Logged conifer lowlands (SS)[c]	20.83	2.92	1.25	5.83
Clearcut[c]	20.00	2.92	3.33	4.58
Wet Meadow (M)[c]	9.58	1.25	0.00	0.42
Total	21.46	4.65	6.84	11.15

[a] Based on 960 snap-trap nights of effort annually

[b] Based on 720 snap-trap nights of effort annually

[c] Based on 240 snap-trap nights of effort annually

Table 5. Small mammal species composition changes (catch per 100 trap-nights index) at the Huntington Wildlife Forest, survey taken each July from 1977 to 1980.

Species	Year			
	1977	1978	1979	1980
Peromyscus spp.	3.92	2.22	3.89	6.70
Clethrionomys gapperi	13.13	0.21	0.66	2.26
Blarina brevicauda	2.74	0.14	1.11	1.11
Sorex cinereus	0.35	0.73	0.21	0.07
Sorex fumeus		0.03		
Microtus pennsylvanicus	0.63	0.07		
Microtus chrotorrhinus	0.07	0.14	0.03	
Synaptomys cooperi	0.35			
Napaeozapus insignis	0.07	1.01	0.83	0.55
Zapus hudsonius				0.03
Tamias striatus	0.21	0.10	0.10	0.76
Yearly total[a]	21.46	4.65	6.84	11.49

[a] Column total may be different from yearly total due to rounding error.

caught in 1977 but their population apparently declined greatly during the year as they were captured at a rate of only 0.21/100 trap nights and comprised only 4.5% of the small mammals (n = 134) caught in 1978.

Few examples of small mammal abundance indices and concurrent utilization have been reported. Comparisons between studies are difficult because various techniques have been used to survey small mammals. Small mammals are often trapped during the summer whereas bobcats are usually collected in the fall and winter. Accepting these limitations, the reported utilization (i.e. the percent occurrence and percent volume) of mice and voles does not appear to be directly related to an index of their abundance. In southern Alabama, mice and voles constituted 30.6% of the stomach content volume but small mammals were trapped at a rate of only 0.56/100 trap nights (Miller 1980). Small mammal populations were indexed for 2 years at 22.4/100 trap nights and 39.0/100 trap nights while the volume of these species in the diet of southern Texas bobcats was determined to be 52.7% and 73.5% respectively (Beason and Moore 1977). Small mammals were captured at a rate of 13.85/100 trap nights in Arizona yet they were found in 67% of the scats analyzed by Jones and Smith (1979) and were the most important prey category.

This study found no relationship between small mammal prey availability and bobcat population characteristics. Microtines are essentially unavailable to bobcats during winters with deep snow accumulations. The relationship between small mammal availability and bobcat utilization of these prey in the CASA was not tested because insufficient bobcat scats were found during summers. However, age specific reproductions and harvest age structure of bobcats in the Adirondacks (see Part B of this report) did not appear to vary with annual changes in small mammal prey. Because annual small mammal densities were observed to vary considerably, yet bobcat population characteristics did not vary, it seems appropriate to assume that food is not limiting to bobcats during the seasons when small mammals are available. This could be due to the availability of alternative prey or the result of sufficient small mammal prey even at their low density.

Bone marrow has traditionally been used as a physical condition indicator of ungulates (Harris 1945, Cheatum 1949) but has not been previously used as an indicator of physical condition of bobcats. Marrow has been characterized as a 3 component system comprised of water, fat, and non-fat residue (Bischoff 1954). The non-fat residue portion of the marrow has been shown to be a small fraction of the fresh weight in caribou femurs (Neiland 1970). The fat and water component of bone marrow are inversely related and nearly linear (Neiland 1970). The percent dry weight of the oven dried samples should therefore provide a reliable index of fat in the femurs.

Marrow samples were obtained from the femurs of 212 bobcats submitted for necropsy. Regional, seasonal, age, and sex comparisons were then made of a fat index consisting of the percent dry weight of the marrow. Figure 3 shows the divergences in this fat index that occurred between the Adirondack region and the Catskill and Taconic regions during the late winter, especially between adult females and juveniles. Yearly variations in the late winter fat index between the Adirondack region and the Catskill and Taconic regions are depicted in Figure 4.

Bobcats in the Adirondack region are stressed during the winter. Weights taken on bobcat bounties in St. Lawrence County during the period 1949-1955 suggest that this is not a new development. The average weight of bobcats taken in the months September, October and November was compared with the average weights of bobcats taken in February, March and April. A significant

Figure 3. The mean femur fat index ($\bar{X} \pm SE$) of adult males, adult females, and juvenile bobcats from the northern (Ɨ) and southern (⌶) regions of New York during the fall and winter period, 1976 to 1980. Center line indicates mean and vertical lines plus or minus one standard error.

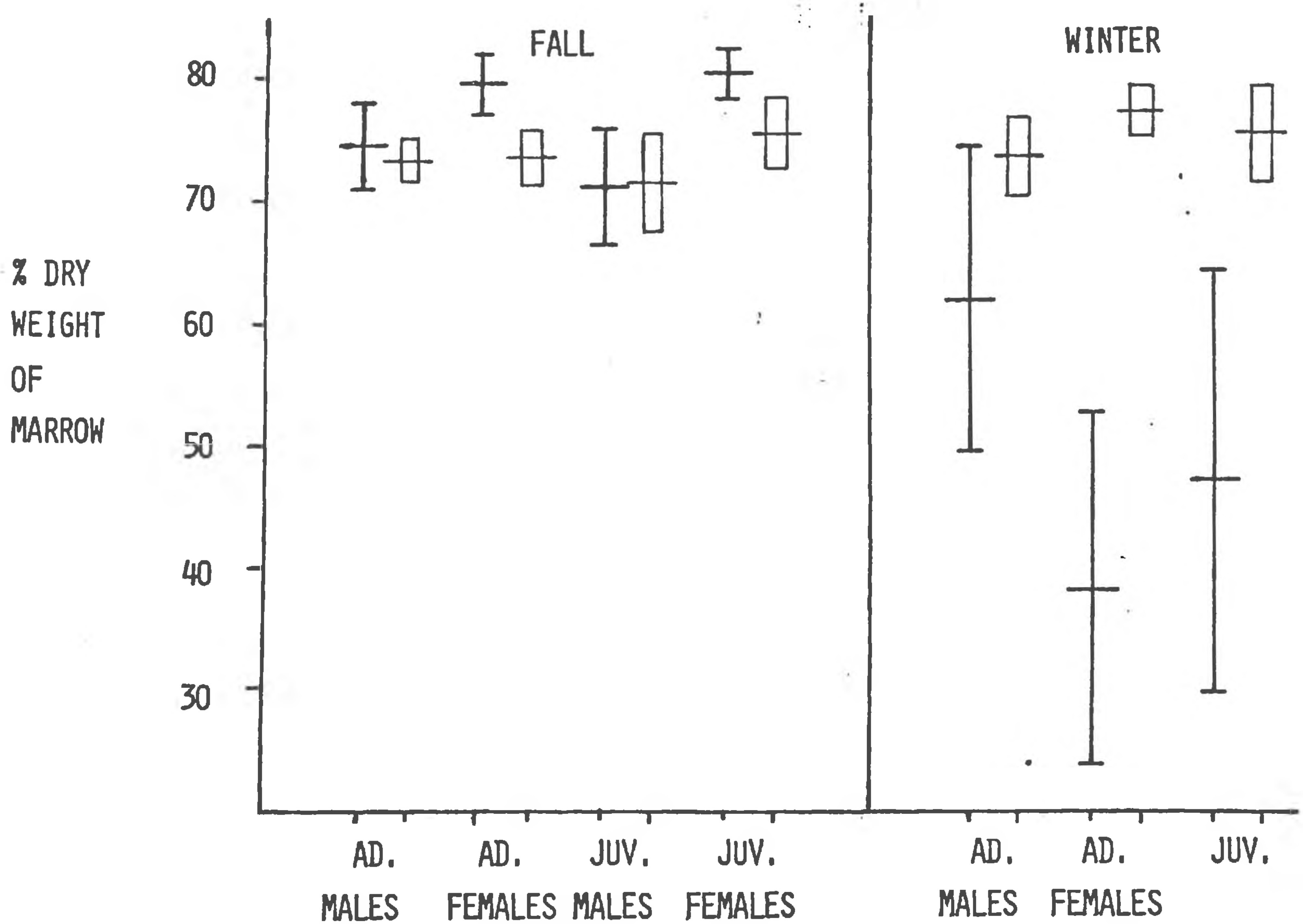
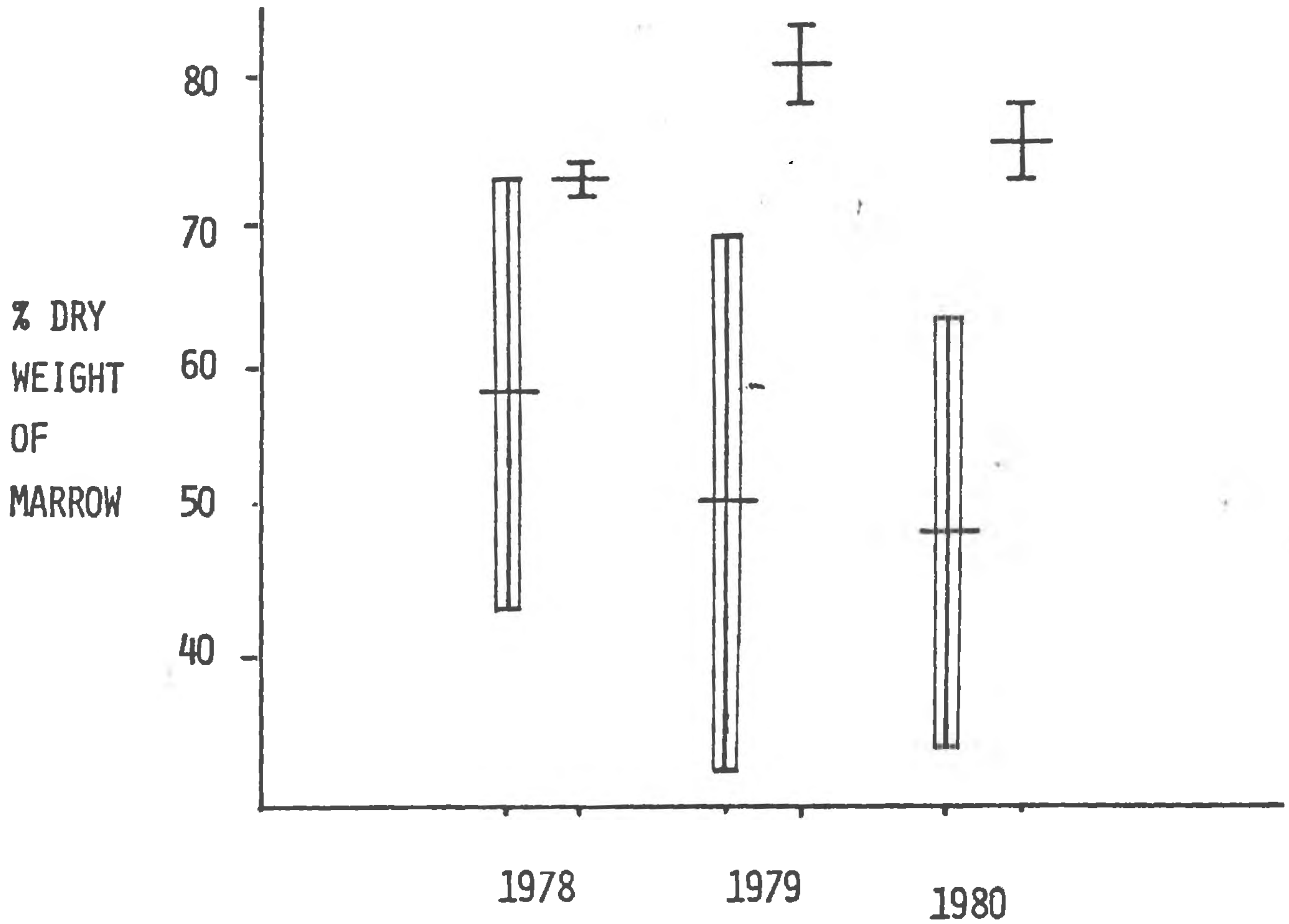

FALL
WINTER
% DRY
WEIGHT
OF
MARROW
80
70
60
50
40
30
AD.
MALES
AD.
FEMALES
JUV.
MALES
JUV.
FEMALES
AD.
MALES
AD.
FEMALES
JUV.

Figure 4. The mean femur fat index ($\bar{X} \pm$ SE) of bobcats during the late winter periods (January, February and March) of 1978, 1979, and 1980 for the northern (ǂ) and southern (▯) regions of New York. Center line indicates mean and vertical lines plus or minus one standard error.


% DRY
WEIGHT
OF
MARROW
80
70
60
50
40
1978
1979
1980

($P < 0.01$) difference was detected between the average fall weight of 9.59 ± 0.38 for 90 bobcats and the average late winter weights of 7.96 ± 0.41 for 49 bobcats.

Large prey or cached prey may be critical to winter survival under Adirondack conditions. Supporting this hypothesis is the observation that 3 telemetered bobcats known to have fed upon deer during the winter of 1978-79 all survived whereas 2 telemetered bobcats that died (one during the winter of 1979 and the other during the winter of 1980) were not known to feed on deer and did not restrict their movements as was characteristic of bobcats feeding on deer. A test of this hypothesis was made by comparing the femur fat index of bobcats known to feed upon deer (i.e. bobcats that died with a trace or more of deer in their stomachs) with bobcats that did not have deer in their stomachs at the time of death. Bobcats that did not have deer in their stomachs at the time of death might have benefitted from a diet of deer prior to their death. This potential error would make it more difficult to detect a difference. However, a significant ($P < 0.01$) difference was detected in the average femur fat index of 79.8 ± 4.7 for 2 bobcats known to be feeding on deer during the late winter in the Adirondacks and the average femur fat index of 47.4 ± 9.0 for 13 bobcats now known to feed on deer.

Movement Patterns

Data for 18 bobcats (7 males, 11 females) are given for the telemetry portion of the study. A summary of the characteristics and history of each animal is given in Table 6. Sufficient data were obtained for 9 bobcats to determine home range and habitat preference.

The size of each animal's total home range and the seasonal components of that area, as determined by the convex polygon method are presented in Table 7.

Figures 5 through 14 show the distribution of locations and the perimeters of the home range as described by the convex polygon, bivariate ellipse, and the harmonic mean home range models for 9 bobcats. Home range areas calculated by 4 methods are summarized by the sex and region of the individuals and presented in Table 8.

Home ranges described by the convex polygon method on 4 males and 4 female bobcats in the Adirondacks averaged 325 ± 61.1 km^2 and 86.4 ± 28.6 km^2 respectively. These are the largest bobcat home ranges ever reported. If only the central 75% of the locations were included and the harmonic mean home range model was used, the size of these home ranges would be estimated as 91.3 ± 16.3 km^2 for males and 49.6 ± 8.1 km^2 for females. The latter estimates would still exceed the largest previously reported home ranges of 62 km^2 for males and 38 km^2 for females calculated by the convex polygon method and reported by Berg (1979) for northern Minnesota.

The size of bobcat convex polygon home ranges in the Catskills were estimated to be 36.0 ± 28.4 km^2 for 2 males and 31.0 km^2 for 1 female. These values are comparable to home ranges reported in Idaho, Tennessee, and Missouri (Bailey 1974, Ketchings and Story 1978 and 1979, D.A. Hamilton, pers. comm.).

Bivariate normality, a vital assumption of an elliptical home range model, was found to be the exception rather than the rule in the distribution of telemetry points of bobcats in New York. The null hypothesis that the data had a bivariate normal distribution was rejected at the $\alpha = 0.05$ level for 6 of 10 individuals checked with the Kolmogorov-Smirnov test for univariate normality (Zar 1974:81) when this test was performed on data that had been rotated to the orientation of the major and minor axis of the ellipse. The distribution of telemetry points for those individuals that were rejected, generally lacked a central tendency which resulted in elliptical home range estimates being

Table 6. Characteristics and history of the bobcats acquired for the telemetry studies in New York State.

Bobcat # (Ear tag #)	Study Area	Age when captured	Sex	Weight, Kg	Total length mm	Tail length mm	Hind foot length mm	Ear length mm	Telemetry Locations	Date of contact	Fate
105 (105-106)	CASA NASA	2½	M	10.0	896	140	174	65	230	8/10/78-11/14/78	transmitter failure
306 (306-307)	CASA	7½	M	11.3	930	163	166	84	205	10/4/78-11/19/78	transmitter failure
51 (51)	NASA	2½	M	11.6					44	10/30/79-5/29/80	killed by dear hunter 11/24/81
67 (67-68)	NASA	1½	F	8.6	858	133	159	66	118	11/17/78-12/18/79	transmitter failure
65 (65-66)	NASA	3½	F	7.7	880	150	167	62	1	12/7/78-12/29/78	unknown
70 (70-72)	WASA	3½	F	7.3	815	126	150	61	7	11/20-78-2/15/79	found dead (emaciated)
69 (69-71)	WASA	3½[a]	F	7.7	815	125	159	65	1	11/11/78-11/30/78	unknown
73 (73-74)	CASA	1½	F	7.1	827	125	155	63	0	11/16/78-11/3078	died in captivity
452 (none)	CASA	1½	F	5.9	795	110	150	67	0	11/16/78-11/30/78	died in captivity
54 (54-55)	CASA	1½	F	6.8					71	10/17/79-4/8/80	found dead (emaciated)
454 (454-455)	CASA	2½	F	7.3	787	121	155	63	21	11/6/79-12/21/79	unknown
58 (58-60)	WCSA	5½	F	6.8	1086	160	156	63	73	12/14/78-4/21/80	transmitter failure
132 (132)	WCSA	Juv	F	5.0	708	140	152	66	6	11/7/79-11/21/79	killed by dear hunter 11/24/79
450 (none)	WCSA	10½	F	6.9	845	115	153	60	0	12/29/79-present	kept in captivity for bioenergetics study
61 (61-62	WCSA	Juv	M	5.0	679	135	160	63	4	11/25/78-1/20/79	slipped collar
133 (133)	WCSA	1½	M	8.2		160	152	60	23	11/28/79-4/21/80	unknown
53 (53)	WCSA	1½	M	8.7	865	163	157	60	21	12/15/79-4/21/80	killed by trapper 11/7/80
451 (none)	WCSA	Juv	M	1.9					0	11/5/80-present	kept in captivity for bioenergetics study

Table 7. Convex polygon size (km^2) of the home range area used during each season by bobcats in New York.

Bobcat #/ Study Area[b]	Fall Km^2(n)	Winter Km^2(n)	Spring Km^2(n)	Summer Km^2(n)	Total Km^2(n)
105/CASA	260.4(66)	234.9(68)	212.2(14)	15.2(54)	465.1(202)
105/NASA[d]					388.8(18)[a]
306/CASA	116.9(33)	141.2(37)	51.3(27)	119.3(76)	207.2(205)
	76.8(32)[a]				
51/NASA	28.3(7)	189.4(30)	56.7(7)		240.8(44)
54/CASA	36.1(18)	73.1(53)			73.1(71)
454/CASA	45.5(6)	41.9(15)			74.3(21)
70/WASA					31.3(7)[c]
67/NASA	16.0(3)	66.0(21)	28.7(17)	19.1(44)	166.8(118)
	82.0(28)	7.4(6)			
133/WCSA					64.4(23)[a]
53/WCSA					7.5(21)[a]
58/WCSA					31.0(73)[a]
132/WCSA					1.9(6)[c]

[a] Insufficient data to permit seasonal home range calculations.

[b] CASA - Central Adirondack Study Area
NASA - Northwestern Adirondack Study Area
WASA - Western Adirondack Study Area
WCSA - Western Catskill Study Area

[c] Insufficient data, area represents minimum estimate of home range size.

[d] A second home range was estimated for this individual after it dispersed over 70 km.

Table 8. Home range size (km^2) as determined by four techniques for bobcats in the Adirondack and Catskill regions of New York.

Method of home range determination	Adirondack		Catskill	
	males X ± S.E.	females X ± S.E.	males X ± S.E.	females X ± S.E.
Convex polygon	325.71 ± 61.09 n = 4	86.39 ± 28.62 n = 4	35.98 ± 28.45 n = 2	30.97 n = 1
95% confidence ellipse	624.47 ± 275.38 n = 4	272.30 ± 106.39 n = 4	125.28 ± 108.53 n = 2	45.67 n = 1
Jenrich and Turner	538.50 ± 212.28 n = 4	175.55 ± 29.90 n = 4	103.25 ± 89.69 n = 2	42.89 n = 1
Harmonic mean[a]	251.29 ± 53.21 n = 4	128.45 ± 29.68 n = 3	58.04 ± 37.05 n = 2	62.03 n = 1

[a] Harmonic mean algorithm with a 2.0 km grid spacing, and an isopleth value which included 95% of the data points.

Figure 5. Locations (Δ) determined by telemetry for adult male bobcat #105 on the CASA. Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.

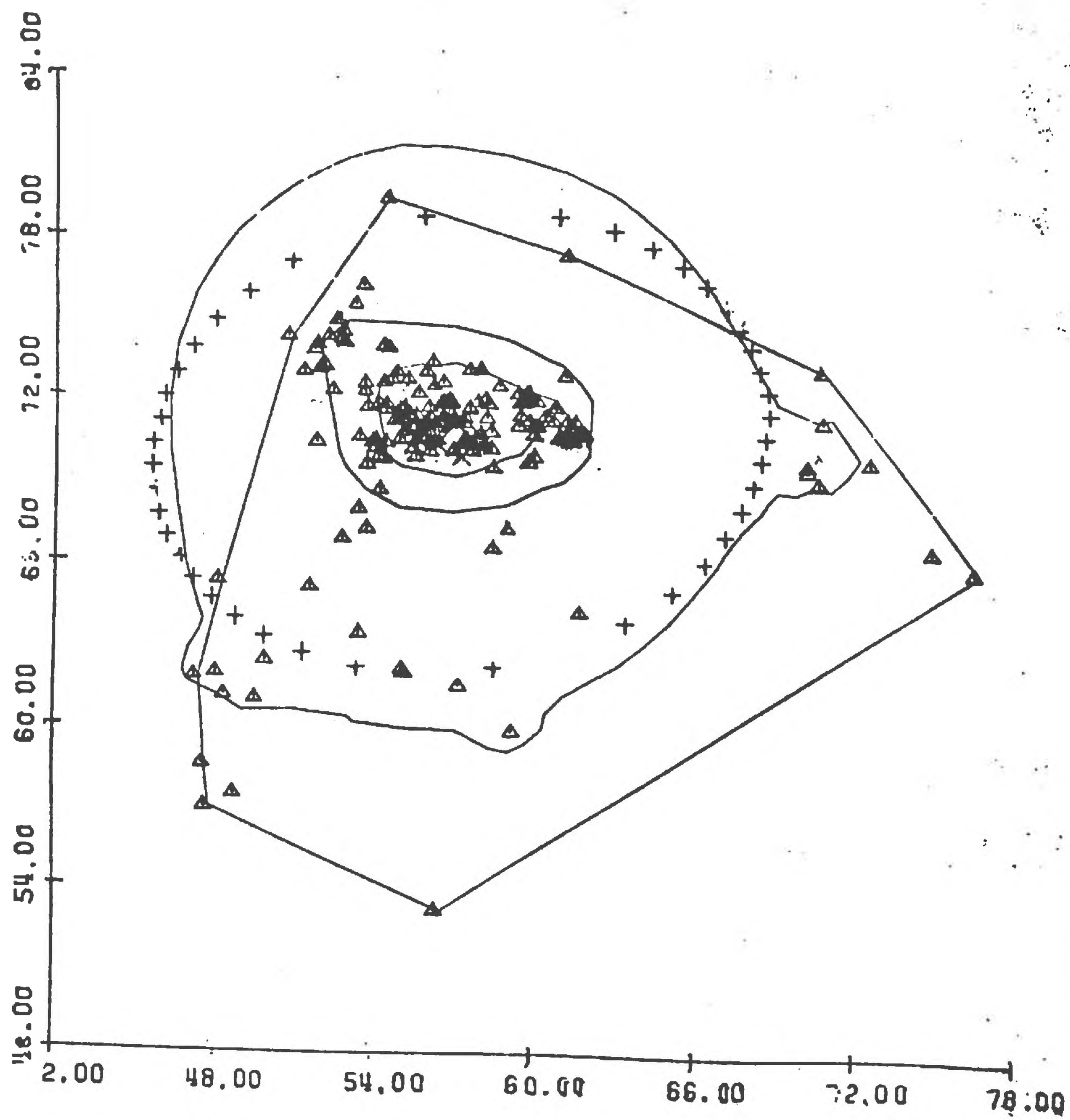
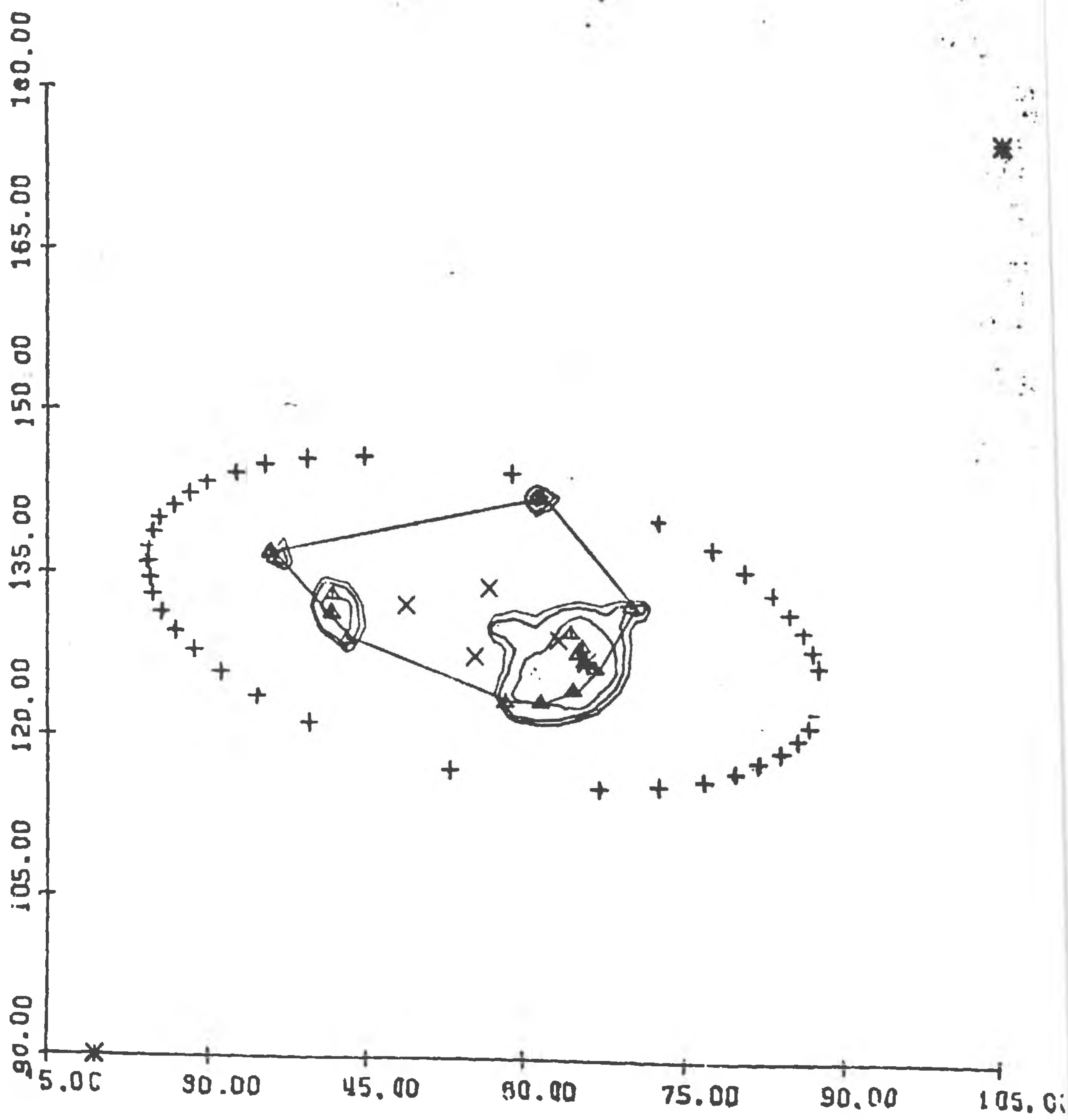

84.00
78.00
72.00
60.00
54.00
48.00
2.00
48.00
54.00
60.00
66.00
72.00
78.00

Figure 6. Locations (Δ) determined by telemetry for adult male bobcat #105 on the NASA Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.



180.00
165.00
150.00
135.00
120.00
105.00
90.00
15.00
30.00
45.00
60.00
75.00
90.00

Figure 7. Locations (Δ) determined by telemetry for adult male bobcat #306. Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.

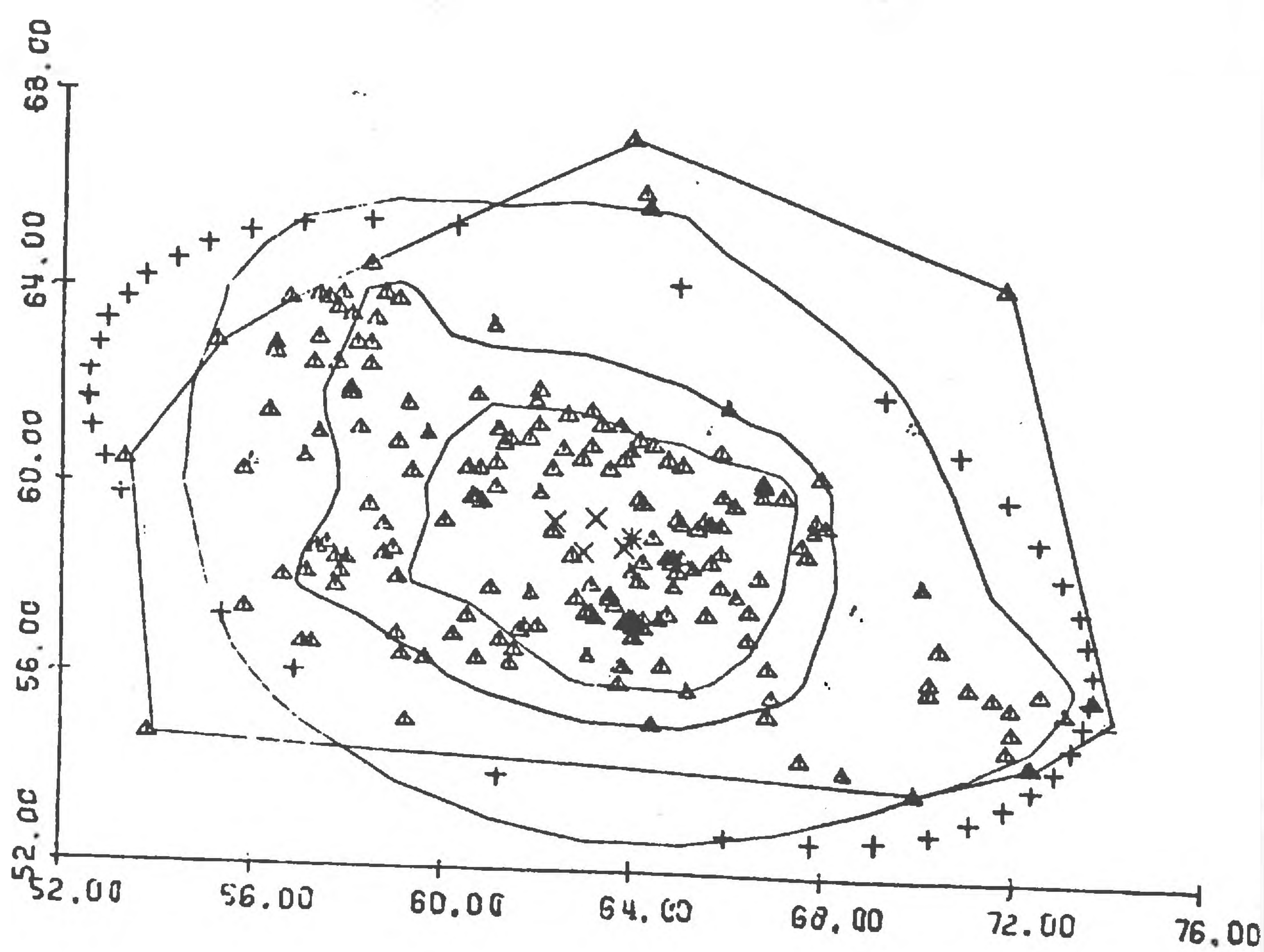

68.00
64.00
60.00
56.00
52.00
52.00
56.00
60.00
64.00
68.00
72.00
76.00

Figure 8. Locations (Δ) determined by telemetry for adult male bobcat # 51. Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.

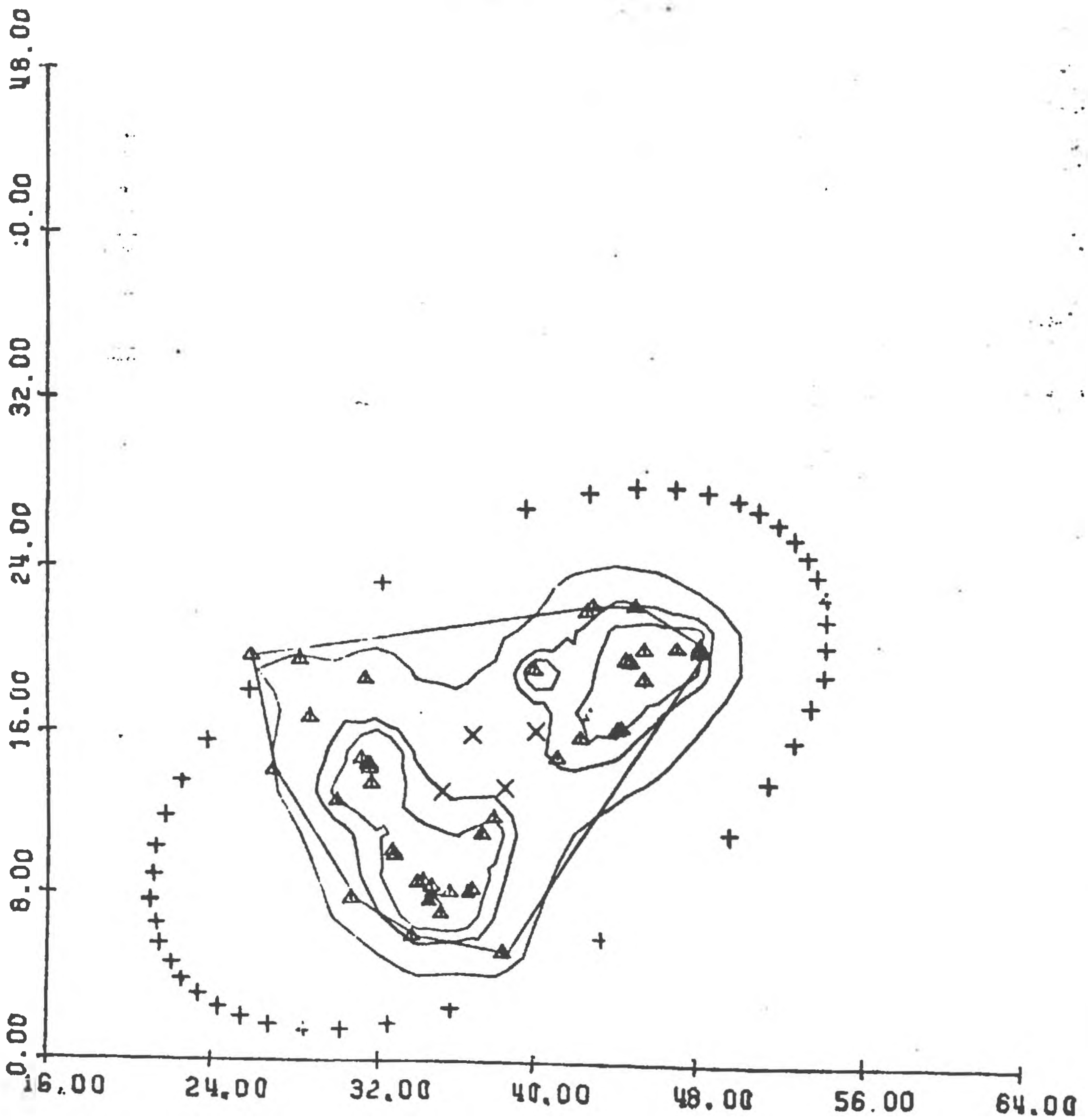

48.00
40.00
32.00
24.00
16.00
8.00
0.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00

Figure 9. Locations (Δ) determined by telemetry for adult female bobcat # 54. Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.

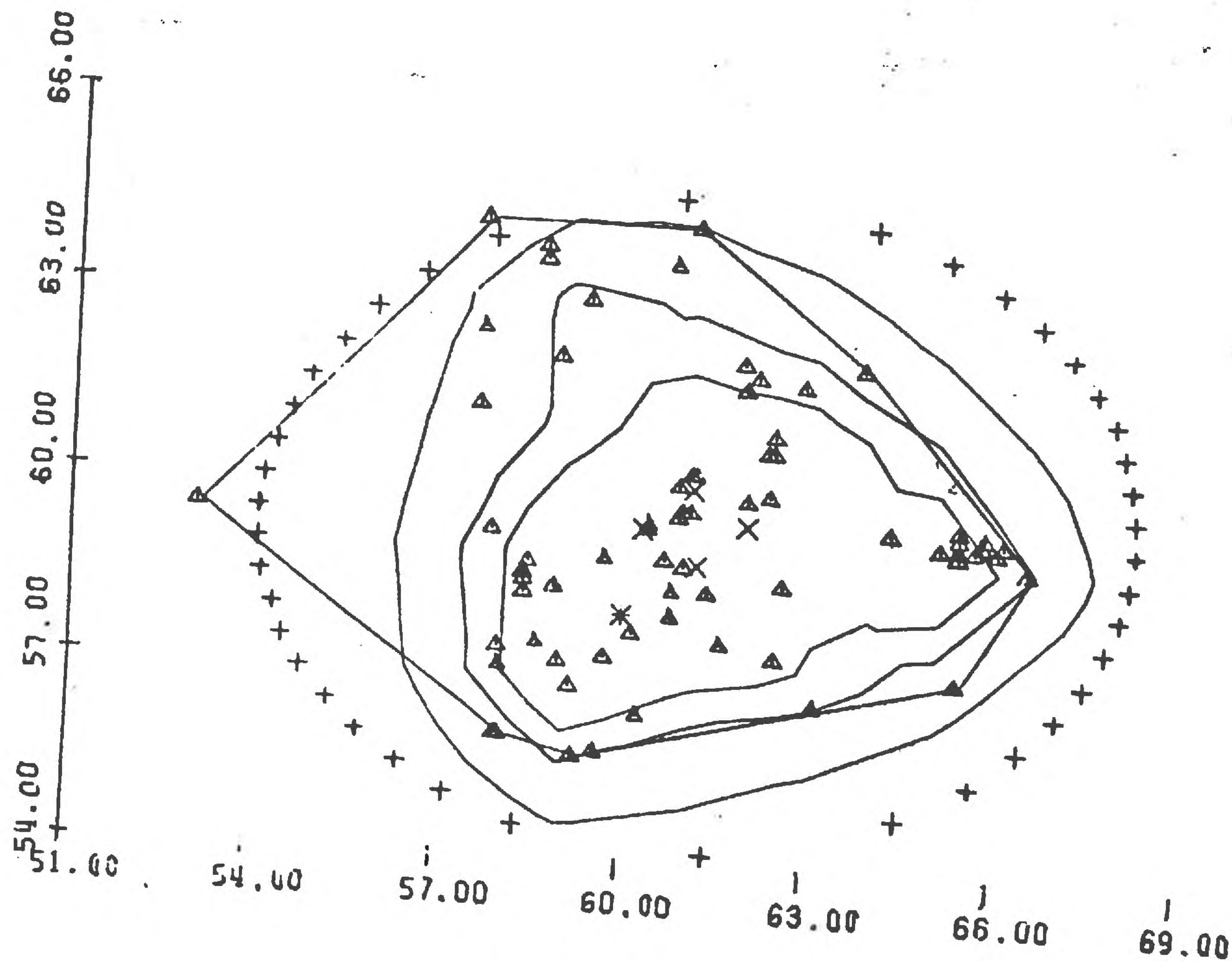
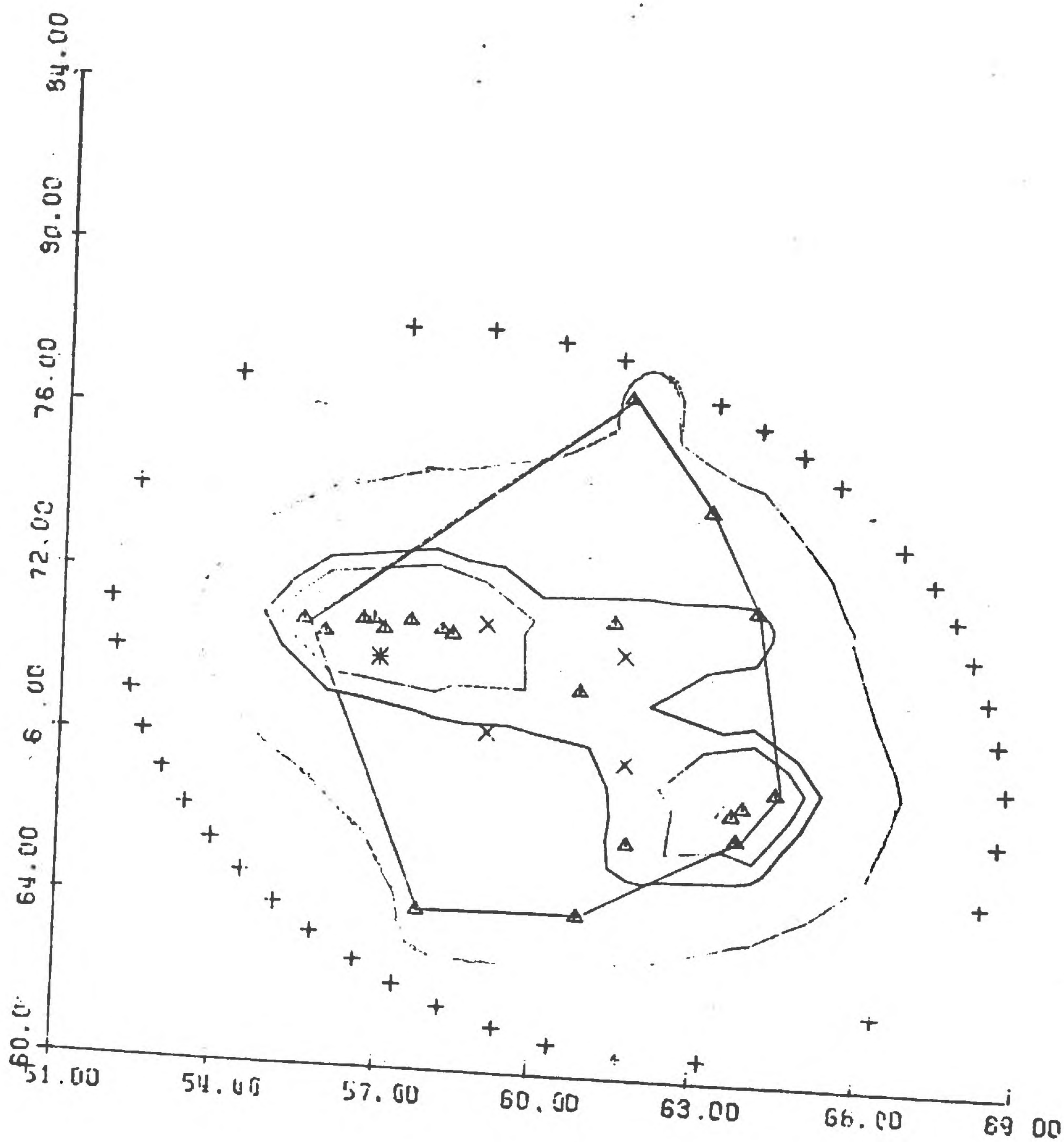

66.00
63.00
60.00
57.00
54.00
51.00
54.00
57.00
60.00
63.00
66.00
69.00

Figure 10. Locations (Δ) determined by telemetry for adult female bobcat #454. Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.



84.00
90.00
76.00
72.00
6 .00
64.00
60.0
51.00
54.00
57.00
60.00
63.00
66.00
69 00

Figure 11. Locations (Δ) determined by telemetry for adult female bobcat # 67. Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.

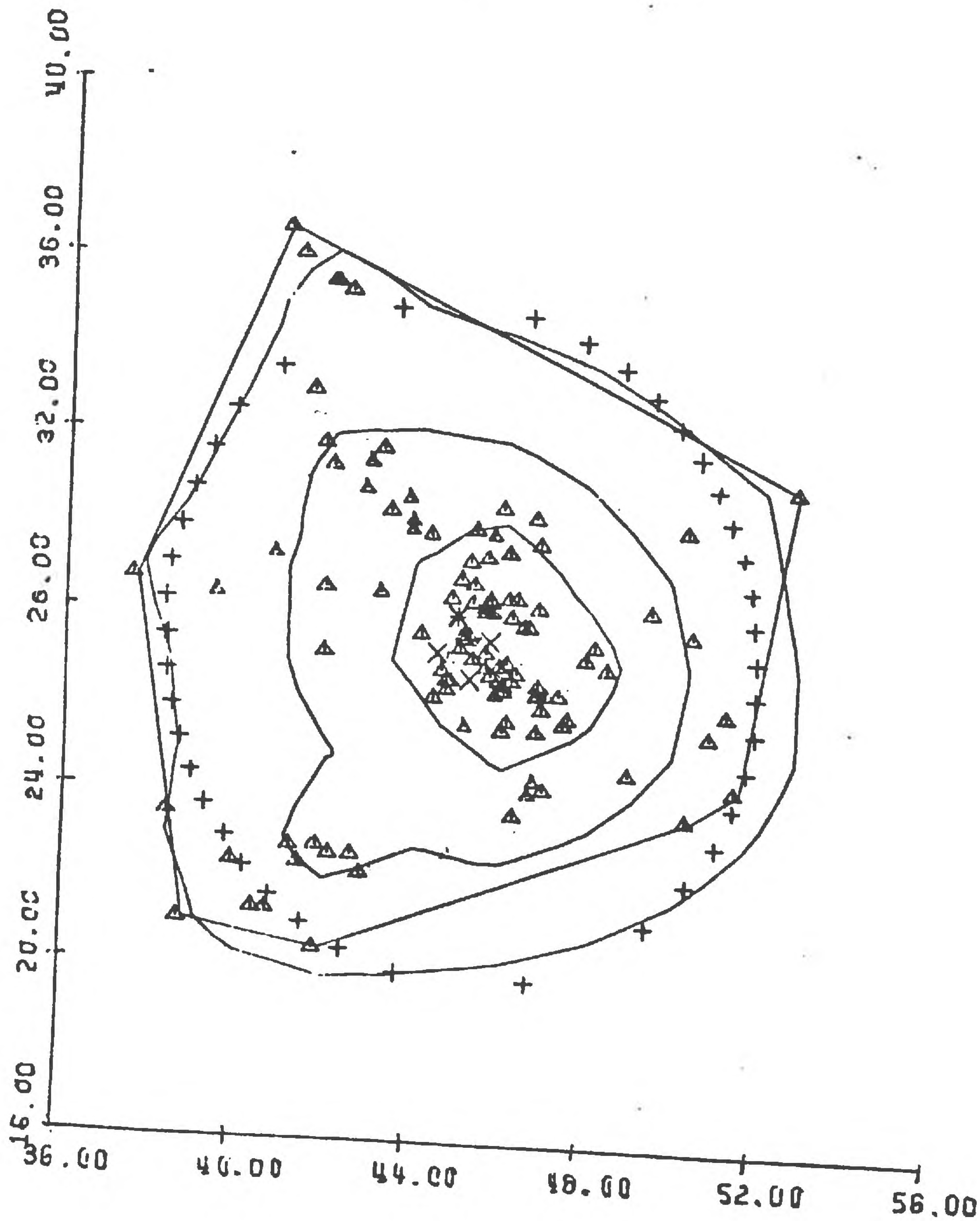

40.00
36.00
32.00
28.00
24.00
20.00
16.00
36.00
40.00
44.00
48.00
52.00
56.00

Figure 12. Locations (Δ) determined by telemetry for adult male bobcat #131. Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.

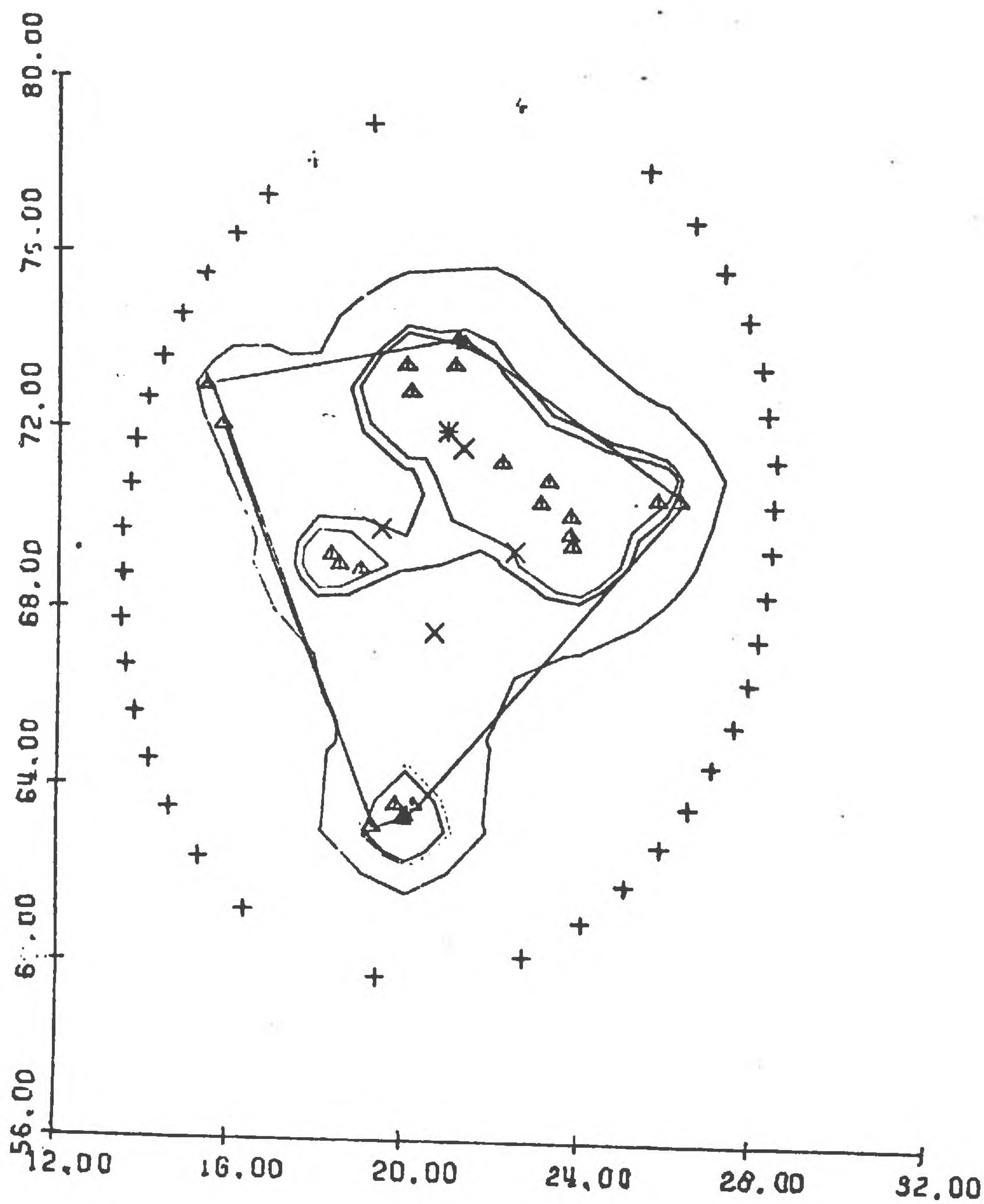

80.00
76.00
72.00
68.00
64.00
60.00
56.00
12.00
16.00
20.00
24.00
28.00
32.00

Figure 13. Locations (Δ) determined by telemetry for adult male bobcat # 53. Home range boundaries determined by the convex polygon method (Δ—Δ), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents one kilometer, values indicate UTM coordinates.

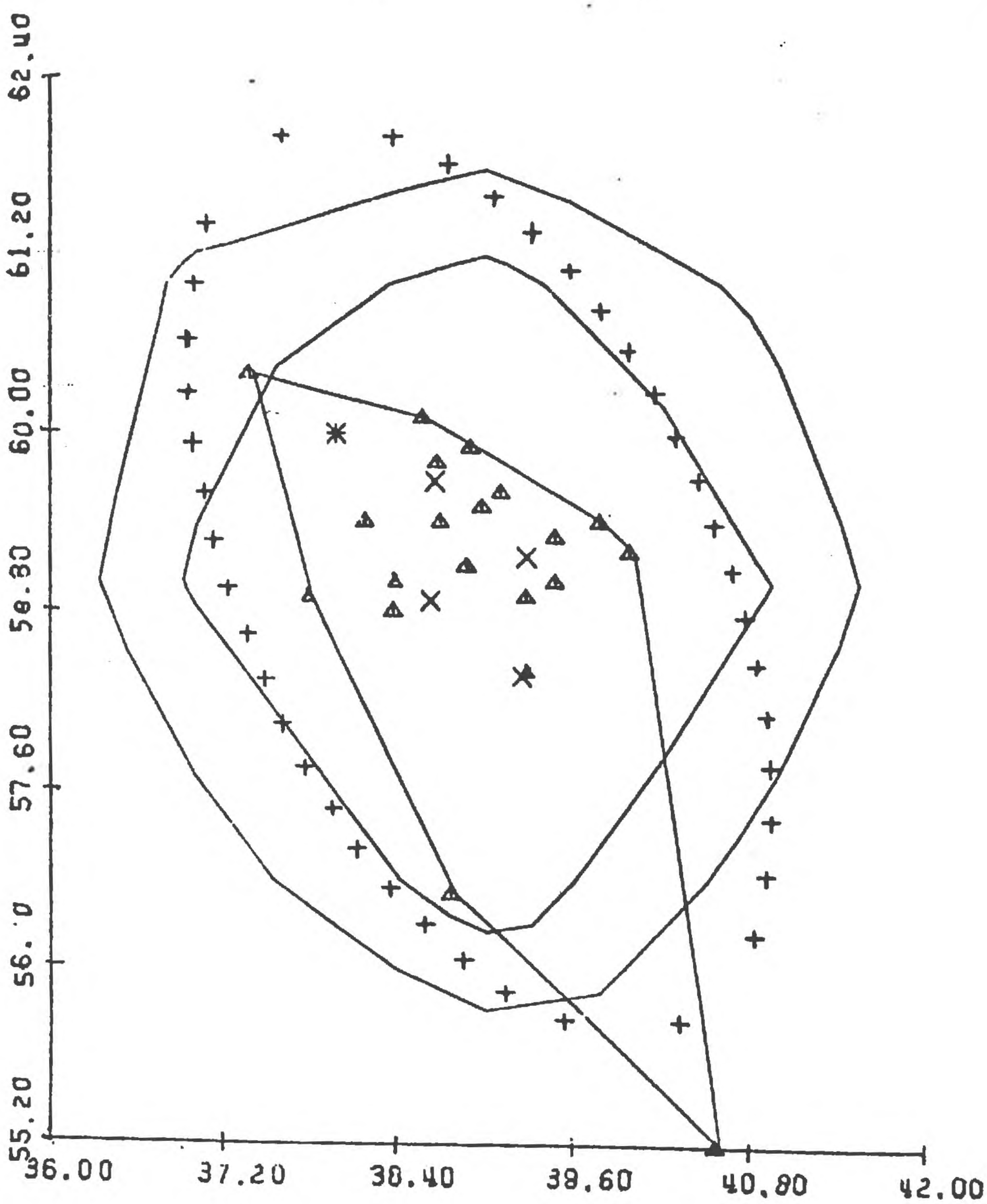

62.40
61.20
60.00
58.80
57.60
56.40
55.20
36.00
37.20
38.40
39.60
40.80
42.00

Figure 14. Locations (△) determined by telemetry for adult female bobcat #58. Home range boundaries determined by the convex polygon method (△—△), 95% confidence ellipse (+ + +) and harmonic mean measures of the home range that include 50% (inner solid line), 75% (middle solid line), and 95% (outer solid line) of the data points. Each unit on axis represents 1 kilometer, values indicate UTM coordinates.

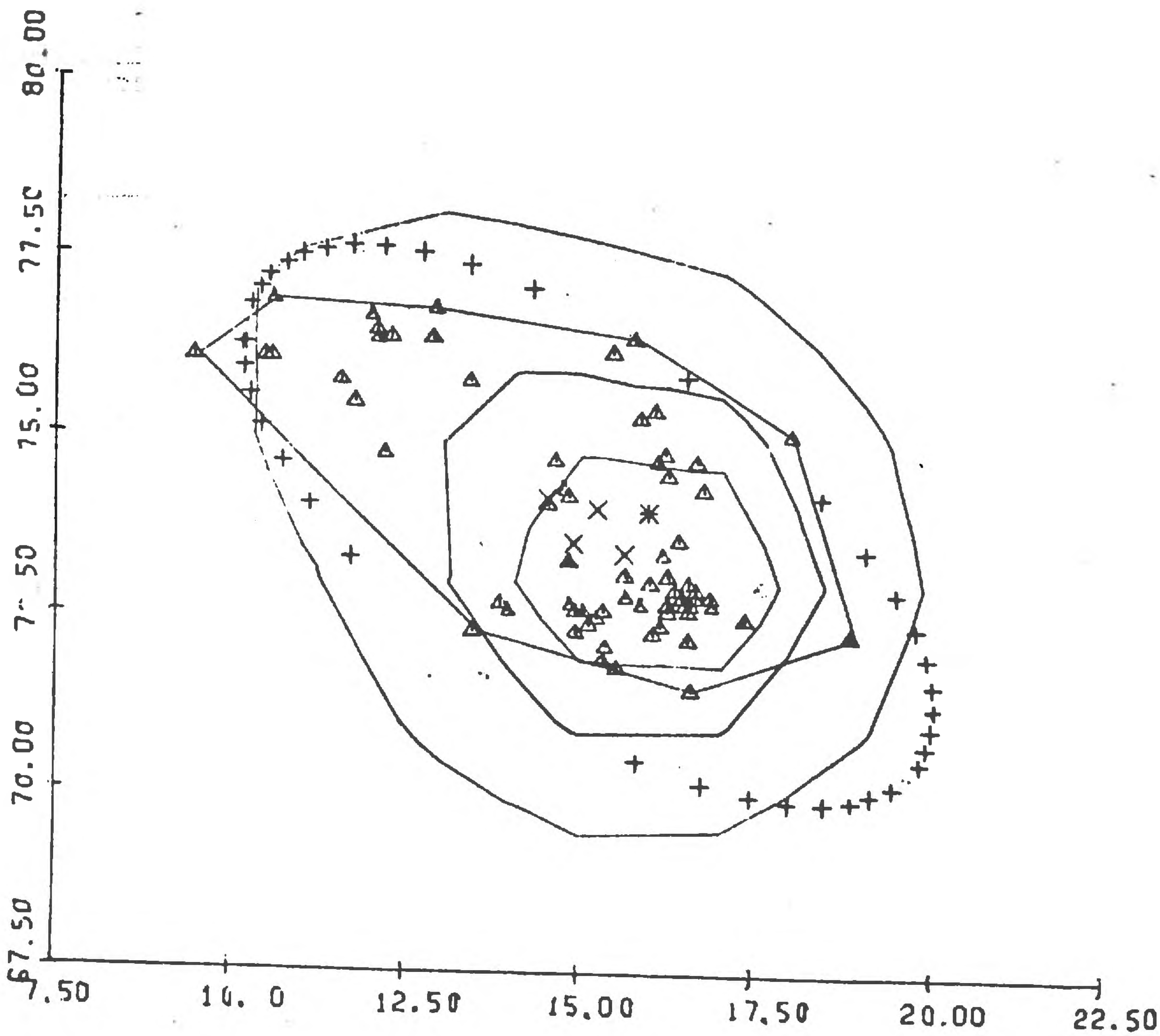

80.00
77.50
75.00
72.50
70.00
67.50
7.50
10.0
12.50
15.00
17.50
20.00
22.50

Table 9. Minimum diel travel distance ($\bar{X} \pm$ SE) of New York bobcats.

Bobcat No.	Fall km(n)	Winter km (n)	Spring km (n)	Summer km (n)
Adirondack Adult Males				
105	2.01 ± .37 (35)	2.15 ± .62 (22)	3.35 ± .67 (10)	1.79 ± .32 (15)
306	4.06 ± .45 (38)	2.48 ± .66 (8)	4.37 ± .70 (9)	4.57 ± .56 (24)
51	0.4 (1)	2.19 ± .63 (14)	2.35 ± 1.25 (2)	
Adirondack Adult Females				
54	2.39 ± .85 (8)	3.41 ± .37 (26)		
454		2.49 ± .63 (9)		
67	3.80 ± .73 (8)	1.67 ± .32 (3)	2.67 ± .22 (3)	1.63 ± .40 (15)
Catskill Adult Males				
133	0.91 ± .15 (7)	0.60 ± .17 (4)		
53		1.10 .26 (8)		
Catskill Adult Females				
58	1.53 ± .31 (7)	1.92 ± .36 (18)	2.11 ± .25 (10)	
	2.80	2.32	3.14	2.98

seasonal weighted mean.

x 3 for max NDTD of 9.42

considerably larger than either the convex polygon or the harmonic mean model (Figs. 6, 8, 10, and 12).

The minimum estimated diel travel distance (MEDTD) was recorded 304 times. These measurements are presented for each telemetered bobcat, by season, in Table 9. Analysis of variance indicates that there were significant differences ($P < 0.0029$) among individuals but no significant differences ($P < 0.05$) among seasons or between sexes were detected in the sample of Adirondack bobcats. The mean Adirondack male MEDTD of 3.03 ± 0.2 km was significantly greater ($P < 0.0001$ than the mean Catskill male MEDTD of 0.93 ± 0.1 km, and the mean Adirondack female MEDTD of 2.73 ± 0.2 km was significantly greater ($P < 0.0077$) than the mean Catskill female MEDTD of 1.89 ± 0.2 km.

The MEDTD observed for Adirondack bobcats is greater than the estimates of this parameter obtained in other locations. Male bobcats in Idaho averaged 1.8 km between consecutive daily radio-locations whereas the females average 1.2 km (Bailey 1964). The MEDTD observed for bobcats in Tennessee averaged 2.2 km and 1.3 km for males and females respectively (Kitchings and Story 1979). Measurements of the maximum distance between 2 points in a diel movement averaged 2.2 km in Louisiana (Hall and Newsom 1978) and 3.0 km for males and 2.4 km for females in Florida (Guenther 1980).

The daily movements of Adirondack bobcats during the winter were influenced by the availability of a large prey cache. During periods when telemetered bobcats were known to be feeding from a deer carcass, they generally restricted their movements to the vicinity of that carcass. For example, bobcat #67 killed a young of the year deer on 17 February 1979 and remained within 25m of the carcass until 21 February 1979 when she was disturbed while the carcass was examined. After being disturbed, this bobcat ran a short distance and then returned to the carcass. She was at the carcass again on 27 February 1979 when it was reexamined. Fresh bobcat tracks could not be detected leading to the carcass and most of the usable flesh had been eaten. Apparently she had spent considerable time at the carcass since it was first examined.

Track surveys have been used or suggested as a technique to estimate annual changes in abundance of predators (Hilton 1979, Klepinger et al. 1979, Karpowitz and Flinders 1979). The irregular nature of bobcat movements during periods when caches of large prey are available suggests that this technique should be used with caution.

Bobcats were found to be active during 63.2% of the 3040 15-minute time periods they were monitored. Repeated observations of individuals failed to reveal activity patterns syncronized with photoperiod. Individuals would occasionally be active throughout the day and inactive at dusk and night one day and then show the opposite activity pattern the following day. There was a slight tendency for bobcats to be least active during the day and most active during the evening dusk period. Bobcat activity is summarized by season and time of day in Table 10. Sufficient movement data were not collected for analysis in reference to meteorological events, however no obvious patterns related to rain, overcast,wind or temperature were observed.

The irregular activity pattern observed for New York bobcats was unexpected. A review of previously reported activity of bobcats shows substantial differences between areas with a characteristic pattern of activity for each area. A crepuscular pattern was reported in Louisiana where the bobcat's major prey was also crepuscular (Hall 1973). Hall observed the greatest activity during the period 1500 h to 1700 h, and the least during the period 1100 h to 1300 h with another lull in activity during the period 0100 h to 0300 h. Southern Alabama bobcats were active only 15% of the time during the period 0700 h to 1000 h

Table 10. Percent of time New York bobcats were observed active during 4 periods of the day and each season, sample size in parenthesis.

	Night	Dawn	Day	Dusk	Total
Fall	77.1	68.1	56.3	78.3	62.6
	(105)	(72)	(565)	(83)	(825)
Winter	65.5	37.8	52.4	74.0	56.0
	(58)	(37)	(584)	(123)	(802)
Spring	84.6	81.8	55.0	80.9	67.4
	(78)	(44)	(211)	(47)	(380)
Summer	51.3	68.4	68.8	79.0	68.0
	(117)	(79)	(718)	(83)	(1033)
Total	68.4	65.9	59.4	77.4	63.2
	(358)	(232)	(2078)	(372)	(3040)

whereas between the periods of 0300 h to 0400 h, and 1800 h to 1900 h they were active 90% of the time (Miller 1980). The time period between 2000 h and 0700 h was found to be the period of greatest activity for Florida bobcats (Guenther 1980). They were found to be active over 90% of the time during the period 2100 h to 2300 h as compared to only 5-15% of the time during the period 1300 h to 1600 h (Guenther 1980). Bobcats monitored in Maine tended to be active the majority of the time, with activity during the period between 0400 h and 0800 h being the least but still occurring approximately 50% of the time (May 1981). A bobcat studied under laboratory conditions was found to be arrhythmic with bouts of activity 21 minutes and 13 minutes in length and with rest periods averaging 67 minutes and 161 minutes during the night and day respectively (Kavanau 1971).

Habitat Utilization

The utilization of habitats classified by 3 systems (i.e. LUNR, elevational zones, and cover type and logging history) was compared to the availability of these habitats within the home ranges of 9 bobcats. Clear non-random utilization was observed for some individuals. Utilization patterns appear to be specific for individuals but not part of a pattern of species preference even within study areas. For example, bobcats #306 (an adult male) and #54 (a yearling female) had home ranges in the CASA that included much of the same area. Over 95% of bobcat #54's home range was within the convex polygon home range of bobcat #306. Locations within the home range of bobcat #54 were frequently used by bobcat #306. Even though these individuals had very similar habitat available, they utilized the habitat differently.

Bobcat #54 did not use the area at random ($P < 0.001$) in relation to topography and appeared to select areas below 610m and avoid areas above that elevation. Bobcat #306 also did not use the area at random ($P < 0.05$) but appeared to select areas within the elevational range of 610 to 762m. These 2 bobcats partitioned their use of this area among the habitat categories described by cover type and logging history. Neither of these bobcats utilized these habitat categories at random ($P < 0.001$). Bobcat #306 tended to utilize hardwoods and areas that had been logged while avoiding softwood stands and stands that were predominately large trees. Bobcat #54 showed the opposite tendency, utilizing softwood stands and stands with small stem sizes (i.e. sapling and polewood stands) in excess of their availability in the area.

Bobcats generally utilized lower elevation areas within their home ranges. Four bobcats utilized the lowest elevational zone in their home range in excess of its availability. The mid-elevation zone was apparently selected by bobcat #306. None of the 9 bobcats appeared to select areas in the higher elevational zones of their home ranges.

Bobcats in the CASA utilized the LUNR habitat types in proportion ($P < 0.05$) to their availability in home ranges even though each of these bobcats had shown at least one significant ($P < 0.001$) non-random use of their home ranges when it was classified by either elevational zones or cover type and logging history. The LUNR classification system was useful in delineating habitat used non-randomly by bobcats at the NASA and the WCSA. Bobcat #51, a NASA adult male, utilized his home range non-randomly ($P < 0.001$). He was located more frequently in wooded wetlands (Ww) and wooded bogs (Wb) and less often in mature forest (Fn). Bobcat #67, a NASA adult female, also utilized her home range non-randomly ($P < 0.001$). She was more frequently located in wooded wetland (Ws) and brush-land (Fc) and less often than expected in mature forest (Fn). An adult female, bobcat #53 at the WCSA, also made non-random ($P < 0.001$) use of her home range.

She apparently selected brushland (Fc) in comparison to other types. She also utilized the lowest elevation zone (areas below 549m) out of proportion to its availability ($P < 0.01$).

During the winter there was a general shift in habitat utilization of bobcats at the CASA towards stands with a conifer component. For example, bobcat #306 utilized mixed stands more than expected and utilized softwood stands at least in proportion to their availability. He had used cut-over hardwoods (HCL) predominately during the other season.

PART B: POPULATION CHARACTERISTICS, EXPLOITATION INDICES, DISTRIBUTION AND ABUNDANCE OF BOBCATS IN NEW YORK.

Abstract: Pelt tag harvest data indicated bobcats (Lynx rufus) were distributed over 35,000 km^2 in New York during the period 1976 to 1981. Populated areas included the Adirondack, Catskill and Taconic regions. This same distribution was reported on the bobcat in the 1890's. Bobcats have apparently declined in abundance within the central Adirondacks since the 1950's, but the harvest has been stable during the last 5 years. Bobcats are generally harvested incidental to other hunting and trapping activities. Few persons harvest more than one bobcat during a season. The sex ratio of the animals necropsied was 100 males per 84.8 females. Placental scar counts averaged 1.2, 2.8, and 3.4 for yearlings, 2 year olds, and bobcats over 3 years of age respectively. Within an age class, no significant differences ($P > 0.05$) in reproductive rate were observed between northern and southern regions. Juveniles comprised 27.2% of the sample from the northern region and 24.3% of the animals harvested from the southern region, whereas yearlings comprised a significantly greater ($P < 0.05$) amount of the harvest in the southern region (42.6%) than in the northern region (23.3%). The post-dispersal adult ($\geq$ 2 1/2 years old) segment of the bobcat population was estimated to be over 500 individuals during the late winter and early spring period.

BACKGROUND

This portion of the study was designed to provide baseline data on bobcat populations in New York. There was a time when the bobcat resource of North America was managed by ommission. The species was not destructive enough to warrent eradication nor was it valuable enough to justify furbearer or game status. Progulske (1952:16) described this condition when he wrote: "The bobcat is considered to be a predatory animal and has negligible sporting value in Virginia. Likewise, in the surrounding states, it is seldom hunted for sport or trapped for its fur." The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) substantially changed the status of bobcats. The bobcat became an internationally regulated commodity on 4 February 1977 as the result of the blanket inclusion of all species of Felidae on Appendix II of CITES (initially even the house cat was included, only those species of Felidae on Appendix I were omitted). Once listed on Appendix II, it became the responsibility of state wildlife agencies to prove that a favorable conservation status existed for the bobcat before an export quota would be established. Johnson (1980) stated: "Proof of a favorable conservation status requires that all of 4 conditions are true: (1) data on population dynamics suggest that a species is at least stable on a long-term basis, (2) the range of a species is not, nor is likely to be, reduced on a long-term basis, (3) there is and will be sufficient habitat to maintain the population on a long-term basis, and (4) the distribution and abundance approachs historic coverage and levels to the extent that potentially suitable ecosystems exist and to the extent consistent with wise wildlife management."

The population characteristics, distribution and abundance of bobcats in New York has received scant attention in scientific literature. Historical data is found mainly in the writings of naturalists, records of bounty payments, and annual harvest records. Nationwide the quality of data seems little better than that in New York. Conventional census techniques (e.g. scent station survey lines, catch per effort, mark recapture, etc.) applied to bobcats has resulted in frustration if not confusion (Jenkins et al. 1979, Knowlton and Tzilkowski 1979, ... 1979, Hatcher and Shaw 1981). Knowlton and Tzilkowski (1979) stated: "... the level of individual states, it is probably impractical from a logistical ... to attempt indices of carnivore abundance on an individual species ... For this reason, indirect determination of trends in populations have ... possible alternatives (Crowe 1975, Henderson 1979, Dixon 1980, ... 1981).

...tion and abundance of bobcats in New York was analyzed using ... records. Hamilton County bounty records from 1947 to 1971 were examined to determine trends in take by each person bountying either coyote or bobcat. St. Lawrence County bounty records, provided by N.Y.S.D.E.C., detailed the town of take and thus provided information on distribution trends within a county. Changes in the distribution of the bobcat harvest from 1977-78 to 1981-82 were analyzed with pelt tag data and the harmonic mean home range model. Trends in the historical harvest levels were examined by comparing annual harvest reports with currrent pelt tag harvest estimates.

Data on bobcat population characteristics were obtained through the examination of a sample of carcasses. Age at death was determined by tooth eruption patterns, size of canine apical root foramen, and cementum deposition patterns (Crowe 1975). The canine apical root foramen of the bobcat and lynx closes at between 13 and 18 months of age (Sanders 1961, Van Zyll de Jong 1963, Crowe 1972, Brand and Keith 1979, Johnson et al. 1981). If the peak of bobcat births occur in May and June there should be a substantial number of bobcats harvested during October and November that have open apical root foramen but which are not young of the year. Examination of the size of lower canine apical root foramen revealed 2 size classes, the smaller (i.e. where the product of the measurements across the widest part of the foramen and the width perpendicular to that was less than 5.00 mm^2) were considered to be individuals between 13 and 18 months old and they were classified as yearling (1 1/2 year-olds) rather than juveniles (1/2 year-olds). Tooth sectioning was performed at the Wildlife Resources Center in Delmar, NY, following the procedures of Stone et al. (1975). Lower canines were used whenever possible. Teeth were decalcified in 20% formic acid until soft and translucent. They were placed in distilled water for a minimum of 24 hours with at least 2 changes in the water bath. Sections 12-15 microns thick were taken with a freezing microtome. Sections were stained for 20 minutes in a solution of one part Giemsa stain to 25 parts distilled water. The sections were then rinsed in 3 water baths, dried, cleared for 20 minutes in xylenes and cover slips were mounted.

Three slides, thus producing 3 complete series, were prepared from each tooth with 4 to 10 sections per slide. Three trained observers independently analyzed each slide series and recorded the number of annuli observed through a binocular microscope at magnifications of 60X and 150X. Comparisons were made after the observers had read all slides. Whenever there were 3 or more discrepencies in the total readings of a tooth or if any observer felt the sections were unusable, an additional tooth was sectioned.

The telemetry and captive bobcats provided a check for the validity of the technique. An upper molar was extracted on these animals when they were acquired. The opposite upper molar and a canine was sectioned if the animal died in the wild. The opposite upper molar was extracted a year later with captive animals. A bobcat captured as a kitten provided a check for the age at which the first annulus is formed.

Female reproductive tracts were preserved in a 10% solution of buffered formalin. The ovaries were sectioned with a razor blade at 1-2mm intervals and examined macroscopically. Luteal bodies were categorized into either current season corpora lutea (Duke 1949) if they were yellowish or a very light tan, or luteal bodies of previous cycles (LBPC) if they were dark tan, brown or gray (Crowe 1975). Uteri were examined with transmittered light and then opened and examined with reflected light to detect placental scars.

A series of computer programs written in APL were prepared to aid in making survival estimates based on frequency distributions. A smoothing function (SPF) allowed corrections for estimated values of the finite rate of increase (λ) and smooths the observed distribution with either a first or second order polynomial. The smooth and corrected age structure can then become the input to a lifetable function (LIFET) that calculates survival values based on the methods described by Caughley(1977:90-93). A variety of population simulation functions were developed to evaluate the estimates of survival and fecundity derived from this sample.

FINDINGS AND ANALYSIS

Distribution and Abundance of Bobcats

Bobcats were presumably distributed throughout the state of New York at the time it was settled. Their range diminished during the subsequent clearing of land for agriculture. Many of the early records of bobcats are of questionable value because improperly identified lynx were included. Long Island (Suffolk County) had sufficient bobcats (wildcats) in the mid 1700's to justify the enactment of a bounty (Connor 1971). By the mid 1800's, bobcats had been extirpated from the island (DeKay 1842). A similar trend occurred in western New York. Taylor (1873:41) was quoted by Severinghaus and Brown (1956) as saying: "The principal of these animals found existing in the wilds of the now Town of Portland (Chautauqua County) were bear, wildcats, beaver, deer, fox, rabbits, porcupine, woodchuck, raccoon, muskrat, skunk, mink, weasel, and squirrel. The first 5 of these have entirely disappeared..." Naturalists have described the distribution of the bobcat in the state at various times. DeKay (1842:53) indicated that they were still found in the "more northern and western counties of the wooded district." Merriam (1882:41) observed: "The wildcat is, for some reason, an extremely rare animal in the Adirondacks. It may be that our climate is too severe for it, since it is much more common further south." The current distribution of bobcats had been established by the 1890's when

Merrill (1899:378) wrote: "The wildcat, which once ranged throughout the state, appears now exterminated except in the wilder parts of the Adirondacks, the Catskills, and the Hudson highlands."

The distribution of bobcats in New York within the regions where they can be legally harvested, can best be described using pelt tag data. During the period 1977 through 1982, there has been 862 bobcats pelt tagged within the state. The number of bobcats harvested annually since 1977 is summarized by town in Appendix 5. The 5 year (i.e. 1977-78 to 1981-82) average harvest density (Fig.15) indicates 3 population centers, namely a western and peripheral Adirondack area, a Catskill area and a Taconic area.

Changes in the distribution of the bobcat harvest have been slight during the study period. The harmonic mean home range model was used to evaluate these changes. The UTM coordinates of the approximate center of each town was used as the coordinates for the location of take on each bobcat taken within that town. Harmonic mean measures of this distribution were then made and plotted (Appendix 6). The size of these annual distribution estimates were similar between years (Table 11). The slope of the linear regression of harmonic mean size of the distribution versus year was not significantly different from zero ($P > 0.05$).

A shift in the distribution of bobcats has apparently occurred in the central Adirondacks and portions of the western Adirondack foothill ecological zones since the 1950's. A comparison of the bobcat harvest densities in the towns of St. Lawrence County during the period 1947-1955 (bounty data), with the harvest densities during the period 1977 -1982 (pelt tag data) demonstrates this shift (Fig. 16). Many of the towns in the western Adirondack foothills and central Adirondack ecological zones have much lower harvest densities now than

Table 11. Size (km^2) of bobcat distribution in New York from 1977 to 1982 as described by harmonic mean measures[a] of the locations from pelt tagged bobcats.

Year	Sample size	Isopleth value 7	8	9	10
1977-78	88	4,785	16,812	33,450	43,988
1978-79	173	9,230	17,430	32,803	42,612
1979-80	240	3,955	13,606	29,813	43,646
1980-81	187	7,013	19,836	31,766	44,804
1981-82	174	6,887	14,983	26,358	43,117

[a] The harmonic mean home range model was used. Standardization between years was achieved using a grid size that divided the total distribution into a 15 X 15 unit reference and then standard, but arbitrary isopleth values, were designated.

Figure 15. Bobcat harvest density (mean number of bobcats pelt tagged in a town during the period 1977 to 1982 per 100 km^2).

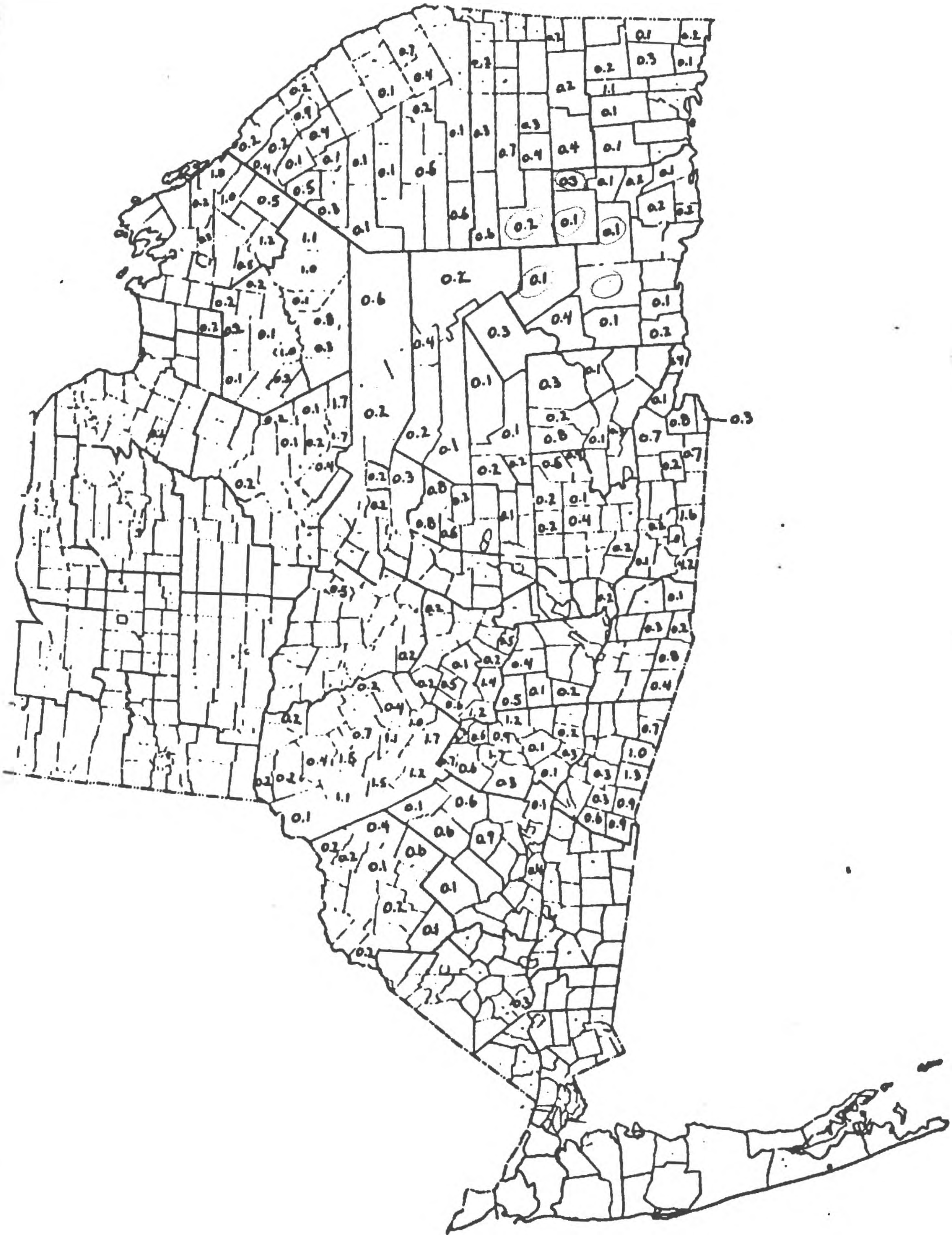
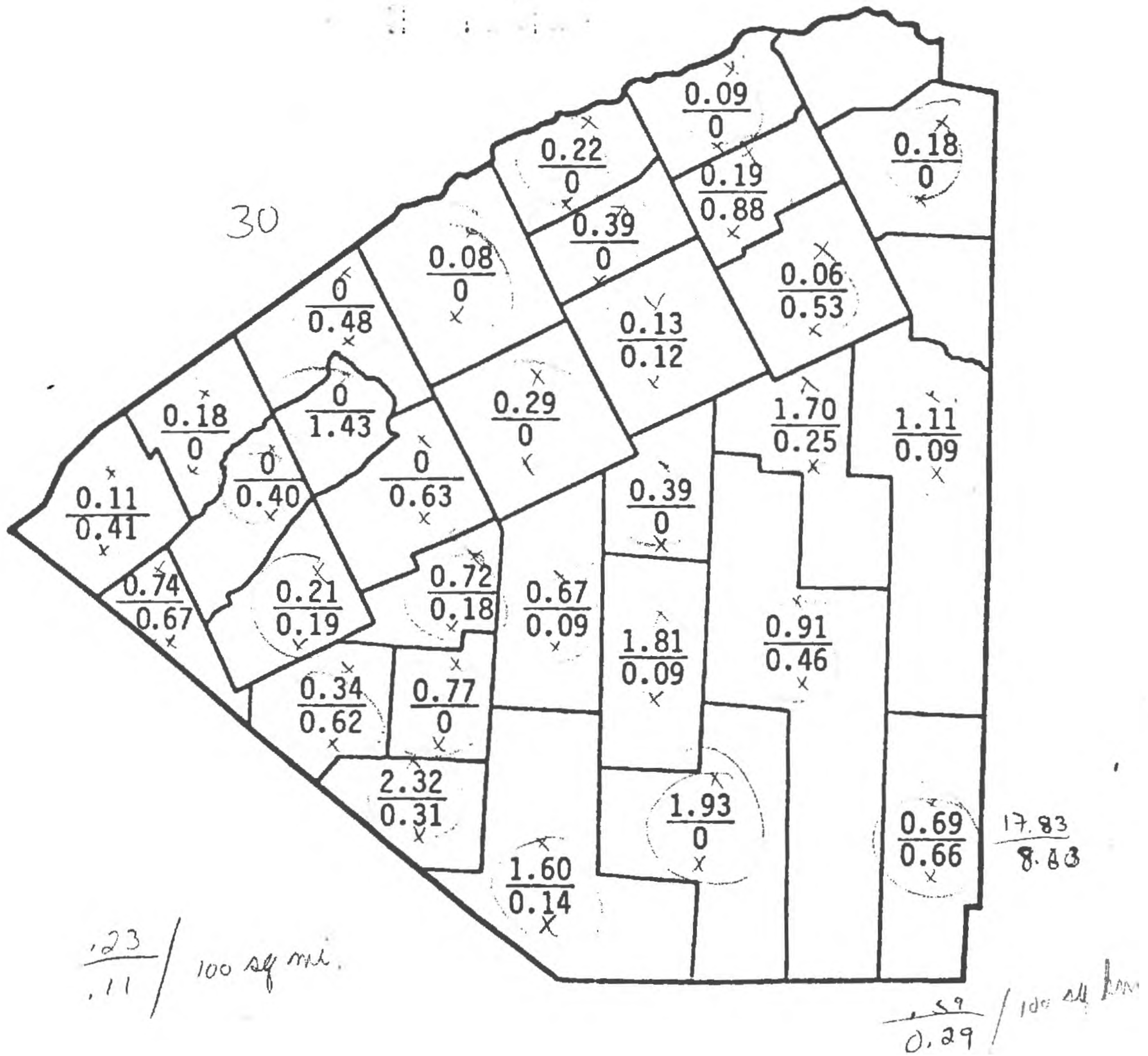


Figure 16. Annual bobcat harvest density (bobcats harvested/100 km^2) in towns of St. Lawrence County during the period 1947 to 1955 (top value) versus the period 1977 to 1982 (bottom value).


30
0.09 / 0
0.22 / 0
0.19 / 0.88
0.18 / 0
0.39 / 0
0.08 / 0
0.06 / 0.53
0 / 0.48
0.13 / 0.12
0 / 1.43
0.29 / 0
0.18 / 0
1.70 / 0.25
1.11 / 0.09
0 / 0.40
0 / 0.63
0.11 / 0.41
0.39 / 0
0.74 / 0.67
0.72 / 0.18
0.21 / 0.19
0.67 / 0.09
0.91 / 0.46
1.81 / 0.09
0.34 / 0.62
0.77 / 0
2.32 / 0.31
1.93 / 0
0.69 / 0.66
17.83 / 8.83
1.60 / 0.14
.23 / .11 / 100 sq mi.
.59 / 0.29 / 100 sq km

they had formerly while some of the towns in the Indian River Lakes ecological zone have higher harvest densities now than they did formerly.

A reduction in the harvest of bobcats in Hamilton County further supports the generalization that there has been a reduction in the abundance of bobcats in the central Adirondacks. The linear regression of the natural logarithm of bobcats harvested in Hamilton County annually versus year shows a negative trend through time (Fig.17). This regression line is derived primarily from bounty records; the absolute number of bobcats harvested was probably less than the number reported. An additional approach was therefore used to evaluate this apparent reduction in bobcat numbers in Hamilton County.

The ratio of bobcats to coyotes taken annually per trapper during the period 1955 to 1971 was noticed to decline despite the fact that either species was worth $25.00 apiece throughout this period. The records of 40 persons who bountied both bobcats and coyotes and reported a take during 5 or more years (i.e. experienced trappers), were examined for trends in their harvest of the 2 species. A linear regression of the percent coyotes in the annual aggregate bobcat and coyote take of trappers versus the year (Fig.18) shows that coyotes were becoming increasingly more prevalent in the aggregate take of bobcats and coyotes. Similar results were obtained with the St. Lawrence County bounty records where total annual harvest was used rather than the records of only the principal trappers (Fig. 19). Interviews with trappers that had years of experience in specific areas of the central Adirondacks support this trend of coyotes increasing while bobcats declined, however the timing of this trend varied throughout the region.

The validity of a bobcat population decline in the central Adirondacks during the period 1947 to 1981 is supported by a reduction in the number of

Figure 17. Natural log of the number of bobcats harvested versus year for Hamilton County, 1955-1982; 95% confidence limits are given.

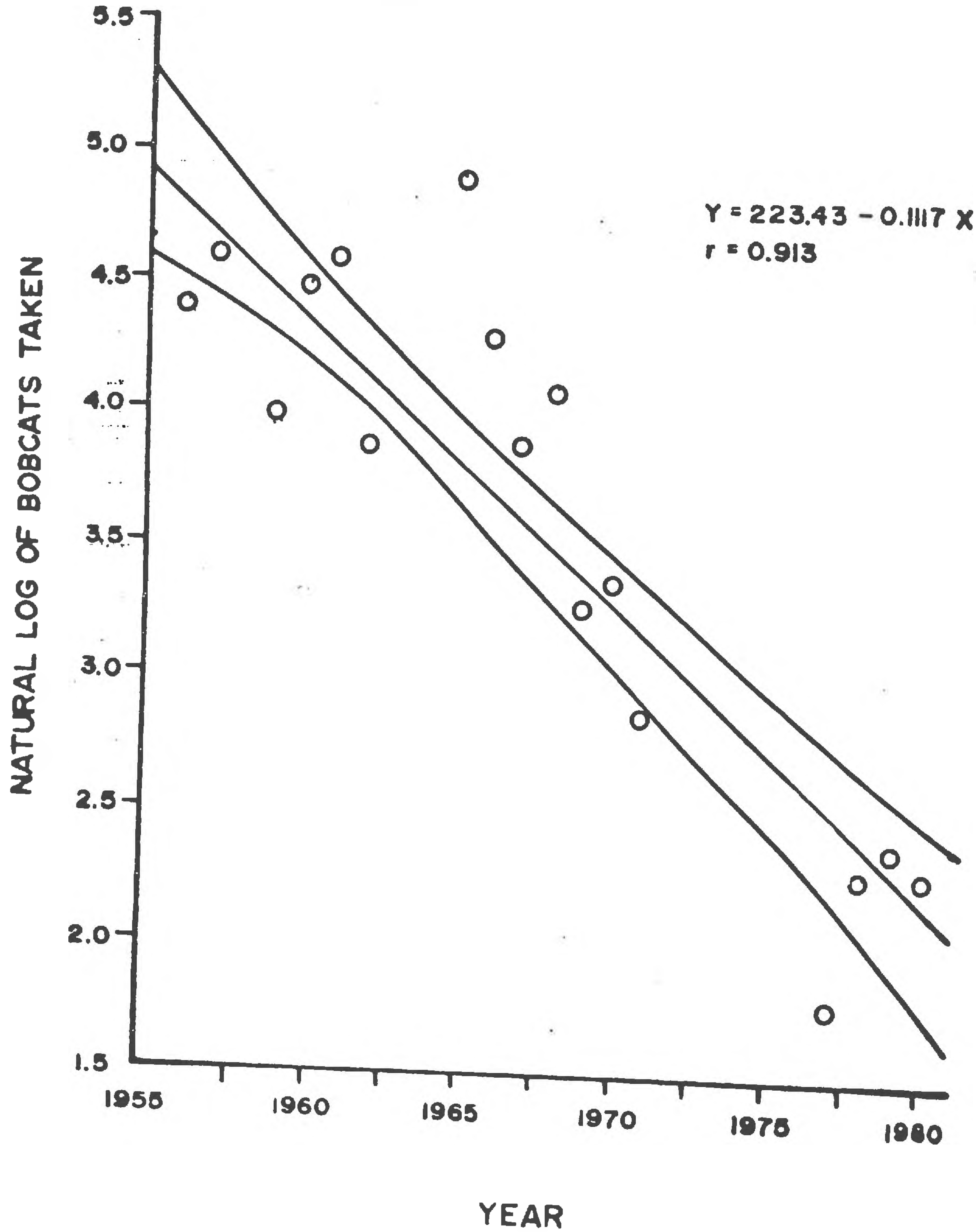

5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
NATURAL LOG OF BOBCATS TAKEN
1955
1960
1965
1970
1975
1980
YEAR
Y = 223.43 - 0.1117 X
r = 0.913

Figure 18. The percent coyotes in the aggregate take of coyotes and bobcats of Hamilton County for trappers that bountied these species at least 5 years during the period 1955 to 1971; 95% confidence limits are given.

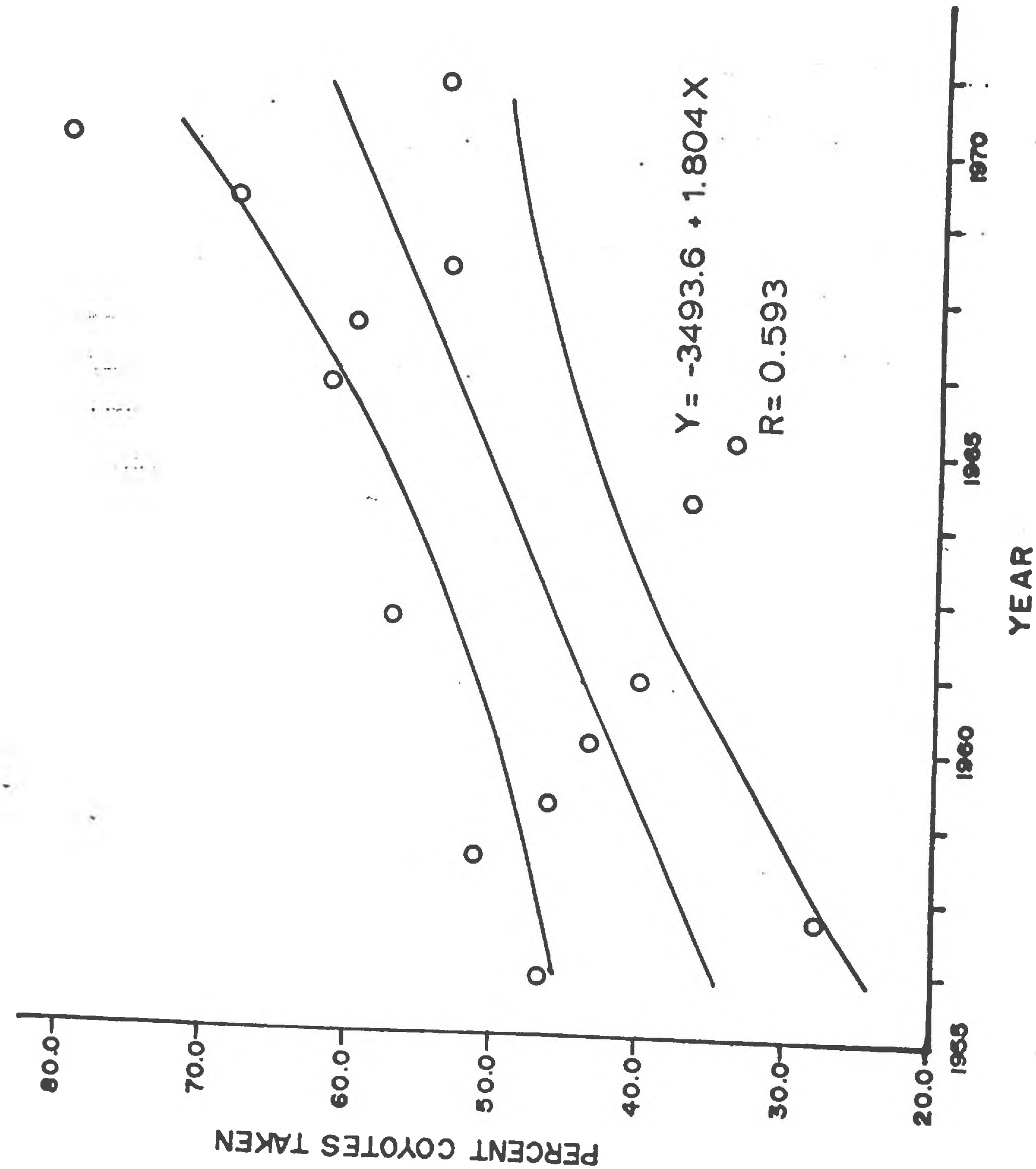
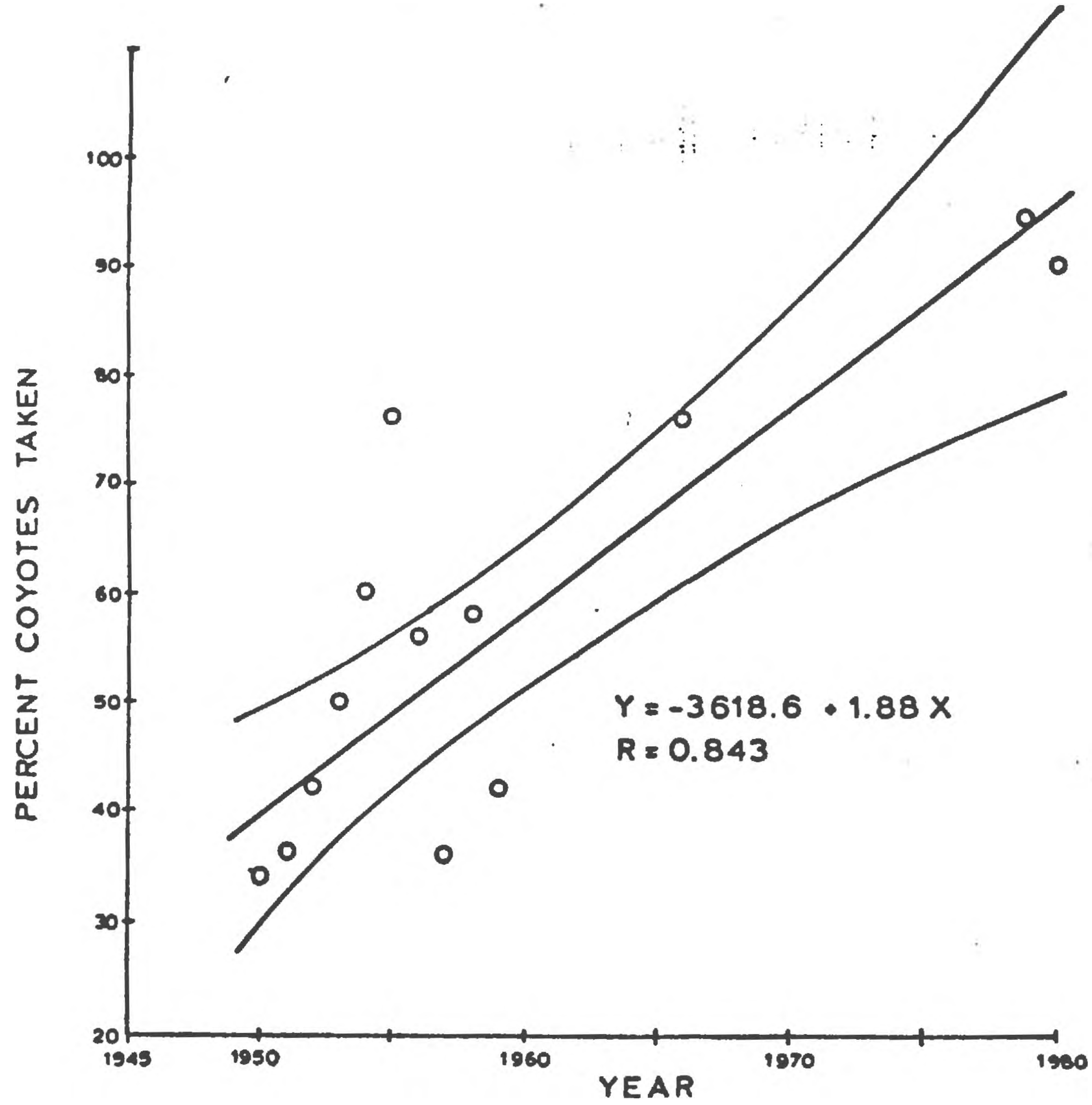

PERCENT COYOTES TAKEN
20.0
30.0
40.0
50.0
60.0
70.0
80.0
YEAR
1955
1960
1965
1970
Y= -3493.6 + 1.804X
R= 0.593

Figure 19. Percent coyotes in the aggregate take of coyotes and bobcats of St. Lawrence County, 1949 to 1980; 95% confidence limits are given.


PERCENT COYOTES TAKEN
100
90
80
70
60
50
40
30
20
1945
1950
1960
1970
1980
YEAR
Y = -3618.6 + 1.88 X
R = 0.843

bobcats harvested annually. The records of individual experienced trappers showed that they continued to trap during this period, that they took fewer total bobcats, and that they took more total coyotes. Finally, there has been a shift in the distribution of the harvest. The bulk of the harvest in St. Lawrence County came from towns in the central Adirondack and western Adirondack foothills during the 1940's and 1950's. Now some of these towns (e.g. Clifton) have few or no bobcats harvested within them annually.

Historical bobcat abundance in the state is difficult to determine from early harvest records and bounty payments. Using annual reports collected by county clerks at the time of reissuing a license, Cook and Maunton (1949:5) estimated an average of 173 bobcats taken per year during the period 1918 to 1937. This is not significantly different ($P > 0.05$) from the 172.2 ± 24.4 pelts tagged annually during the period 1977 to 1982. This data should be interpreted with caution. Only those individuals that purchased a license, thus excluding landowners trapping on their own land and minors, and only those individuals that had bought a license the previous year, were included by Cook and Maunton (1949). This would tend to cause an underestimation of the true harvest. However, their data are further complicated by what Cook and Maunton (1949:4) felt was "a common practice for trappers as a group to exaggerate the take of the rarer species", and the bobcat was taken in the smallest numbers of any furbearer discussed in their report.

Trends in the estimated annual harvest and the comments of naturalists (e.g. Merriam 1882) strongly suggest that bobcats have not been historically abundant in the state. The apparent abundance of bobcats in the central Adirondacks during the 1950's may represent an exception rather than a tradition.

Hamilton County records for the period 1955 to 1971 were examined to determine the distribution of harvest by individuals and to shed some light on seasonal distributions of harvest and local exploitation levels. An alphabetical listing was made of all individuals (n = 386) submitting either bobcats or coyotes for bounty payments. The total number of bobcats and coyotes harvested by each individual was tallied. The majority of individuals (52.2%) that bountied bobcats harvested only a single bobcat during the complete 17 year period, whereas only 21 individuals (7.7% of the people taking bobcats) bountied over half of the bobcats reported during this period (Table 12). It should be noted that the memories of hunters and trappers become distorted with time. I interviewed hunters and trappers that had been active during the 1950's and 1960's. Their recollection of their mean annual take of bobcats during the bounty years was consistently higher than county bounty records showed them to be. The 40 trappers in Hamilton County with over 5 years of bounty activity (i.e. the most experienced trappers) averaged only 1.72 ± 0.16 bobcats/year; 4 individuals took 11 bobcats each during their peak year but the most successful trapper averaged only 3.7 ± 0.9 during the 10 years that he bountied bobcats. The average successful hunter or trapper during the period 1976-1980 took 1.18 ± 0.04 bobcats/year (based on records of cooperating individuals who submitted bobcats for necropsy, Table 13).

Predators could be taken throughout the year when bounties were offered. Bobcats were most frequently taken during December and February. Coyotes were generally bountied earlier in the fall during September, October, November and December (Table 14). Date of kill data from bobcats pelt tagged in the Adirondacks concurs with the bounty data that bobcats are trapped more frequently in December than October or November (Fig. 20). Pelt tag data also shows that Catskill bobcats are more frequently taken by hunting during the deer season. Experienced bobcat trappers in the central Adirondacks often state

Table 12. Total number of bobcats or coyotes taken by each individual (n = 396) that bountied animals in Hamilton County during the period 1955 to 1971.

Total no. of each species bountied during period 1955 - 1971	Frequency of individuals harvesting the various total numbers Coyotes	Bobcats
1	134	142
2	42	42
3	18	24
4	13	9
5	5	9
6	3	5
7	4	6
8	2	7
9	3	1
10	1	1
11	2	3
12	3	2
13	1	1
14	1	2
15	1	2
17	1	1
18	2	
19	2	2
≥ 20	10	13

Table 13. Number of bobcats harvested/person/season in New York during four years, 1976-1980[a].

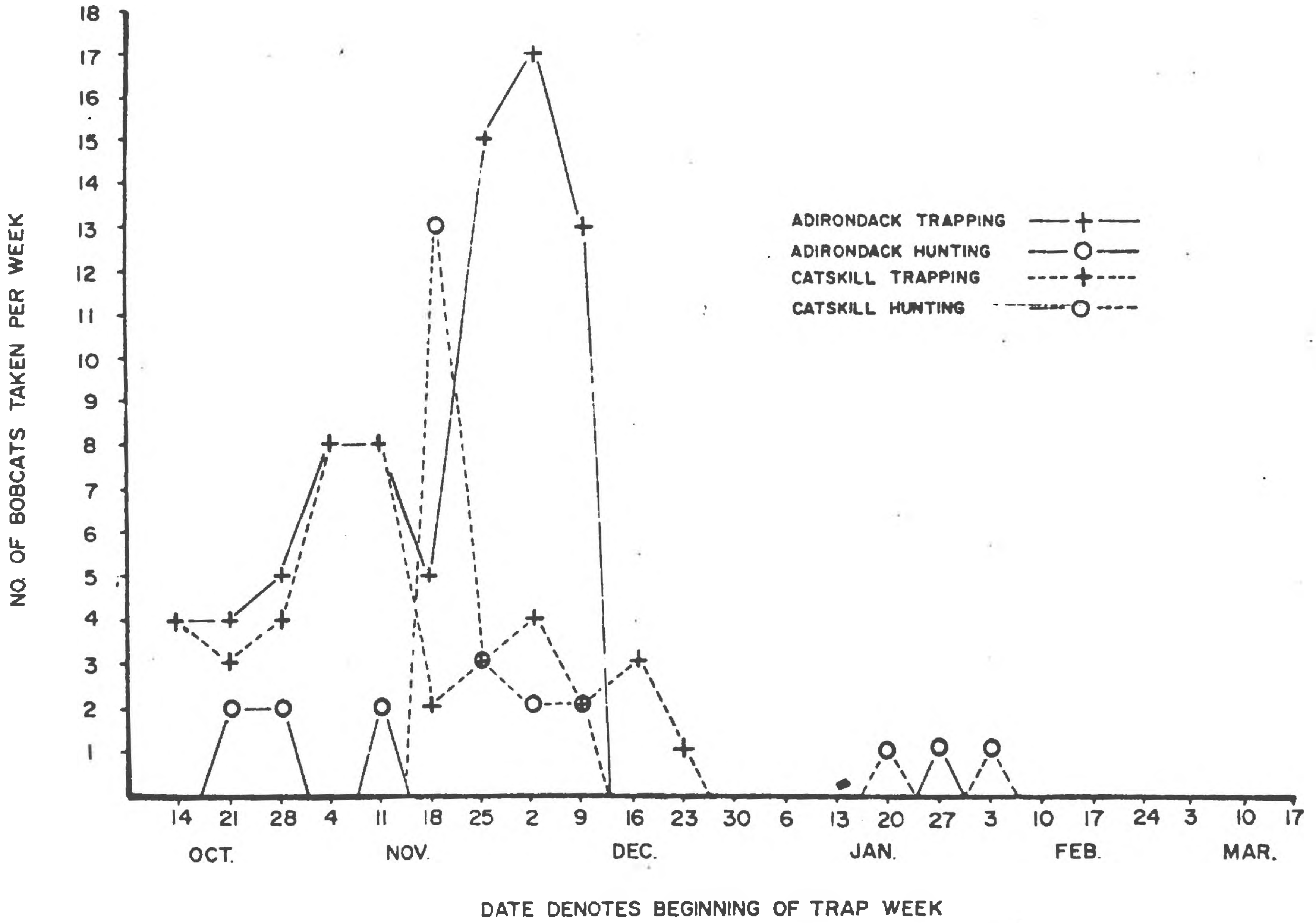
Season bag	1976-77	1977-78	1978-79	1979-80
1	17	35	46	66
2	2	5	3	5
3			4	2
4			1	
5				
6				1
$\bar{X}$ take per successful hunter or trapper	1.1	1.1	1.3	1.2

[a] Determined from individuals that submitted bobcats for necropsy.

Table 14. Monthly harvest of bobcats and coyotes in Hamilton County during 1947-1971.

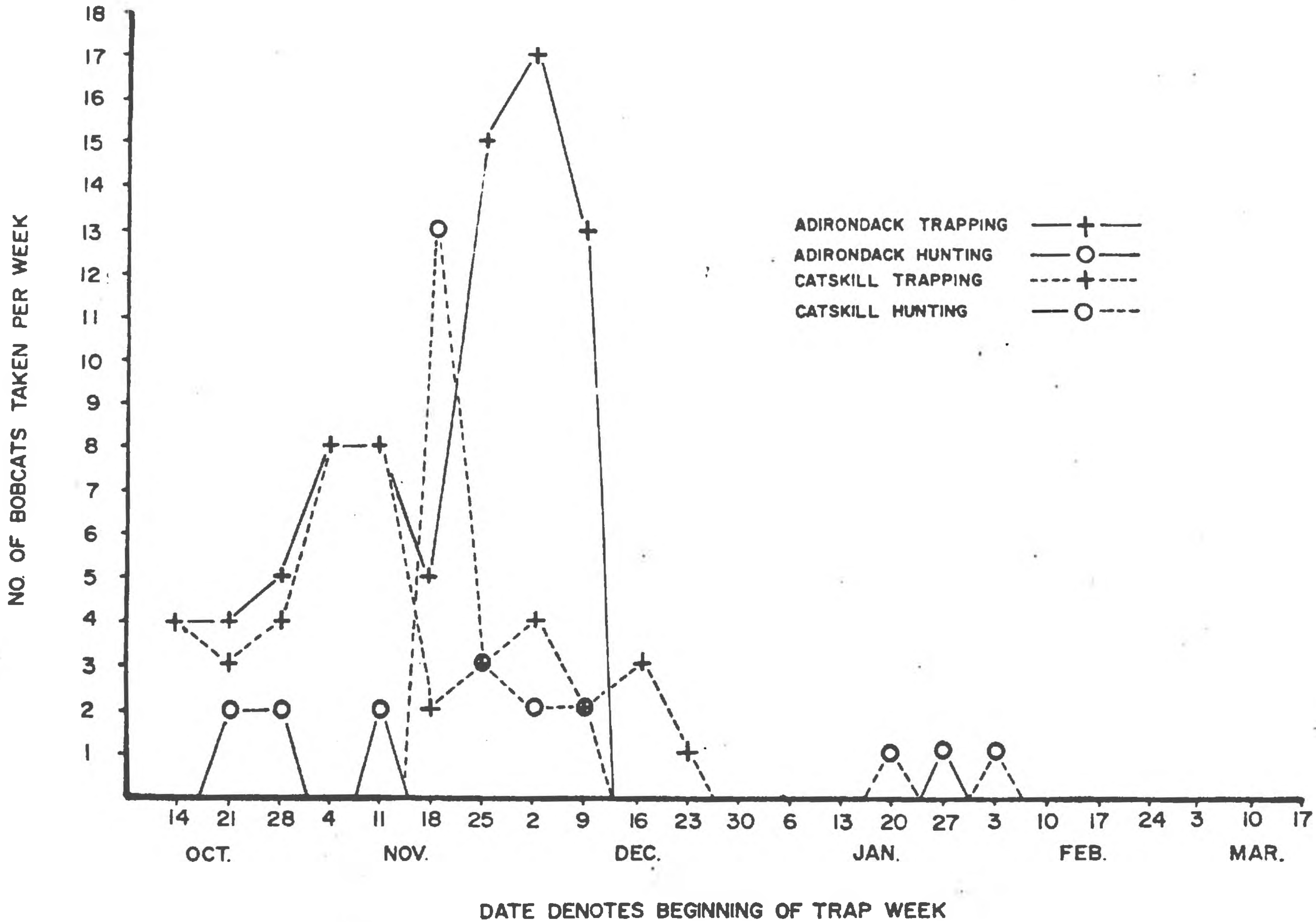
Month	Bobcat		Coyote	
	Total number taken	% of annual take	Total number taken	% of annual take
January	33	2.3	14	1.4
February	239	17.1	26	2.6
March	71	5.1	15	1.5
April	116	8.3	42	4.2
May	98	7.0	17	1.7
June	54	3.9	19	1.9
July	50	3.6	42	4.2
August	61	4.3	42	4.2
September	76	5.4	166	16.6
October	111	7.9	232	23.2
November	171	12.2	189	18.9
December	420	30.0	195	19.5

Figure 20. Dates of harvest for bobcats taken by hunting and trapping in the northern and southern zones of New York during the 1978-79 season.



NO. OF BOBCATS TAKEN PER WEEK
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
ADIRONDACK TRAPPING
ADIRONDACK HUNTING
CATSKILL TRAPPING
CATSKILL HUNTING
14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 3 10 17
OCT. NOV. DEC. JAN. FEB. MAR.
DATE DENOTES BEGINNING OF TRAP WEEK

Figure 21. Dates of harvest for bobcats taken by hunting and trapping in the northern and southern zones of New York during the 1978-79 season.


NO. OF BOBCATS TAKEN PER WEEK
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OCT.
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DEC.
JAN.
FEB.
MAR.
DATE DENOTES BEGINNING OF TRAP WEEK
ADIRONDACK TRAPPING
ADIRONDACK HUNTING
CATSKILL TRAPPING
CATSKILL HUNTING

that they have better luck attracting bobcats to bait after the ground has been covered with snow. The femur fat index of Adirondack bobcats shows that some bobcats are experiencing a negative energy balance by December and January, probably increasing their vulnerability to baited traps.

The adjustment of season length and timing of hunting or trapping may have considerable impact on bobcat harvest. Modifications of season length have been shown to be a useful tool in managing beaver (Castor canadensis) in New York (Parsons and Brown 1980), and beaver and muskrat (Ondatra zibethicus) in Missouri (Erickson 1980).

Juvenile bobcats are apparently still associated with the adult female during the hunting and trapping seasons. It is not known whether this association is a weak bond or dependency, however it may last until mating season. On the 11th and 12th of February, 1978, I chased a single juvenile bobcat with hounds in the towns of Diana and Croghan, Lewis County. This bobcat ran to a den which was occupied by a large bobcat and 2 smaller ones. Three of these animals were traveling together on 16 February 1978 and the other (apparently a juvenile) remained at the den. This is the latest date that I have observed an adult and juveniles traveling together.

The harvest of more than 1 bobcat during a season by an individual is an unusual event but may shed some light on the age of independence and the cause for the current distribution of bobcats in New York. Only 23 of the 175 individuals (13.1%) submitting bobcat carcasses for necropsy took 2 or more bobcats in a single year, however 16 of these individuals (70%) took what appeared to be all or part of a family unit (i.e. either an adult female and kittens or just kittens). This is surprising because juvenile lynx are generally underrepresented in samples obtained from trappers (Brand and Keith 1979).

The vulnerability of family groups may have an impact on the successful colonization of new areas. When young adult females disperse, establish a home range, and produce kittens in a location where harvest pressure is intense, there is a good chance that the whole family unit will be taken. For example, on 12 November 1978 a Catskill trapper took a 3.5 year-old female which had 2 current year placental scars. On the 16th and 17th, he trapped 2 juvenile males and these 3 bobcats were the extent of the bobcats he captured during 4 years. A population sink might occur around the perimeter of an established population if the perimeter were an area of intense harvest pressure. The productivity in this peripheral area if measured by young to adult ratio and harvest density, may appear higher than the adjacent population stronghold and hence suggests greater population strength than is actually present.

Age Structure

Two bobcats used in the telemetry study were harvested a year later. An upper molar had been extracted and sectioned from both of these bobcats at the time of their capture. The opposite upper molar and a lower canine were extracted and sectioned from these bobcats when their carcasses were submitted for necropsy. An adult female held in captivity for over a year had one upper molar removed each year. The 2 telemetered bobcats had an additional annulus in the upper molar extracted a year after the 1st tooth was extracted, and the number of annuli in the second upper molar and the lower canine were equal. The adult female held in captivity for over a year had annuli that were extremely difficult to read (this animal was over 10 years old and that number of annuli in the small width of the upper molar cementum is extremely difficult to read).

However, 3 observers read that second tooth as 1 year older than the first, even though 1 observer aged both teeth less by 1 year than the other 2 observers. A bobcat estimated to be 6 months old when it was acquired, based on tooth replacement (Crowe 1975) had an upper molar sectioned when it was approximately 22 months old that had an annulus just beginning to appear. These known age and known increment of age animals support Crowe's (1972; 1975) technique for determining age of bobcats.

Age at the time of harvest or death was determined for 221 bobcats. The age distribution of the male and female component of the Adirondack region and the combined Catskill and Taconic regions (southern region) are presented in Table 15. Age distributions have been summarized by N.Y.S.D.E.C. ecological zones (Davis 1977, Will et al. 1982, J. Ozark, N.Y.S.D.E.C., pers. comm.). in Table 16. The Catksill and Taconic harvest age structures were similar to each other ($P > 0.05$) but significantly different ($P < 0.05$) from the age structure of the Adirondack bobcats. In the southern region, principally in the Schoharie hills, Delaware hills, and the Taconic mountain ecological zones, the yearling age class was harvested at a significantly higher level ($P < 0.05$) than in the northern region. More yearlings than juveniles were harvested each year in the southern region (Table 17).

Interpretation of harvest age structure rests upon various critical assumptions (Caughley 1974, 1977). After careful consideration, it is my opinion that the harvest age structure of New York bobcats has been influenced by regionally different vulnerabilities to capture, that the magnitude of these vulnerabilities are unknown and could not be acquired without substantial investments in time, money, and additional research, and finally that traditional methods of analyzing age structure to determine survival could lead to misunderstanding of the population dynamics of bobcats in the state.

Table 15. Age structure of male and female components of the bobcat populations in the northern and southern regions of New York, 1976-1981.

	Northern Region		Southern Region	
Age[a]	Males (n = 60)	Females (n = 43)	Males (n = 58)	Females (n = 57)
0-1	18	10	16	12
1-2	15	9	21	28
2-3	6	8	4	7
3-4	6	3	4	5
4-5	2	2	4	2
5-6	1	2	2	
6-7	1	3	1	
7-8	1	1	4	2
8-9	3	2	1	1
9-10				
10-11	4			
11-12		1	1	
12-13		1		
13-14	1	1		
14-15	1			
15-16				
16+	1			

[a] Ages estimated by tooth cementum method, except for bobcats with open apical root formen of the lower canines.

Table [illegible]. Bobcat age structures within the ecological zones of New York, [illegible]76-1981.

Ecological Zone	Age not deter.	Age 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+	Total[a]
Mongaup Hills	1												
Central Appalachians		2	1	1	1								5
Finger Lakes Highlands			1										1
Helderberg Highlands	1	2	3	1					1				7
Schoharie Hills	7	9	16	4	2	3	2		3			1	40
Catskill Peaks	3	8	6		2			1		1			18
Delaware Hills	4	2	7	2		1			2				14
Neversink Highlands		1											1
Eastern Ontario Plains		1											1
Mohawk Valley	1		1									1	2
Central Hudson	1	1	3						1				5
Shanangank Hills					1								1
Catskill Region Sub-total	18	26	38	8	6	4	2	1	7	1		2	95
Taconic Foothills			2		2								4
Taconic Mountains		1	7	3	1	1				1			14
Rensselaer Hills	2	2	2	1		1							6
Taconic Region Sub-total	2	3	11	4	3	2				1			24
Central Tug Hill			1										1
Black River Valley		1											1
Indian River Valley		1	1	2	1		1						6
St. Lawrence Plains			1	1		1							3
St. Lawrence Transition			1			1		1					3
Western Adir. Transition		3	1	1	2					2			9
Western Adir. Foothills	1	7	7	8	4	1	1					1	29
Central Adirondacks		8	7	2	2			3	1	2		5	30
Adirondack High Peaks		2	3										5
Sable Highlands		1	1										2
Eastern Adir. Foothills	1	1					1			1		2	5
Eastern Adir. Transition	1	3											3
Champlain Transition			1										1
Champlain Valley						1							1
Adirondack Region Sub-total	3	27	24	14	9	4	3	4	1	5		8	99
State Total	23	56	63	26	18	10	5	5	8	7		10	218

[a] Total number of bobcat classified by age.

Table 17. Annual harvest age structure of bobcats in the Northern and Southern regions of New York.

Age	1976-77		1977-78		1978-79		1979-80	
	Northern Region	Southern Region	Northern Region	Southern Region	Northern Region	Southern Region	Northern Region	Southern Region
0-1	4		6	6	10	10	8	13
1-2	5		4	7	5	24	10	18
2-3			2	3	7	2	5	7
3-4	3		2		1	5	3	4
4-5					1	3	3	3
5-6	1		1	1	1	1		
6-7	1			1	1		2	
7-8			1	2		1	1	3
8-9	1		2	1	1		1	1
9-10								
10-11	2				1		2	
11-12	1					1		
12-13			1					
13-14					2			
14-15					1			
15-16								
16-17	1							

Reproduction

A sex ratio of 100 males to 67.2 females was derived from the harvested composition of bobcats in the Adirondacks, whereas a sex ratio of 100 males per 95.6 females was derived for the southern region. Males outnumbered females in the Adirondack sample 4 consecutive years whereas they were taken in equal proportion in the southern region (Table 18). There was no significant differences ($P > 0.05$) in the observed sex frequency and an expected ratio for this small sample.

Female reproductive tracts were examined on 102 bobcats. Four of 80 bobcats over a year old had not ovulated and 40% of the Adirondack yearlings and 56% of the Southern Region yearlings showed no sign of implantation. Within an age group there were no significant regional differences in the means of either corpora lutea or placental scars (Table 19). Implantation rates of yearlings were significantly different ($P < 0.001$) from the implantation rates of older bobcats. No age specific differences in implantation rates were detected among bobcats older than 2 years of age.

A bobcat killed in the road in the town on Denning, Ulster County, on 5 May 1979 contained 2 embryos completely developed. A telemetered female (#67) was snow tracked on 13 March 1979 traveling with 2 other bobcats. It was assumed that mating occurred at that time. On 6 June 1979 a litter of 2 kittens was observed.

The reproductive rate of New York bobcats is essentially the same as has been described in other portions of the bobcat range (Gashwiler et al. 1961, Crowe 1975, Fritts and Sealander 1978, Bailey 1979, and Johnson 1979). Bobcats can become reproductively active at 1 year of age. Four to 6 corpora lutea are generally present, 2-4 placental scars can be observed, and embryo and kitten counts are approximately 2. The similarities in bobcat reproduction among the

Table 18. Sex of bobcats harvested in the Northern and Southern regions of New York, 1976 to 1980.

	Northern Region		Southern Region	
Season	Males	Females	Males	Females
1976-77	14	7		
1977-78	13	7	13	10
1978-79	17	15	26	27
1979-80	20	14	29	28
Total[a] [b]	64	43	68	65

[a] The sex of 3 bobcats could not be determined.

[b] Three females came from an unspecified region, and 1 female came from western New York.

Table 19. Age specific reproduction of female bobcats in the Northern and Southern regions of New York, 1976 to 1980.

	Northern Region				Southern Region			
	Corpora lutea		Placental scars		Corpora lutea		Placental scars	
Age at death	$\bar{X}$	SE(n)[a]	$\bar{X}$	SE(n)[b]	$\bar{X}$	SE(n)[a]	$\bar{X}$	SE(n)[b]
1-2	2.22	0.46(9)	1.30	0.40(10)	3.09	0.37(22)	1.16	0.28(25)
2-3	6.00	0.58(7)	3.13	0.44(8)	4.83	1.35(6)	2.43	0.78(7)
> 3	5.43	0.76(14)	3.50	0.24(16)	4.00	0.50(8)	3.11	0.42(9)

[a] Includes individuals with no corpora lutea but excludes individuals with poor differentiation of corpora lutea and LBPC.

[b] Includes individuals with no placental scars but excludes individuals with unreadable tracts.

diverse environmental conditions where they have been studied is more striking than the dissimilarities mentioned in reference to food or weather conditions. Apparently at very high bobcat densities, reproduction is reduced (Hall 1973: 108).

Population Estimation

Bobcat population levels were estimated for the post-dispersal adult segment of the bobcat population. The post-dispersal segment of the population was specified because of its relative stability compared to the younger individuals. The juvenile and yearling component of the population have a greater degree of annual variability. A harvest sample of bobcats may not accurately reflect the actual age structure of the population. Juvenile bobcats may be underrepresented as are juvenile lynx (Brand and Keith 1979). Yearling bobcats appear to be more vulnerable to hunting and trapping than older animals, and may therefore be overrepresented in a harvested sample. A higher representation of yearlings than junveniles, as obtained in the southern region, is not unique (Bailey 1979, Brittell et al. 1979). An explanation for these observations is that juveniles are still dependent upon the female during the hunting and trapping season and are less mobile than adults so they encounter fewer traps or hunters, whereas yearlings establish home ranges in areas unoccupied by other bobcats and these areas may be where the former occupant was harvested the previous year (i.e. a high hazard area for bobcats).

The first technique used to estimate the bobcat population is based on bobcat density estimates derived from direct observation by snow tracking and telemetry on the CASA and WCSA. Estimates were made in the late winter and early spring with an effort to identify each bobcat in the study areas.

Juveniles traveling with adults were not included. These estimates may include some resident yearling animals. Density estimates ranged from 1.93 bobcats/100 km^2 in the CASA to 6.18 bobcats/100 km^2 in the WCSA. The high and low density estimates were obtained by field observations, whereas the median density estimate was subjectively based on my experience for all years of the study and region wide rather than at the study areas (Table 20).

The area of the state occupied by bobcats was estimated from the distribution of locations obtained from pelt tag returns. Visual interpretation was used to delineate this range (Fig. 22). The size of the areas designated as core areas is 17242 km^2 and this is similar to the 5 year average harmonic mean measure of the pelt tag distribution of 15004 ± 1728 km^2 obtained with an isopleth value that included 50% of the observed harvest. The size of the areas designated as core plus peripheral areas is 35081 km^2, and this is less than the 5 year average harmonic mean measure of the pelt tag distribution of 57275 ± 2575 km^2 obtained with an isopleth value that included 95% of the observed harvest. I believe that this is a conservative estimate of bobcat range. Using the low density estimates and the conservative estimate of core range, I calculated the adult portion of the bobcat population in New York to be 395 animals, including the peripheral range and using the high density estimate results in a population estimate of 1475 individuals.

The second technique for estimating the adult bobcat population was based on home range size and social system. No overlap between members of the same sex and no exclusions between opposite sexes was used as the first approximation of social system. This results in a conservative estimate of social spacing. The average size of the home ranges was derived by the irregular polygon method. The total adult bobcat population was estimated at between 496 and 1113 individuals (Table 21).

Table 20. Estimated New York adult bobcat population based on occupied range and density estimates.

Area	Size, km^2	Low		High		Median	
		Density[c]	Popu.	Density	Popu.	Density	Popu.
Adirondack[a]	22,554	1.93	435	3.09	697	2.31	536
Adirondack[b]	11,909	1.93	230	3.09	368	2.31	279
Catskill[a]	7,993	3.09	247	6.18	494	4.12	329
Catskill[b]	3,727	3.09	115	6.18	230	4.12	154
Taconic[a]	4,535	3.09	140	6.18	280	4.12	187
Taconic[b]	1,606	3.09	50	6.18	99	4.12	66
Total[a]	35,082		822		1,471		1,052
Total[b]	17,242		395		697		498

[a] Includes peripheral and core areas

[b] Includes only core areas

[c] Bobcats per 100 km^2 estimated during the late winter on study areas

Table 21. Estimated New York adult bobcat population based on estimates of occupied range and home range size.[a]

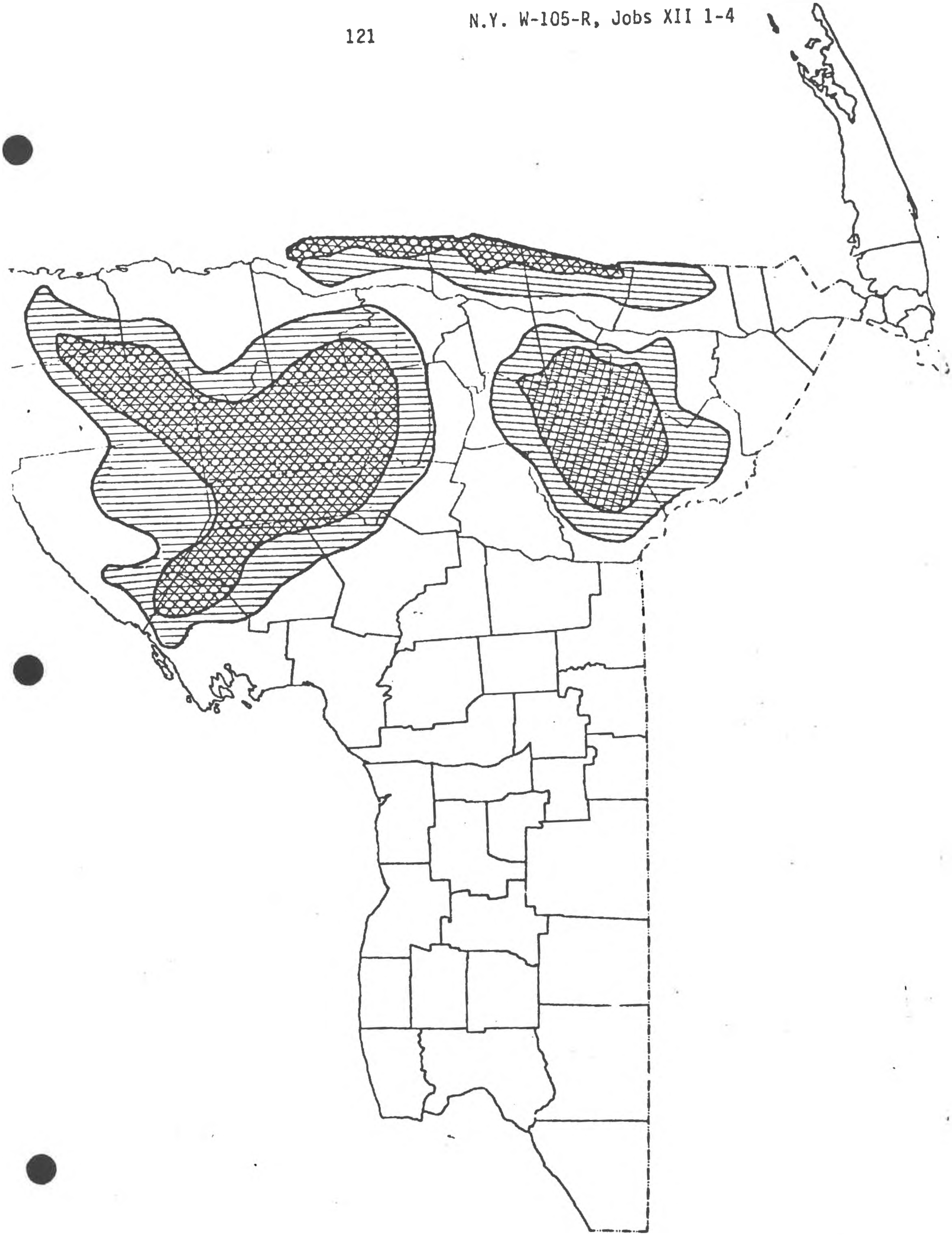
Area	Size, km^2	Estimated population
Adirondacks[b]	22,554	361
Adirondacks[c]	11,909	175
Catskills[b]	7,993	480
Catskills[c]	3,727	224
Taconic[b]	4,535	272
Taconic[c]	1,606	97

[a] Average home range sizes are: 326 km^2 for Adirondack males, 86 km^2 for Adirondack females, 36 km^2 for Catskill males, and 31 km^2 for Catskill females.

[b] Includes peripheral and core areas

[c] Includes only core areas

Figure 22. Distribution of bobcats in New York; [crosshatch symbol] core of populations, [vertical line symbol] additional peripheral areas.



The third technique used to estimate the population was based on age structure, rate of population increase, and harvest levels. The mortality rate (i.e. q_x) for the 2.5 and older bobcats was estimated with 5 values of r (0.2, 0.1, 0.0, -0.1, -0.2). These age structures were smoothed using a $\log_{10}$ linear regression of frequency vs. age. This assumes there is a constant post-dispersal adult mortality rate. The total number of adults (> 2.5 yrs.) harvested was then calculated based on the sample age ratio and the pelt tag total. Assuming that harvest was the only cause of adult mortality and that complete harvest records were available with no errors in age determination, and that the population had a stable age distribution, then the adult population would be:

$$\text{Post dispersal adult population} = \frac{\text{No. adults harvested}}{q_x}$$

It has been suggested that adult non-harvest mortality is low (Bailey 1974). However, the magnitude of non-harvest adult mortality is unknown. The findings discussed in Part A of this report, which agree with those of Petraborg and Gunvalson (1962), suggest that adult mortality in the central Adirondacks may be influenced by winter weather and deer herd conditions. The above equation will underestimate the true population unless appropriate corrections are made to account for the adults dying from non-harvest causes. Annual adult deaths are some multiple of the harvest. If annual adult deaths were 1.5 times the harvest take, and the rate of population increase was between 0.1 and -0.1, then the statewide adult bobcat population would be between 380 and 815 individuals. If annual adult deaths were more than 1.5 times the harvest take, the statewide adult bobcat population estimate would be larger. I believe the 1.5 expansion factor was a conservative estimate. The fate of 5 telemetered bobcats provides insight. Three of these animals were harvested and 2 died of non-harvest causes, yielding an expansion factor of 1.67.

MANAGEMENT ALTERNATIVES

The fact that bobcat populations have remained viable in New York State attests to the remarkable adaptability of this species. Three native cat species existed in the state until the late 1800's. Only the bobcat remains today. Bobcats are uniquely adapted for a varity of environmental conditions. Sound management practices in 1 area may be inappropriate elsewhere. Because of the expense and difficulties involved in acquiring sufficient pertinent biological and ecological data and the diverse and often conflicting nature of the values placed on bobcats, this species presents one of the greatest management challenges of any mammalian species exploited by man in New York.

Economic and legal changes in the status of bobcats have recently accentuated the management problems. Sportsmen pursuing bobcats with trained hounds, trappers, and hunters that incidentally harvest bobcats while hunting other wildlife species, are concerned that their use of this species may be curtailed or usurped by 1 or more of the other groups of consumptive users. There has been a growing recognition and appreciation for non-consumptive values of wildlife. Some individuals perceive the bobcat as a symbol of environmental quality; a fierce, solitary, wild creature of great aesthetic value, which is being persecuted to the brink of extinction for the monetary gain of a few individuals. Future exploitation of the bobcat resource for consumptive purposes may be impossible if this non-consumptive public is not appropriately addressed.

Habitat Considerations

Much can be gleaned from the literature on the resiliency of bobcat populations in the northeast. There is strong evidence that the range of the species was reduced by large scale conversion of forest to agricultural land, especially in areas lacking refuges such as caves. The range of habitat conditions that this species utilizes suggests that it was not the interaction of the bobcat with the new land use that caused their range to decrease, but rather the increased vulnerability that resulted from increased human occupancy of that land. Bobcat population centers in the northeast have generally been associated with remote sites or rough terrain. Throughout the majority of the range of bobcats in the northeast it appears that the bobcat exists where man either allows it to survive or where man cannot eliminate it.

The resilience of the bobcat species within the population stronghold or core areas of its distribution in the northeast, can be surmised from the writings of Silver (1957). During the period 1882 to 1895, extensive pressure was applied to the bobcat population in New Hampshire, yet on the average the entire harvest in the state was only 4.3 bobcats and lynx combined per year. The state was highly settled with 29% of the land committed to improved farmland and less than 60% being forested and the human population was distributed throughout the rural area. One might argue that this apparent low bobcat density was the result of poor reporting, however Silver (1957:308) states: "Over the first three quarters of the 19th century, wildcats were common enough to be troublesome, while remaining sufficiently unusual to rate individual mention in many town histories." Thus if a bobcat was killed it was publicized, if a bounty was offered, that bounty was claimed. The bobcat population of New Hampshire thrived during the next 40 years despite its original low level and no legal protection. During the period 1935 to 1951 an average of 195 bobcats were bountied each year. Thus the resiliency of bobcat populations in the northeast is such that the species will not disappear rapidly due to human harvest pressure alone.

Timber harvest along portions of the northern fringe of the bobcat range coincided with the northward expansion of bobcats. Increased logging activity may be beneficial for bobcats in other regions of the country (e.g. Missouri, Georgia). However, within a region like the Adirondacks, increased logging activity might increase the vulnerability of the population, favor competitors and result in an absolute shortage of preferred habitat as stands grow into intermediate seral stages. The central Tug Hill has a large amount of early seral stage forest. During the 1950's it was heavily populated by bobcats and yet the species has declined substantially in recent times within this region. The reasons for this decline are subjects for debate but could include competition with coyote (Canis latrans) and/or fisher (Martes pennanti), locally heavy exploitation by man, changes in weather, reduced deer population, etc. Malnutrition is a problem for bobcats in the central Adirondacks. Considering the low density of bobcats in that region and the difficulty of finding sick or dying animals, the number of bobcats I observed during the late winter that were in poor condition suggests that malnutrition must be an important factor. A telemetered bobcat that spent all of its time within an area that had been intensively and repeatedly logged, died of malnutrition. It seems that early seral stages are not a panacea for survival.

A preliminary study of the regional difference between areas that had bobcats and areas that did not have bobcats was conducted. The SAS (Helwig and Council 1979) version of discriminant analysis was used to compare some characteristics (i.e. human population density, snowfall, land ownership patterns and uses, deer density, road density, and coyote harvest) of towns where bobcats had been pelt tagged vs. adjacent towns where they had not been reported. The preliminary results showed that a function could be prepared that could reclassify these towns as either having a bobcat harvest or not having a bobcat harvest with surprising accuracy (Table 22). Further analysis of these data is beyond the scope of this report. However, this approach deserves future consideration.

Suggestions For Data Collection

Bobcat pelt tag data should be collected and analyzed annually. Expanding the current pelt tag system to include red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*) and raccoon (*Procyon lotor*) could tell us much about the interactions of terrestrial furbearer species. Bobcat pelt tagging and carcass collection systems should be interfaced. There were occasions during this study when I obtained partial or no harvest data with a carcass submitted for necropsy, thus restricting and complicating analysis. Improved data processing capabilities, such as the SAS, would facilitate more thorough and rapid utilization of this data. Data collected from necropsied bobcats should include age, corpora lutea counts, placental scar counts, and a condition indicator in addition to the harvest data.

Because of the small sample of bobcats harvested each year, it is imperative to collect the majority of available carcasses. There has been a great deal of cooperation with the volunteer carcass submission program, however important data have been lost because numerous bobcats were field dressed and decapitated, particularly in the southern zone, or the carcass was never submitted. Data on the characteristics of individuals harvesting bobcats clearly show that the majority of these people will probably harvest only a single bobcat annually and possibly throughout their life. Individuals that harvest a bobcat incidentally to other activities are often unfamiliar with a carcass collection program and therefore may fail to contribute information to the data base. A possible solution to this problem may be the inclusion of a bobcat carcass tag with

Table 22. Discriminant function analysis for the reclassification of New York towns having a reported bobcat harvest or no harvest.

	Percents classified into locations			
	Adirondack Towns		Catskill Towns	
Observations from[a]	with harvest	without harvest	with harvest	without harvest
Adirondack towns with harvest	100	0	0	0
Adirondack towns without harvest	6.25	93.75	0	0
Catskill towns with harvest	0	0	100	0
Catskill towns without harvest	0	0	6.25	93.75

[a] The characteristics of 16 towns from each category were included in the analysis.

big-game licenses and the compulsory, prompt reporting of kill (similar to the procedure for black bear). Many bobcats harvested in the southern region are considered trophies. Perhaps they should be managed as such.

Data Interpretation

It is my belief that bobcat populations in New York are influenced by the overall harvest regulations of terrestrial furbearers rather than specific regulations pertaining to bobcats. Improved management may be possible by adjusting season lengths, opening and closing dates and regulating techniques. However, to do this the interactions between regulations and their influence on each species population must be known. Multiple regression techniques to predict harvest, similar to those conducted by Erickson (1980), may be helpful. Additional research is needed on the interaction between regulations, harvest, population dynamics and public acceptance. The feasibility of a bobcat population-environment-harvest model is currently being evaluated (Wain Evans, pers. comm.). Models of this type will aid managers during the decision making process.

A technique for analyzing pelt tag data to determine changes in harvest distribution has been presented (harmonic mean model). This system could be refined by obtaining more precise locations of harvest and analyzing each population center independently in addition to the total statewide distribution. A limitation of this technique occurs around the border of the state where a biased sample of the true population is obtained (i.e. only those animals harvested within the state). This limitation tends to underestimate the influence of populations occurring along the border (e.g. the Taconic population of bobcats).

Direct interpretation of harvest age structure has been seriously challenged (Caughley 1974). Bobcat harvest age structures are the result of all factors affecting population dynamics plus harvesting bias. Hence, component parts cannot be isolated. These age structures do provide a number of checks and add support to certain hypotheses. For example, a sequence of harvest age structures that reveal a strong cohort suggest that some environmental factor favors recruitment. Examination of trends in environmental factors may reveal this causative factor. A harvest age structure that contains more individuals in older age class than a younger age class should not be interpreted to mean a declining population. A population with these characteristics could be increasing, decreasing, or stable (Alexander 1958). A sequence of harvest age structures that contains more individuals in an older age class than a younger age class, obtained from a population that is being harvested at the same level each year and which shows no noticeable decline in range size (e.g. the bobcat harvest age structure of southern New York) suggests either age differential harvest vulnerability or immigration of an older age class. The lack of this age structure pattern in the northern sample suggests that the second alternative shoud be accepted initially.

Two hypotheses for interpreting female bobcat reproductive effort have been given. The first emphasizes that reproductive rates are related to prey density (Young 1958:49). The second emphasizes that female bobcat density influences reproductive rate, being expressed as an older age before the first reproductive activity, and reduced numbers of individuals showing signs of reproductive activity when density is high (Hall 1973, Miller 1980). Conditions within New York suggest that the second idea does not need to be considered and that it is very difficult to refute the first. My impressions are that bobcat reproductive rates are generally constant. This may be due to stable prey levels or some other factor.

Condition class in furbearers has seldom been analyzed. The findings of Mech et al. (1968) relative to the raccoon in Minnesota and Brocke (1970) relative to the Virginia opossum (Didelphis virginiana) in Michigan indicate that this technique provides insight into the distribution of species near the northern limits of their range. I found the oven dry femur fat index of bobcats to be easy, quick and informative and suggest that this technique be part of any future necropsy work done on bobcats and possibly tested and expanded to other furbearers necropsied in the state.

Bobcat Management Options

The bobcat currently has a "favorable conservation status"(as defined by Johnson 1980) in New York State. The population dynamics of the species suggest that it is stable on a long-term basis. The range of the bobcat in New York is not likely to be reduced on a long-term basis. Legislative mandates regulating land use on much of the area occupied by bobcats insures that habitat quality will remain relatively constant on a long-term basis. The distribution of the bobcat in New York has not changed substantially since the turn of the century. Considering the changes that have occurred with other wildlife species, this is an impressive record of stability. Potential options for future bobcat management in New York follows even though the species currently has a favorable conservation status. Priorities may change so that new options for bobcat management may need to be considered in the future.

Permanent bobcat study areas could be established to measure population trends and function as control areas to evaluate the influence of various management practices. These areas should have the following attributes: (1) the area should currently have a bobcat population, and have a history of being occupied range, (2) land ownership patterns should be present which would allow various management options to be applied, (3) access to the area should be controlled, and (4) the area should be of sufficient size to contain a viable population. Two areas within the Adirondacks currently meeting these attributes are the Moose River Plains Recreational Area and Fort Drum.

Within permanent bobcat study areas no harvest of bobcats should initially be allowed. Permits could be issued to allow the use of trained hounds and special capture devices by selected individuals. Each bobcat captured in this manner should be tagged (possibly transmittered) and released. The emphasis would be on the research values of these animals. The involvement of sportsmen in this program could foster future cooperation and support. This study has shown that there is a reservoir of enthusiastic individuals who would be delighted to participate in field research.

Research on these areas should initially address the question of whether sanctuaries of this nature act as population cores with adjacent exploited areas serving as population sinks. It is my opinion that natural sanctuaries occurring within the Catskill region contribute dispersal age bobcats which are harvested at a high rate in adjacent areas and contribute to the observed skewed age structure. Knowledge of the dynamics and necessary size of these areas could contribute greatly to the future management of this species.

There are numerous additional research topics that could be addressed at these study areas (e.g. fate of juveniles, dispersal, interspecific and intraspecific interactions). These areas could also serve as general furbearer study areas from which the accumulation of data and experience would be a base for improvements in management.

The Adirondack high peaks deserve special mention in relation to bobcat management. The harvest of bobcats from this area is and historically has been low. Reports of high bobcat densities in the Boreas Pond area were unsubstantiated during 2 fall months of trapping and during winter track searches. All carcasses examined from this area were under 2 years of age, suggesting that they may have been animals that dispersed into the area. Telemetry data suggest that bobcats in the Adirondacks generally use lower elevations. For these reasons we do not believe bobcats should be given a high management priority in the Adirondacks high peaks area.

The central Tug Hill region also has a low bobcat harvest, however bobcats were apparently numerous in that location during the 1950's and 1960's. By observing the fate of bobcats that disperse into that area we might gain insight into the cause of this apparent decline. However, the cost of specifically studying this problem may outweigh the benefits. Managing this area for other species (fisher and coyote) appears to be more promising at this time than efforts to increase the bobcat population.

Harvest of bobcats in the Adirondack region could be reduced if desired by ending the season earlier. Lengthening the season during the early fall should not increase the harvest. There are disadvantages to an early season. It is unfortunate that the techniques to harvest fox, coyote and raccoon (species whose pelt primeness occurs early in the season and whose populations are very resilient to harvest pressure) incidentally take fisher and bobcat, species whose peak pelt primeness occurs in January (Stains 1979) and whose populations are less resilient to harvest pressure. Improved species specific harvest techniques would allow better utilization of the furbearer resource.

Harvest of bobcats in the southern region of the state could be reduced by eliminating harvest during the big-game season. This might be warranted on an experimental basis to determine if survival of yearlings could be increased and the range of bobcats, particularly in the southern and western Catskills, could be expanded.

Reestablishing a bobcat population in the Allegheny State Park has a potential for success. Towns within the Allegheny State Park score very high on the discriminant function that compares areas where bobcats occur (from harvest information) versus areas where they do not occur. Scattered reports of bobcat sightings occurred throughout western New York. A report was received of a road killed bobcat near the Park, however I did not have the opportunity to examine the specimen. A yearling female that had apparently produced kittens was killed in Yates County. A reconaissance of the Park should reveal if a bobcat population does exist. A restoration project could be initiated if a population does not currently exist there.

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APPENDICES

Appendix 1. Summary of regional bobcat densities reported in the literature.

Source		Region (State)	Density Bobcats per 100 km^2
		SOUTHEAST	
Progulske	1952	(Virginia)	8.6
Marshall and Jenkins	1966	(South Carolina)	25.7
Guenther	1980	(Florida)	10-14 adults 20 total
Miller	1980	(Alabama)	77 - 116
		SOUTHWEST	
Beason and Moore	1977	(Texas)	219 - 317[a]
Lawhead	1977	(Arizona)	26
Jones and Smith	1979	(Arizona)	24.4 - 27.6
Lembeck and Gould	1979	(California)	115 - 153[b] 124[c]
Zezulak and Schwab	1979	(California)	5 - 10
		NORTHWEST	
Bailey	1974	(Idaho)	5.4
		UPPER MIDWEST	
Berg	1979	(Minnesota)	3.9 - 5.6
Klepinger et al.	1979	(Wisconsin)	3.9 - 7.8

[a] Derived by elimination trapping, probably includes immigration.

[b] Unharvested population.

[c] Harvested population.

Appendix 2. The percent occurrence of food items utilized by bobcats, a summary of reported food habit studies.

Source (location)	Food Item Categories[c]										
	Rabbits and hares	Squirrels	Mice and Voles	Other Rodents	Carnivores	Ungulates	Shrews	Grouse	Other Birds	Misc. and Unknown	Sample Size
NORTHEAST											
Hamilton and Hunter 1939 (Vermont)	22	10	26	13	8	23	4	9	4	4	140
Foote 1945 (Vermont)	22	9	16	13	5	20	5	6	3	13	244
Pollack 1951 (New England)	49	12	5	13	1	36	1	2	3	1	163
Westfall 1956 (Maine)	22	18	16	15	2	41	5	7	7	8	88
Stevens 1966 (New Hampshire)	43	21	7	7	4	28	2	0	5	T	401
May 1980 (Maine)	79	4	12	5	1	10	0	0	6	1	168
SOUTHEAST											
Progulske 1952 (Virginia)	25	25	25	3	31	25	3	0	6	3	32
Progulske (North Carolina)	24	24	24	4	20	20	0	0	4	4	25

Appendix 2. The percent occurrence of food items utilized by bobcats, a summary of reported food habit studies.

Source (location)	Rabbits and hares	Squirrels	Mice and Voles	Other Rodents	Carnivores	Ungulates	Shrews	Grouse	Other Birds	Misc. and Unknown	Sample Size
	Food Item Categories[c]										
Davis 1955 (Alabama)	63	12	20	3	5	11	1	0	12	1	239
Fritts 1973 (Arkansas)	39	21	15	5	8	7	0	0	6	0	150
Hall 1973 (Louisiana)	74	0	51	5	2	0	0	0	21	5	43
Buttrey 1974 (Tennessee)	35	10	45	4	14	24	0	0	12	26	49
Kitchings and Story 1978 (Tennessee)	70	30	50			20				10	10
Miller 1980 (Alabama)	30	5	45	7	7	9	2	0	12	11	136
Fox and Fox 1982 (W. Virginia) unpubl. data	23	13	39	6	8	48	4	3	6	4	154
SOUTHWEST											
Stone 1977 (Texas)	27	0	97	0	0	0	0	0	21	0	33

Appendix 2. The percent occurrence of food items utilized by bobcats, a summary of reported food habit studies.

Source (location)	Food Item Categories[c] Rabbits and hares	Squirrels	Mice and Voles	Other Rodents	Carnivores	Ungulates	Shrews	Grouse	Other Birds	Misc. and Unknown	Sample Size
Beason and Moore 1977 (Texas) 1971	20	2	53	0	0	24	0	0	1	T	51
1972	24	0	74	0	0	T	0	0	1	1	74
Jones and Smith 1979 (Arizona)	38	0	67	0	2	4	0	0	4	11	176
Turkowski 1980 (Arizona)	21	0	60[a]	0	0	34	0	0	12[b]	55	67
WEST											
Schwartz and Mitchell 1945 (Washington)	62	33	18	2	0	8	1	1	6	5	105
Leach and Frazier 1953 (California)	29	17	87	0	1	6	0	0	2	1	166
Young 1958 (70% from Western states)	37	7	8	T	0	16	0	5	13	8	3990
Gashwiler et al. 1960 (Utah and E. Nevada)	45	6	25	6		32	0	0	8	4	53

Appendix 2. The percent occurrence of food items utilized by bobcats, a summary of reported food habit studies.

Source (location)	Food Item Categories[c]										
	Rabbits and hares	Squirrels	Mice and Voles	Other Rodents	Carnivores	Ungulates	Shrews	Grouse	Other Birds	Misc. and Unknown	Sample Size
Nassbaum and Maser 1975 (Coast Range, Oregon)	53	15	46	8	0	3	4	1	13	11	143
(Cascad Range, Oregon)	71	35	44	3	0	3	6	3	3	6	34
Bailey 1979 (Idaho Mts.)	62	0	20[a]	0	3	12	0	0	16[b]	0	197
(Idaho Sagebrush Plains)	67	0	17[a]	0	6	0	0	0	25[b]	0	36
Brittell et al. 1979 (Washington)	40	9	9	61	0	7	3	0	5	17	76
NORTHCENTRAL											
Dearburn 1932 (Michigan	90	7	2	3	T	4	0	0	1	T	300
Rollings 1945 (Minnesota)	52	4	2	22	2	44	10	2	2	2	50
Erickson 1955 (Michigan)	49	6	11	12	1	35	4	5	5	1	112

Appendix 2. The percent occurrence of food items utilized by bobcats, a summary of reported food habit studies.

Source (location)	Food Item Categories[c]										
	Rabbits and hares	Squirrels	Mice and Voles	Other Rodents	Carnivores	Ungulates	Shrews	Grouse	Other Birds	Misc. and Unknown	Sample Size
Berg 1979 (Minnesota)	40	16	9	12	0	24	0	0	0	0	73

[a] all rodents reported as one category

[b] all birds reported as one category

[c] Values are the sum of the percent occurrences of each species reported in the original paper within a category. This tends to inflate categories such as mice and vole where individual bobcats may have consumed numerous species.

Appendix 3. Summary of bobcat movement patterns reported in the literature.

Source	Home Range km^2	Actual diel travel distance (ADTD)km	Estimated diel travel distance (EATD)km	Minimum estimated diel travel distance (MEDTD)km	Dispersal distance km
Bailey 1979					12 - 158
Bailey 1974	M. x = 42.1			M. x = 1.8	
	F. x = 19.3			F. x = 1.2	
Berg 1979	M. x = 62				32 - 136
	F. x = 38				
Brittell et al. 1979	F. 11.6				43.3 - 9.6
	M. 6.5 - 15.5				
	F. 3.9 - 8.4				
Buie 1979	M. x = 20.8		M. x = 9.9		
	F. x = 10.4		F. x = 6.2		
Erickson 1955	39 - 52	x = 5.6-7.2		x = 2.3	
Guenther 1980	M. x = 13.6		M. x = 6.2	M. x = 3.0[a]	
	F. x = 6.8		F. x = 6.6	F. x = 2.4[a]	

Appendix 3.

Karpowitz and Flinders 1979	M. 13-34				24
Kavanau 1971		x = 6.9			
Kitchings and Story 1979	M. 42.9			M. x = 4.5	
	F. x = 11.5			F. x = 1.2	
Kitchings and Story 1978	M. 30.8			M. x = 3.3	
	F. 14.2			F. x = 1.0	
Hall and Newsom 1978	M. x = 4.9		M. x = 4.4	M. x = 2.2[a]	
	F. X = 1.0		F. x = 2.9		
Hamilton 1980	M. x = 58.7				
	F. 25.9				59.5
Lawhead 1978	M. x = 9.1				
	F. x = 4.8				
Lembeck and Gould 1979	M. 2.5-6.0				
	F. 1.4				
Marshall and Jenkins 1966	F. 4.6		F. x = 2.7		

Appendix 3.

May 1981	M. x = 4.7[b]			
	F. x = 13.9			
Miller 1980	M. x = 3.0			
	F. x = 1.5			
Miller and Speak 1979	M. x = 2.6			
	F. x = 1.1			
Pollack 1951	104	3.2 - 8.0		
Robinson and Grand 1958				x = 6.6
				max = 37.0
Rollings 1942	26-39	x = 8.9	1.2-6.0	
Zezulak and Schwab 1979	26-95 (lava beds N.M.)			24
	5-54 (Joshua Tree N.M.)			

[a] Maximum distance between any two points in one day's movement.

[b] Probably underestimated due to an insufficient monitoring interval.

Appendix 4. Land Use and Natural Resource Inventory of New York State (LUNR) habitat categories occurring on bobcat study areas.

Ac - Cropland and cropland pasture: Areas used for growing cultivated field crops, forage crops, grain, dry beans, etc.

Rotated pastures may be included here, particularly if aftermath grazing is practiced.

If this land use is associated with dairy farming, the headquarters is point counted as d, and if associated with poultry, as e. If it is associated with neither but is used with an active farm whose major enterprise is listed above (Ao, Av, Ah, At) or is simply in general farming, the headquarters is point counted as f.

Ap - Pasture: Usually permanent or unrotated pasture areas. Some areas may show scattered brush, but with evidence of grazing or cow trails they are still classified as Ap rather than as Forest brushland Fc.

Ay- Specialty farms: All areas are delineated as Ay and point data are mapped separately in the following categories: Ay-1 to 5.

Ai - Inactive agricultural land: Identifies unused agricultural land that has not yet developed brush cover Fc but is probably committed toward that category. This is one of the most difficult land uses to identify. It is sometimes impossible to differentiate between this type of land use and land diverted from active use in a government program, which may come back to active agricultural use after a diversion program of one or more years. The entire area around the particular field or section must be studied for any abandoned farm buildings or a developing residential or commercial area.

Cr - Resorts: Commercial resorts which range in size from converted farmhouses to luxury resort hotels, featuring associated outdoor recreation such as swimming pools, tennis courts, small golf courses, small ski-slopes, riding stables. Full sized outdoor recreation facilities possibly associated, such as golf courses or ski-slopes, are mapped as OR.

Cs - Strip development: Commercial activities along a major highway or city or village street. Behind and mixed with such areas may be residential, agricultural, industrial or inactive areas. Individual commercial businesses may also be shown this way.

Eg - Sand and gravel pits: Evidence of active use is necessary.

Fc - Forest brushland: Generally areas where forests are regenerating, with more than 10% brush cover, up to and including pole stands (6" in diameter) less than 30' in height and 40 to 50 years of age. This is often land formerly cleared for agriculture, or older forested areas that have been clearcut, heavily grazed or completely burned over.

Fn - Forest lands: Land areas with natural stands where 50% or more of the trees are over 50 years old and over 30' high.

Appendix 4. (cont.)

Fp - Plantations: Areas artifically stocked, of any species, age class or size.

Il - Light manufacturing and industrial parks: Light manufacturing processes, storage, shipping and industrial administration and research, including parking lots to serve these installations, and warehouses. These industries may be thought of as "clean" - for designing, assembling, finishing and packaging products rather than for processing basic or heavy raw materials.

Nr - Exposed rock cliff, rock slopes and slide areas: Little or no vegetation is apparent. Includes such areas as the Hudson River Palisades and rock faces of mountains.

OR - Outdoor recreation: All areas where this activity is the predominant land use are identified as OR.

P - Public and semi-public land use: Areas mapped as P: types identified for the point count by P followed by a number.

Re - Rural estate: Residences with developed lot sizes of more than five acres, including the home, lawns, gardens, fenced areas, roadways and shrubbed areas but not undeveloped wooded growth.

When a farm operation, with additional houses, is associated with the estate, the main residence is included in Re and the farm is indicated as a regular farm operation, with the most logical additional house considered the farm headquarters.

Rk - Shoreline development: Areas of residential structures, usually extending back one parcel from the shoreline.

Rl - Low density: Lot frontage greater than 100 feet.

Rs - Strip development: Four or more non-farm residences per 1,000 feet of highway frontage, usually in predominantly open country in a single line along an existing through road.

Rr - Rural hamlet: Any community with a population under 1,000 in the 1960 Census but with visible community development. Besides residences, there usually are a few commercial establishments and/or public buildings, focusing on a crossroads or road intersection.

Rc - Farm labor camp: Usually barrack-type camps to house migrant or seasonal laborers, associated with agricultural areas of high-intensity crops. Secondary information is used to verify the few found with lumber operations.

Wn - Natural ponds and lakes: Natural water bodies with an area of more than one acre, not ones constructed by interrupting a natural water course.

Wc - Artificial ponds, lakes and constructed reservoirs: Bodies with a water area of more than one acre, defined by obvious water level control structures.

Appendix 4. (cont.)

Ws - Streams and rivers: Area delineation includes only segments of streams averaging 100 feet wide, but if a stream generally above this width is constricted over a short distance, that section is also mapped as Ws. If a stream, whatever its width, is impounded, the area is mapped as Ws and the structure counted as c.

Wb - Marshes, shrub wetlands and bogs: Ranging from waterlogged areas with no standing water to areas with a maximum of three feet of water and vegetation predominantly of shrub size or smaller.

Ww - Wooded wetlands: Areas covered with varying depths of water for much of the year, with vegetation mainly of trees.

Appendix 5. Pelt Tag Record of Harvest

ADIRONDACKS

CLINTON COUNTY	Bobcat Pelts Tagged Per Year				
Town	1977-78	1978-79	1979-80	1980-81	1981-82*
Altona	0	0	2	0	2
Black Brook	0	0	0	1	0
Chazy	1	0	0	0	0
Champlain	0	0	0	0	1
Danemora	0	3	1	0	5
Ellenburg	0	0	1	1	1
Mooers	0	0	0	0	1
Saranac	0	0	0	0	1
ESSEX COUNTY					
Chesterfield	0	1	0	0	0
Crown Point	0	0	0	1	0
Essex	0	1	0	0	0
Jay	0	0	1	1	0
Keene	0	0	0	0	1
Lewis	0	0	1	0	1
Minerva	1	4	0	2	0
Newcomb	0	1	0	2	1
North Elba	0	0	1	0	0
St. Armand	1	0	1	0	0
Schroon	0	0	0	0	1
Ticonderoga	0	0	0	2	0
Wilmington	0	0	0	0	1

* As of March 23, 1982

Town	1977-78	1978-79	1979-80	1980-81	1981-82
FRANKLIN COUNTY					
Altamont	0	1	3	4	2
Bellmont	0	0	3	1	1
Brighton	1	2	0	1	0
Burke	0	0	0	1	0
Duane	0	0	1	0	2
Franklin	3	0	2	2	1
Harrietstown	3	0	1	0	1
Moira	0	0	0	1	0
Santa Clara	4	1	5	3	4
Waverly	2	1	0	0	2
FULTON COUNTY					
Caroga	0	0	1	0	0
Ephratah	0	1	1	0	1
Mayfield	0	0	1	0	0
Oppenheim	2	0	1	1	2
Stratford	4	1	1	2	0
HAMILTON COUNTY					
Arietta	1	0	2	1	0
Benson	0	0	1	1	0
Hope	0	1	0	0	0
Indian Lake	0	4	3	3	0
Inlet	0	1	1	0	1

Town	1977-78	1978-79	1979-80	1980-81	1981-82
Lake Pleasant	0	0	0	2	1
Long Lake	1	2	3	3	2
Morehouse	4	0	1	0	0
Wells	0	2	0	0	1
HERKIMER COUNTY					
Fairfield	0	0	0	1	0
Norway	0	0	1	0	0
Salisbury	0	0	0	2	2
Webb	4	13	10	6	6
JEFFERSON COUNTY					
Alexandria	0	6	2	2	0
Antwerp	0	1	1	4	1
Champion	0	1	1	0	1
Orleans	0	2	0	0	0
Pamelia	0	0	0	1	0
Theresa	0	2	1	5	1
Wilna	0	0	1	0	0
Worth	0	0	1	0	0
LEWIS COUNTY					
Croghan	1	0	9	12	2
Denamrk	0	0	0	0	1
Diana	2	8	5	3	1
Greig	1	0	0	2	0

Town	1977-78	1978-79	1979-80	1980-81	1981-82
Martinsburg	0	0	0	0	1
Montague	0	0	0	0	2
New Bremen	0	0	0	1	0
Osceola	0	1	0	0	0
Pinckney	0	0	0	1	0
Turin	1	0	0	1	2
Watson	0	1	4	3	4
West Turin	0	0	0	0	2
ONEIDA COUNTY					
Ava	0	0	0	1	0
Boonville	0	0	0	0	1
Forestport	1	3	1	6	6
Remsen	2	2	2	0	4
Steuben	0	1	0	0	0
Trenton	0	0	1	0	1
Verona	0	0	2	0	0
Western	1	0	0	0	0
OSWEGO COUNTY					
West Monroe	1	0	0	0	0
ST. LAWRENCE COUNTY					
Clare	0	0	1	0	0
Colton	1	1	3	6	4
DePeyster	0	0	5	0	0

Town	1977-78	1978-79	1979-80	1980-81	1981-82
Dekalb	0	1	0	2	1
Fine	0	2	0	0	1
Fowler	0	2	2	0	0
Gouveneur	0	0	1	0	0
Hammond	0	1	0	0	1
Hermon	0	1	0	0	0
Hopkinton	0	0	0	2	0
Macomb	0	0	2	0	0
Norfolk	0	0	0	4	1
Oswegatchie	1	0	0	0	1
Parishville	0	0	2	0	1
Piercefield	0	0	3	1	5
Pitcairn	0	2	0	0	0
Potsdam	0	0	1	0	0
Rossie	0	1	0	1	1
Russell	0	1	0	0	0
Stockholm	0	0	3	1	1
SARATOGA COUNTY					
Corinth	0	0	0	1	0
Day	0	1	2	1	0
Edinburg	1	0	0	1	0
Greenfield	0	1	1	0	1
Hadley	0	2	2	1	0
Half Moon	0	0	1	0	0

82-83 82-8

Town	1977-78	1978-79	1979-80	1980-81	1981-82
Providence	0	1	0	0	0
Saratoga	0	0	0	1	0
WARREN COUNTY					
Chester	1	0	0	0	0
Johnsburg	0	1	5	1	1
Lake George	1	0	0	0	0
Lake Luzerne	1	3	0	2	0
Stony Creek	0	2	5	2	0
Thurman	0	0	1	1	1
Warrensburg	0	1	0	0	0
Total Adirondack Harvest	50	94	128	117	101
CATSKILLS					
ALBANY COUNTY					
Berne	0	1	0	1	1
Coeymans	0	1	0	0	0
Rensselaerville	2	0	0	1	1
Westerlo	0	0	1	0	0
DELAWARE COUNTY					
Andes	3	2	5	6	6
Bovina	1	2	2	0	1
Colchester	1	6	5	4	4

Town	1977-78	1978-79	1979-80	1980-81	1981-82
Davenport	0	0	1	0	0
Delhi	0	1	2	1	2
Deposit	0	0	1	0	0
Hamden	0	1	4	4	3
Hancock	0	1	1	0	0
Kortright	0	0	2	1	0
Middletown	2	6	2	3	3
Roxbury	0	7	3	3	7
Sidney	0	1	0	0	0
Stamford	0	2	2	0	2
Tompkins	0	0	0	2	1
Walton	0	5	0	0	0
GREENE COUNTY					
Ashland	0	0	0	0	2
Athens	0	0	0	1	0
Cairo	0	1	0	0	0
Catskill	0	0	0	1	0
Coxsackie	0	0	1	0	0
Durham	2	2	3	0	1
Halcott	0	0	0	1	1
Hunter	0	1	2	1	0
Jewett	1	0	2	2	1
Prattsville	1	1	1	2	1
Windham	0	0	2	1	2

Town	1977-78	1978-79	1979-80	1980-81	1981-82
ORANGE COUNTY					
Highlands	0	0	1	0	0
OTSEGO COUNTY					
Exeter	2	0	0	0	0
Worchester	0	1	0	0	0
SCHOHARIE COUNTY					
Blenheim	0	0	2	0	0
Broome	1	7	0	1	0
Conesville	1	1	1	0	3
Fulton	0	0	0	1	0
Gilboa	0	1	2	0	2
Jefferson	0	1	0	0	0
Middleburg	0	1	0	0	0
Sharon	1	0	0	0	0
Wright	0	0	2	0	0
SULLIVAN COUNTY					
Callicoon	0	1	0	0	0
Fremont	0	0	0	0	1
Liberty	1	0	0	0	0
Lumberland	1	0	0	0	0
Mamakating	0	0	1	0	0
Neversink	4	2	1	0	0
Rockland	0	1	3	0	1
Thompson	0	0	2	0	0

Town	1977-78	1978-79	1979-80	1980-81	1981-82
ULSTER COUNTY					
Denning	1	0	5	0	2
Esopus	0	0	1	0	1
Hardenburgh	0	1	0	0	0
Olive	2	1	2	2	0
Saugerties	0	1	0	0	0
Shandaken	1	3	2	1	2
Wawarsing	0	0	1	0	0
Total Catskill Harvest	29	66	74	41	51
TACONICS					
COLUMBIA COUNTY					
Ancram			1	1	1
Austerlitz			2	2	0
Canaan			1	0	1
Claverack			0	1	0
Copake			3	0	0
Gallatin			1	1	0
Hillsdale			3	0	2
Taghkanic			0	1	0
RENSSELAER COUNTY					
Berlin	1	3	2	0	0
Brunswick	0	1	0	0	0

Town	1977-78	1978-79	1979-80	1980-81	1981-82
Grafton	0	1	1	0	0
Hoosick	0	0	0	0	1
Petersburg	0	0	1	0	0
Poestenkill	1	0	0	0	0
Sand Lake	1	0	0	0	0
Stephentown	0	0	3	0	0
WASHINGTON COUNTY					
Dresden	0	0	0	0	1
Easton	0	0	0	1	0
Fort Ann	0	1	0	6	3
Granville	4	0	0	1	0
Greenwich	0	0	1	0	0
Hampton	0	0	0	1	0
Hartford	0	0	0	1	0
Jackson	0	0	1	2	2
Putnam	0	0	2	2	2
Salem	0	4	4	2	1
White Creek	1	2	9	7	7
Whitehall	1	1	3	0	1
Total Taconic Harvest	9	13	38	29	22
Grand Total New York State Harvest	88	173	240	187	174

Appendix 6. Harmonic mean measures of the bobcat harvest distribution in New York. Figures A through E represent the plots of the harmonic mean measures for the 1977-78 through 1981-82 season respectively.

Figure A. Harmonic mean measures of the 1977-78 bobcat harvest distribution in New York. Inner line represents an isopleth value of 7.0, outer line represents an isopleth value of 10.0, and intermediate isopleth values of 8.0 and 9.0 have also been plotted. Each unit on the axis represents 10 km, and the values are multiples of the UTM system. Open circles (o) designate the center of towns from which bobcats were harvested.

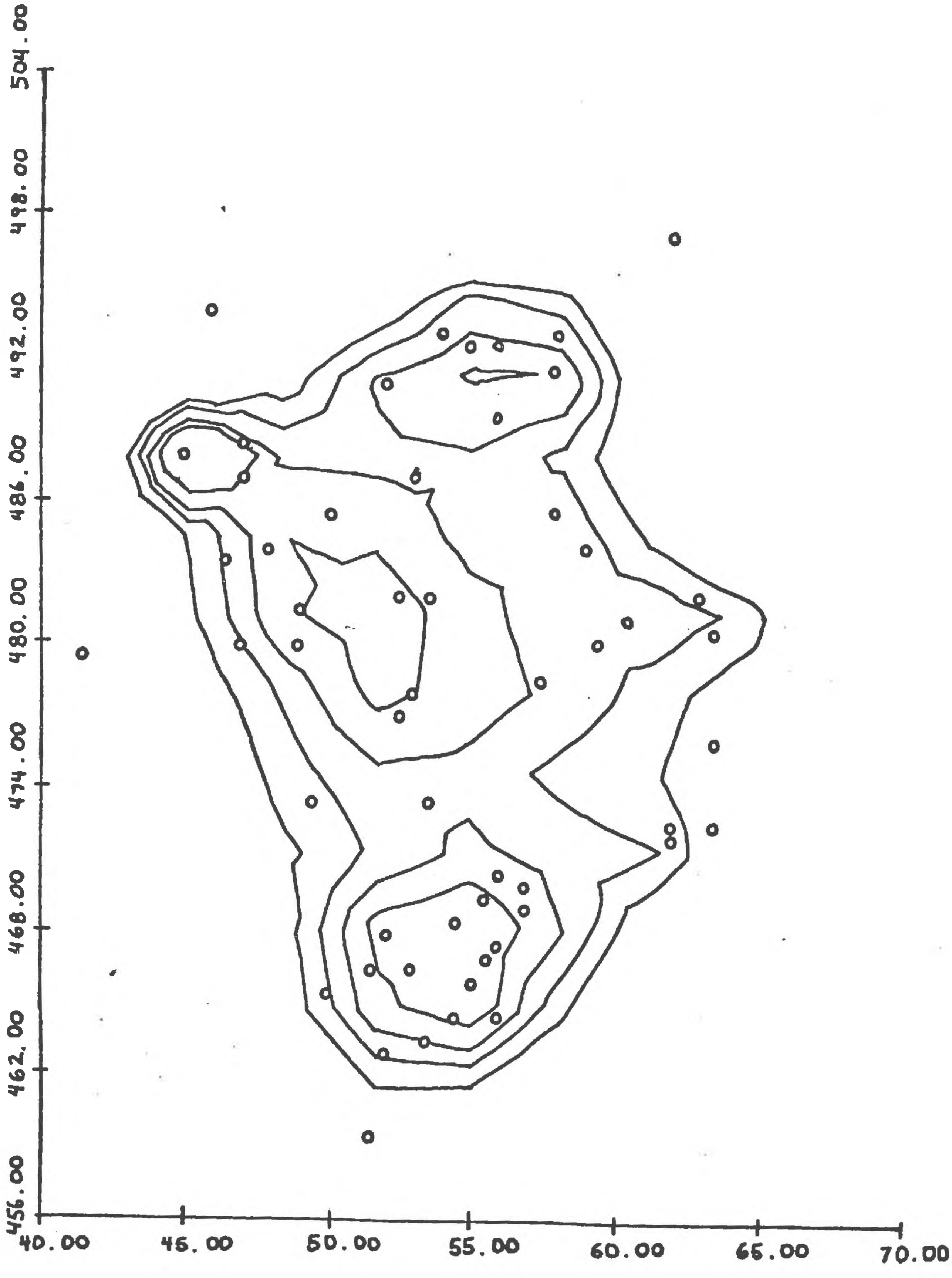
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Figure B. Harmonic mean measures of the 1978-79 bobcat harvest distribution in New York. Inner line represents an isopleth value of 7.0, outer line represents an isopleth value of 10.0, and intermediate isopleth values of 8.0 and 9.0 have also been plotted. Each unit on the axis represents 10 km, and the values are multiples of the UTM system. Open circles (o) designate the center of towns from which bobcats were harvested.


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Figure C. Harmonic mean measures of the 1979-80 bobcat harvest distribution in New York. Inner line represents an isopleth value of 7.0, outer line represents an isopleth value of 10.0, and intermediate isopleth values of 8.0 and 9.0 have also been plotted. Each unit on the axis represents 10 km, and the values are multiples of the UTM system. Open circles (o) designate the center of towns from which bobcats were harvested.

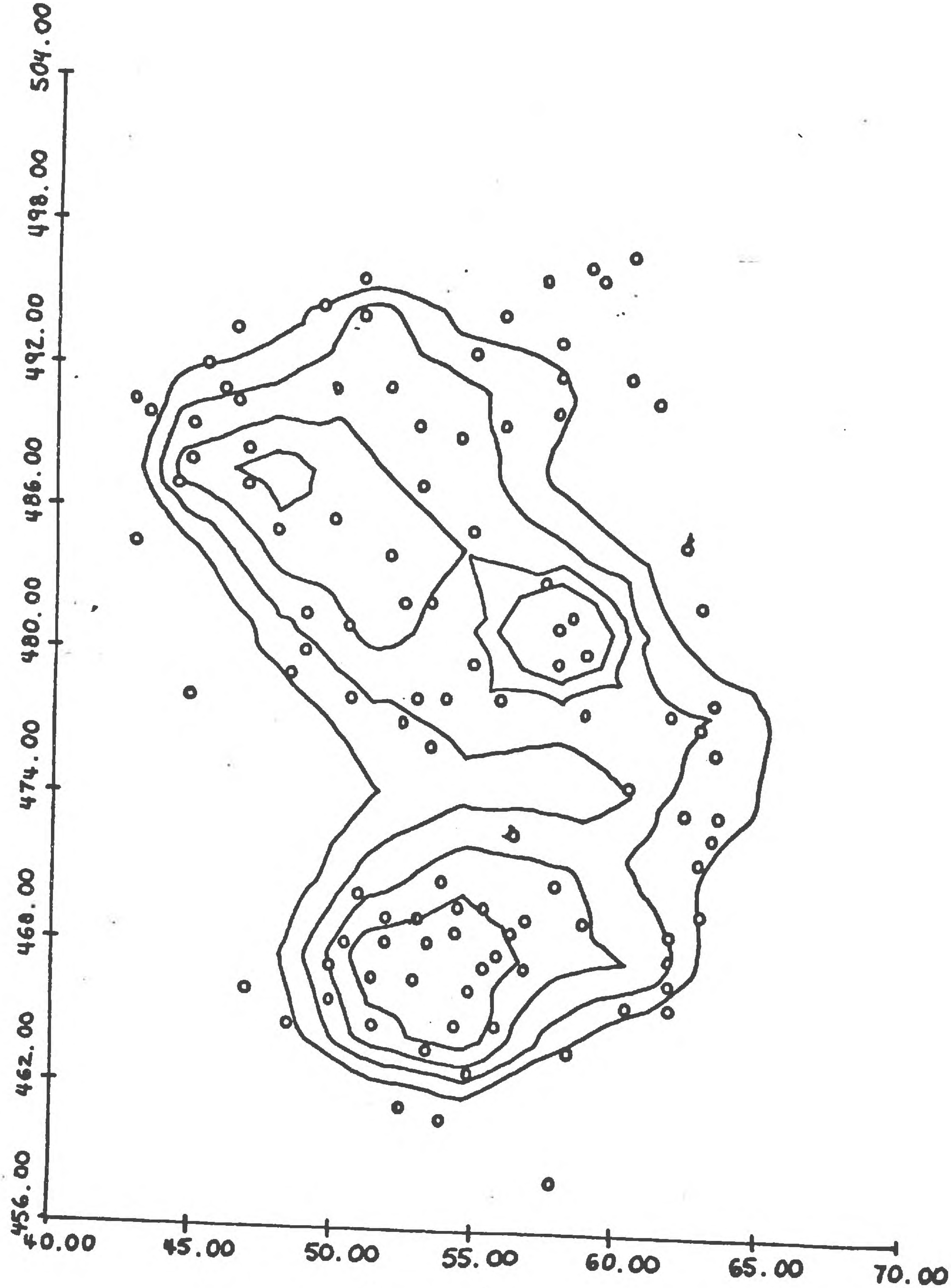

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Figure D. Harmonic mean measures of the 1980-81 bobcat harvest distribution in New York. Inner line represents an isopleth value of 7.0, outer line represents an isopleth value of 10.0, and intermediate isopleth values of 8.0 and 9.0 have also been plotted. Each unit on the axis represents 10 km, and the values are multiples of the UTM system. Open circles (o) designate the center of towns from which bobcats were harvested.

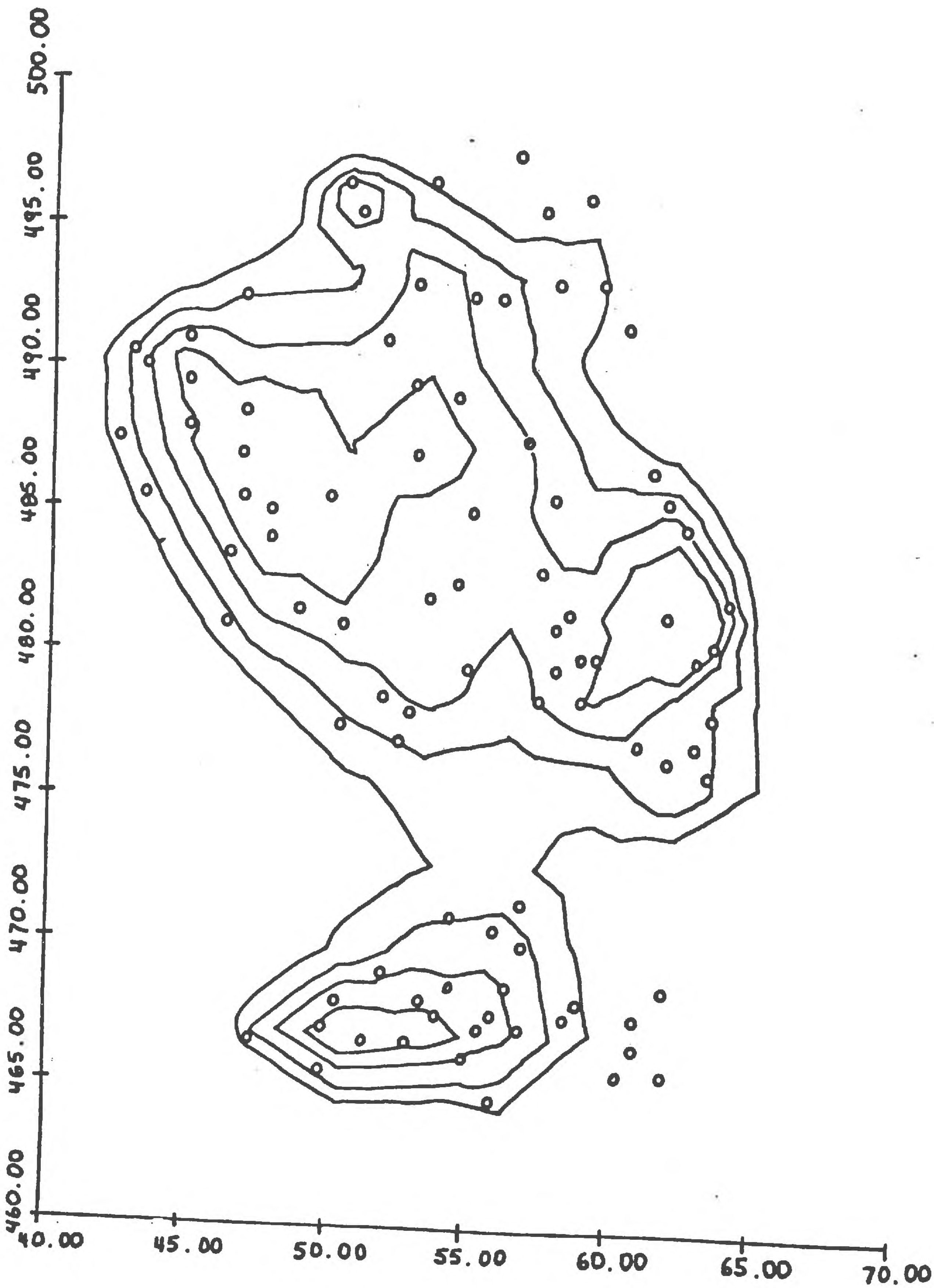

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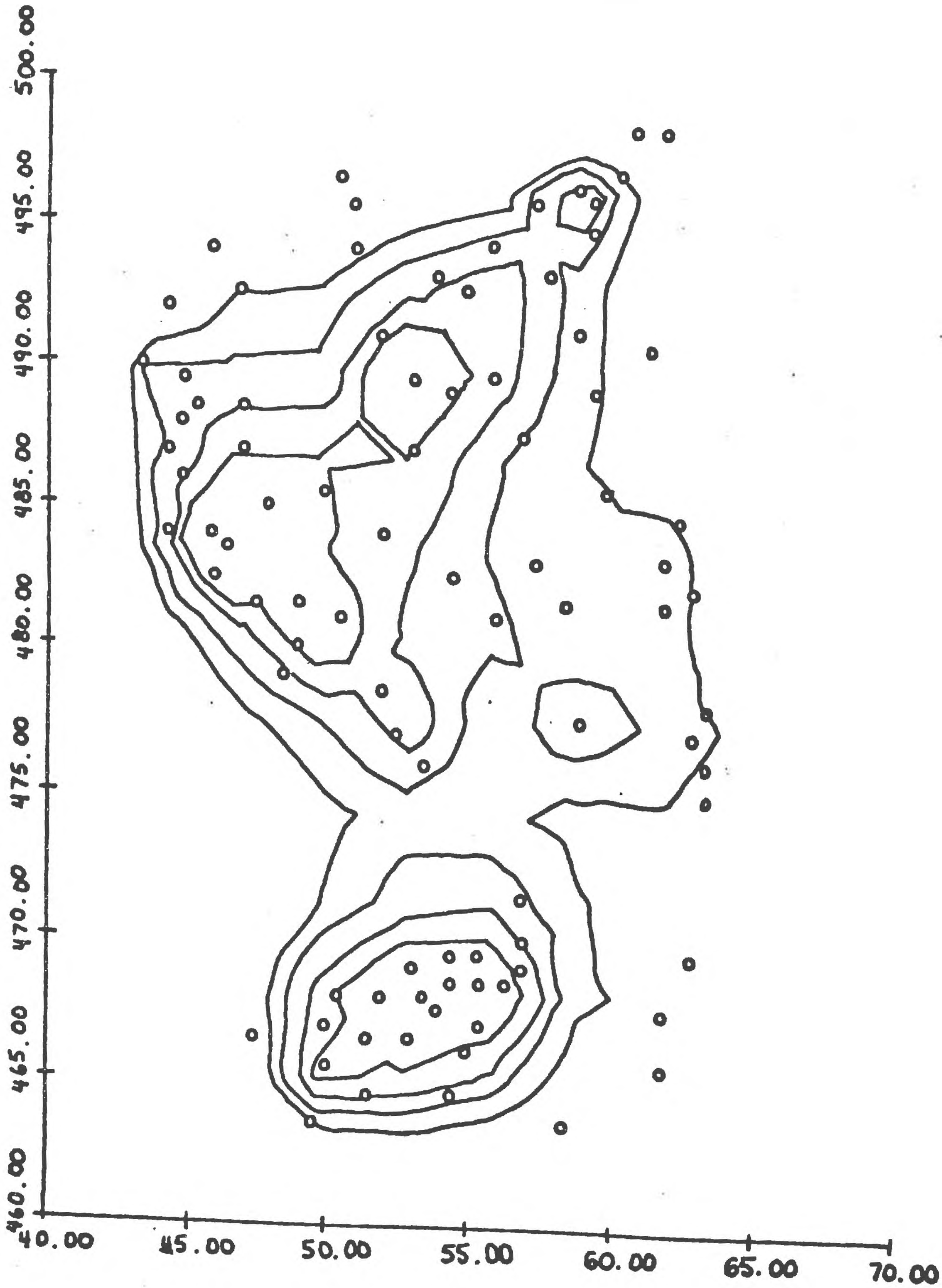
Figure E. Harmonic mean measures of the 1981-82 bobcat harvest distribution in New York. Inner line represents an isopleth value of 7.0, outer line represents an isopleth value of 10.0, and intermediate isopleth values of 8.0 and 9.0 have also been plotted. Each unit on the axis represents 10 km, and the values are multiples of the UTM system. Open circles (o) designate the center of towns from which bobcats were harvested.



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