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Dickey-Lincoln School Lakes Project Environmental Impact Statement: Appendix F: Terrestrial Ecosystem Analysis (Supplement 2)

University of Maine at Orono, Maine

Cooperative Wildlife Research Unit

United States Army Engineer Division

New England Division

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX F
TERRESTRIAL ECOSYSTEM ANALYSIS
(SUPPLEMENT 2)

Dickey-Lincoln School Lakes

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Army Corps
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PREDATOR HABITAT UTILIZATION STUDIES, DICKEY-LINCOLN SCHOOL LAKES PROJECT, MAINE

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1.0. The Study Area

The overall study area encompassed the St. John River and its major tributaries; including the Little and Big Black Rivers (and their tributaries), and all lands extending 3.2 km (2 mi) beyond the maximum elevation of the predicted impoundment of the Dickey Dam (1,560 km^2). Research was concentrated in a portion of this area roughly bounded on the north by Chimenticook Stream, on the east by the St. John River, on the west by the United States-Canadian border, and on the south by a line drawn east-west through Seven Islands (Figure 1.0-1). Intensive marten studies were restricted to townships T14 R15 and T14 R16. Some radio-collared animals did not respect these boundaries and consequently were tracked in large portions of northern Maine and eastern Quebec.

Hilton and Richens (1975:75) described the study area as having relatively flat terrain and moderate rolling hills. "The area is characterized by spruce-fir climax forest with interspersion of a maple-beech-birch forest type. Many cuttings of various ages provide abundant edge. The mean daily minimum temperature for July and January, respectively, are 54°F and 0°F. The average annual number of days with snow cover is 140 and the mean annual total snowfall is 96 inches" (Lull 1968).

Vegetation, soils, and other aspects of the overall study area have been characterized in various sections of the Environmental Impact Statement for the Dickey-Lincoln School Lakes Project (CE, 1978).

2.0. Techniques and Methods

2.1. Small Mammal Trapping

Small mammal abundance was sampled on 12, 1-ha grids. Each grid consisted of 121 trap stations spaced 10 x 10 m with 2 snap traps baited with peanut butter at each station. All grids were sampled for 3 consecutive nights in the spring (05-22-80--06-12-80) and again in late summer (07-16-80--08-16-80). To examine prey differences among major vegetation types, 3 grids were established in each of four major habitat types; softwood, hardwood, mixed wood, and regenerating clearcut. Hardwood stands were dominated by maple/beech overstories; softwood stands were fir/spruce; mixed stands were approximately 50/50 hardwood/softwood; and of the 3 clearcut grids, 1 was dominated by raspberries with clumps of regenerating softwoods and hardwoods, and 2 were open space with a thick ground cover of blueberry.

2.2. Snow Transects

Six transects totaling 120 km in length were established for counting tracks as an index of predator and prey abundance, and also to supplement habitat utilization data obtained by radio telemetry. All 6 transects consisted mostly of inactive and unplowed logging roads and old jeep trails. Transects were located so as to sample most of the intensive study area (Figure 2.2-1). Transects were run by snowmobile 12 to 24 hours after a snowfall or drifting condition. Tracks entering and crossing the middle of the transect were tallied by species and by habitat (both sides of the transect). If it was obvious that an individual had left and then re-entered, the tracks were not tallied again.

2.3 Capture and Handling

Coyotes *(Canis latrans)*, fox *(Vulpes fulva)*, and bobcat *(Lynx rufus)* were captured with leg-hold traps (No. 2 and No. 3 coil spring). Traps were commonly set along active and inactive logging roads, although old log landings, campsites, abandoned farms, air strips, and quarries were occasionally used.

Marten *(Martes americana)* and fisher *(Martes pennanti)* were captured in wire mesh box traps (Tomahawk Live-Trap Co., Tomahawk, Wisconsin). Traps were baited with beaver meat, salted herrings, sardines, jam, or a combination thereof. Traps were set along old logging roads or on transects established through suitable habitat.

Captured coyotes, foxes, and bobcats were physically restrained and some were also immobilized with ketamine hydrochloride (Ketaset, Bristol Laboratories, Syracuse, New York, or Vetalar, Parke, Davis and Co., Detroit, Michigan) at 22 mg/kg of body weight. Marten and fisher were restrained in a wire and canvas handling cone and, if they were to be radio-collared, immobilized with ketamine hydrochloride.

Coyote, fox, and bobcat were marked with either Temple ear tags (Temple Tag Co., Temple, Texas) or Allflex ear tags (Delta Plastics, Palmerston-North, New Zealand). Marten, fisher, and coyote and fox pups, were earmarked with various sized monel, self-piercing, tags (National Band and Tag Co., Newport, Kentucky).

Physical measurements obtained from all predators handled except marten included; weight, body length (tip of nose to base of tail), tail length (base of tail to tip of flesh), chest girth, and neck girth (immediately behind the head). Marten were weighed only. Each animal was examined for reproductive condition and gross evidence of ectoparasites or injuries. Injured animals were administered an antibiotic (intramuscular injection and/or powder) on the injury site.

Canids and cats were classified as young-of-year, sub-adult, or adult based on tooth wear and replacement, size, and other gross morphological features of the animal, and reproductive condition. Identification of young-of-year posed little problem, however, separating sub-adults and adults was difficult in some cases. Marten and fisher age classification was based primarily on saggital crest measurements (Marshall 1951, Coulter 1966).

2.4. Radio-Location Telemetry

Many individuals of each predator species handled were equipped with radio-transmitting collars. Collars for coyote, fox, cats, fisher and male marten were obtained primarily from Telonics (Telemetry-Electronics Consultants, Mesa, Arizona). Those for female marten were purchased from Wildlife Materials Inc. (Carbondale, Illinois). A few homemade transmitters (Cochran 1967) and transmitters donated by EMF Systems, Inc. State College, Pennsylvania, were also used. A variety of collar and antenna configurations were utilized including collars with whip antennas, ribbon antennas, or collars with whip antennas that had been coiled back on themselves and taped to the collar. A few collars were equipped with dual-mode transmitters that pulsed at two different rates depending on whether the animal was active or inactive. Radio receivers were Telonics Model TR-2 148/150 receivers; some were matched to Model TS-1 Scanner/ Programmers.

Collared animals were located either by ground triangulation or from aircraft (Cochran 1980). Triangulation involved determining azimuth fixes on an animal from two or more ground locations (Cochran 1980). Hand-held directional "H-antennas", hand-held 4-element yagi antennas, or truck-mounted dual-beam 4-element yagi arrays were used to determine the direction of the signal. Field tests, conducted during the study, indicated locations obtained by triangulation were on the average within 300 m of the true location for the larger predators, and within 100 m for marten.

A single-engine fixed-wing aircraft with an H-antenna mounted on each strut was used for aerial tracking. Aerial locations were generally within 0.5 ha, and frequently the target animal was visually observed.

Information recorded for each radio location included date, time, activity of the animal, X-Y coordinate, primary and associated habitat types, weather, distance to water and to the flood zone, and elevation.

2.5. Analyses of Habitat Use

Data needed to address habitat use were obtained from either direct observation or vegetation type maps. Habitat for aerial radio-locations, and snow transect data were obtained by direct observation. Habitat types for radio-locations determined by triangulation were secured from vegetation type maps from the Army Corps of Engineers (CE), and in some cases, from forest cover maps of Seven Islands Land Company (Bangor, Maine). Each triangulation determined location was plotted on a type map and a 300 m (100 m for marten) radius circle (representing the average accuracy of the triangulation technique) drawn around it. The habitat type composing the largest proportion of the circle was coded as the primary habitat type because the true location of the animal was most likely to be in that type. The next two most dominant habitat types within the circle were coded as associated habitat types. Each location was compared to the latest aerial photos (made available by Seven Islands Land Co.) to check for recent lumbering activity.

Coding of the habitat data was based on the Forest Land Classification System for the State of Maine (MIDAS System, Maine State Planning Office, Augusta, Maine).

Preference or avoidance of habitats, as indicated by telemetry, track counts, and small mammal trappings were tested by methods of Neu et al. (1974). The null hypothesis that the distribution of locations or tracks among habitat types was proportional to the availability of habitat types (expected) was first tested by chi-square. If the null hypothesis was rejected, then preference or avoidance of a specific habitat type was determined by constructing confidence intervals for the observed frequency in each type. The expected value was subsequently examined to see if it was included within the interval.

The expected catch of a small mammal species in a habitat, was the product of the total catch of that species and the proportion of trap nights in each habitat type. For snow transect data, the expected number of tracks of a species in a habitat type, was the product of the total number of tracks for that species and the proportion of the transect in each habitat type.

Expected habitat values for telemetry data were extrapolated from earlier reports by Environmental Research and Technology, Inc. (ERT) (1975:175) for the entire Dickey-Lincoln School Lakes Project study area; including the impoundment area and the 3.2 km (2 mi) zone beyond the maximum pool level. Although estimates of availability were based on an area that did not cover the entire range of some study animals, the relative amounts of each habitat were considered representative of the region as a whole. Since marten had more restricted ranges than the larger predators, habitat availability for marten was determined within the intensive marten study area by means of a dot grid.

Home range estimates were based on the convex polygon technique (Voigt and Timline 1980). This measure includes the area within a unique convex polygon (all angles $\geq 90°$ that encloses all data points.

2.6. Scat Collection and Analysis

Predator scats encountered incidentally while conducting research activities were collected and labeled as to species, date of collection, location, estimated age of scat, and a brief description of surrounding habitat at the collection site. Scats were dried, examined, and food items tallied by frequency of occurrence (percent of scats containing a particular item).

2.7. Miscellaneous

Two other predator projects were conducted by the University of Maine at Orono concurrently with the present study Comparable methods were used in all 3 studies, therefore, results are often compared in this report.

One study was in the Cherryfield area in eastern Maine and is referred to as Wildlife Management Unit 6 (WMU 6), and the other was in the Pierce Pond area in western Maine and is referred to as Wildlife Management Unit 3 (WMU 3) (Figure 2.7-1).

3.0. Results and Discussion

3.1. Prey Abundance and Habitat Utilization

3.1.1. Small Mammals. A total of 354 small mammals were captured in 16,698 trap nights (TN) for an overall capture rate of 2.1/100 TN (Table 3.1-1). Significantly (P<0.005) more captures were made in late summer [256(3.2/100TN)] than in the spring [98(1.1/100TN)] which probably reflects recruitment during the summer reproductive period. Species captured (in order of greatest occurrence) were redback vole *(Clethrionomys gapperi)*, deer mouse *(Peromyscus maniculatus)*, woodland jumping mouse *(Napaeozapus insignis)*, shrew *(Sorex* spp.) meadow vole *(Microtus pennsylvanicus)*, and short tail shrew *(Blarina brevicauda)*. Redback voles and deer mice accounted for 71% of the catch.

Small mammal capture rate for this study was lower than the 5.6/100TN reported for the Medway area of Maine (Burke 1980), and the 4.27/100TN for WMU 6 (Brown 1980); but slightly higher than the 1.87/100TN noted for WMU 3 (Major 1980). All 3 studies were conducted concurrently with the present study.

Earlier studies in Maine (using similar techniques in summer and fall) reported small mammal populations fluctuate dramatically from year to year. Monthey (1978), studied small mammals near Moosehead Lake, Maine, and observed a drop in capture rate from 25.6/100TN in 1975 to 3.2/100TN in 1976. Richens (1974) worked at Pierce Pond, Maine, and noted a decline from 20.6/100TN in 1969 to 9.86/100TN in 1970. Based on the above information, it appears that small mammal populations were at a low throughout the state during the present study.

Significant (chi-square, P<0.005) differences between vegetation types were observed for captures of individual species as well as for total catch (Table 3.1-1). Significantly (P<0.10) more redback voles were captured than expected in the mixed wood stands, and less than expected in hardwood and clearcut stands. Deer mice were caught more often than expected in hardwood stands and less than expected in softwood stands. Woodland jumping mice were trapped more often in hardwood stands than expected, and fewer shrews were caught in hardwood stands and more in softwood stands than expected. Overall capture frequencies indicated significantly (P<0.10) fewer small mammals were caught in clearcuts than expected.

The low redback vole capture rate in clearcuts was comparable to other studies in northern forest regions of eastern North America; which have shown that, in general, deer mice and meadow voles prefer the dense herbaceous cover of early successional stages, whereas redback voles prefer later successional stages (Richens 1974, Kirkland 1977, Martell and Radvanyi 1977, Monthey 1978). However, unlike the present study, these studies indicated either no difference or an increase in small mammal densities during the first few years after clearcutting.

3.1.2. Snowshoe Hare. Snowshoe hare *(Lepus americanus)* were abundant in the study area and were the species most commonly encountered on snow transects (2,887/222 km, Table 3.1-2). Significantly ($P<0.10$) more than expected hare tracks were transected in softwood stands and clearcuts, and fewer than expected in hardwood and mixed wood stands. Although habitat category "other" (which included all other types of habitat where tracks were encountered) could not be statistically tested, 192 tracks (6.8%) were classified as such. Most of these tracks were encountered in alder patches too small to appear on vegetation type maps. Hares have been generally documented as being associated with dense regenerating conifer or mixed wood stands and their edges (Bider 1961, Conroy et al. 1979).

A regional biologist and game wardens for WMU 2 of the Maine Department of Inland Fisheries and Wildlife (MDIFW) believed that snowshoe hares were at or near their peak of abundance during the study period (Jackson 1980, Noble 1980, Sirois 1980).

3.1.3. Deer. Deer densities in the study area (winter 1979-1980) were estimated to be 3.45/mi^2 (135/100 km^2) using pellet count techniques (MDIFW, P-R Project W-67-1-219, Deer Density Levels in Maine). This is the lowest deer density estimate of the 8 Wildlife Management Units in the state. Estimated densities for the other 2 areas where concurrent predator studies were conducted were 5.00/mi^2 (193/100 km^2 for WMU 3) and 5.12/mi^2 (198/100 km^2) for WMU 6.

The winter of 1979-1980 was the mildest in a decade (Lavigne 1980) and deer did not concentrate to the extent they often do. Nevertheless, most deer sign encountered during winter field work were on, or near, rivers, streams, and their associated bottomland cover. Deer tracks were noted 95 times while conducting snow transects (Table 3.1-2). Significantly ($P<0.10$) more of the tracks were found in softwood dominated mixed wood stands than expected, and significantly fewer than expected were observed in softwood stands. No tracks were transected in hardwood stands, and only a few were present in hardwood dominated mixed stands and clearcuts.

3.1.4. Moose. Moose were frequently encountered during the course of the study. Although too large to be an important prey species for predators known to exist in Maine, they may be an important source of carrion. The current estimate of moose density in WMU 2 is 1.63 moose/mi^2 (63/100 km^2) (MDIFW 1980).

3.1.5. Other Prey. Red squirrels *(Tamiasciurus hudsonicus)* were also common on the study area. However, only 128 tracks were encountered along the snow transects (Table 3.1-2). This probably under represents their relative abundance because of the arboreal and snow-tunneling habits of the species. Although the total number of red squirrel tracks encountered were too few to test statistically for habitat utilization, it appears that most tracks were encountered in softwood or softwood dominated mixed wood stands.

Porcupines *(Erethizon dorsatum)*. a species often listed as prey of fisher and cats, were present though scarce in the study area. Only 1 porcupine track was encountered on the snow transects; 3 were captured incidental to other trapping activities, and a few were encountered during other aspects of field work. They were probably too scarce to be an important prey species in the study area.

Ruffed grouse *(Bonasa umbellus)* and to a much lesser extent spruce grouse *(Canachites canadensis)* appeared to be common in the study area. Ruffed grouse were frequently encountered incidental to field research activities while spruce grouse were observed occasionally. Of 17 grouse tracks noted on snow transects, 12 (70.6%) were associated with softwood vegetation types (Table 3.1-2).

3.2. Lynx

3.2.1. Population Density and Status. Lynx *(Lynx canadensis)* were scarce in the study area. No lynx were captured during an intensive trapping effort, and lynx tracks were encountered only twice, including once while conducting snow transects (Table 3.2-1). Local residents and trappers have indicated that lynx at one time were more abundant than bobcat in the study area, but more recently have become scarce (Sirois 1980). Trapping records of lynx for Maine have not been kept.

Numbers and range of lynx in North America have generally declined over the years. Its disappearance from southern fringes of Canada appear to have been preceded by loss of forest habitat (deVos and Matel 1952). Short-term densities of lynx have been linked to snowshoe hare densities which appear to be on a 9 to 10 year cycle, at least in some regions (MacLulich 1937, Elton and Nicholson 1952, deVos and Matel 1952, Wing 1953, Keith 1963, Brand et al. 1976, Keith et al. 1977). Since snowshoe hare are believed to be at, or near, their peak of abundance in the study area; then based on the above studies, lynx should also be near their peak of abundance.

Lynx numbers in the study area could increase in the future, however, due to an influx of lynx from the north, and/or maturing of recent cuts of softwood stands to advanced regeneration stages. Mech (1980) noted that in Minnesota, which (like Maine) is on the southern fringe of lynx range, lynx numbers have changed drastically within a short period. Increases were attributed to influxes of lynx from more northern populations, and decreases to low productivity. mortality by humans, and possibly a return of some individuals to Canada. Advanced regenerating stands of softwoods have been reported as preferred lynx habitat in Newfoundland (Saunders 1963) and Nova Scotia (Parker 1980).

3.2.2. Habitat Utilization. The lynx has been described as a creature of undisturbed boreal forest who is intolerant of a changed environment (deVos and Matel 1952). Specific studies of habitat utilization by lynx are few, particularly in northeastern North America. In Newfoundland, Saunders (1963) noted lynx were associated with large tracts of 10-20 year second growth timber. Lynx in Cape Breton, Nova Scotia, preferred advanced regenerating forest types followed by open mature conifers, and open bog types (Parker 1980). Parker (1980) also reported lynx least preferred closed-mature-mixed forests; however, it was in this type that lynx had the greatest hunting success.

3.2.3. Prey Utilization. Snowshoe hare is the principle prey of lynx. Parker (1980) found that of 200 chases by lynx, 198 were of hares; the remaining 2 were of grouse. In Newfoundland, hare remains occurred in 73% of the lynx scats and intestinal tracts examined (Saunders 1963a). Ungulate carrion and grouse were the next most important food items reported. Occasionally lynx prey on young caribou or deer (Marston 1942, Saunders 1963a). This pattern of prey utilization is typical over much of its range (Van Zyllde Jong 1966, Nellis and Keith 1968, Nellis et al. 1972, Brand et al. 1976).

3.3. Bobcat

3.3.1. Population Density and Status. Bobcat were not abundant in the study area. Only 2 bobcats were captured and radio-collared, and there were no recaptures. Four sightings of untagged bobcat were made by project personnel on the study area. Bobcat tracks were not encountered during snow transect runs, but 1 was noted incidental to other activities. There was evidence, however, that bobcat may have been more abundant in other portions of the project area not studied: namely the Rocky Mountain area and the area south of Depot Lake (Dumond 1980, Jackson 1980).

State fur tagging records for the years 1977, 78, and 79 revealed that 12 bobcat were captured in a 32 township area containing the project area; this is the lowest catch of the legal species (Table 3.3-1). Bounty records indicated there has been a shift in the highest number of bobcats caught, from northwestern Maine, to central, and eventually to eastern Maine (MDIFW 1980). In 1939-41, WMU 2 ranked highest in the state for number of bobcat killed, but between 1968 and 1973, it ranked only fifth. Currently the estimate of 0.3 bobcat/mi^2 (18/100 km^2) for WMU 2; the lowest of all management units (MDIFW 1980).

3.3.2. Movements. A total of 36 radio-locations were obtained from the 2 radio-collared bobcat. The adult male was captured 29 March 1980 and relocated 11 times before he was found dead, probably of disease on 12 May 1980. He moved very little during that time and his estimated home range was only 3.5 km^2 (1.4 mi^2). The sub-adult female was captured 22 May 1980 and relocated 25 times before she disappeared sometime after 29 June 1980. Her estimated home range for that period was 27.6 km^2 (10.8 mi^2). On 7 November 1980 she was snared northeast of Edmundston, New Brunswick; 148 km (92.5 mi) from her capture site (Figure 3.3-1). This move gives some indication of the dispersal potential of the species. The home range sizes of these 2 animals may not be typical of cats in the study area so the information must be interpreted cautiously.

There is little information available pertaining to movements of bobcats in the northeast. Pollack and Sheldon (1951) estimated home ranges of bobcats in Massachusetts to be 1.5-5.4 mi^2 (4-14 km^2). Marston (1942) estimated the home range of a bobcat in Maine to be 40 mi^2 (104 km^2), and Rollings (1945) estimated bobcat home ranges as 10-15 mi (26-39 km^2) in Minnesota.

3.3.3. Habitat Utilization. The data collected in the study area was insufficient to make any conclusions concerning habitat utilization by bobcat. However, based on 36 radio-locations, the 2 bobcats used the major habitat types approximately proportional to availability. The most obvious exception is that 8 (22.2%) of the radio-locations were classified as "others"(Table 3.3-2). This is because the male cat was found in a recent clearcut much of the time. Examination of the associated habitat types indicated that 12 (33.3%) of the locations were associated with roads and 10 (27.8%) were associated with clearcuts.

Pollack and Sheldon (1951) noted recovery of bobcats in Massachusetts paralleled the return of forest and brush to abandoned cultivated lands. Later McCord (1974) in Massachusetts observed bobcat selected for road, cliff, spruce plantation, and hemlock-hardwood cover types; and avoided hardwoods, exposed shore, abandoned field, pine, pine-hardwood and reservoir ice cover types during winter. Rollings (1945:135) described preferred bobcat habitat in Minnesota as "second growth forest with much undercover interspersed with numerous clearings and swamps." It would appear then, bobcat prefer a mid-successional stage somewhere between mature forest and cleared land. Observations of 2 cats in this study, and bobcats in concurrent studies in WMU 3 and 6, support this hypothesis (Major 1980, May 1980).

3.3.4. Prey Utilization. No bobcat scats or prey kills were found in the study area. However, 137 bobcat scats were collected in WMU 3 and 6 during the period of this study (Table 3.3-3). Snowshoe hare, small mammals, and deer occurred most frequently during all seasons. It should be noted that the deer could be either carrion or prey.

It is clear from the literature that in New England, hares, deer, and rabbits (*Sylvilagus* spp.) were the most frequent prey or food items

(Hamilton and Hunter 1939, Marston 1942, Pollack and Sheldon 1951, Westfall 1956, Stevens 1966). Small mammals, squirrels, porcupines, and grouse may also be important. With the exception of rabbit, all these species were present in the project area.

3.4. Fisher

3.4.1. Population Density and Status. Currently fisher are not abundant in the study area. A trapping effort aimed specifically at fisher yielded only 1 capture and no recaptures in 892 trap nights. No fisher were trapped incidental to other trapping activities. In contrast, a concurrent study in Management Unit 3, 3 fisher were captured incidental to trapping coyotes, foxes, and bobcats (Major 1980). Fisher tracks were tallied 18 times in 222 km of snow transects (Table 3.2-1). and approximately 20 times while conducting other field research. In addition, there were 2 visual sightings of fisher in the study area by project personnel.

Four tagging records for the 32 township area encompassing the project area indicated that only 22 fisher had been taken during 1977, 1978, and 1979 of which only 5 were trapped within the intensive study area. Of the predators studied, only cats had fewer captures (Table 3.3-1).

Historical data pertaining to the abundance and distribution of fisher in Maine, are sparse. Coulter (1960) presented evidence of increased fisher populations and range expansion in the late 1940's through the 1950's. Numbers of fisher prior to that time were considered to be low throughout the state, with the exception of isolated areas of the northwestern highland regions of the state. Currently fisher are found throughout the state, except in WMU 5 and 6 (MDIFW 1980). WMU 2 is estimated to have 1-2 fisher/10 mi^2 (26/100 km^2), a density that is believed to be below optimum (MDIFW 1979). It appears that fisher density in the study area is below this estimate for WMU 2.

3.4.2. Movements. One sub-adult male was radio-collared 18 January 1980 and tracked until it died of unknown causes 15 May 1980. Analysis of the 90 radio-locations revealed he had a home range of 118.8 km^2 (46.4 mi^2) that was oriented along the Big Black and St. John Rivers (Figure 3.4-1).

A recent study in New Hampshire revealed that the long axis of the home range of most fishers generally paralleled valleys, and borders often coincided with streams (Kelly 1977). The sizes of the home ranges varied from 6.6 km^2 (2.6 mi^2) to 39.6 km^2 (15.5 mi^2). Sub-adult males had the largest ranges, and winter ranges were larger than summer ranges. An adult male radio-tracked in WMU 3, concurrently with the present study, had a home range estimated at 28 km^2 (10.9 mi^2). It would appear then that the young male fisher radio-tracked in the project study area may have had an unusually large home range.

3.4.3. Habitat Utilization. Of 90 radio-locations obtained on the fisher, 71 (79%) were in softwood stands (Table 3.4-1), and 54 of these (60% of all locations) were in dense mature softwood stands. Of the 19 locations not in softwood, 11 (12.2% of all locations) were associated with softwoods (Table 3.4-1). Thus 82 (91%) of the locations were in softwoods, or associated with softwoods. Heavy use of softwood stands along the rivers and streams, and parallel orientation of the fisher's home range to rivers, is evidenced by the 43 (48%) locations associated with rivers or streams (Table 3.4-2).

Other studies of fisher have nearly all reported selection of softwood dominated forest types and avoidance of non-forested or hardwood types (deVos 1952, Coulter 1966, Kelly 1977, Powell 1978). deVos (1952) and Coulter (1966) suggested, however, fisher were more flexible in use of habitat than species such as marten. Kelly (1977) observed selection of softwoods by fisher was most pronounced in winter.

Fisher are reported to use open hardwoods where porcupine are abundant (Powell 1978), but apparently avoid crossing open areas or rivers (Coulter 1966, Kelly 1977, Powell 1978). Powell (1978) reported fisher ran across open spaces and often minimized the open distance to be traversed. The fisher in the present study was snow-tracked through open clearcuts on a few occasions and was known to have crossed the frozen St. John River at least once.

Den sites, particularly during winter, may be critical to survival. The fisher in this study denned once in a clump of mistletoe in the crown of a spruce tree. Coulter (1966) reported fishers used a wide variety of den types such as temporary snow dens, brush piles, under logs, etc. Suitable denning sites appear to be abundant in the study area, so it is doubtful they are limiting to fisher.

3.4.4. Prey Utilization. Fisher prey upon and/or eat a wide variety of food items including (in rough order of importance), hare, porcupine, deer, shrews, birds, mice, and squirrels (Hamilton and Cook 1955, Coulter 1966, Clem 1975, Kelly 1977, Powell 1978). Reportedly fisher diet changes seasonally according to prey availability (Coulter 1966, Clem 1975). Clem (1975) found fisher responded to winter prey scarcity by increasing the variety of prey species taken.

3.5. Marten

3.5.1. Population Density and Status. Marten were abundant in the study area. A trapping effort of 3,931 trap nights resulted in 177 captures of 55 individuals (Table 3.5-1). Intensive live trapping was limited to townships T14 R15 and T14 R16, though incidental captures were made while trapping for fisher elsewhere in the study area. Marten ranked highest, both in number of tracks encountered on transects (Table 3.2-1), and in MDIFW fur tagging records (Table 3.3-1).

Density estimates for the study area were based on home range sizes calculated for radio-collared animals. It was assumed that males and females had overlapping ranges, but home ranges of the same sex did not overlap. An average home range size of 2.88 km^2 (7.34 mi^2) for females equated to 34 females/100 km^2, and an average home range of 5.57 km^2 (14.2 mi^2) for males equated to 18 males/100 km^2. The two density estimates were added together (since it was assumed home ranges of different sexes could overlap) to arrive at a density estimate of 52 adults/ 100 km^2 Soutiere (1979) demonstrated that much lower densities of marten can be expected in areas of intensive timber removal, such as existed in portions of the project area.

3.5.2. Movements. Five adult marten (2 males, 3 females) were radio-collared and tracked from May through September 1980. Home range size averaged 2.94 km^2 (2.53-3.53 km^2 based on 270 recaptures and radio-locations) for males (Table 3.5-2, Figure 3.5-1). Home ranges of females overlapped with those of males; but with no adjacent collared animals of the same sex, intrasexual spacing could not be examined. One juvenile male (kit of a radio-collared female) dispersed at least 4.3 km (2.7 mi) before being trapped in Canada.

Steventon and Major (1981) found summer home ranges of 10, 7.8, and 5.0 km^2 for 3 males, and 2.0 km^2 for 1 female in a commercially clearcut area near Moosehead Lake, in central Maine. They also noted that home ranges of adjacent males did not overlap.

3.5.3. Habitat Utilization. Distribution of 457 marten radio-locations revealed softwood stands and mixed stands were used in proportion to availability, while hardwood stands were avoided (Table 3.5-3). Track count data indicated softwood and softwood dominated mixed stands were used as expected while hardwood and hardwood dominated mixed stands were avoided (Table 3.2-1).

An analysis of radio-locations for each sex separately (Table 3.5-3) showed that females selected for softwoods, used hardwood dominated mixed wood stands equal to expected, and used softwood dominated mixed wood stands and hardwood stands less than expected. Males showed greater than expected use of softwood dominated mixed stands, less than expected use of softwoods, and proportional use of hardwood dominated mixed stands. The importance of softwood cover for females was evident with 50.4% of locations for females in dense mature (15 m high) softwood stands and another 49.6% within 100 m of such stands. Males were in mature softwood stands 31.5% of the time and were within 100 m of such stands 29.4% of the time. Preferential use of mature softwood stands or mixed stands has been reported across the martens' range; presumably due to greater prey availability, denning opportunities, and over-head cover (Marshall 1951, deVos 1952, Koehler and Hornocker 1977, Soutiere 1979, Steventon and Major 1981). Soutiere (1979) and Steventon and Major (1981) in Maine noted females were more restricted than males in use of habitat.

Den sites represent a special use of habitat. A total of 17 male and 21 female dens (or resting sites) were located for radio-collared marten. Eleven female sites (including 5 natal dens) were in large diameter (>25 cm dbh) cedar trees or logs; 9 were in crowns of trees (3 in mistletoe clumps, 2 on branches, 3 unseen); and 1 was under a pile of slashings. Fifteen male resting sites were in fir trees (10-43 cm dbh) of which 12 were in mistletoe clumps.

Female use of secure den sites may be related to rearing of young. Of 12 dens used by a female marten with kits, 8 were secure ground dens (<1 m above ground level), whereas none of 6 dens used by her after departure of the kits were gound dens. Only 1 natal den has been described in the literature and that was a hummock beneath a standing tree in Alberta (More 1978). Steventon and Major (1981) described winter dens of marten in Maine as being beneath the snow, typically in well protected cavities in hummocks formed around large decayed stumps, snags or similar features.

3.5.4. Prey Utilization. Analyses of 117 marten scats collected between April and August 1980 revealed redback vole was the most common prey item (69%), snowshoe hare ranked second (12%), and other small mammals, muskrat, squirrel, and berries were found in lesser amounts. The mixed wood and softwood stands where redback voles were most common were also those types where marten were most frequently radio-located.

Soutiere (1979) examined 412 scats from Moosehead Lake area of Maine and found voles dominated the diet in all seasons, with berries common in summer, and snowshoe hare a minor component through all seasons. Similar food habits have been reported across the marten's range (Cowan and McKay 1950, Lensink et al. 1955, Weckwerth and Hawley 1962, Francis and Stephenson 1972).

3.6. Coyote

3.6.1. Population Density and Status. Eastern coyote were common in the study area. Trapping efforts produced 21 captures and 4 recaptures (Table 3.6-1, Figure 3.6-1). Six tagged coyotes were known to have died during the study period and a seventh has been reported but not verified. This was a known mortality of 36.7% for 19 tagged coyotes (2 very young pups could not be tagged). All coyotes killed were either trapped, snared, or shot in Canada.

During 222 km of snow transects, 45 coyote tracks were encountered; the most of any predator species studied (Table 3.2-1). Coyote sign were frequently noted and project personnel sighted coyotes on several occasions.

Fur tagging records of MDIFW for a 3-year period (1977-79), indicated 42 coyotes were trapped or killed in the 32 townships that encompass the project area; 14 of these were taken from the intensive study area (Table 3.3-1). Tagging records also indicated an increase in coyote take, from 4 coyotes in 1977, to 20 in 1978 and 18 in 1979. It is difficult, however, to know whether to attribute the increase to a growing coyote population, to increased trapping pressure, or to some combination of both factors.

The eastern coyote is a recent arrival to the project area and its numbers are believed to be increasing (Aldous 1939, Richens and Hugie 1974, Hilton 1978). Estimates of current coyote numbers in WMU 2 by the MDIFW (1980) is 2,860 coyotes (0.3/mi^2 or 12/100 km^2) and a projected population of 3,442 coyotes (0.4/mi^2 or 15/100 km^2) for 1982.

Data collected during the present study indicated these estimates may be high. However, it should be stated estimates presented here are based on limited data for animals known to have complex social structures and dynamic population systems (Bekoff and Wells 1980). Estimates were based on home range sizes for 2 groups of coyotes radio-tracked during the study (see Section 3.6.2 for details). One group consisted of an adult breeding female, a non-breeding female, a breeding male (assumed) and at least 2 pups. This pack had a home range estimate of 310 km^2 (119.7 mi^2). The other group consisted of a breeding pair of adults and at least 3 pups. This breeding pair had a home range of 29 km^2 (11.2 mi^2).

Some major assumptions were also made: (1) the two groups had exclusive use of their home ranges except for intrusion by occasional nomads (Camenzind 1978, Messier and Barrette 1979, Bekoff and Wells 1980); (2) maximum density would occur when packs and pairs had pups, and minimum density would occur after the young had dispersed (Storm et al. 1976, Bekoff and Wells 1980); and (3) overall, the study area is relatively homogenous. Population densities were estimated based on the assumption that 60% of the coyotes in the study area belonged to small packs, 25% were mated pairs, and 15% were nomads (Camenzind 1978). Two population extremes were then calculated assuming: (1) no young-of-year were present (as might be the case after dispersal), and (2) each pack or pair had a full complement of 7 pups (Hilton 1978). For complete details of calculation refer to Appendix I.

Our population estimates for the total study area ranged 48 permanent residents (3/100 km^2 or 0.080/mi^2) to 205 permanent residents and young (13/100 km^2 or 0.336/mi^2). Therefore, the population estimate for WMU 2 was 689-2,888 coyotes. This estimate is believed to be high for 2 major reasons: (1) the home range estimate for pairs is believed to be an underestimate, because the pair were radio-tracked for only 1 month; and (2) it is doubtful that 7 pups per breeding pair survive to dispersal. More data are needed to fully understand the social composition of coyotes in the study area, and to determine average litter size and survival of young.

In nearby Quebec, Canada, Messier and Barrette (1979) estimated winter density of coyotes utilizing a deer yard as being 12 coyotes/100 km^2. This is somewhat higher than estimates for the present study, but may represent a concentration of coyotes near a major food source.

3.6.2. Movements. Fifteen coyotes were radio-collared, of which 7 are known to be dead (46.7% mortality of collared animals) (Table 3.6-1). During the study, 502 radio-locations were obtained for 11 individuals (Table 3.6-2). Home range estimates varied from 11 km^2 for an adult female to 2,650 km^2 for an adult male. The mean home range size for males 1,129 km^2 (± 1,152, n=4) and 124 km^2 (± 109, n=7) for females. The mean distance between relocations (based on aerial locations only) was 7.5 km (± 2.6, n=4) for males, and 4.7 km (± 1.5, n=7) for females. Variations in these estimates are best understood when individual animals and their associates are categorized.

It appeared that individual coyotes fell into 3 major categories: (1) those associated with a group (packs or mated pairs); (2) those that appeared to be nomads (Camenzind 1978); and (3) those that appeared to disperse. Each of these categories, and individuals composing them, are discussed.

3.6.2.1. Groups. Groups were composed of 2 or more adult animals who shared the same home range and who often traveled together. There were 2 definite groups and 3 other associations considered to be groups identified in the study area. Group I (for which the most data were available) consisted of adult female 4, sub-adult female 31, 2 male pups of female 4 (78 and 79), and an unidentified, non-collared coyote (Table 3.6-2, Appendix II). Female coyotes 4 and 31 were often located together, but at other times were widely separated. However, the home range of female 31 was within the range of female 4, and was smaller (Table 3.6-2, Figure 3.6-2). The unidentified coyote was observed twice in mid to late winter, bedded close to female 4, and again during spring near the natal den site of female 4. Since coyote packs in the west were generally composed of 1 breeding pair and some other non-breeding associates (Camenzind 1978, Bekoff and Wells 1980), it is believed that the uncollared coyote was the mate of coyote 4.

Group I appeared to have exclusive use of their 310 km^2 (119.7 mi^2) range. An intensive trapping effort within the boundaries of their range yielded only 2 recaptures of female 4, and 3 other coyotes (2, 5, and 77); all of which were either transients or dispersed (Appendix II).

Members of Group II were captured during late summer and early fall 1980. This group consisted of adult male 98, adult female 89, and 3 male pups (95, 97, and 100) apparently belonging to these adults (Table 3.6-2, Appendix II). All 3 pups and male 98 were captured on the same road, within a few hundred meters of each other, and during the same 6-day period. Male 98 was subsequently located with female 89 on several occasions, and capture sites of the pups fell well within the home ranges of the 2 adults (Figure 3.6-2).

Home ranges of coyotes 89 and 98 were superimposed, and were 29 km^2 and 25 km^2 respectively (Table 3.6-2). These estimates may be low because the 2 animals were monitored for only 2 months; and that was while they were rearing pups.

Group III was believed to be composed of adult female 28 and at least 2 other fully grown, non-collared coyotes seen in her company. The home range of female 28 was the smallest measured (11 km^2). The entire home range was located in mixed agriculture-woodland habitat characteristic of the Canadian side of the border in that area (Figure 3.6-2). Female 28 was monitored for only 1 month before she was shot. The short monitoring period probably biased the estimate of her home range.

Group IV was believed to have included at least female 9 and her mate. Female 9 was an older coyote whose teats and tooth wear indicated she was a breeding female. Her home range was 168 km^2 (64.8 mi^2), which was intermediate to Groups I and II (Table 3.6-2, Figure 3.6-2).

Group V was based on adult female 91 and her assumed mate. Her home range was 28 km^2 (Table 3.6-2), but that is probably an under-estimation because only 7 locations were obtained over a 2 week period.

3.6.2.2. Nomads. Nomads were solitary animals who did not appear to be dispersing. There was only 1 animal that could definitely be placed in this category; adult male 77 Male 77 had the largest home range (2,650 km^2 or 1,022 mi^2). He was initially captured within the range of Group I. His earlier moves were believed to be that of dispersal Subsequent locations, however, indicated considerable doubling, suggesting he was a nomad (Figure 3.3-1). Two other coyotes (males 5 and 92) might have been classified as nomads also, based on their comparable distances moved and estimated home ranges (Table 3.6-2, Figure 3.3-1); however, neither was tracked long enough to verify this.

3.6.2.3. Dispersers. Dispersers were those animals who either shifted the locality of their home range, or appeared to be in the process of doing so. Six coyotes from the present study were classified as possible dispersers. Two were females (8 and 96) and 4 males (2, 5, 16, and 92) (Appendix II). Adult female 8 was captured near Seven Islands in late September 1979. She was subsequently snared 1 month later 19.8 km northwest in Canada. Sub-adult female 96 was captured near Blue Pond 29 August 1980 and stayed in that area at least until 9 September 1980. Between 9 September and 13 September she moved 30 km northwest into Canada where she remained until she was snared on 11 January 1981 (Figure 3.6-2). Males 2 and 5 (both young-of-year and probably litter mates) were captured late September 1979 (Appendix II). Male 2 was subsequently shot in Canada 31 km southwest of his capture site. Male 5 was radio-tracked until 15 January 1980 when contact was lost. At that time he was 50 km from his capture site (Figure 3.3-1). Sub-adult male 16 was captured 17 October 1979 near Blood Lake. He was snared in Canada 10 days later, 10 km northwest of his capture site.

Adult male coyote 92 was most interesting. He was captured 18 August 1980 near the Priestly Bridge on the St. John River (Figure 3.3-1). He was radio-tracked until 30 October 1980. Initially he remained near the capture site until at least 5 September 1980. On 9 September he was radio-located 29 km northwest in Canada where he stayed for at least the next 15 days. While there he was observed by project personnel on 2 different occasions. The first time he was with a small pack of coyotes that included 3 blond-phased animals similar to those described by Hilton (1978). Several days later he was seen alone near a small settlement. It appeared that the small pack he had been seen with earlier, might have been what Camenzind (1978) referred to as an aggregation. By 29 September he had made another big move 28 km to the southwest. He was not located again until 19 October 1980 when he was found 22 km southeast of the last location. He was in this area (55.5 km from his capture site) until 30 October 1980 when monitoring ceased.

3.6.2.4. Discussion. It appeared that social classifications of coyotes similar to those described by Camenzind (1978) and Bekoff and Wells (1980) may have existed in the study area. What was unknown was the percentage of individuals belonging to each classification, and the stability of the social groups, i.e., packs, pairs, and nomads. For instance, Camenzind (1978) found that in Jackson Hole, Wyoming, 61% of coyotes belonged to packs, 24% were resident pairs, and 15% were nomads. Nomads were thought to serve as a recruitment pool for the reproductively active and resident segments of the population. Camenzind (1978) further noted cohesiveness of packs fluctuated seasonally, and Bekoff and Wells (1980) suggested cohesiveness was related to availability of large clumped prey items.

Home range estimates varied considerably from study to study. Often comparisons were made between adults and juveniles and between sexes with little or no reference to the social structure to which they belonged. Nonetheless, it appeared that coyotes in the study area had larger home ranges than those reported elsewhere. Bekoff and Wells (1980) observed mated pairs and solitary individuals had larger home ranges (average = 30.1 km^2) than those of packs (14.3 km^2). They also reported packs had the most stable home range size. Berg and Chesness (1978) in northern Minnesota noted male coyotes had larger home ranges than females (68 km^2 and 16 km^2 respectively) and females had exclusive home ranges. In the Curlew Valley (Utah and Idaho) adult female coyotes had larger home ranges; 138 km^2 as compared to the males 90 km^2. It is interesting home ranges for females in that study ranged from 29-469 km^2, which is comparable to those of females from this study area (Table 3.6-2). In 2 studies in the northeast, Post et al. (1975) reported that a male and female yearling in northwestern New York had home ranges of 76.6 km^2 and 4.5 km^2 respectively, and Messier and Barrette (1979) estimated the average winter home range of coyotes in an area of eastern Quebec was 15-16 km^2.

It is interesting that all dispersals in this study were in a westerly direction (southwest to northwest), while expansion of the coyote range has been northeasterly (Hilton 1978). A similar pattern of dispersal was witnessed for coyotes in Iowa (Andrews and Boggess 1978). They felt that it was related to differential hunting pressure which was highest in the west. They concluded that coyotes dispersing to the west were more vulnerable than those moving elsewhere, thus resulting in a higher recovery rate of those that moved west. All coyotes recovered in the present study were radio-collared, therefore, the bias in recovery does not apply. However, greater hunting pressure does exist in Canada, so what may be happening is the higher removal rate in the west may be encouraging immigration into Canada and emmigration elsewhere, i.e., the study area.

Andrews and Boggess (1978) noted that the average recovery distance for dispersed coyotes was 61.6 km and 68.6 km, respectively for males and females. In northern Minnesota, Berg and Chesness (1978) reported that 70% of juveniles dispersed for an average distance of 48 km (16-68 km), and generally in a southwestern or southeastern direction. Post et al. (1975) reported 3 coyotes dispersed 30-50 km; 1 male 75 km; and 2 young males more than 160 km, during a study in northwestern New York.

3.6.3. Habitat Utilization. Radio-collared coyotes were located in hardwood types and hardwood dominated mixed wood types significantly ($P<0.10$) fewer times than expected (Table 3.6-3). Other forest types were used as expected. Non-forest habitats were used more than expected. When the 3 coyotes, that spent most of their time in the agriculture-woodland habitat of Canada, were eliminated from the analysis, the percentage use of softwood types and softwood dominated mixed wood types increased, but habitat rankings and significance did not change.

Roads and waterways appeared to be important associate types with 37.9% of all locations close to roads and 25.9% along rivers or streams (Table 3.6-3). Although hardwood dominated mixed stands were selected against as primary habitat, 22.0% of the locations were associated with this type.

In New York, 4 radio-collared coyotes showed no preference or avoidance of available habitats (Post et al. 1975). Michigan coyotes preferred mixed aspen, conifer swamp, and lowland brush habitats, but avoided upland hardwoods (Ozoga and Harger 1966). Coyotes in Quebec also avoided hardwood types, but preferred regenerating cuts and conifer stands (Messier and Barrette 1979).

In the northeast, eastern coyote were found in a variety of habitats, including wilderness, timberland, farmland, and suburbia (Hilton 1978). Hilton (1978) also noted coyotes in northwestern Maine often used shorelines of rivers and streams as travel routes, which was further substantiated by the present study.

Habitat selection by coyotes appeared to be a function of prey availability. In a study conducted concurrently with this study, Caturano and Sherburne (1981) observed coyotes in eastern Maine used conifer stands extensively during summer, but substantially shifted use to blueberry barrens at the onset of fruit availability. Hilton (1978) observed most hunting and denning activities of coyotes in winter were along rivers and their tributaries, and felt this was related to deer abundance in these areas. In an earlier report, Hilton and Richens (1975) reported 95% of coyote tracks they followed passed through areas of high snowshoe hare density. In Michigan, abundance of snowshoe hare and deer were believed to influence habitat selection, because coyotes there moved quickly (and nearly directly) from 1 deer carcass, or area of snowshoe hare abundance, to another (Ozoga and Harger 1966). Litvaitis and Shaw (1980) suggested selection of habitat by coyotes in Oklahoma was related to prey abundance. Messier and Barrette (1979) in Quebec, noted coyotes had a marked preference for the 2 habitats containing the greatest concentrations of deer and hares.

3.6.4. Prey Utilization. Analysis of 188 coyote scats collected over 3 seasons revealed that deer occurred most frequently (39.4%) followed by snowshoe hare (21.3%), small mammals (18.1%), and raspberries (*Rubus* spp.) (17.0%). There was evidence of seasonal change in food habits (Table 3.6-4, Figure 3.6-3). Winter scats contained primarily deer (52.9%) and snowshoe hare (47.0%). During spring, deer continued to occur frequently in scats (57.5%), but snowshoe hare declined (27.9%). Summer scats were mostly composed of raspberries (43.2%), other fruits, and small mammals (32.4%). Whether the presence of deer in scats represented carrion or prey is not known, however, 2 incidents of deer predation by coyotes in the study area were documented.

No moose remains were observed in any of the scats. This was a mystery because members of Group I were known to have fed on at least 2 moose carcasses and possibly 3. Coyotes in other parts of the study area were also known to have utilized moose carcasses. Several factors may have contributed to this discrepency: (1) coyotes feeding on a moose carcass may remain localized thus reducing the opportunity for collecting scats containing moose hair. This hypothesis is supported by the fact that coyote 31 of Group I was radio-located 3 times at the same spot over a 13-day period (24 September 1980-6 October 1980), and coyote 31 was also located there 28 September 1980. Subsequent examination of the location site from the ground on 6 October 1980 indicated the coyotes had been feeding on a moose carcass. All that was left of the carcass was a few bone fragments, and an abundance of moose hair and coyote scats. It appeared the coyotes had remained at the carcass for a prolonged period and had deposited most, or all, of their scats in the immediate area. Interestingly, the carcass was less than 100 m from a road where many scats were collected for analysis, yet none contained moose hair. (2) The hair to meat ratio in moose is much lower than for smaller species. Thus, when coyotes feed on a moose carcass they could ingest considerable quantities of meat without ingesting much hair (the identifiable component of scats). This possibility was substantiated somewhat by studies of wolf scats by Floyd et al. (1978). (3) Hair of moose is very coarse and as such may discourage ingestion. This possibility was based on the observation that all moose carcasses examined, after coyotes and other scavengers finished feeding, where characterized as being composed by a few bone fragments and an abundance of hair

Richens and Hugie (1974) examined 51 coyote stomachs collected throughout Maine between 1968 and 1973. Most were collected during fall and winter. They concluded eastern coyotes had diverse diets governed by availability of food items, and that there was no evidence deer was a staple food of coyotes. Hilton and Richens (1975) on the other hand, examined coyote scats collected from the present study area in 1974 and reported similar results to the present study; a high occurrence of deer and snowshoe hare in winter-spring and a decrease in occurrence of deer and an increase in occurrence of small mammals in summer scats. They also noted of the 95 miles (110 km) of coyote tracks they followed during winter, 95% passed through areas of high snowshoe hare density, and all coyote-killed deer they examined were pursued either downhill or in open areas by 2 or more coyotes.

More recent studies in Maine (conducted concurrently with the present study) revealed similar seasonal trends for deer, small mammals and fruits, but both areas had more consistent seasonal patterns and higher percent occurrence of snowshoe hare than the present study (Figure 3.6-3).

In neighboring eastern Quebec, Messier and Barrette (1979) examined 673 coyote scats representing all seasons. They reported deer and snowshoe hare as the 2 major prey items but importance varied with season and size of coyote groups. They noted 55% of the coyotes were affiliated with groups (or packs) and that groups accounted for 95% of deer predation. They also estimated the winter deer predation rate was 12% during a normal severity winter and 25% of the fawns born in the study area were preyed upon by coyotes before fall. Therefore, they concluded coyotes removed a significant portion of the deer population studied.

Hamilton (1974) reported coyotes in the Adirondack region of New York utilized snowshoe hare as the primary prey species. He examined 1500 scats between 1956 and 1961 and reported seasonal trends for percent occurrence of deer and fruit similar to those of the present study. However, deer occurred in only 39.2% of winter scats which they felt represented mostly carrion scavenged from hunter and winter killed deer.

Other studies in Canada and northern or northeastern United States, have reported high occurrence of deer in stomach and scat samples (particularly during winter and spring), but most have attributed it to coyotes feeding primarily on carrion (Ozoga and Harger 1966, Nellis and Keith 1976, Neibauer and Rongstad 1977, Berg and Chesness 1978, and McGinnis and George 1980). McGinnis and George (1980) stated it was rare for coyotes to kill deer. Neibauer and Rongstad (1977) suggested deer utilization was related to severity of the winter (i.e., increased severity resulted in increased utilization of deer) and concluded coyotes fed mostly on carrion.

There were indications coyote may have utilized deer to a greater extent than indicated by scat analysis. If deer utilization by coyote increases as severity of winter increases (Niebauer and Rongstad 1977), then coyotes in the study area may be expected to utilize more deer during other years, because the winter of 1979-80 was the mildest in 10 years (Lavigne 1980). Also, it appeared that coyotes may localize near a deer carcass as they do for moose carcasses, but for a shorter period. This could result in deposition of scats containing deer hair at the carcass site, thus reducing availability for collection purposes. Finally, as with moose, the hair to meat ratio of deer is much lower than that of hare or small mammals. The effect on scat analysis was demonstrated by

Floyd et al. (1978). They showed as prey size increased, the number of collectable scats from wolves *(Canis lupus)* decreased, and smaller prey yielded relatively higher proportions of undigestable components (e.g., hair). Thus it could be expected that in terms of weight, deer were underestimated in frequency occurrence in coyote scats.

3.7. Red Fox

3.7.1. Population Density and Status. Fox were common in the study area. During the study, 33 foxes were captured 40 times (Table 3.7-1, Figure 3.6-1). Fox ranked third among predators for tracks encountered on snow transects (Table 3.2-1) and second in fur tagging records (Table 3.3-1). Tagging records also indicated fox may have increased over the past 4 years. Of the foxes captured for this study, 8 (24%) were known to have died (Table 3.7-1). One was apparently killed by coyotes shortly after release, 3 were found dead of unknown causes (possibly predation), and 4 were killed by man. Of the 4 mortalities caused by man, 2 were shot by deer hunters, 1 was trapped, and 1 was struck by a truck.

Fox density for WMU 2 was estimated at 0.24/mi^2 (9/100 km^2); the lowest density in the state (MDIFW 1980). For the present study. it was assumed a typical adult female fox had a home range of 10 km^2 (see Section 3.7.2), and home ranges of adult females did not overlap. The density of resident adult female foxes was then estimated at 10/100 km^2 (0.26 mi^2). In addition, it was assumed each resident adult female represented a family group which also included an adult male (Sargeant 1972, Storm et al. 1976). The density for resident adults was then calculated to be 20/100 km^2 (0.52 mi^2).

As Storm et al. (1976:60) graphically illustrated, fox populations can be expected to reach their peak during spring and summer when litters are born and raised. Based on estimates of Storm et al (1976:17) that 95% of adult females breed successfully, and average litter size is 5.5; spring densities of fox in the project area could have been as high as 75/100 km^2 (1.94/mi^2). Thus, the maximum density of foxes in the project area could vary between 20/100 km^2 to 75/100 km^2, depending on the season. It appears therefore, that the density estimate of 9/100 km^2 (MDIFW 1980) may be low.

3.7.2. Movements. Mean home range size for 5 foxes was 9.8 km^2 (3.1 to 20.2 km^2) (Table 3.7-1, Figure 3.7-1). Female fox 72 had the largest home range; but it may have been biased by the last 2 locations which were 6 km west of an area she had used regularly during the previous 5 months. Female fox 71 had the smallest home range. Trap injury during capture, which may have limited her movements and home range size. Several weeks after capture, however, she was known to be successfully rearing pups, and subsequent radio-monitoring indicated she was still active 6 months later.

Home range sizes of adult red foxes and red fox families in the midwest have been reported as 3.82 km^2-9.6 km^2 (Storm 1965, Storm et al. 1976). It has also been reported vixens (and their associated families) have exclusive use of their ranges (Keenan 1980, MacDonald 1980). Thus, 9-10 km^2 seems to be a reasonable estimate of average home range size within the project area.

Movements of adult male fox 13 probably represented dispersal (Figure 3.7-2). Shortly after he was tagged he made an initial westward movement of 19 km to the U.S.-Canadian border. His signal was subsequently lost until a year later when he was relocated in Quebec, Canada; 31 km northeast of his last location and 39 km from his original capture site. Storm et al. (1976) accumulated extensive data relating to dispersal of fox in the midwest. They found dispersal distance (based on tag recovery) averaged 31 km for males and 11 km for females. They also noted fox dispersed at any age, but the likelihood was much less for adults. In New York, Sheldon (1950) tagged 120 red foxes and subsequently had several recovered over 15 mi (24 km) away; the most distant being 40 mi (64 km).

3.7.3. Habitat Utilization. Frequency distribution of radio-locations indicated foxes used softwood stands significantly ($P<0.10$) less than expected, but used softwood dominated mixed stands significantly ($P<0.10$) more than expected (Table 3.7-3). Use of non-forest types was also greater than expected, with roads of particular importance. There were too few fox tracks along snow transects for statistical treatment, however, more tracks were encountered in softwood stands than in other habitat types (Table 3.2-1).

Of 151 radio-locations obtained for fox, 133 (88.1%) were associated with other habitat types (Table 3.7-3); 33 (21.8%) were near softwood dominated mixed stands, and 24 (15.9%) near softwood stands. Roads appeared to be the most important association type with 79 (52.3) percent of all radio-locations being near roads.

There was a lack of literature that addressed habitat use by foxes in the forested northeast. Schofield (1959) snow-tracked foxes in the woodlands of Michigan, and concluded foxes preferred lowland brush types but avoided white birch, marsh, and conifer swamp types. Storm et al. (1976) compared populations of foxes from both partially wooded areas, and also from intensive agricultural areas, and noted red fox populations appeared to expand where forests have been cleared.

Location of fox dens represented another use of habitat by foxes. In this study, 3 active dens were located in large hollow logs; another was located in a compacted pile of dirt and debris created when a log landing was bulldozed 5 or 6 years earlier; the fifth was located within 100 m of a logging road and was dug into a hillside, and among the roots of surrounding trees; a sixth was located in the side of a rocky bluff; and a seventh was dug into sandy soil. All sites were characterized as having very dense and brushy undercover.

Both radio-collared females (71 and 72) were known to move their pups to another den side after human disturbance. This behavior appeared to be characteristics of the species (Sheldon 1950, Sargeant 1972, Storm et al. 1976).

3.7.4. Prey Utilization. A total of 107 fox scats were collected within the study area (Table 3.7-4). With all seasons combined, small mammals occurred most frequently, followed by various fruits and snowshoe hare.

Although limited sample size precluded a definitive comparison between seasons, a shift in food habits of fox was suggested (Table 3.7-4). Small mammals remained important throughout the year. In winter, deer carrion and snowshoe hare frequently occurred. In spring, snowshoe hare remained common but deer carrion was infrequent. During summer, deer carrion was scarce, snowshoe hare was less frequent than in winter or spring, and fruits occurred frequently. Birds occurred most frequently in summer scats. Fresh hare remains were commonly found at fox den sites. This suggested hare may have been an important prey item during the pup rearing period. During the study a collared fox was seen feeding on an illegally killed moose, and 1 fox was shot while feeding on the paunch of a hunter-killed deer. On two occasions, trapped foxes dropped prey they were carrying at the time they were trapped. One fox dropped 4 woodland jumping mice, and the other an evening grosbeak (*Hesperiphona vespertina*).

Scats collected in WMU 3 and 6 showed a similar selection of prey items by fox. Heavy use of small mammals and hares paralleled the results of this study, but use of deer carrion was less pronounced.

Importance of hares/rabbits and small mammals as prey of red foxes in the east has been repeatedly demonstrated (Eadie 1943, MacGregor 1947 Dodds 1955). Schofield (1959) in Michigan found deer carrion was the most important winter food item followed by mice and cottontail rabbit. Findings of early food habit studies of fox across North America have been summarized by Korschgen (1959). Macdonald (1980:40) summarized food habits of foxes by noting that "in every study one common denominator amongst the findings has been that in any one area the foxes are eating a large variety of different prey."

3.8. Interspecific Relationships

Separate species within a community do not exist in isolation. Varying degrees of interspecific relationships may be manifested as either direct antagonism and/or competition for available resources (e.g., food and habitat).

Of the species considered in the present study, direct antagonism was evident only between coyote and fox. As previously noted, 4 radio-collared foxes died of predation, possibly by coyotes. The overall detrimental effect on fox, however, could not be established, as both fox and coyote were abundant in the study area and the fox population appeared stable or increasing. Murie (1944) observed coyotes dominated foxes, and in North Dakota intensive coyote control between 1948-1960 coincided with a 10 to 20 fold increase in foxes.

Competition between species for a resource requires that both species utilize the same resource, the resource is limited (relative to demand), and use by one species precludes use by the other (Levine 1976). Only intensive research over several years can provide the detailed data needed to determine resource overlap or partitioning between species. Subtle difference in prey selection, activity schedules, and use of habitat can allow species that appear to be competing, to coexist (Levine 1979). Wiens (1977) pointed out variable environments such as exists in northern Maine may allow coexistence since no one species can be optimally adapted to the entire range of conditions.

The two resources of obvious importance, and for which some data were available, were prey and habitat. Carnivores often show specialization for preying on certain species. Generally, large predators utilize large prey (Bider 1962, Rosenzweig 1966, Powell 1978, Lavine 1979). There was some overlap in prey utilization between all species studied. However, a clear gradient in size of prey used was seen, with marten and coyote at either extreme.

Although small mammals were used by all species, the marten is more specialized for such prey and adapted for hunting them efficiently in tight spaces (e.g., in holes), whereas fox and coyotes hunt them in more open spaces.

Competition is most likely to occur between taxonomically related species of similar size (Rosenzweig 1966). Fisher and marten were the two most closely related species studied. Fisher are best adapted to utilize larger prey such as hares and porcupine (Powell 1978), and competition probably occurs primarily in late winter when fisher rely more heavily on small mammals (Clem 1975). It is interesting to note that trapping records across the range of fisher and marten show they are seldom abundant concurrently in the same area (Strickland 1980).

Coyote and fox were the next most closely related predators studied. A size difference was obvious between them and their habits were markedly different. Foxes relied mostly on small mammals, while deer (carrion) was consumed only in winter. Coyotes ate more deer, including carrion, throughout the year (but to a lesser extent in summer) and were also able to prey on deer. Both fox and coyote preyed heavily upon hare.

There was no strong separation of species by habitats used. More detailed habitat data would be needed to properly assess this factor Marten and fisher were more restricted to mature conifer dominated forests, whereas coyotes and foxes were more flexible. Fox and coyote were captured in the same areas, and fox ranges occurred within those of coyotes. Factors such as the smaller size of foxes may allow them to use areas of denser brush more efficiently than coyotes, and thus remain essentially separated from coyotes. Coyote ranges are much larger than those of foxes, thus a fox may be able to exist in the less utilized portions of coyote ranges.

Since cats were not abundant, their relationship with other predators could not be examined. Overlap in food habits and habitat with other studied species has been apparent, but modes of hunting and habitat use are different (Bider 1962, Rosengweig 1966).

3.9. Impact of Proposed Project

The proposed impoundment will inundate 347.65 km^2 (22.0%) of the 1,579.78 km^2 area within the 3.22 km (2 mi) zone (Table 3.9-1), of which 318.90 km^2 (20.2%) will be terrestial habitat. However, the loss to each habitat type will not be 22.0%; some habitats will be disproportionally affected. Of the terrestial habitats that will be lost, 228.06 km^2 (65.6%) will be softwoods. This will reduce availability of this type in the project area by 26.6%; most of which will be mature conifer stands (ERT 1976:176). The impoundment will also eliminate 64% of the wetlands in the project area.

The overall impact of the proposed impoundment on predator and prey species studied, will basically be a reduction in carrying capacity and restriction to movements. Reduction in carrying capacity will be the result of reduced terrestial habitat, a reduction in some important habitat types, and a reduced prey base. All this will translate into a loss of some proportion of the population of a species. The loss, however, should not be regarded as a certain number of displaced individuals, but rather as a loss in future productivity of the area for each species. The loss in productivity will vary according to the unique habitat and food requirements of each species.

The impoundment will also change movement and dispersal patterns. For some species, particularly marten, it will be a total barrier, while for others it will be a barrier only when it is not frozen. In some cases smaller isolated portions of terrestial habitat will be created by the impoundment which may be incapable of supporting wide ranging species such as bobcat and coyotes. In such cases, that portion of the study area can also be considered unavailable to the species, thus further decreasing the carrying capacity of the area.

What does this mean in terms of predators and their prey? Since small mammals are distributed almost uniformly over several habitat types in terms of total numbers, loss to the population might be expected to approximate the 20.0% loss of terrestial habitat. Deer mice (who appear to avoid softwoods) will probably be affected less, and shrews (*Sorex* spp.) (who appear to prefer softwoods) affected more than loss of terrestial habitat may indicate.

Impact on snowshoe hare will probably be greatest in softwood types. However, the overall proportion of hare populations affected may not be proportional to the 26.6% loss of softwoods because hare generally prefer early regeneration stages; and loss due to flooding will be mostly in mature stands.

Impact on deer could be quite high. A previous study of deer wintering areas in a 27 township area encompassing the project area, indicated the impoundment would affect 44% of the deer wintering areas of the entire 27 township area (Hutchinson 1978); an area much larger than the project area.

This means that at least 44% of the deer in the project area will be affected. Loss in actual numbers of deer cannot be predicted, however, good wintering areas are basic to survival of deer during severe winters of the study area (Banasiak 1961). Therefore, it can be estimated that the impact of the proposed project will substantially reduce the carrying capacity for a deer herd that has been estimated as having the lowest density in the state. The impoundment may also interfere with seasonal movements of deer, particularly to and from wintering areas.

The potential impact on moose is not clear. Although moose appeared to make use of ridge areas and clearcut (particularly during winter), they also made use of wetlands, rivers, and streams to feed on aquatic vegetation and escape biting insects. Removal of 64% of the wetland habitat in the project area will probably reduce carrying capacity for moose more than loss of terrestial habitat would indicate.

Red squirrels and grouse (who prefer softwood stands) can also be expected to be affected proportionately more than the percent loss of terrestial habitat would indicate.

Lynx density in the project area was very low, therefore, the loss of individual lynx can be expected to be low. However. the inordinate loss of mature softwood stands and reduction in prey base in terms of hares and deer, will substantially reduce the carrying capacity of the project area for lynx. Although the impact may not be immediately apparent, it may reduce the potential of the species to recover in the future.

Bobcat will probably not be affected as much by removal of certain habitat types as by reduction in carrying capacity due to loss of terrestial habitat and reduction in prey base. Bobcat movements in terms of dispersal and immigration may be affected by the presence of the reservoir since it has been reported that bobcats avoid frozen reservoirs (McCord 1974).

Fisher will be generally affected by loss of mature softwood types, reduction in stream and river associated habitat, and reduction in the prey base. More importantly. there are indications the presence of a reservoir will restrict movements of fisher (i.e., dispersal and immigration).

Marten will be significantly affected by the proposed project. Loss of more mature softwood types will affect female marten, particularly in terms of loss of denning habitat (e.g., natal dens). The reservoir will serve as a barrier or hinderance to dispersal and immigration.

Impact of the project on coyote is difficult to predict. Carrying capacity in terms of habitat loss and reduction in prey base (especially deer) will undoubtedly be reduced. Dispersal patterns will also be affected by the presence of the reservoir. However, the ability of coyotes to adapt to a wide variety of ecosystems and food will probably buffer the impact to some extent.

Impact on fox will be related to loss of terrestial habitat and reduction in prey base. The loss of deer will affect them in terms of available carrion. The reservoir may serve as a barrier to dispersal and may change movement patterns as has been observed for fox in the midwest (Storm et al. 1972).

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TABLES

APPENDICES

FIGURES

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TABLE 3.1-1. NUMBER OF SMALL MAMMALS CAPTURED IN FOUR HABITAT TYPES WITHIN THE DICKEY-LINCOLN SCHOOL LAKES PROJECT AREA

Species	Season	Habitat Type				Total
		Softwood	Hardwood	Mixed	Clearcut	
Deer Mouse	Spring	1	14	4	7	26
	Summer	5	43	15	4	67
	Total	6(-)[a]	57(+)	19	11	93
Woodland Jumping Mouse	Spring	1	5	4	1	11
	Summer	7	21	4	12	44
	Total	8	26(+)	8	13	55
Redback Vole	Spring	22	6	15	8	51
	Summer	23	20	44	21	108
	Total	45	26(-)	59(+)	29(-)	159
Meadow Vole	Spring	2		1		3
	Summer	1		3	2	6
	Total	3		4	2	9
Shrew	Spring	1		1	4	6
	Summer	14	1	3	9	27
	Total	15(+)	1(-)	4	13	33
Short-tail Shrew	Spring			1		1
	Summer	3	1			4
	Total	3	1	1		5
Totals		80	111	95	68(-)	354

[a] (-) and (+) indicate significantly (P<0.10) lower than expected catch and greater than expected catch respectively as determined according to Neu et al. (1974).

TABLE 3.1-2. TRACKS OF MAJOR PREY SPECIES ENCOUNTERED ON 222 KM OF SNOW TRANSECTS, BY SPECIES AND HABITAT

Habitat	Exp.[1] %	Hare % (Sig.)[2]	Squirrel[3] % (Sig.)	Grouse[3] % (Sig.)	Deer % (Sig.)	Moose[3] % (Sig.)
Softwood	47.2	54.6(+)	39.1	70.6	22.6(-)	48.6
Hardwood	5.0	0.5(-)	7.0			15.5
S-H Mixed	32.1	29.5(-)	36.7	5.9	59.5(+)	21.1
H-S Mixed	13.4	5.3(-)	14.8		8.4	
Clearcut	1.4	3.3(+)	2.4	23.5	9.5	14.8
Other[4]	0.9	6.8				
Total N		2,887	128	17	95	71

[1]Percentage of transect that passed through each habitat type. This value was used as expected value.

[2]% = Is the Percentage of all tracks for a species found in each habitat type.
Sig. = Indicates whether number of tracks of a species in a habitat type was greater (+) or less (-) than expected according to method of Neu et al. (1974) ($P<0.10$).

[3]Not tested for significance--total number of tracks for the species was too small

[4]Included bogs, alders, and open areas. Not tested statistically because of low expected value.

TABLE 3.2-1 PREDATOR TRACKS ENCOUNTERED ON 222 KM OF SNOW TRANSECTS, BY SPECIES AND HABITAT TYPE

Habitat	Exp.[1] %	Lynx[2] % (Sig.)[3]	Fisher[2] % (Sig.)	Marten % (Sig.)	Coyote[2] % (Sig.)	Fox[2] % (Sig.)
Softwood	47.2		52.8	47.9	47.8	61.4
Hardwood	5.0			2.1	7.8	2.9
S-H Mixed	32.1		19.4	39.4(+)	16.6	28.6
H-S Mixed	13.4		19.4	6.2(-)	10.0	
Clearcut	1.4		8.4	3.9	17.8	7.1
Other[4]	0.9	100		0.5		
Total N		1	18	217	45	35

[1]Percentage of transect that passed through each habitat type. This value was used as expected value.

[2]Not tested for significance--total number of tracks for the species was too small.

[3]% = The percentage of tracks for a species found in each habitat.
Sig. = Indicates whether number of tracks of a species in a habitat type was greater (+) or less (-) than expected according to methods of Neu et al. (1974) ($P<0.10$).

[4]Included bogs, alders, and open areas. Not tested statistically because of low expected value.

TABLE 3.3-1. FUR TAGGING RECORDS FOR 32 TOWNSHIPS ENCOMPASSING THE STUDY AREA[1]

Species	Year			Totals
	1977	1978	1979	
Bobcat	6	4	2	12
Fisher	6	5	6	17
Marten	47	28	78	153
Coyote	4	20	18	42
Fox	19	31	51	101

[1]From MDIFW, Augusta, Maine.

TABLE 3.3-2. DISTRIBUTION OF BOBCAT RADIO-LOCATIONS AMONG HABITAT TYPES

Habitat Type	Primary Habitat[1] N (%)[2]		Primary Habitat[1] Rank	Associated Habitat[3] N (%)		Associated Habitat[3] Rank	Avail[4] Habitat %
Softwoods	21	(58.3)	1	9	(18.8)	2	54.[illegible]
Hardwoods	1	(2.8)	5	3	(6.2)	3	17.[illegible]
S-H Mixed	4	(11.1)	3	9	(18.8)	2	12.7
H-S Mixed	2	(5.6)	4				12.2
Other (stream, lake, road, clearcut, alders, open areas)	8	(22.2)	2	27	(56.2)	1	3.7

[1]Habitat type in which animal was located.

[2]Number and percentage of bobcat radio-locations in habitat type.

[3]Habitat type within 300 m of radio-location.

[4]Percentage of habitat type available in the study area.

TABLE 3.3-3. FOOD ITEMS FOUND IN BOBCAT SCATS FROM WMU 3 AND 6, BY % FREQUENCY OF OCCURRENCE

Food Item	WMU 3			WMU 6		
	Winter 1979-80	Spring 1980	Summer 1980	Winter 1979-80	Spring 1980	Summer 1980
Moose	3.1					
Deer	34.3	4.5		9.5		
Snowshoe Hare	68.7	68.1	82.3	90.4	92.8	77.4
Small Mammal	12.5		5.8	9.5	7.1	19.3
Muskrat			11.7			3.2
Squirrel	6.2	4.5	11.7			6.4
Bird	3.1	9.0	5.8	9.5		16.1
Fruit			11.7			
Vegetable	15.5	4.5				6.4
Unknown	3.1					
Total No. of Scats	32	22	17	21	14	31

TABLE 3.4-1. DISTRIBUTION OF FISHER RADIO-LOCATIONS AMONG HABITAT TYPES

Habitat Type	Avail[1] Habitat %	Primary Habitat[2] N (%)	Sig.[3]	Rank	Associated Habitat[4] N (%)	Rank
Softwoods	54.3	71 (78.9)	+	1	11 (11.1)	4
Hardwoods	17.1	1 (1.1)	-	4		
S-H Mixed	12.7	12 (13.3)		2	17 (17.2)	3
H-S Mixed	12.2	6 (6.7)	-	3	6 (6.1)	5
Other: Alders	3.7				3 (3.0)	6
River					26 (26.3)	1
Stream					17 (17.2)	3
Road					18 (18.1)	2

[1]Percentage of habitat type available in the study area.

[2]Habitat type in which animal was located.

[3]N = Number of radio-locations in habitat type.
% = Percentage of radio-locations in habitat type.
Sig. = Indicates whether number of radio-locations in habitat type was greater (+) or less (-) than expected according to techniques of Neu et al. (1974) ($P<0.10$).

[4]Habitat type within 300 m of radio-location.

TABLE 3.5-1. NUMBER OF MARTEN CAPTURED, RECAPTURED, RADIO-COLLARED, AND DEATHS, BY AGE AND SEX

	YOY[1]		Subadult		Adult		Totals
	M	F	M	F	M	F	
Captured	9	4	16	2	15	5	55[2]
Recaptured	18	2	30	5	55	12	122
Radio-collared					2	3	5
Mortality	1	1	1		2	2	8[3]

[1]Young-of-year.

[2]Four were not aged and/or sexed.

[3]Six of these were research related deaths; two were snared in Canada.

TABLE 3.5-2. HOME RANGE ESTIMATES OF RADIO-COLLARED MARTEN IN NORTHWESTERN MAINE

ID Number	Sex	Age	Tracking Period	N	Home Range[1]
17	M	Ad.	05/13/80-10/23/80	109	6.43 km^2
302	M	Ad.	05/27/80-10/23/80	104	4.70
21	F	Ad.	05/19-06/13 & 08/01-09/23/80	57	3.55
301	F	Ad.	05/03/80-07/25/80	71	2.58
304	F	Ad.	06/04/80-08/22/80	116	2.52

[1]Based on convex polygon technique.

TABLE 3.5-3. DISTRIBUTION OF MARTEN RADIO-LOCATIONS AMONG HABITAT TYPES AS COMPARED TO HABITAT AVAILABILITY WITHIN THE MARTEN STUDY AREA

Habitat Type	Avail[1] %	Males N	Males (%)	Males Sig.[2]	Males Rank	Females N	Females (%)	Females Sig.	Females Rank	All Locations N	All Locations (%)	All Locations Sig.	All Locations Rank
Softwood	66.67	125	(58.69)	-	1	186	(76.23)	+	1	311	(68.05)		1
Hardwood	6.32	3	(1.41)	-	4	4	(1.64)		4	7	(1.53)	-	4
S-H Mixed	16.52	51	(23.94)	+	2	28	(11.48)	-	2	79	(16.52)		2
H-S Mixed	10.75	33	(15.49)		3	26	(10.66)		3	59	(12.91)		3
Alder Bog	4.26	1	(0.47)	-	5					1	(0.22)	-	5
Total Locations		213				244				457			

[1]Percentage of habitat type in marten study area (expected value).

[2]N = Number of radio-locations in habitat type.

% = Percent of radio-location in habitat type.

Sig. = Indicates whether number of radio-locations in habitat type was greater (+) or less (-) than expected according to Neu et al. (1974) ($P<0.10$).

TABLE 3.6-1. NUMBER OF COYOTES CAPTURED, RECAPTURED, RADIO-COLLARED, AND MORTALITY, BY AGE AND SEX

	YOY[1]		Subadult		Adult		Totals
	M	F	M	F	M	F	
Captured	7		1	3	4	6	21
Recaptured	1			1		2	4
Radio-collared	2		1	3	3	6	15
Mortality	1		1	1		3	7[2]

[1]Young-of-year

[2]One coyote of unknown identity was trapped.

TABLE 3.6-2. HOME RANGE ESTIMATES FOR RADIO-COLLARED COYOTES IN NORTHWESTERN MAINE

ID No.	Sex	Age[1]	Tracking Period	N	Mean[2] Relocation Distance (km)	Home Range[3] Estimate (km^2)
5	M	YOY	10/10/79-01/15/80	12	7.4	494
77	M	A	05/02/80-09/28/80	30	11.0	2650
92	M	A	08/20/80-10/30/80	19	6.8	1346
98	M	A	09/02/80-10/30/80	14	4.8	25
4	F	A	09/29/79-10/30/80	42(194)[4]	7.4 (2.6)	284 (310)
9	F	A	10/10/79-01/30/80	13(20)	5.7 (5.3)	146 (168)
28	F	A	11/09/79-12/14/79	6(15)	3.1 (2.1)	10 (11)
31	F	SA	11/13/79-10/30/80	37(159)	5.0 (2.4)	173 (188)
89	F	A	08/20/80-10/30/80	17	3.4	29
91	F	A	08/22/80-09/09/80	6	4.5	28
96	F	SA	08/28/80-10/30/80	16	4.1	135

[1]YOY = Young-of-year
A = Adult
SA = Subadult

[2]Mean distance between sequential radio-locations.

[3]Based on convex polygon technique.

[4]Numbers not in parenthesis represent measurements based on aerial locations only. Numbers in parenthesis based on aerial and ground radio-locations.

TABLE 3.6-3. DISTRIBUTION OF COYOTE RADIO-LOCATIONS AMONG HABITAT TYPES

Habitat Type	Avail[1] Habitat %	Primary Habitat[2] N (%)	Sig.[3]	Rank	Associated Habitat[4] N (%)	Rank
Softwoods	54.3	199 (55.4)		1	50 (13.9)	4
Hardwoods	17.1	30 (8.4)		4	9 (2.5)	9
S-H Mixed	12.7	62 (17.3)		2	38 (10.6)	5
H-S Mixed	12.2	26 (7.2)	-	5	79 (22.0)	2
Other: Field	3.7	42 (11.7)	+	3	16 (4.4)	8
River					33 (9.2)	7
Stream					60 (16.7)	3
Road					136 (37.9)	1
Alders/ scrub					8 (2.2)	10
Clearcut					34 (9.5)	6

[1]Percentage of habitat type available in the study area.

[2]Habitat type in which animal was located.

[3]N = Number of radio-locations in habitat type.
% = Percentage of radio-locations in habitat type.
Sig. = Indicates whether number of radio-locations in habitat type was greater (+) or less (-) than expected according to techniques of Neu et al. (1974) (P<0.10).

[4]Habitat type within 300 m of radio-location.

TABLE 3.6-4. OCCURRENCE OF FOOD ITEMS IN COYOTE SCATS COLLECTED IN THE STUDY AREA

Food Item	Winter N = 17 n	(%)	Spring N = 40 n	(%)	Summer N = 37 n	(%)	Total N = 94 n	(%)
Deer	9	(52.9)	23	(57.5)	5	(13.5)	37	(39.4)
Snowshoe Hare	8	(47.0)	11	(27.9)	1	(2.7)	20	(21.3)
Bird	1	(5.9)	5	(12.5)	5	(13.5)	11	(11.7)
Small Mammal	0	(0.0)	5	(12.5)	12	(32.4)	17	(18.1)
Beaver	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Muskrat	0	(0.0)	0	(0.0)	1	(2.7)	1	(1.0)
Red Squirrel	0	(0.0)	0	(0.0)	2	(5.4)	2	(2.1)
Porcupine	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Blueberries	0	(0.0)	0	(0.0)	4	(10.8)	4	(4.2)
Raspberries	0	(0.0)	0	(0.0)	16	(43.2)	16	(17.0)
Seeds (unknown)	0	(0.0)	0	(0.0)	7	(18.9)	7	(7.4)
Grass	1	(5.9)	3	(7.5)	1	(2.7)	5	(5.3)
Insects	0	(0.0)	3	(7.5)	1	(2.7)	4	(4.2)
Strawberries	0	(0.0)	1	(2.5)	0	(0.0)	1	(1.0)

N = Number of scats examined.

n = Number of scats containing food item.

% = Percentage of scats containing food item.

TABLE 3.7-1. NUMBER OF FOXES CAPTURED, RECAPTURED, RADIO-COLLARED, AND MORTALITY, BY AGE AND SEX

	YOY[1]		Subadult		Adult		Totals
	M	F	M	F	M	F	
Captured	2	4	4	4	7	11	33
Recaptured		1		1	2	3	7
Radio-collared		1	4	4	2	5	16
Mortality			3	4		1	8

[1]Young-of-year.

TABLE 3.7-2. HOME RANGE ESTIMATES FOR RADIO-COLLARED FOXES IN NORTHWESTERN MAINE

ID No.	Sex	Age[1]	Tracking Period	N	Mean[2] Relocation Distance (km)	Home Range[3] Estimate (km^2)
13	M	A	10/07/79-10/30/80	8	6.5	81.6[4]
14	M	A	10/10/79-02/25/80	27	1.2	7.3
32	M	SA	11/11/79-01/03/80	6	4.4	9.5
12	F	A	11/20/79-12/17/79	9	1.5	9.0
71	F	A	04/27/80-10/13/80	17	0.8	3.0
72	F	A	04/29/80-10/30/80	69	1.3	20.2

[1]A = Adult
SA = Subadult

[2]Mean distance between sequential radio-locations.

[3]Based on convex polygon technique.

[4]Animal dispersed.

TABLE 3.7-3. DISTRIBUTION OF FOX RADIO-LOCATIONS AMONG HABITAT TYPES

Habitat Type	Avail[1] Habitat %	Primary Habitat[2] N	(%)	Sig.[3]	Rank	Associated Habitat[4] N	(%)	Rank
Softwoods	54.3	57	(37.8)	-	1	24	(15.9)	3
Hardwoods	17.1	12	(7 9)		5	7	(4.6)	7
S-H Mixed	12.7	40	(26.5)	+	2	33	(21.8)	2
H-S Mixed	12.2	16	(10.6)		4	15	(9.9)	4
Other:	3.7	26	(17.2)	+	3			
Road						12	(7.9)	5
Stream						2	(1.3)	10
Road						79	(52.3)	1
Clearcut						10	(6.6)	6
Agriculture						5	(3.3)	8
Cleared Land						4	(2.6)	9
Trash & Debris						4	(2.6)	9

[1]Percentage of habitat type available in the study area.

[2]Habitat type in which the animal was located.

[3]N = Number of radio-locations in habitat type.
% = Percentage of radio-locations in habitat type.
Sig. = Indicates whether number of radio-locations in habitat type was greater (+) or less (-) than expected according to technique of Neu et al. (1974) ($P<0.10$).

[4]Habitat type within 300 m of radio-location.

TABLE 3.7-4. OCCURRENCE OF FOOD ITEMS IN FOX SCATS COLLECTED IN THE STUDY AREA

Food Item	Winter N = 12 n	(%)	Spring N = 21 n	(%)	Summer N = 74 n	(%)	Total N = 107 n	(%)
Deer	4	(33.3)	1	(4.7)	0	(0.0)	5	(4.7)
Snowshoe Hare	6	(50.0)	11	(52.3)	8	(10.8)	25	(23.4)
Bird	1	(8.3)	3	(14.2)	10	(13.5)	14	(13.1)
Small Mammal	5	(41.6)	11	(52.3)	40	(54.0)	56	(52.3)
Beaver	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Muskrat	0	(0.0)	1	(4.7)	3	(4.0)	4	(3.7)
Red Squirrel	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Porcupine	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Blueberries	0	(0.0)	0	(0.0)	14	(18.9)	14	(13.1)
Raspberries	0	(0.0)	0	(0.0)	25	(33.7)	25	(23.4)
Seeds (unknown)	0	(0.0)	1	(4.7)	32	(43.2)	33	(30.8)
Grass	0	(0.0)	2	(9.5)	3	(4.0)	5	(4.7)
Insects	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Strawberries	0	(0.0)	0	(0.0)	1	(1.3)	1	(0.9)

N = Number of scats examined.

n = Number of scats containing food item.

% = Percentage of scats containing food item.

TABLE 3.9-1. AREAS OF MAJOR HABITATS IN PROJECT AREA AND PROPOSED IMPOUNDMENT[1]

	Study Area km^2	Study Area (%)	Impoundment km^2	Impoundment (%)
Softwoods	857.67	(54.3)	228.06	(65.6)
Hardwoods	193.14	(12.2)	11.56	(3.3)
Mixed Wood	468.71	(29.7)	64.95	(18.7)
Non-forested	60.46	(3.8)	43.08	(12.4)
	1579.98		347.65	

[1]From ERT (1977:175).

APPENDIX I

1. Composition of coyote population was assumed to be 61% packs of 3 adults, 24% mated pairs, and 15% nomads (Camenzind 1978).

2. We assume that packs and pairs are territorial and nomads are superimposed. Thus, we assume the whole geographic area is parceled out to packs and pairs.

3. If we had a hypothetical population of 100 coyotes

   then $\frac{61}{100}$ would be in packs and $\frac{24}{100}$ in mated pairs.

   Thus the total number of individuals controlling all the real estate would be

   61 + 24 = 85.

   Thus $\frac{61}{85}$ x 100% = 72% would be controlled by packs

   and $\frac{24}{84}$ x 100% = 28% would be controlled by pairs.

   WMU 2 has 8,605 mi^2 of coyote habitat (MDIFW 1980)

   Proportion controlled by packs

   $.72 \times 8{,}605\ mi^2 = 6{,}196\ mi^2$

   and by pairs

   $.28 \times 8{,}605\ mi^2 = 2{,}409\ mi^2$

4. Based on the home range size of the Group I pack of 119.7 mi^2

   Total pack in WMU 2 = $6{,}196 \div 11.2\ mi^2$ = 52 packs.

5. Based on the home range size of the Group II mated pair of 11.2 mi^2

   Total pairs in WMU 2 = $2{,}409 \div 11.2\ mi^2$ = 215 pairs.

6. Total adult population in WMU 2 would be:

   Total adults in packs = 52 packs x 3 adult/pack = 156 adults.
   Total adults in pairs = 215 pairs x 2 adults/pair = 430 adults.
   Total adults in packs and pairs = 156 + 430 = 586.
   Based on the hypothesis that 15% of the population is nomads then

   $\frac{586}{.85} = \frac{x}{1.00}$ or $x = \frac{586 \times 1.00}{.85}$ = 689 adults

Density of adults = $\frac{689 \text{ coyotes}}{8,605 \text{ mi}^2}$ = 0.080/mi^2 = 3/100 km^2

7 If each pack and pair had 7 pups then:

52 packs x 10 coyotes (3 adults, 7 pups)	=	520 coyotes
215 pairs x 9 coyotes (2 adults, 7 pups)	=	1935 coyotes
Total	=	2455 coyotes

Assuming 15% nomads then:

$\frac{2455}{0.85}$ = 2888 coyotes

Density with pups = $\frac{2888 \text{ coyotes}}{8605 \text{ mi}^2}$ = 0.336/mi^2 = 13/100 km^2

APPENDIX II

PHYSICAL CHARACTERISTICS OF COYOTE CAPTURED IN THE STUDY AREA

ID	Capture Date	Sex	Age	Wt. (kg)	Body (cm)	Tail (cm)	Chest (cm)	Neck (cm)	Comments
2	09/21/79	M	YOY[1]	8.5	82	38		27	Shot in Canada 09/29/79
4	09/22/79	F	A	13.5	94	39		32	Mother of #78 and #79
5	09/22/79	M	YOY	7.9	77	31		25	Disappeared
8	09/23/79	F	A	13.1	98	33		31	Snared in Canada 11/01/79
9	09/24/79	F	A	12.2		32		29	Snared in Canada 02/14/80
16	10/17/70	M	SA	8.2	82	30		27	Snared in Canada 10/27/79
28	11/02/79	F	A	15.9	105	40		37	Shot on border 12/20/79
31	11/09/79	F	SA	10.7	83	36		31	Paired with #4
54	02/10/80	F	A	15.0	105	39	52	34	Disappeared
77	05/02/80	M	A	11.1	93	35	53	31	
78	05/02/80	M	YOY	1.2	36	10	25	18	Pup of #4
79	05/02/80	M	YOY	1.3	37	10	26	18	Pup of #4
89	08/15/80	F	A	11.8	83	35	51	29	Paired with 98
91	08/18/80	F	A	12.9	89	43	52	30	
92	08/18/80	M	A	12.2	104	37	50	28	Dispersed? to Canada
95	08/25/80	M	YOY	5.0	71	24	35	20	Pup of 89? mate to 97 & 100?
96	08/25/80	F	SA	8.6	80	36		28	Snared in Canada 01/11/81
97	08/26/80	M	YOY	7.3	82	28	38	22	Pup of 89? mate to 95 & 100?
98	08/26/80	M	A	13.6	99	35	54	32	Paired with 89
100	08/31/80	M	YOY	5.4	74	26	36	20	Pup of 89? mate to 95 & 97?
102	09/09/80	M	A	16.3	95	40	56	29	

[1]YOY = Young-of-year; A = Adult; SA = Subadult.

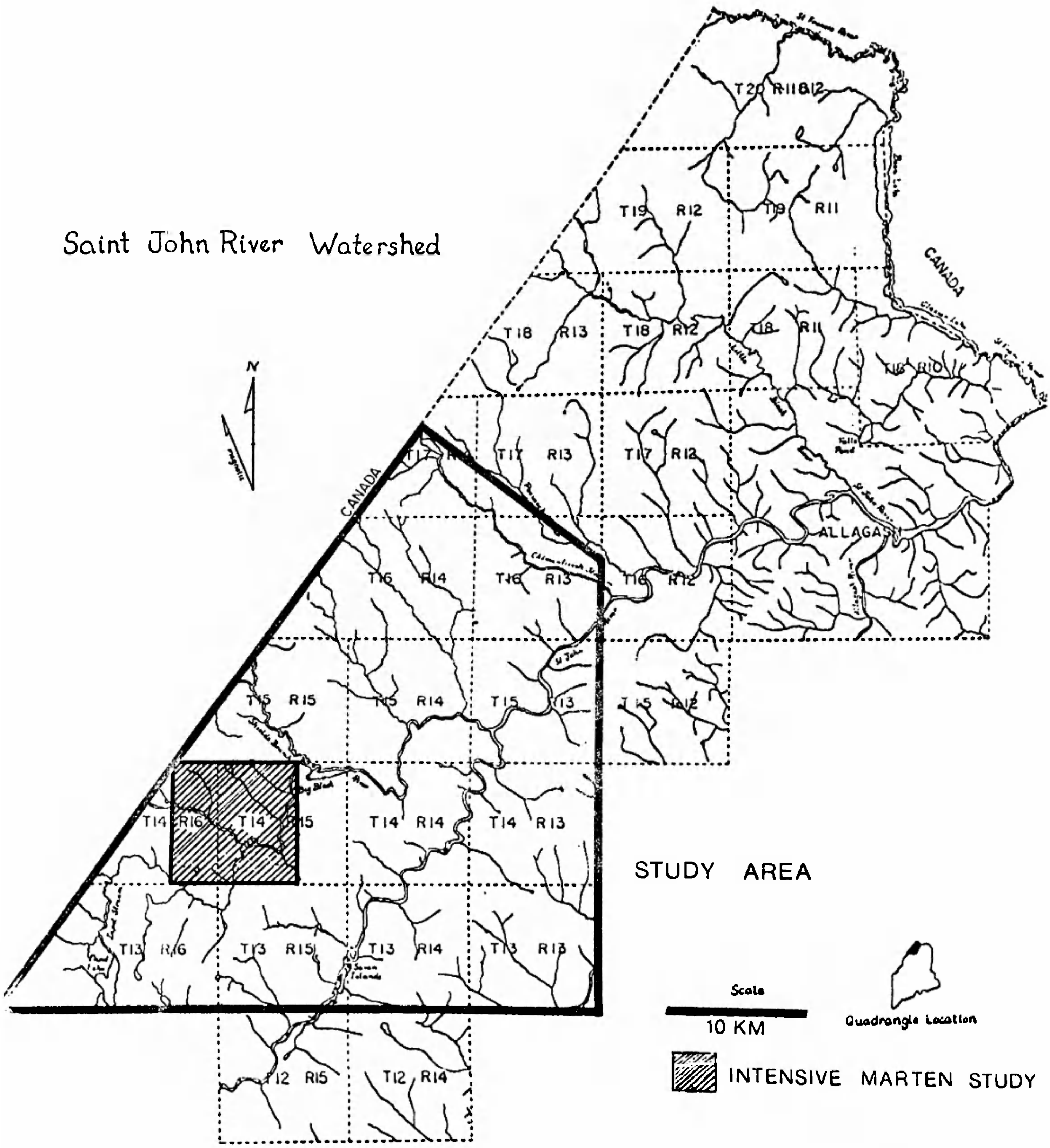

Saint John River Watershed
N
CANADA
STUDY AREA
Scale
10 KM
Quadrangle Location
INTENSIVE MARTEN STUDY
ALLAGASH

FIGURE 1.0-1

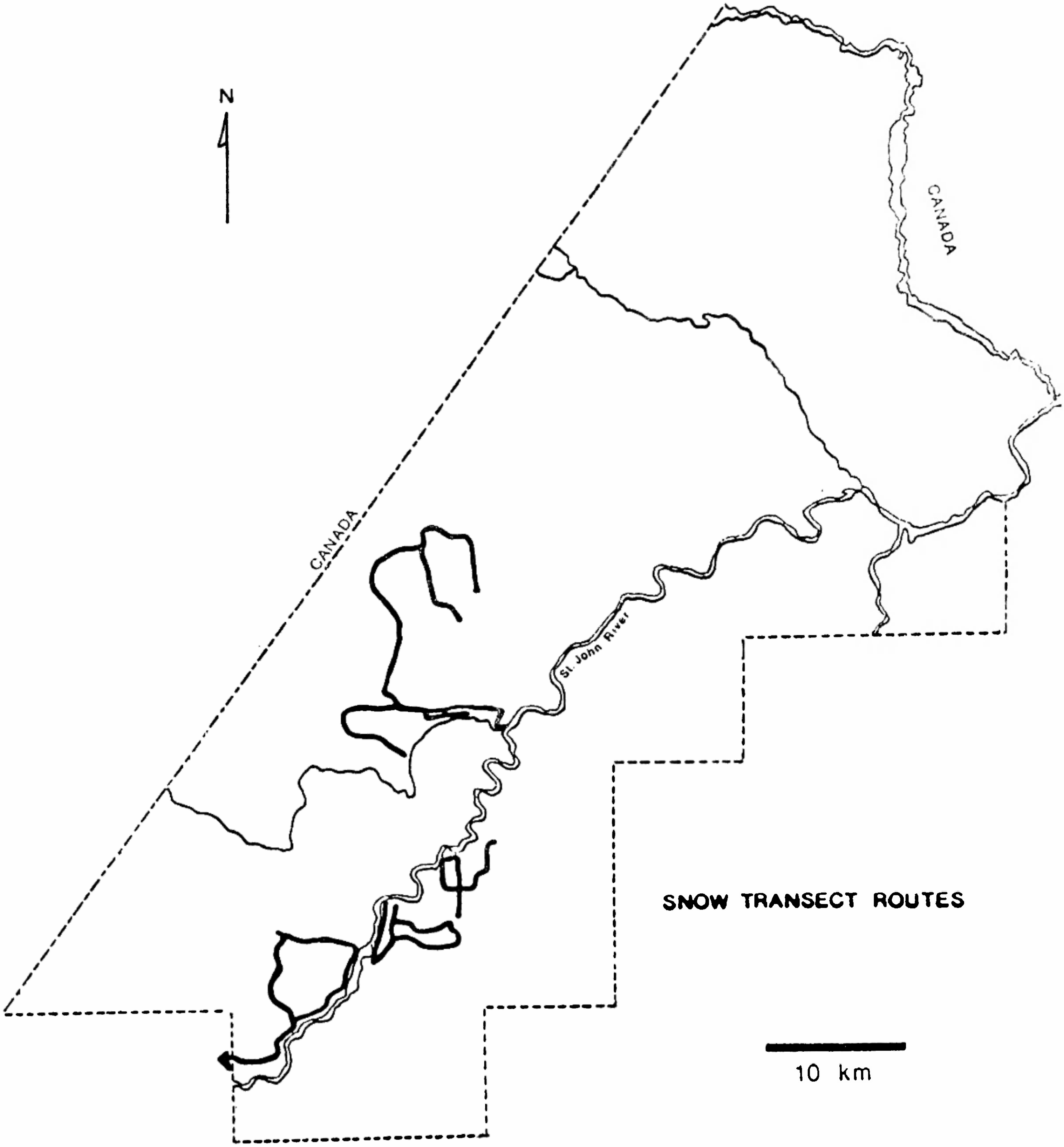
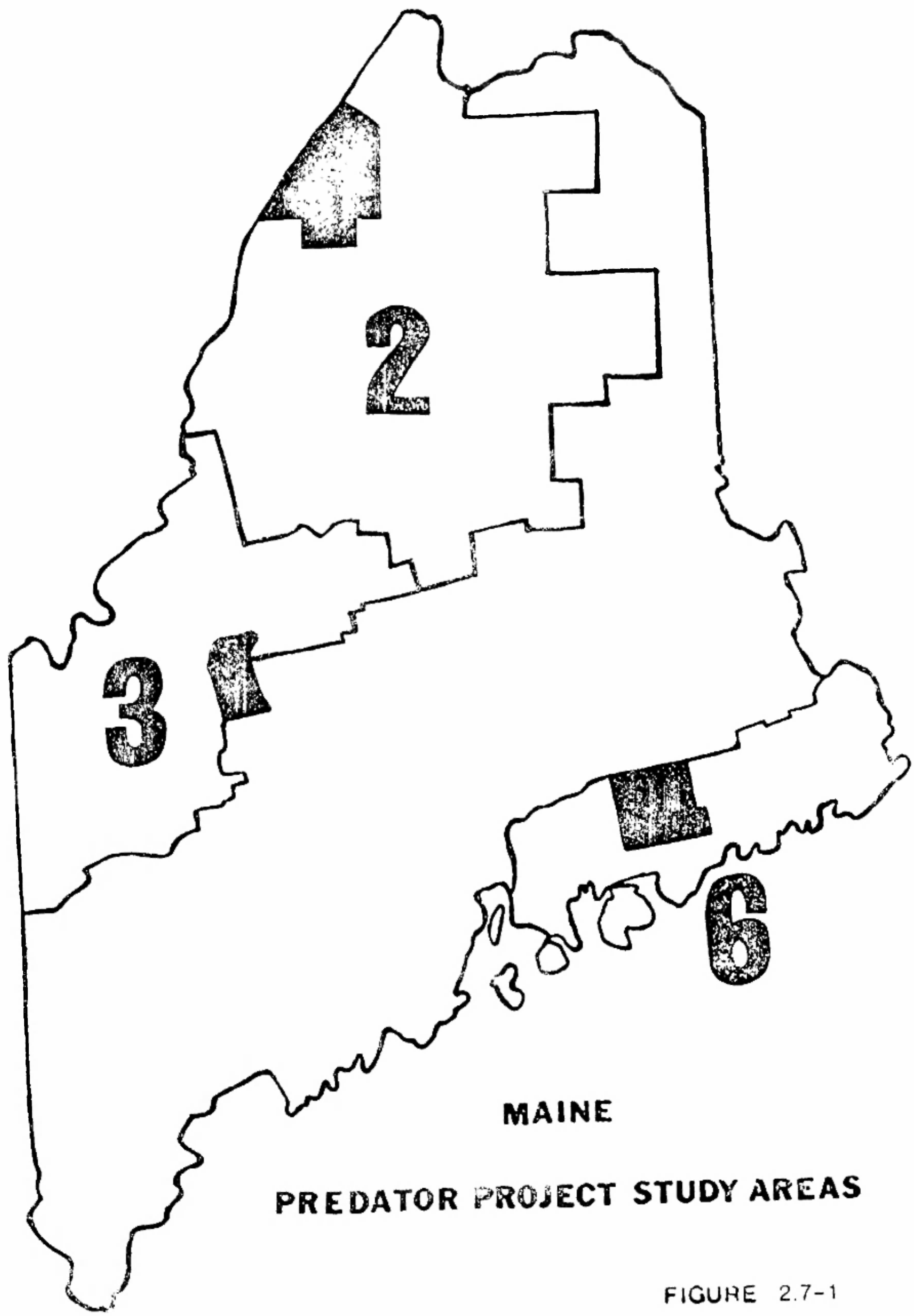


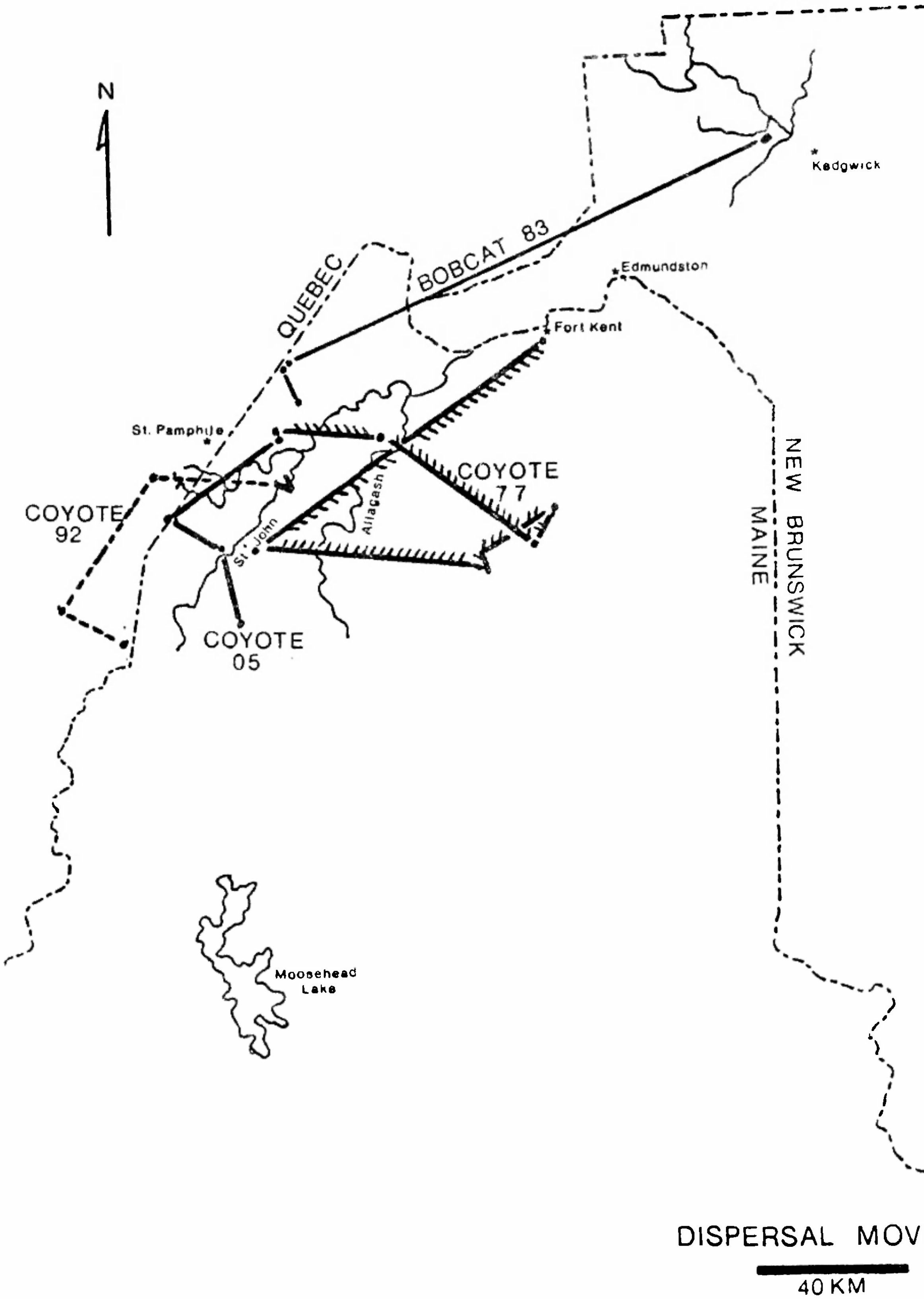
FIGURE 2.2-1



MAINE

PREDATOR PROJECT STUDY AREAS

FIGURE 2.7-1



DISPERSAL MOVEMENTS

FIGURE 3.3-1

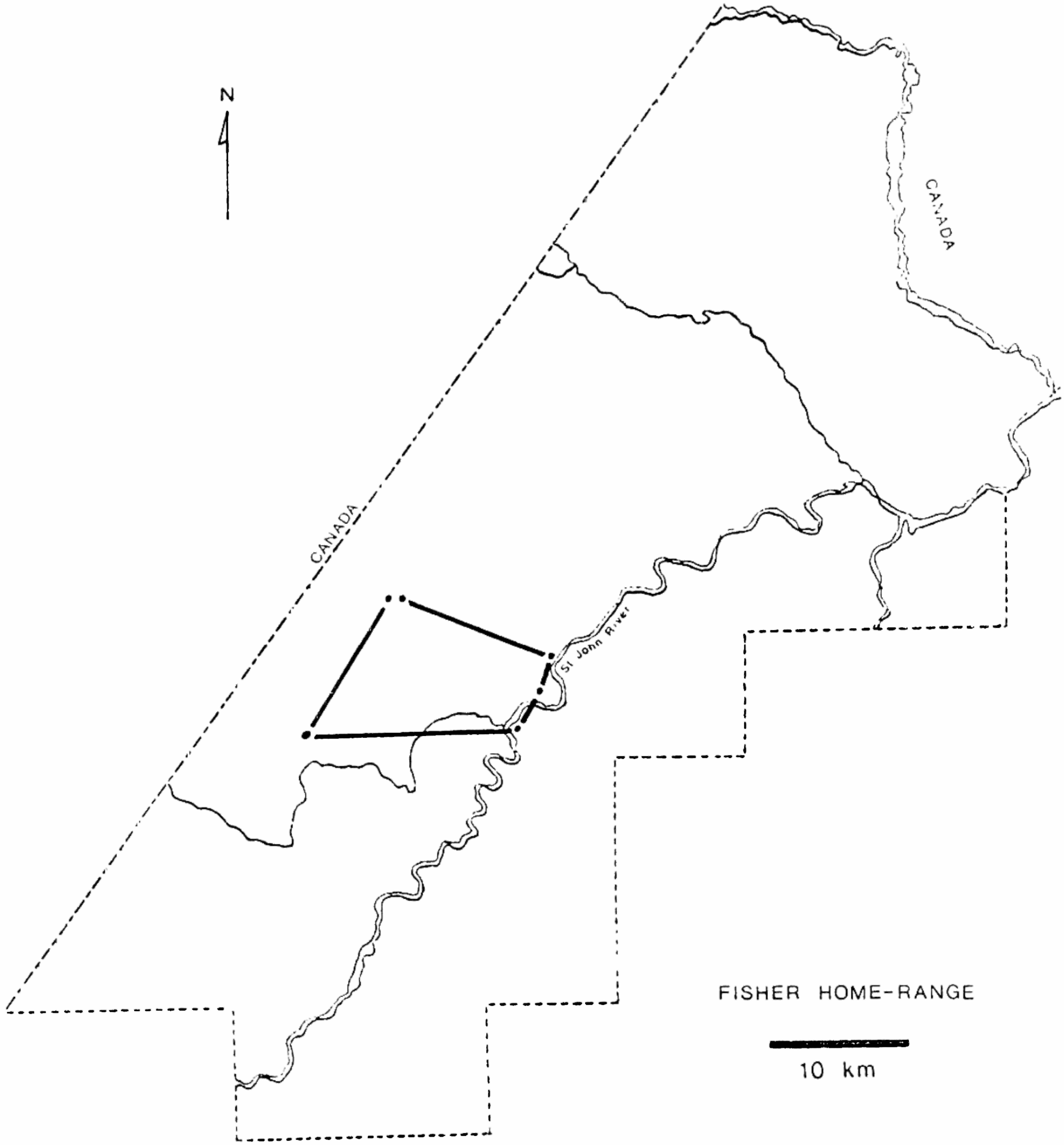
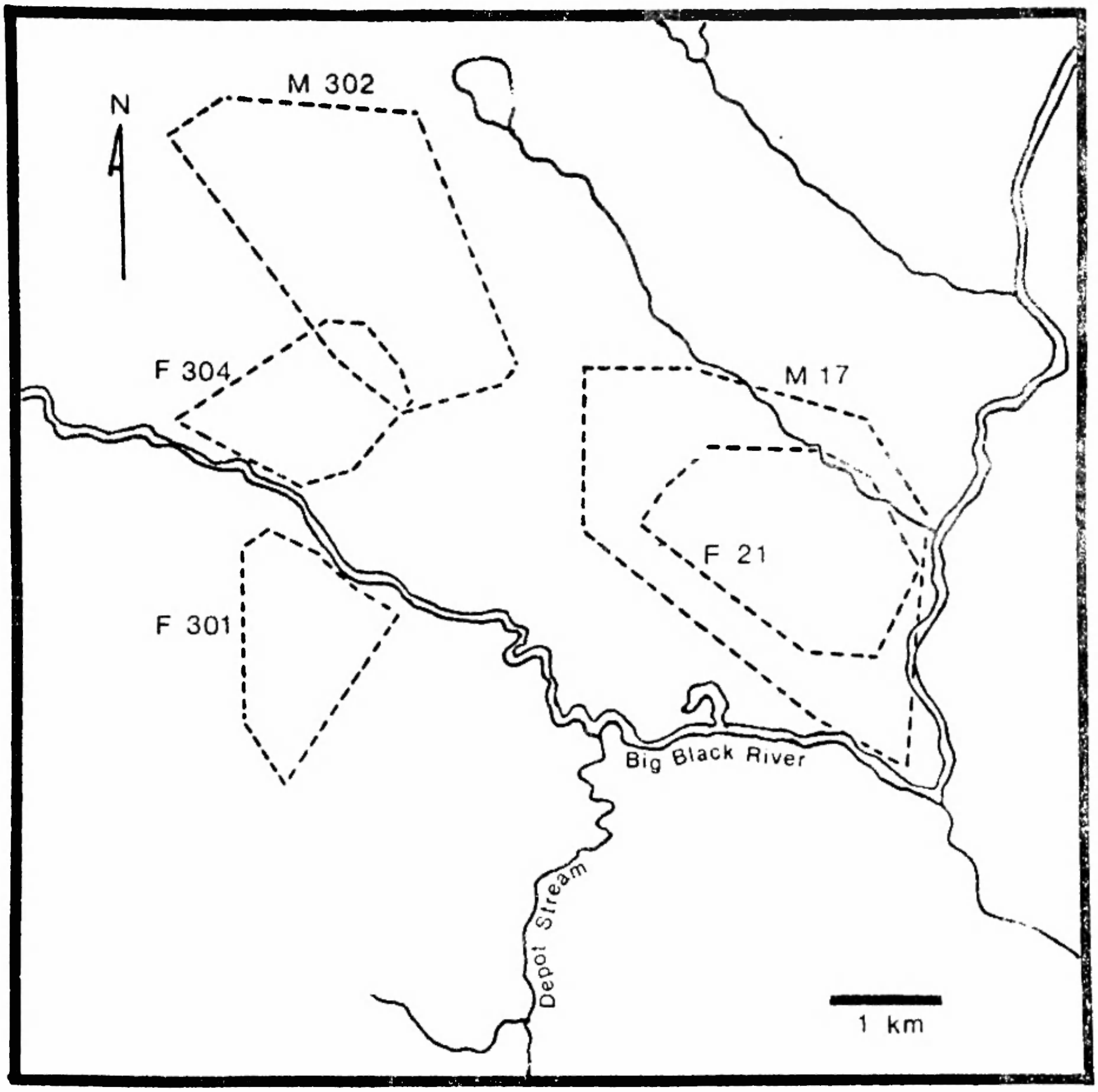


FIGURE 3.4-1



MARTEN HOME-RANGES

FIGURE 3.5-1

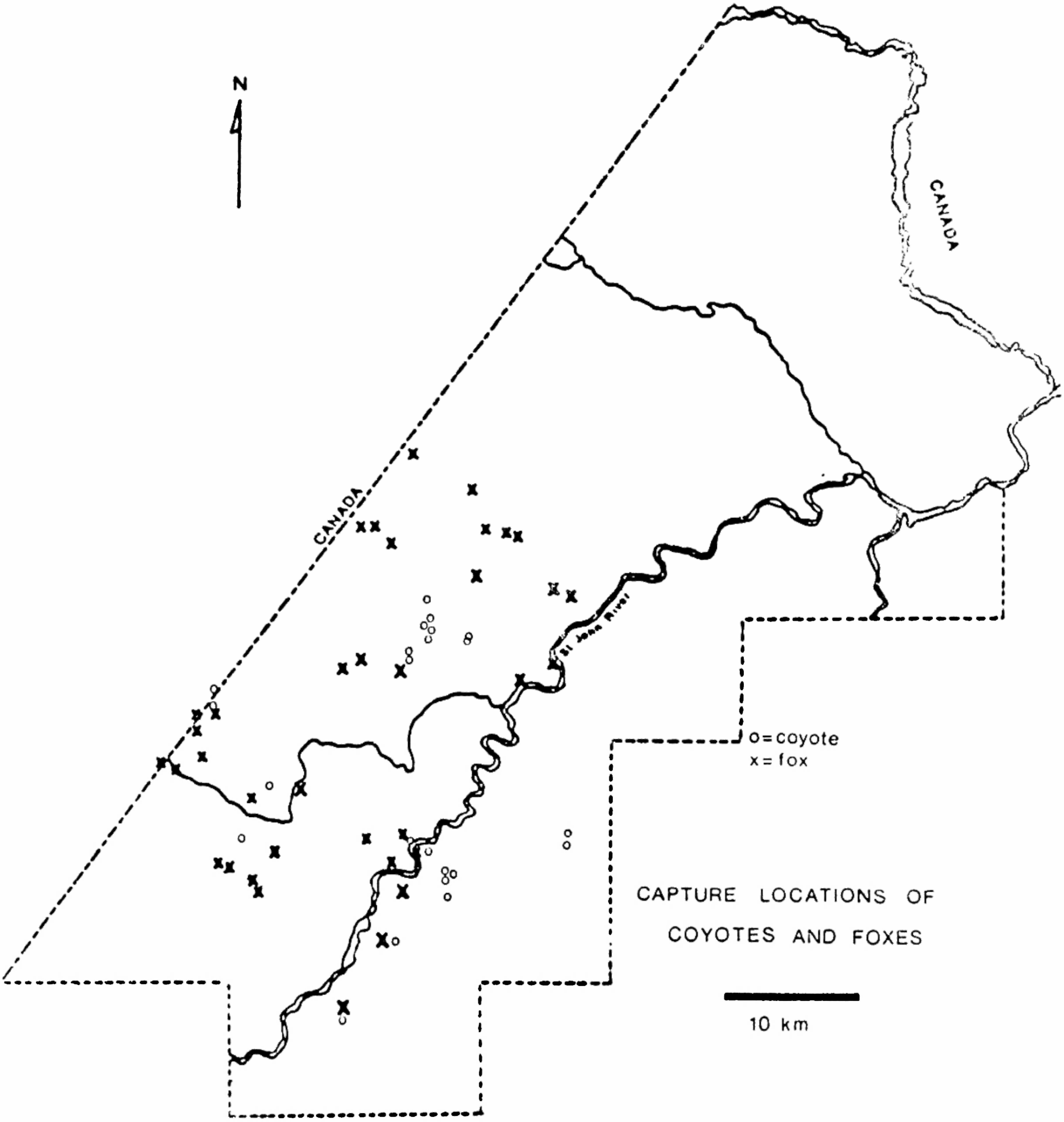

N
CANADA
CANADA
St John River
o=coyote
x= fox
CAPTURE LOCATIONS OF
COYOTES AND FOXES
10 km

FIGURE 3.6-1

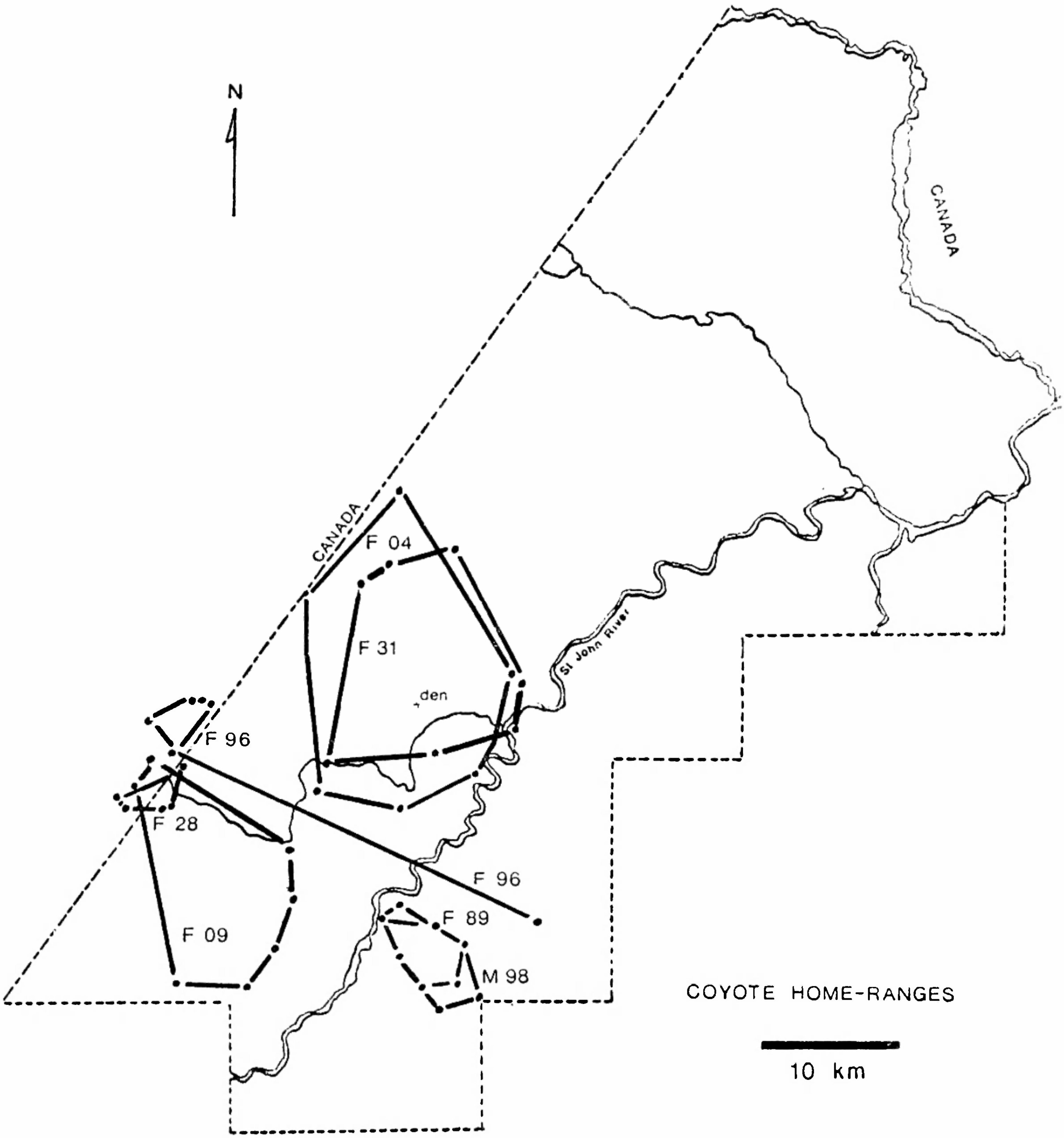
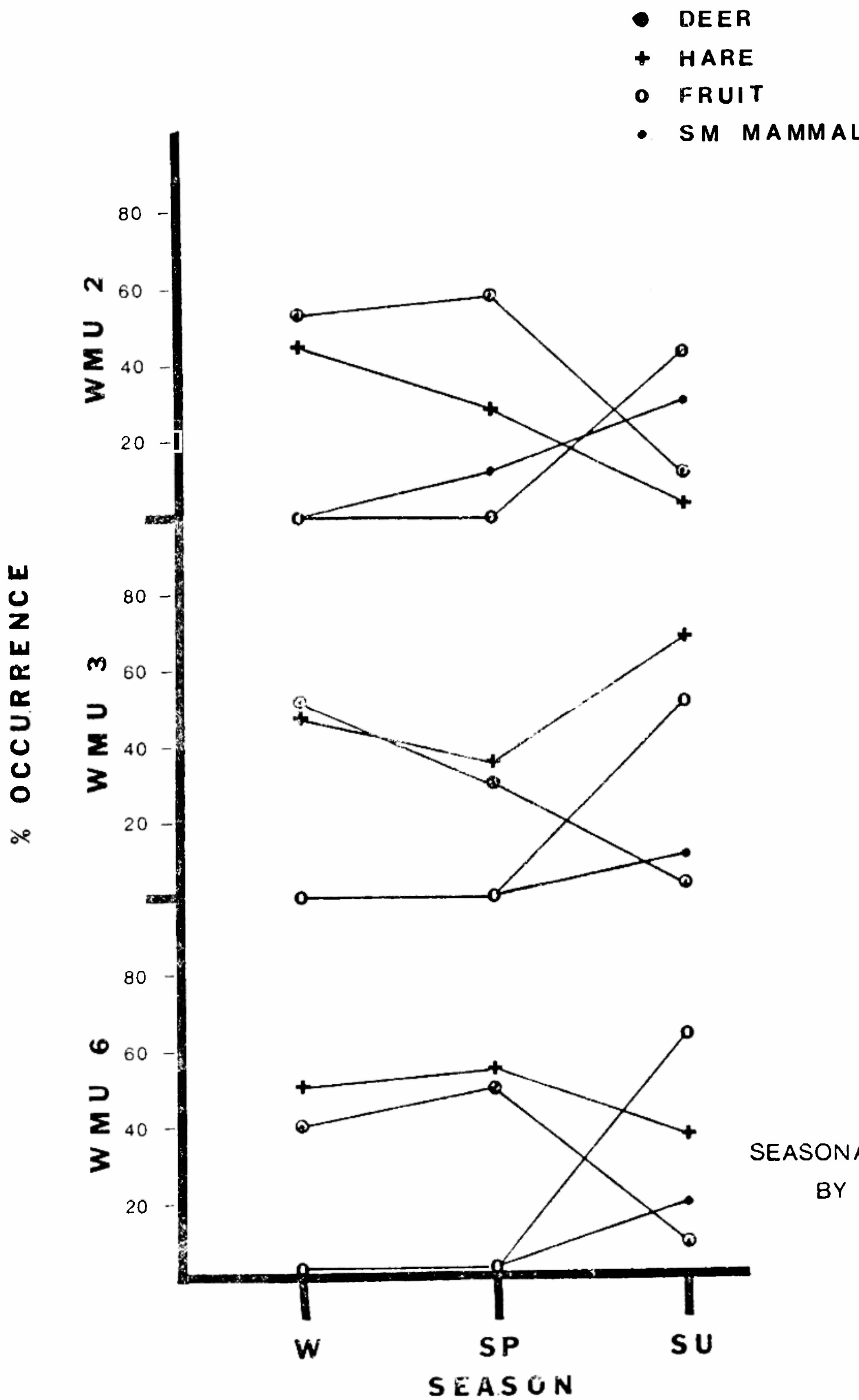
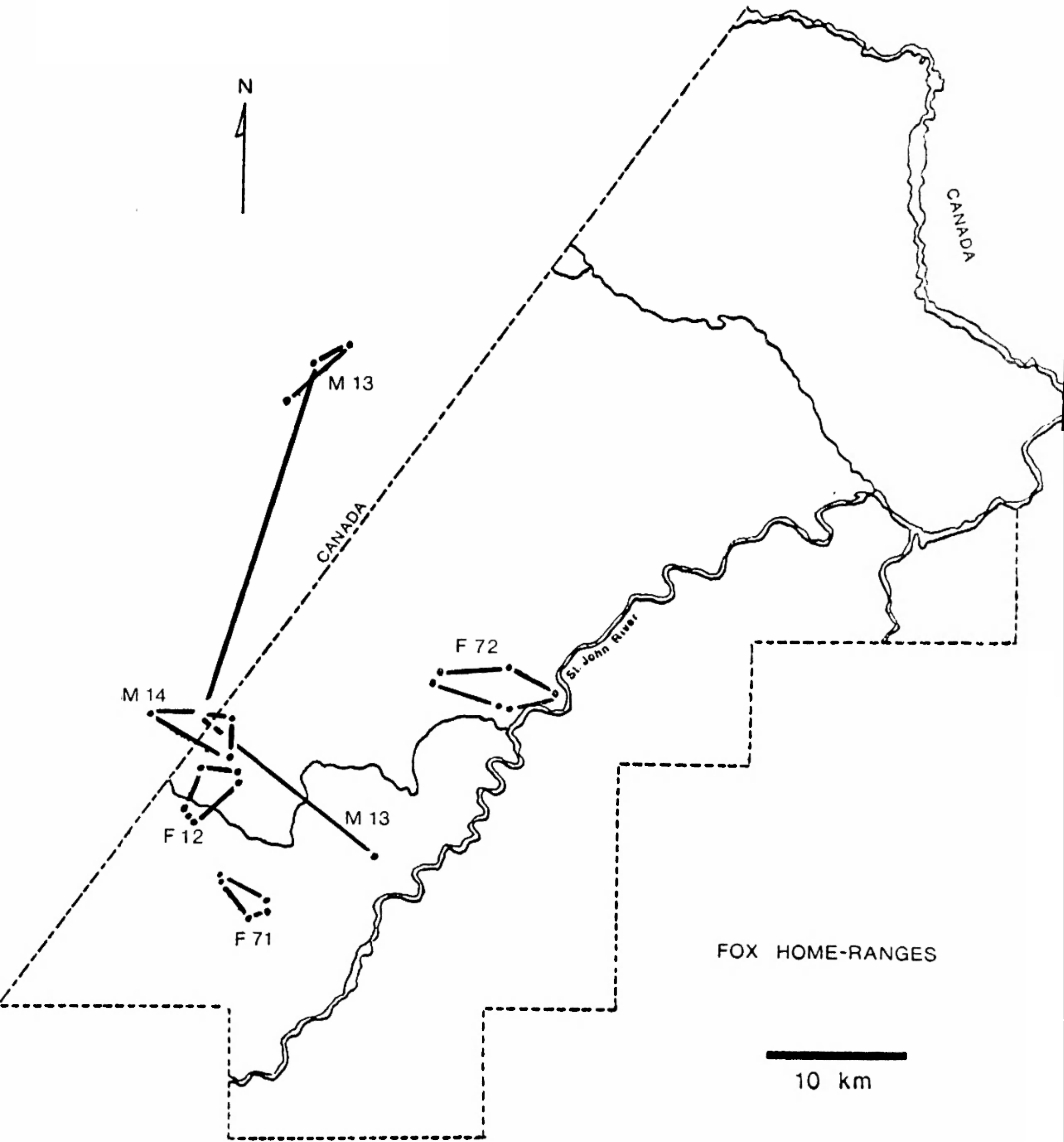

N
CANADA
CANADA
St John River
den
F 04
F 31
F 96
F 28
F 96
F 09
F 89
M 98
COYOTE HOME-RANGES
10 km

FIGURE 3.6-2



SEASONAL PREY USE
BY COYOTES

FIGURE 6-3


N
CANADA
CANADA
M 13
M 14
M 13
F 12
F 71
F 72
St. John River
FOX HOME-RANGES
10 km