INTERIM REPORT II

BASELINE STATES OF SMALL MAMMAL POPULATIONS IN THE AOSERP STUDY AREA

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Prepared For

ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

Project LS 7.1.2

December 1979

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONCLUDED)

LIST OF TABLES

LIST OF TABLES CONT'D

LIST OF TABLES CONT'D

LIST OF FIGURES

LIST OF FIGURES CONT'D

LIST OF FIGURES CONT'D

ABSTRACT

Changes in the demography and habitat use of three small rodent species (*Clethrionomys gapperi, Microtus pennsylvanicus* and *Peromyscus maniculatus*) and snowshoe hares (*Lepus americanus*) were monitored from July to November 1978. Bi-weekly live-trapping programs in six natural habitat types and in two naturally revegetating areas provided detailed demographic information on small rodent populations. A similar bi-weekly live-trapping program in four natural habitat types provided detailed demographic information on snowshoe hares. A snap-trap census program provided information on habitat use and reproduction of small rodents in a wider geographic range of habitats than that sampled by the live-trapping areas.

Preliminary analyses presented in this interim report suggest that:

1. *C. gapperi* is most common in mature forested areas (specifically areas with white spruce, balsam fir, birch, balsam poplar or aspen tree cover).
2. *M. pennsylvanicus* most commonly inhabits area with little or no tree cover--both live-trapping and snap-trapping indices indicated that *M. pennsylvanicus* preferred successional areas or grass-dominated areas (e.g., willow scrub, grass meadows, marshes, edges of waterbodies). Tamarack-black spruce bog was also heavily used.
3. *P. maniculatus* was most abundant in balsam poplar, aspen and successional areas but generally showed few preferences for any particular habitat (areas dominated by birches were more heavily used than expected).
4. *L. americanus* was most numerous in black spruce forest in the summer and fall followed by balsam poplar, aspen and jack pine forests. In the early

spring, however, balsam poplar habitat was most heavily utilized.

5. Data on other species of small mammals (red squirrels, flying squirrels, chipmunks, various species of small rodents and shrews) were insufficient for determination of habitat preferences or an analysis of population changes.

Continued research in each study area, particularly in the early spring period, is required.

ACKNOWLEDGEMENTS

Many people at LGL have contributed much to the field program and the analysis and preparation of this report. H. Hurtak was instrumental in the establishment and implementation of the field program and provided invaluable assistance throughout the analysis of the data and preparation of the final report. Many thanks must also go to the field crew--C. McKillop, G. Searing, J. Roland, M. Ballantyne and G. Clarke. I am grateful to R. Ebel for his help in establishing the study plots and N. Morgan for her assistance in solving the inevitable logistical problems.

I am grateful to P. Lulman and H. Hurtak for identification and preparation of plant specimens. I also thank D. Whitford for key-punching and verification of field data. B. Harvie provided much help and expertise in computer programming and analysis. I am indebted to A. Birdsall for his encouragement, discussion and editorial comments. I appreciate the reviews of the draft manuscript of this report by C. Krebs and two anonymous reviewers. I also thank C. Furlong, D. Whitford, G. Wylie and J. Bjornson for preparation of the typescript and K. Bruce, R. Dressler and D. Hollingdale for preparation of the figures.

I am grateful to O. Glandfield and D. Krause of the Alberta Forest Service and to M. Neil of Alberta Fish and Game for their assistance and recommendations in establishing the study areas. I would also like to thank L. McRae of Alberta Power Ltd. and L. Pasiechnyk of Simmons Pipeline Ltd. for allowing us to work on the Poplar Creek power line and Thickwoods pipeline right-of-ways respectively.

This research project LS 7.1.2 was funded by the Alberta Oil Sands Environmental Research Program, a joint Alberta-Canada research program established to fund, direct, and co-ordinate environmental research in the Athabasca Oil Sands area of northeastern Alberta.

1. INTRODUCTION

The destruction of large tracts of land associated with oil extraction developments in the Athabasca Oil Sands of northern Alberta will affect the natural environment. In an effort to assess the impact of these developments on the floral and faunal communities of the Athabasca Oil Sands area, the Alberta Oil Sands Environmental Research Program (AOSERP) is conducting a series of baseline environmental studies in a large area in the vicinity of the Athabasca oil sands deposits (hereafter called the AOSERP study area [Figure 1]).

Because small mammals are important components of most temperate and arctic ecosystems both as herbivores and as prey of raptors and furbearers (Golley *et al.* 1975; Batzli 1975), a baseline study of small mammal populations in the AOSERP study area was begun in the fall of 1977. The major objective of the small mammal baseline study as outlined in the terms of reference was to

> "describe the species composition and demography of small mammal populations in selected habitats in the AOSERP study area".

This objective was to be fulfilled by a review of the literature pertaining to the distribution, habitat utilization and demography of the major small mammal species in the AOSERP study area and by a two-year small mammal trapping program and habitat study. The review and synthesis of the literature is presented in Green (1979a).

Although the main objective of this research program was to provide baseline information on small mammals (small rodents and snowshoe hares) in the AOSERP study area, it will also provide demographic and habitat utilization data that are directly comparable to data obtained in a closely related study on the experimental control of small mammal damage in revegetation areas (Green 1979b). Such knowledge of natural small mammal populations is essential to the formulation of an effective and ecologically acceptable program of control.

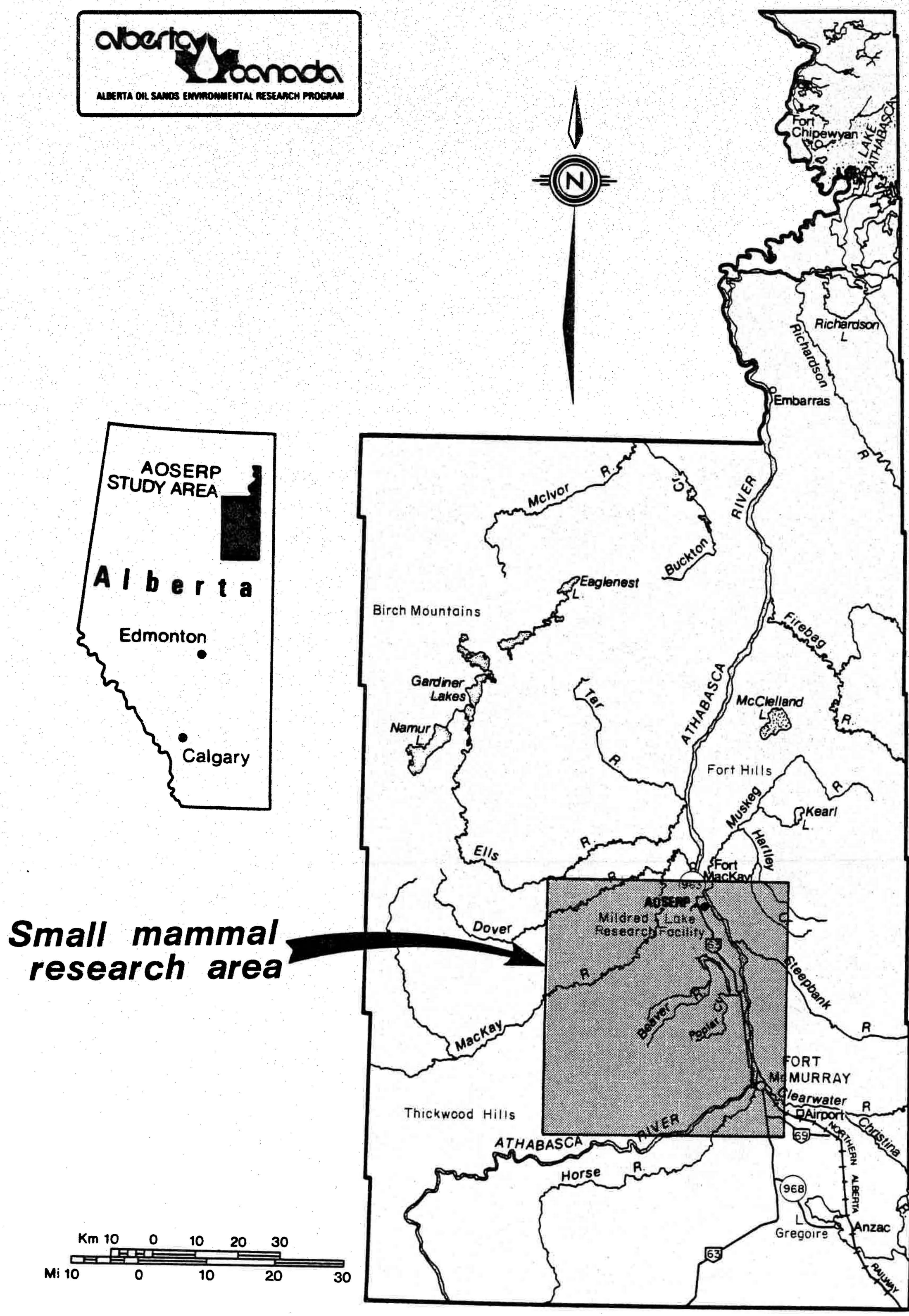

Figure 1. The Alberta Oil Sands Environmental Research Program study area and the general location of the small mammal research area.

This is the second interim report on baseline studies of small mammals in the AOSERP study area. An analysis of data obtained in 1977 is presented in Green (1978). It is anticipated that the research program will be continued for another year. This report does not represent a complete analysis of the data available and conclusions herein are tentative. The intention of this report is to discuss preliminary results and to describe analyses that will be continued as the project progresses. An effort has been made to highlight interesting and possible significant trends in the data which should be considered for the duration of this program.

Mammalian nomenclature follows that of Banfield (1977). Plant nomenclature follows that of Moss (1967) for grasses, forbs and shrubs and that of Hosie (1973) for trees.

2. METHODS

In order to obtain information on the distribution, abundance and habitat preferences of the major small rodent species and snowshoe hares, six small rodent study plots and four snowshoe hare study plots were established in six different habitat types. Two small rodent study plots were also established in recently disturbed but naturally revegetating areas to provide information on the species composition and densities of small mammals in naturally revegetating sites and the response of small mammals to successional vegetation in these areas. Data were also obtained on the levels of small mammal damage in naturally revegetating sites for comparison with similar data obtained in a related experimental study on the GCOS reclamation sites.

2.1 STUDY AREA DESCRIPTIONS

2.1.1 Natural Habitats

Small mammal study plots were established in six of the ten major vegetation types of the AOSERP study area as described by Stringer (1976). All grids were established in the last two weeks of June, except for the Aspen and Jack pine grids, which had been established in October 1977 (Green 1978). Plots were located in white spruce-aspen forest (to be referred to as the Aspen grid) (Figure 2), jack pine forest (Jack pine grid), tall willow shrub (Willow grid), bottom-land balsam poplar (Balsam poplar grid), black spruce bog forest (Black spruce grid) and semi-open black spruce-tamarack bog forest (Tamarack grid). Study plots were not established in the other four vegetation types described by Stringer (1976) because they were not thought to represent suitable habitats for small mammals. Snowshoe hare study plots were established in the jack pine forest (referred to as the SH-Jack pine grid), white spruce-aspen forest (SH-Aspen grid), bottom-land balsam poplar (SH-Balsam poplar grid), and black spruce bog forest (SH-Black spruce grid).

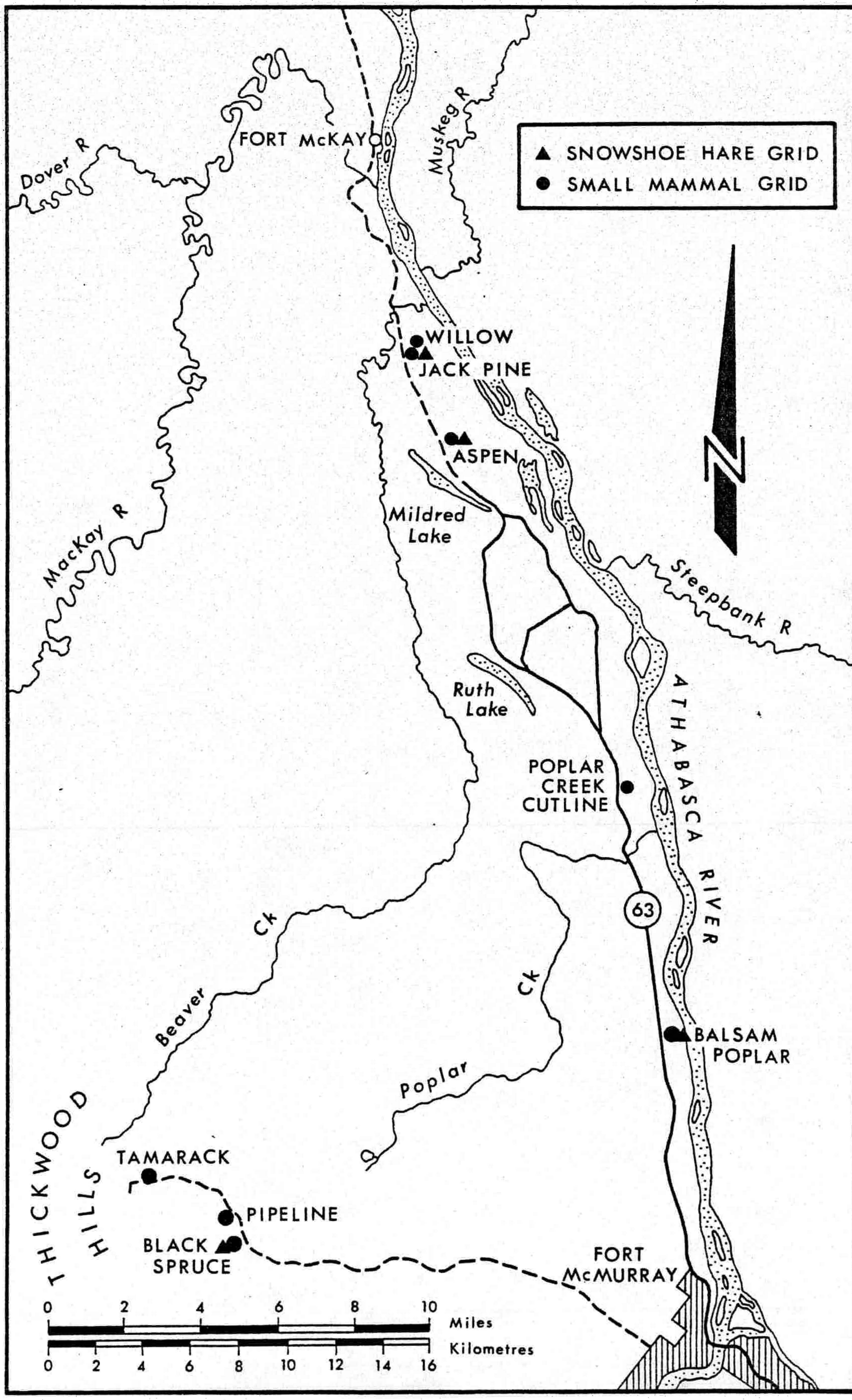

Figure 2. Locations of the 8 small mammal study plots and the 4 snowshoe hare study plots.

The Aspen grid and SH-Aspen grid were located in an upland white spruce-aspen forest type. The stand is composed of aspen (*Populus tremuloides*) 15-17 m high and some white spruce (*Picea glauca*), with a well-developed stratum of medium and low shrubs (0.5-1.0 m in height) dominated by *Amelanchier alnifolia, Rosa acicularis, Rosa woodsii, Symphoricarpos albus, Viburnum edule* and *Vaccinium myrtilloides*.

The Jack pine grid and SH-Jack pine grid are located mainly in a stand of jack pine forest (12-15 m in height) on well-drained sandy soils. Some parts of these grids are situated in lower, moist areas dominated by tall willow scrub. Jack pine (*Pinus banksiana*) is the major tree species although a considerable number of aspen saplings are also present. The understory is characterized by extensive areas of fruticose lichens (*Cladonia* spp.) with a sparse dwarf shrub stratum of *Arctostaphylos uva-ursi* and *Vaccinium caespitosum*. Clumps of green alder (*Alnus crispa*) also occur within the jack pine stands.

The Willow grid is situated in an area dominated by swamp and dwarf birch (*Betula glandulosa* and *Betula pumila*) and willows (*Salix* spp.) varying from 0.5-3 m in height. The understory is composed primarily of *Vaccinium uliginosum* and a dense mat of sedges.

The Balsam poplar grid and SH-Balsam poplar grid is located in a mature stand of balsam poplars (*Populus balsamifera*) with heights of 25-30 m. The understory is composed of either clumps of river alder (*Alnus tenuifolia*) with a 3-5 m canopy or clumps of a lower shrub stratum (1-2 m high) dominated by *V. edule, Ribes oxyacanthoides, Ribes triste, Rubus strigosus* and *Rosa acicularis*.

The Black spruce grid and SH-Black spruce grid were established in black spruce (*Picea mariana*) forest of low to medium density. Most trees are only 4-6 m high. A few tamarack (*Larix laricina*) and *Betula papyrifera* are also present. *Salix* spp. are present on parts of the snowshoe hare and small rodent grid, but the predominant understory species are *Ledum groenlandicum* and *V. myrtilloides* with occasional patches of *B. glandulosa*. The ground cover is composed predominantly of various sphagnum mosses.

The Tamarack grid is located in a poorly drained area dominated by a sparse cover of black spruce and tamarack. Few large trees exceed heights of 6-8 m. The shrub understory is composed primarily of *B. pumila* and *Salix* spp. The ground cover consists of an almost continuous layer of sphagnum mosses with a dwarf shrub layer composed largely of *L. groenlandicum, Vaccinium vitis-idaea* and *Rubus chamaemorus*.

2.1.2 Naturally Revegetating Areas

Two small rodent plots were established in recently disturbed but naturally revegetating areas. Although a naturally disturbed area (i.e., recently burned) would have been a preferable site, no sufficiently large burned areas were accessible. Two cutline right-of-ways were chosen instead.

The Poplar Creek cutline grid was established on a section of the Alberta Power Limited cutline right-of-way, 22-23 July 1978 (Figure 2). The area was cleared and burned in 1972 and has received no further treatment since that time (letter dated 1 September 1978, L. McRae, Alberta Power Ltd.). The cutline is bounded on the north and south edges by deciduous forest dominated by aspens. Vegetation on the cutline is characterized by a sparse regrowth of *Salix* spp., *Rosa* spp., *Rubus melanolasius, Lonicera* spp. and *R. oxycanthoides* with a dense grass ground cover.

The Thickwood Cutline grid was established on the Simmons Pipelines Limited pipeline right-of-way 20-21 June 1978. The right-of-way was cleared in late November and December 1976 (letter dated 9 January 1979, L.T. Pasiechnyk, Project Engineer, Simmons Pipeline Ltd.). Brush was bulldozed , wind-rowed and burned. The area has received no further treatment to date.

Very little vegetative cover is present on this plot. The sparse ground cover consists primarily of very young *P. tremuloides*, *P. balsamifera*, *Rosa* spp., *Equiseteum* spp. and some grasses.

2.2 SNAP-TRAP CENSUS AREAS

Snap-trap censuses of small rodents were undertaken to provide information on the abundance, distribution, habitat preferences and reproductive indices of the major small rodent species from a wider geographic area than that sampled by live-trapping. Forty-six snap-trap lines were situated along Highway 63 (and its extension past Fort MacKay) and the road to the Thickwoods Fire Tower (Figure 3). Nineteen snap-trap lines were set in remote areas (in the vicinities of the Birch Mountain Fire Tower, the Muskeg Mountain Fire Tower and the Richardson sand dunes).

2.3 VEGETATION ANALYSES

2.3.1 Vegetation Analyses on Live-trapping Areas

Vegetation analyses on live-trapping areas were conducted during the period of 25 June-30 July 1978. Estimates were made of (a) sapling density and species composition of saplings, (b) levels of small mammal damage to woody-stemmed plants, and (c) density, species composition and vertical composition of ground cover. Thirty sample points were chosen using coordinates selected from a table of random numbers. At each sample point, a 4 m x 4 m quadrat and a 1 m x 1 m quadrat were placed on the ground as shown in Figure 4.

2.3.1.1 Estimation of Sapling Density and Small Mammal Damage.

Sapling density and species composition were estimated by counting the number of each species of sapling present in the $16\ m^2$ quadrat. For the purpose of this study, saplings were defined as individual young coniferous or deciduous trees with

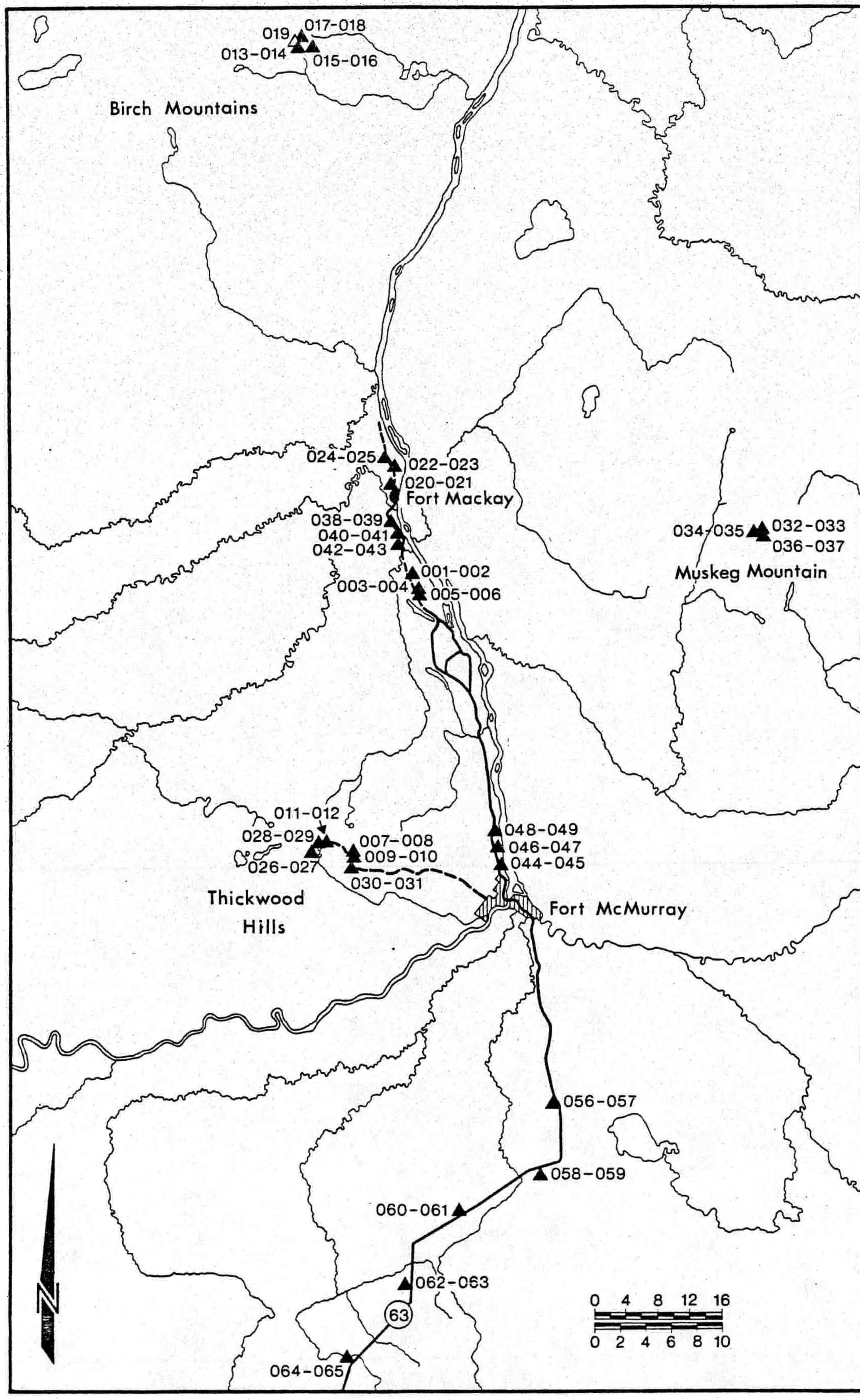

Figure 3. Location of snap-trap census lines. (Solid triangles indicate that 2 parallel lines were set at that location. Open triangles indicate that one line was set at that location. File numbers for each line are indicated.)

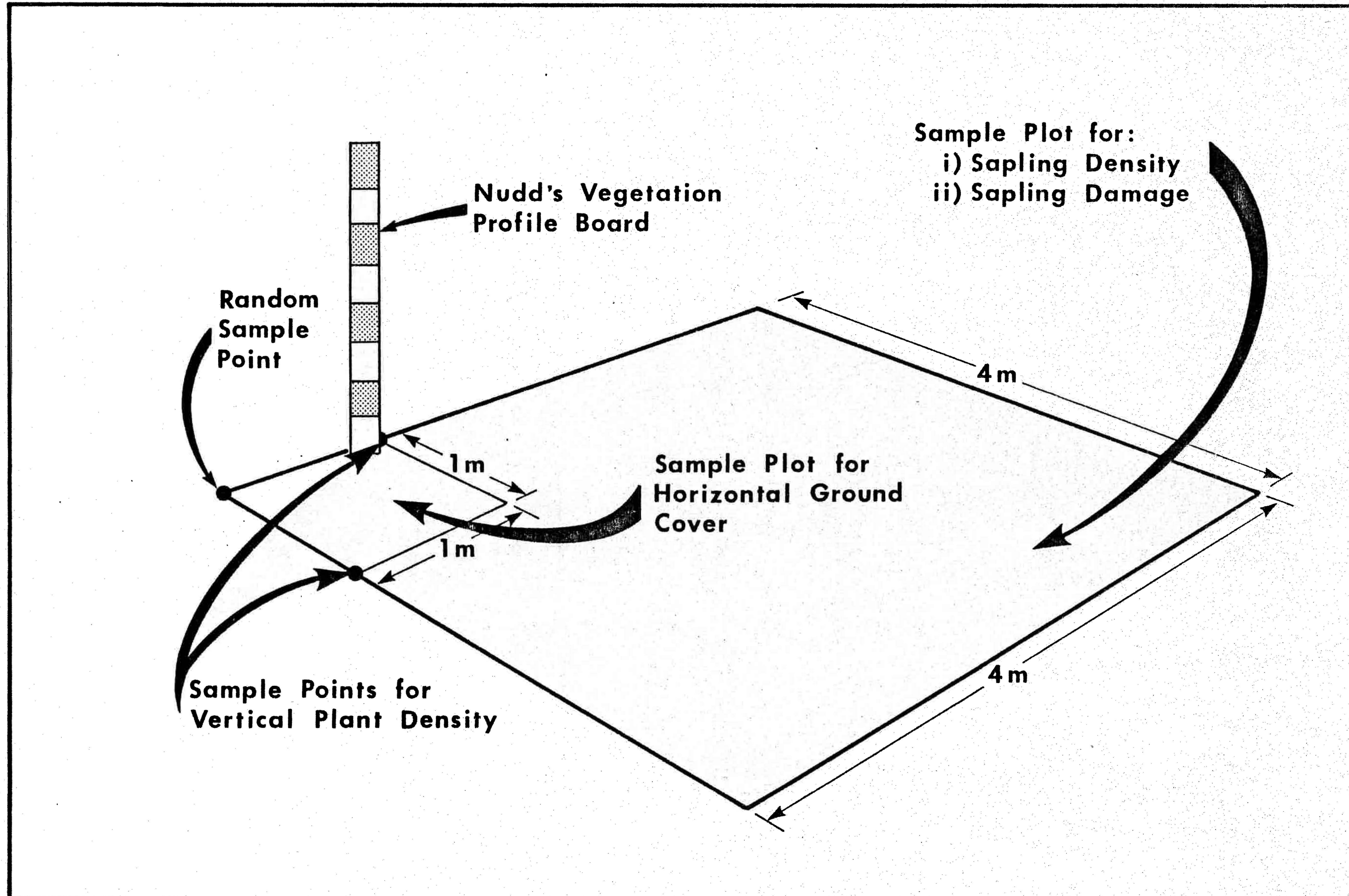

Figure 4. The vegetation sampling system showing the spatial relationships of the sapling density and sapling damage quadrat, the horizontal ground cover quadrat, the vertical plant density sample points and the vegetation profile board.

a stem diameter of 3 cm or less at a height of 15 cm above ground level. Individual shrubs were termed saplings if all main branches had diameters of 3 cm or less at a height of 15 cm above the ground. Each deciduous or coniferous sapling or each distinct shrub (i.e., a distinct grouping of branches at ground level) was counted as one sapling.

The following three types of small mammal damage to saplings were recognized: girdling by small rodents, girdling by snowshoe hares and browsing by snowshoe hares. Girdling refers specifically to the removal of the phloem and the outer cambium layers of the stem, roots and/or branches. Browsing refers to the clipping of terminal and lateral twigs and buds. Girdling damage was rated according to the percentage (in 25% increments) of the total circumference of the stem that had been damaged (see Green 1978 for details). Browsing and girdling damage was described as old or new, according to the criteria used by Green (1978). All saplings present in the 16 m^2 quadrat were examined for small mammal damage and the number of saplings of each species that showed evidence of old or new rodent girdling, snowshoe hare girdling or snowshoe hare browse was recorded.

2.3.1.2 Estimation of Ground Cover Density and Composition. The percentages of the ground within the 1 m x 1 m quadrat that was covered (on the horizontal plane) by each plant species and by ground litter were estimated using a Blaun-Blanquet cover scale (see Green 1978 for details).

To determine whether the vertical distribution of vegetation on the plots is important to the distribution of small mammals, two measures of the vertical structure of plant cover were obtained.

The vertical composition of the ground cover was measured at two opposite corners of the ground cover quadrat (Figure 4). The vertical density (percent cover) of all vegetation in each 0.25 m vertical increment was visually estimated using the vegetation profile board method of Nudds (1977), which provides a cumulative estimate for all components of vertical plant cover. More specific information on vertical plant cover was collected for each of the three most dominant species in each horizontal ground cover quadrat (based on the estimates of percent horizontal cover). For each dominant species, the vertical zone with the highest density of cover was first estimated and the minimum height of this zone (from the ground surface) was recorded. Two minimum heights for each dominant species were obtained--one at each of the corners of the quadrat that were sampled for vertical cover. The depth of the plant litter (i.e., dead grasses, twigs, leaves, etc.) was also measured at each of these sample points.

2.3.2 Vegetation Analyses on Snap-trapping Areas

Estimates of habitat availability and habitat use were obtained for each snap-trap census. Habitat availability was estimated by recording the dominant tree, shrub and ground cover species for each 15 m interval between trap stations along each snap-trap line.

Habitat use was estimated using the number of each small rodent species captured in each habitat type. For each mouse captured during a snap-trap census, the dominant tree, shrub and ground cover species and an estimate of the total ground cover (percent coverage) in the vicinity of the trap were recorded. The dominant tree and shrub species were determined for the area within a 5 m radius of the trap--the species with the highest percent coverage (based on the area of the canopy) of the sampling area was recorded as the dominant species. The dominant ground cover species and an estimate of the percent coverage of all ground cover in the vicinity of each capture of a small mammal were based on ground vegetation within a 1 m radius of the trap location. The plant species that covered the greatest percent of the ground in the sampling area was the dominant ground cover species. An estimate of total ground cover (percent coverage) was obtained using a Blaun-Blanquet cover scale.

2.4 SMALL MAMMAL TRAPPING TECHNIQUES

Live-trapping (of small rodents and snowshoe hares) and snap-trapping (of small rodents) techniques were used to obtain information on the demography, distribution and habitat preferences of the major species of small mammals present in the AOSERP study area and on the species composition of the small mammal community.

2.4.1 Live-trapping Techniques

Small mammal live-trapping techniques similar to those described by Keith *et al.* (1968) for snowshoe hares and by Krebs *et al.* (1969) for small rodents, were used during this study. All small mammal live-trapping areas were trapped once every two weeks as described below.

Each small rodent trapping grid except for the two cut-line grids was 0.81 ha in size and consisted of a 10 x 10 grid of trapping stations at 10 m intervals. One Longworth Small Mammal Trap was placed within a 1.5 m radius of each trap station. All traps were prebaited (trap doors were locked open) for two weeks before commencing the bi-weekly program of live-trapping. Cotton felt for bedding and a small amount of whole oat groats for bait were placed in the nest box of each trap and were replenished when necessary during each trapping period. Between trapping periods, all doors on all traps were locked in the open position to allow mice to freely enter and leave the traps.

Fifteen chipmunk/squirrel traps (Tomahawk #201) were also placed on each small rodent trapping grid. One trap was set at the first, fifth and tenth trap station on alternate rows of the trapping grid. Traps were not prebaited. During each trapping period, traps were baited with peanut butter on the first day and were rebaited as necessary.

Snowshoe hare live-trapping grids overlapped the small rodent grids as shown in Figure 5. Snowshoe hare trapping grids were 5.7 ha in size[1] and consisted of a 8 x 10 grid of trapping stations at 30 m intervals. One Tomahawk rabbit trap (single door) was placed on a well-defined runway (if possible) within a 5 m radius of alternate trap stations. Alfalfa hay and fresh clover (when available) for bait were placed in each trap. All traps were prebaited (traps were locked open on both ends) for two weeks prior to commencing the regular bi-weekly schedule of live-trapping. Traps were arranged so that, during one trapping period, traps on even-numbered rows were set at the even-numbered stations whereas traps on odd-numbered rows were set at the odd-numbered stations. Traps were then rotated between trapping periods so that during the following trapping period, traps on even-numbered rows were set at odd-numbered stations and traps on odd-numbered rows were set at even-numbered stations. Between trapping periods, both the front and back of each trap were locked open to allow hares to move freely through the traps.

Each trapping period consisted of three days of live-trapping. On the first day of each trapping period, all traps were set in the afternoon. All traps were checked and reset the following morning and again in the afternoon. On the morning of the third day, all traps were checked and locked open until the next trapping period.

When first captured, all new small rodents were ear-tagged with a numbered fingerling fish tag (Salt Lake Stamp Company). Newly-captured snowshoe hares were tagged with a numbered #3 monel metal ear tag (National Band and Tag Company). Following tagging or when tagged animals were captured during subsequent trapping periods, the tag number, species, trap

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[1]Partial flooding of the SH-Balsam Poplar grid, resulting from the damming of an old river channel by beaver, effectively reduced the trapping grid to a size of 5.0 ha (an 8 x 9 station trapping grid).

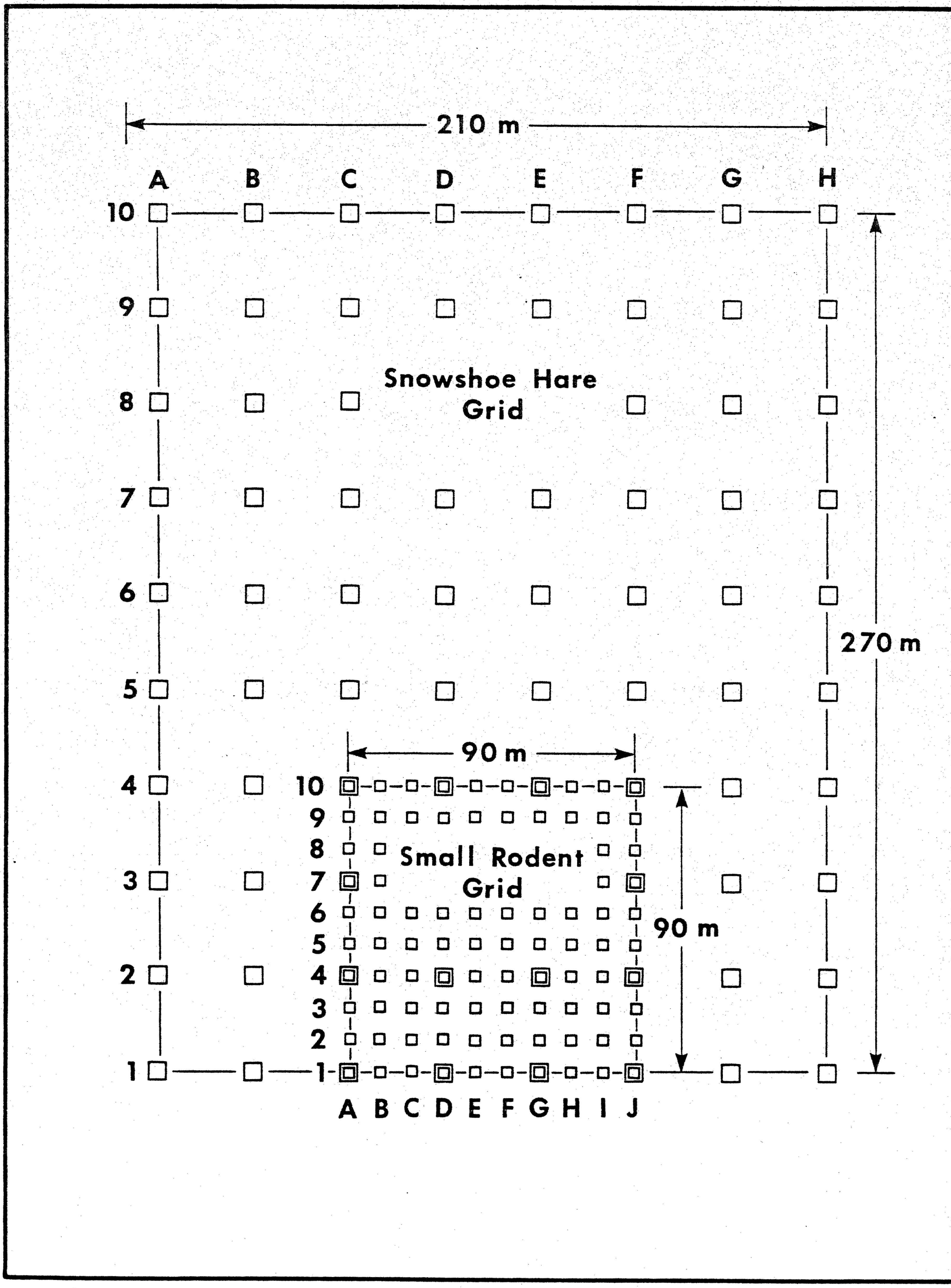

Figure 5. Overlapping arrangement of snowshoe hare and small mammal live-trapping grids.

location, sex, breeding condition, weight, number of wounds on the posterior portion of the body (small rodents only), the number of subdermal parasites (*Cuterebra* spp.) and the number of ticks were recorded. If the same animal was recaptured in the same trapping period, only its tag number, species and trap location were recorded.

Most small rodent trapping plots and all snowshoe hare live-trapping plots were trapped at bi-weekly intervals from 30 June-16 November 1978. One small rodent trapping area, the Poplar Creek cutline, was not established until 23 July--bi-weekly trapping commenced 2 August and continued until 10 November. Each snowshoe hare plot was also trapped for one 5-day period in the early spring (27 February-7 March 1979).

2.4.2 Snap-trapping Techniques

Small rodent snap-trapping techniques similar to those described by Krebs (1964) were used during this study. Snap-trap lines consisted of 20 stations spaced at 15 m intervals along a straight line. Three Woodstream Museum Special Snap Traps were set at each station, and were baited with a small amount of peanut butter. Traps were set in the afternoon of the first day and were checked daily for three days. Two parallel lines placed approximately 100 m apart were set at each sampling location. Normally, six snap-trap lines were set every three weeks. Snap-trap censuses were conducted from the 17 July-17 October 1978.

2.5 AUTOPSY TECHNIQUES

All animals captured in snap-traps were autopsied to provide information on reproductive characteristics and to obtain indices of nutritional condition. The procedures followed were similar to those described by Krebs (1964). For each animal autopsied, the body weight, total length, tail length, skull (zygomatic) breadth, reproductive condition, number of subdermal parasites (*Cuterebra* spp.) and an index of the amount of fat in the abdominal mesentery (no fat [1] to very fat [5]) were recorded. For males, testes position (abdominal or scrotal), testes weight and the size of the epididymus tubules (visible or not visible) were recorded. For females, size of mammary glands (small, medium or small), vaginal opening (perforate or non-perforate) uterus size (thread-like, normal, slightly enlarged or large), uterus weight, number of placental scars, number of embryos and number of resorbing embryos were recorded. Testes and uteri from mature animals were preserved in formalin and were later weighed on an analytical balance.

2.6 DATA ANALYSES

Small mammal live-trapping and snap-trapping data were analysed using computer programs provided by Dr. C.J. Krebs (Krebs 1970, 1972) of the University of British Columbia. Additional programs for specific analyses of population and habitat were developed as needed.

3. RESULTS: SMALL RODENTS

This research program was designed to provide detailed information on changes in the density and structure of small mammal populations in natural areas and the use of natural habitats by various species of small mammals. The methods of data collection and the types of analyses are identical to those used in the concurrent experimental study (Green 1979b) so that direct comparisons of data from natural areas and from reclamation sites are possible.

Habitat use can and does vary with changing population densities (Green 1979a). Because changes in population densities are invariably associated with changes in population structure, this research program has concentrated on obtaining detailed information about changes in both population structure and in population densities. In the following analyses I will first review the observed changes in the population densities and will then attempt to explain some of these changes through an examination of population losses, recruitment and differences in population structure.

The demography and habitat utilization of only three small rodent species (*Clethrionomys gapperi*, *Microtus pennsylvanicus* and *Peromyscus maniculatus*) and snowshoe hares (*Lepus americanus*) will be discussed in detail in this report because no other species were captured in sufficient numbers to merit detailed analyses. The analysis of small rodent data is presented in Section 3, the analysis of snowshoe hare data in Section 4.

Other small mammal species such as *Microsorex hoyi*, *Sorex cinereus*, *Sorex obscurus*, *Sorex arcticus*, *Phenacomys intermedius*, *Synaptomys borealis*, *Zapus hudsonicus*, *Eutamias minimus*, *Tamiasciurus hudsonicus*, *Glaucomys sabrinus*, *Mustela erminea* and *Mustela vison* were captured in live traps and snap traps during the 1978 field program. For any one of these species, very few animals were captured during any one trapping period. As a result, analyses were restricted by sample size and information about the habitat utilization and demography of these species for this study is limited.

3.1 POPULATION CHANGES

Population densities of small rodent populations have usually been assessed using mark-recapture methods of estimating population size. To avoid the assumptions of mark-recapture techniques a complete enumeration of small mammal populations within each study area was attempted and I have instead used the minimum number known to be alive (MNA) (Chitty and Phipps 1966) during each bi-weekly sampling period as a biased estimator of population size. For each sampling (trapping) period, the MNA includes the number of animals captured in that period plus any animals caught both before and after the sampling period.

Green (1979b) discusses problems associated with methods of estimating population densities based on live or kill trapping of small mammals. Biases in population estimates (usually underestimates) may be caused by poor trappability, poor trap availability or social interactions (Green 1979b). I have attempted to minimize the biases inherent in small mammal trapping studies by 1) ensuring that each area was saturated with traps (i.e. by using a small inter-trap distance) and 2) by only using MNA estimates when the trappability exceeds 50%. Hilborn *et al.* (1976) found that when the trappability of tagged animals falls below 50%, enumeration techniques generally underestimate the trappable population size by more than 20%.

3.1.1 Trappability

Hilborn *et al.* (1976) have demonstrated with a computer simulation model that enumeration techniques provide acceptable estimates of population size when trappability (the proportion of the tagged population captured each week) is greater than 50%. Estimates of trappability were calculated for each species captured on Grids 1-8 to provide an indication of the reliability of MNA estimates of population size. Minimum unweighted trappability was calculated for a population of N captured individuals according to the following formula (Boonstra and Krebs 1978):

$$\text{Minimum Unweighted Trappability} = \frac{1}{N} \sum_{i=1}^{N} \frac{\text{Number of actual captures for a given animal}}{\text{Number of possible captures for that animal}}$$

The first and last captures are not included in these calculations (because all animals are necessarily caught at these times).

Estimates of minimum unweighted trappability were calculated for *M. pennsylvanicus*, *C. gapperi*, and *P. maniculatus* for both the summer period (30 June-20 September) and the fall period (21 September-17 November) on all grids and are shown in Tables 1, 2 and 3.

In most cases, the trappability of *M. pennsylvanicus*, *C. gapperi* and *P. maniculatus* exceeded 50%. The MNA estimates should consequently underestimate the trappable population sizes by acceptably small amounts. However, total trappabilities (males and females combined) for *M. pennsylvanicus* on the Aspen grid and the Balsam poplar grid in the fall period were 6.7% and 25.0% respectively--in these cases the MNA does not provide an acceptable estimate of the population size. Similarly, the trappabilities of *P. maniculatus* on the Aspen grid and Balsam poplar grid in the fall period were unacceptably low (49.0% and 44.0%, respectively).

3.1.2 Population Changes on Live-trapping Areas

MNA estimates of population size for *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* on the eight natural habitat grids are shown in Figures 6 to 13. Estimates of *P. maniculatus* and *M. pennsylvanicus* population sizes on the Aspen grid and Balsam poplar grid in the fall period (21 September-17 November) are not considered because trappabilities were below acceptable levels. Several important trends should be noted:

1. *C. gapperi* was the most abundant species on the Aspen, Jack pine and Balsam poplar grids; it also was one of the two most abundant species on the Black spruce and Tamarack grids.

Table 1. Seasonal estimates of minimum unweighted trappability for *C. gapperi* on the eight study plots.

	Summer						Fall					
	Males		Females		Total		Males		Females		Total	
Grid	MUT	N[1]	MUT	N	MUT	N	MUT	N	MUT	N	MUT	N
Aspen	80.0	21	75.2	21	77.6	42	97.9	24	87.5	28	92.3	52
Jack pine	83.0	10	71.1	9	77.4	19	92.9	14	83.3	8	89.4	22
Willow	88.1	14	81.3	4	86.6	18	98.2	18	85.7	7	94.7	25
Balsam poplar	81.8	52	70.9	44	76.8	96	83.0	43	78.6	35	81.0	78
Poplar Creek cutline	76.3	19	71.8	26	73.7	45	89.6	16	93.5	18	91.7	24
Black spruce	73.3	22	88.9	12	78.8	34	90.3	24	100.0	9	92.9	33
Thickwoods cutline	69.4	12	56.9	6	65.3	18	73.6	12	83.3	3	75.6	15
Tamarack	80.0	27	67.6	24	74.1	51	81.0	29	91.1	30	86.2	59

[1]N=the number of animals captured in three or more trapping periods.

Table 2. Seasonal estimates of minimum unweighted trappability of *M. pennsylvanicus* on the eight study plots.

Grid	Summer						Fall					
	Males		Females		Total		Males		Females		Total	
	MUT	N[1]	MUT	N	MUT	N	MUT	N	MUT	N	MUT	N
Aspen	77.8	3	48.3	5	59.4	8	0.0	2	11.1	3	6.7	5
Jack pine	75.0	8	91.7	6	82.1	14	100.0	5	100.0	2	100.0	7
Willow	57.9	28	68.0	32	63.3	60	66.7	24	77.0	21	71.5	45
Balsam poplar	66.7	3	69.4	3	68.1	6	0.0	3	100.0	1	25.0	4
Poplar Creek cutline	61.3	34	71.4	49	67.3	83	57.8	39	61.1	42	59.5	81
Black spruce	65.1	32	74.5	32	69.0	55	86.5	16	74.4	13	81.0	29
Thickwoods cutline	79.0	31	71.6	29	75.4	60	74.7	25	79.0	19	76.5	44
Tamarack	68.0	26	82.4	34	76.1	60	83.3	18	75.6	26	78.8	44

[1]N=the number of animals captured in three or more trapping periods.

Table 3. Seasonal estimates of minimum unweighted trappability of *P. maniculatus* on the eight study plots.

	Summer						Fall					
	Males		Females		Total		Males		Females		Total	
Grid	MUT	N[1]	MUT	N	MUT	N	MUT	N	MUT	N	MUT	N
Aspen	72.2	9	56.3	12	63.1	21	57.4	9	39.6	8	49.0	17
Jack pine	100.0	1	51.4	6	58.3	7	100.0	1	44.4	3	58.3	4
Willow	---------- No Captures ----------						---------- No Captures ----------					
Balsam poplar	77.1	17	63.1	24	68.9	41	51.7	10	37.9	11	44.4	21
Poplar Creek cutline	81.5	9	16.7	4	61.5	13	94.4	9	50.0	4	80.8	13
Black spruce	55.6	3	100.0	1	66.7	4	100.0	3	100.0	1	100.0	4
Thickwoods cutline	78.6	20	73.8	14	76.6	34	90.5	14	84.6	13	87.7	27
Tamarack	---------- No Captures ----------						---------- No Captures ----------					

[1] N=the number of animals captured in three or more trapping periods.

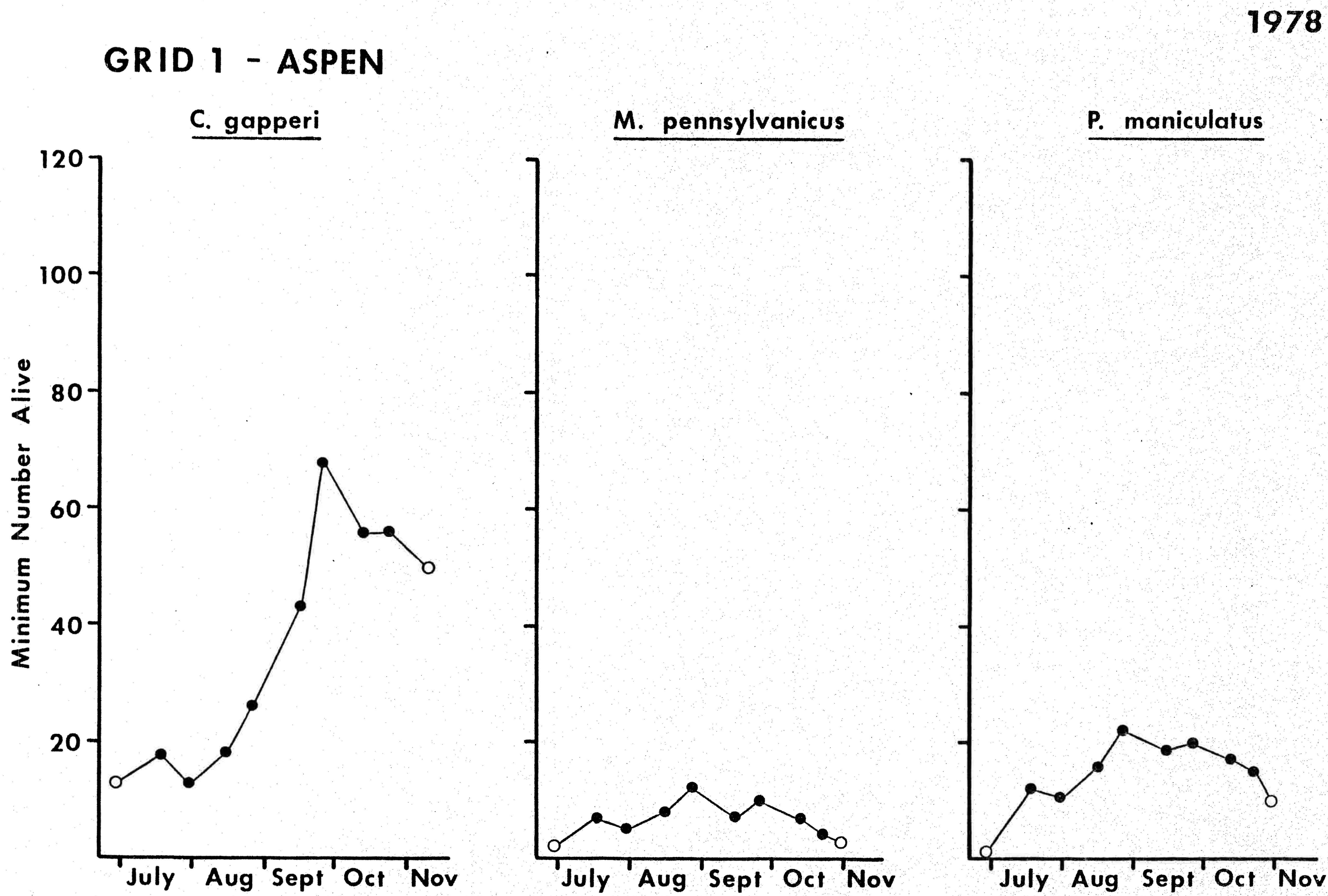

Figure 6. The minimum number (MNA) of the major species of small rodent on the Aspen grid. (The open points indicate that the estimate is based on the number of animals actually captured during that trapping period. Solid points indicate the estimate is based on the MNA.)

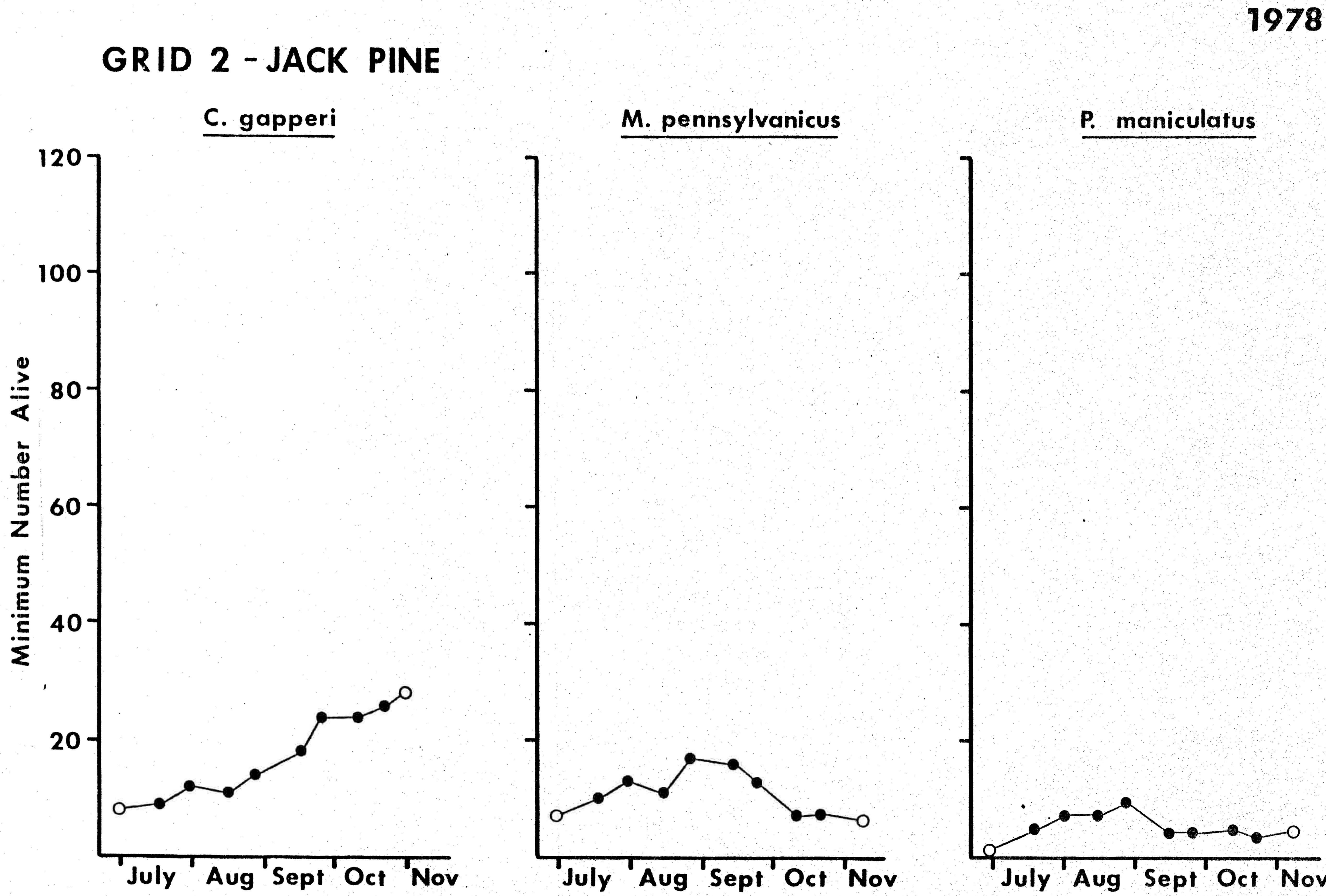

Figure 7. The minimum number (MNA) of the major species of small rodent on the Jack pine grid. (Open points indicate that the estimate is based on the number of animals actually captured during that trapping period. Solid points indicate the estimate is based on the MNA.)

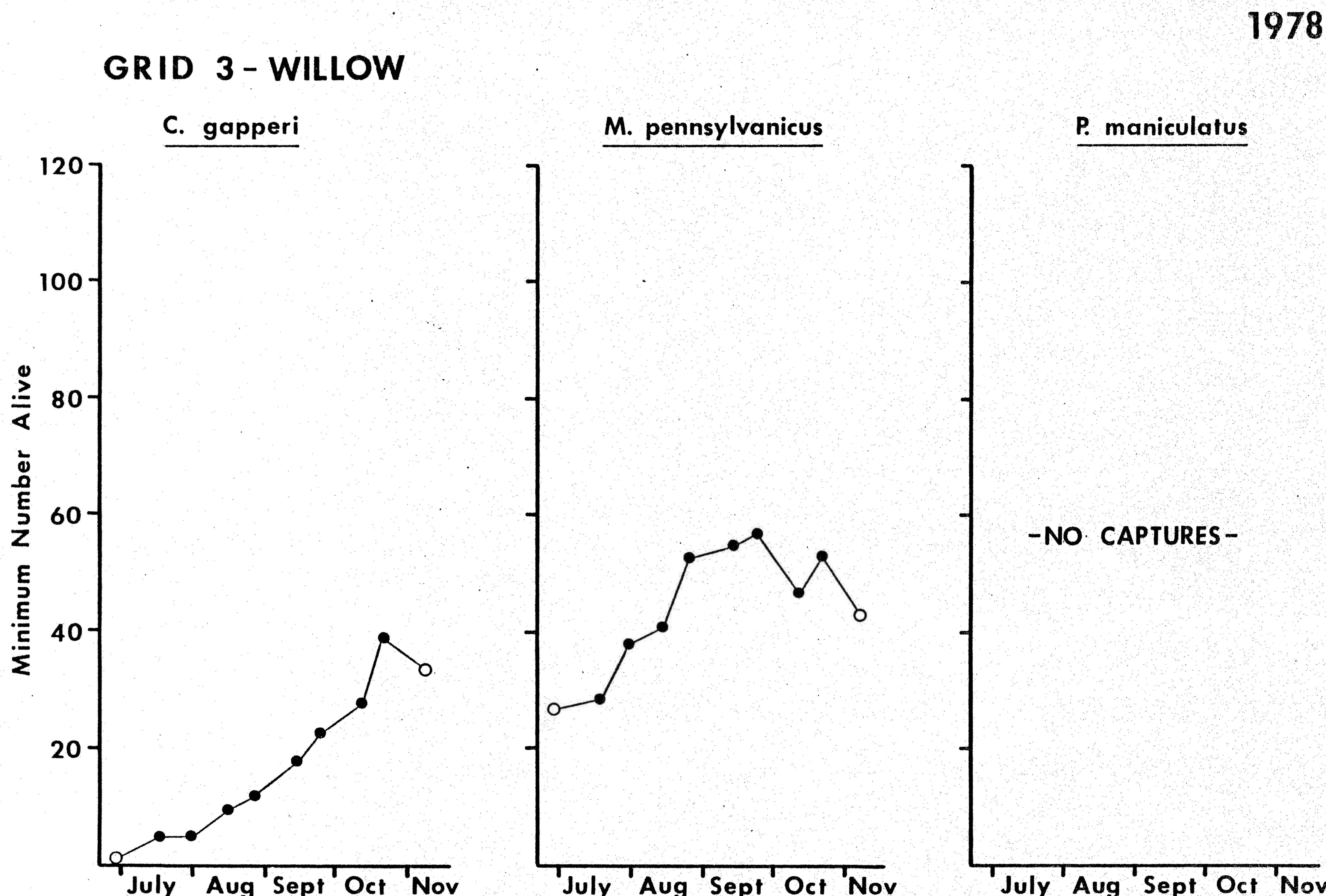

Figure 8. The minimum number (MNA) of the major species of small rodent on the Willow grid. (Open points indicate that the estimate is based on the number of animals actually captured during that trapping period. Soild points indicate the estimate is based on the MNA.)

1978

GRID 4-BALSAM POPLAR

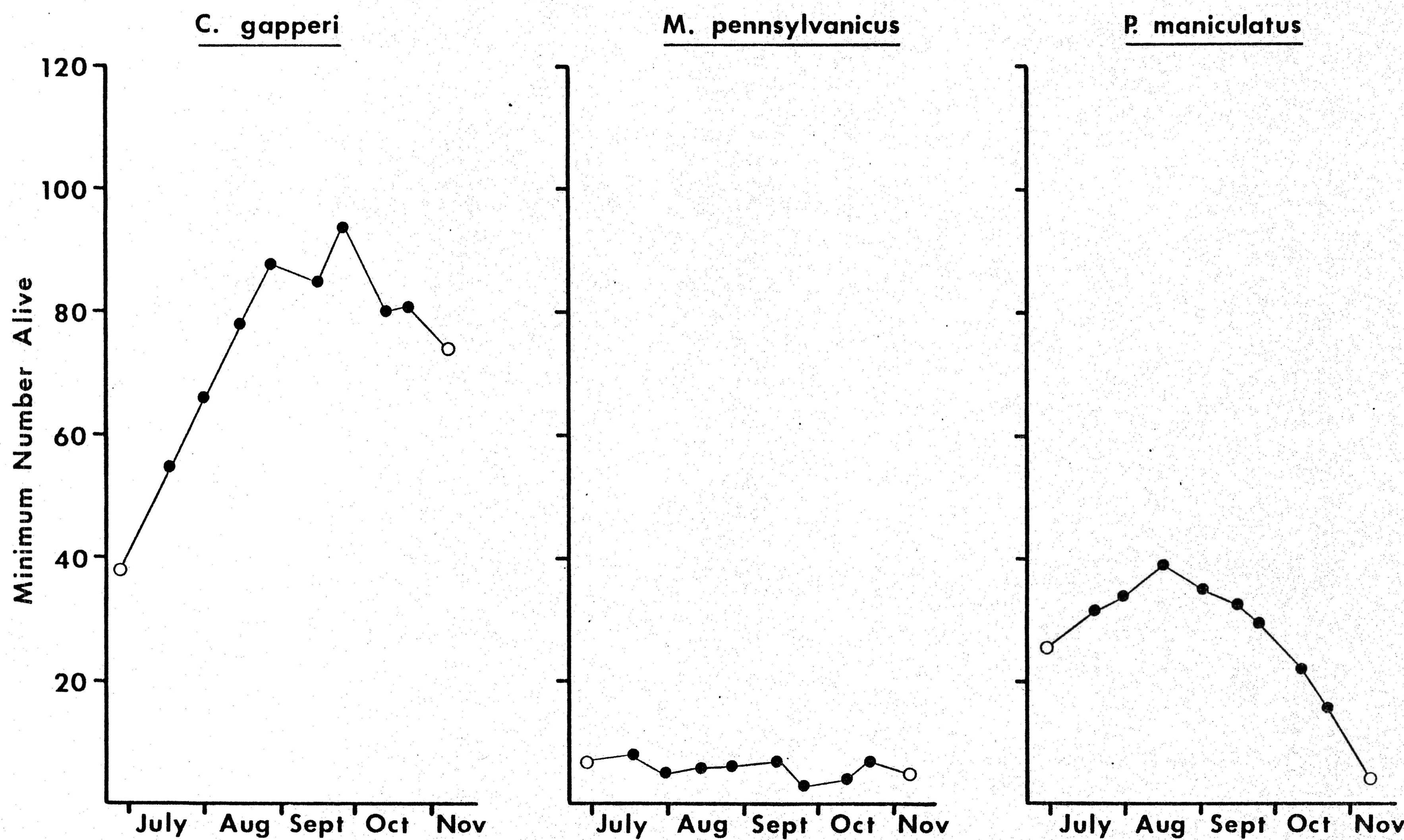

Figure 9. The minimum number (MNA) of the major species of small rodent on the Balsam poplar grid. (Open points indicate that the estimate is based on the number of animals actually captured during that trapping period. Solid points indicate the estimate is based on the MNA.)

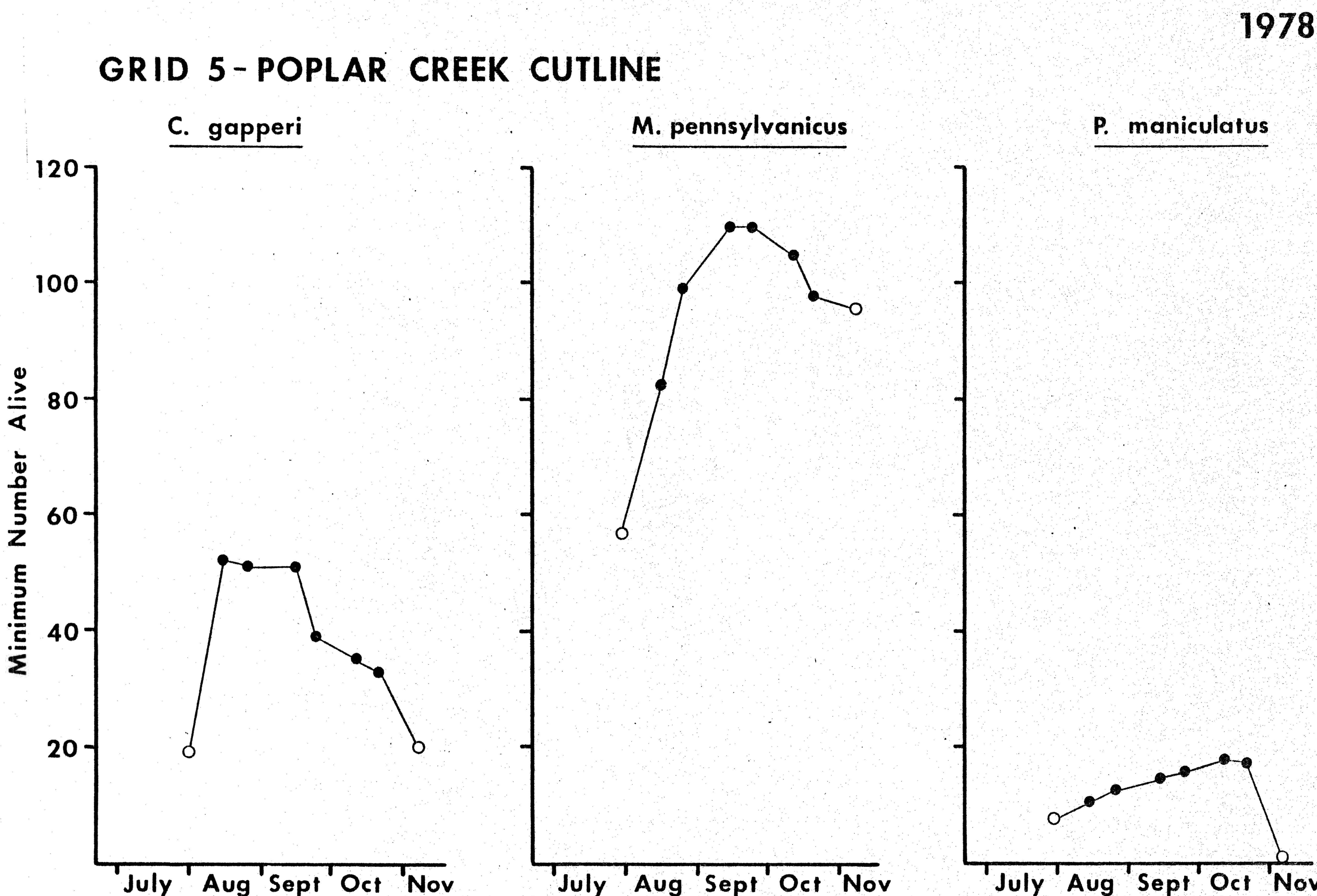

Figure 10. The minimum number (MNA) of the major species of small rodent on the Poplar Creek cutline grid. (Open points indicate that the estimate is based on the number of animals actually captured during that trapping period. Solid points indicate the estimate is based on the MNA.)

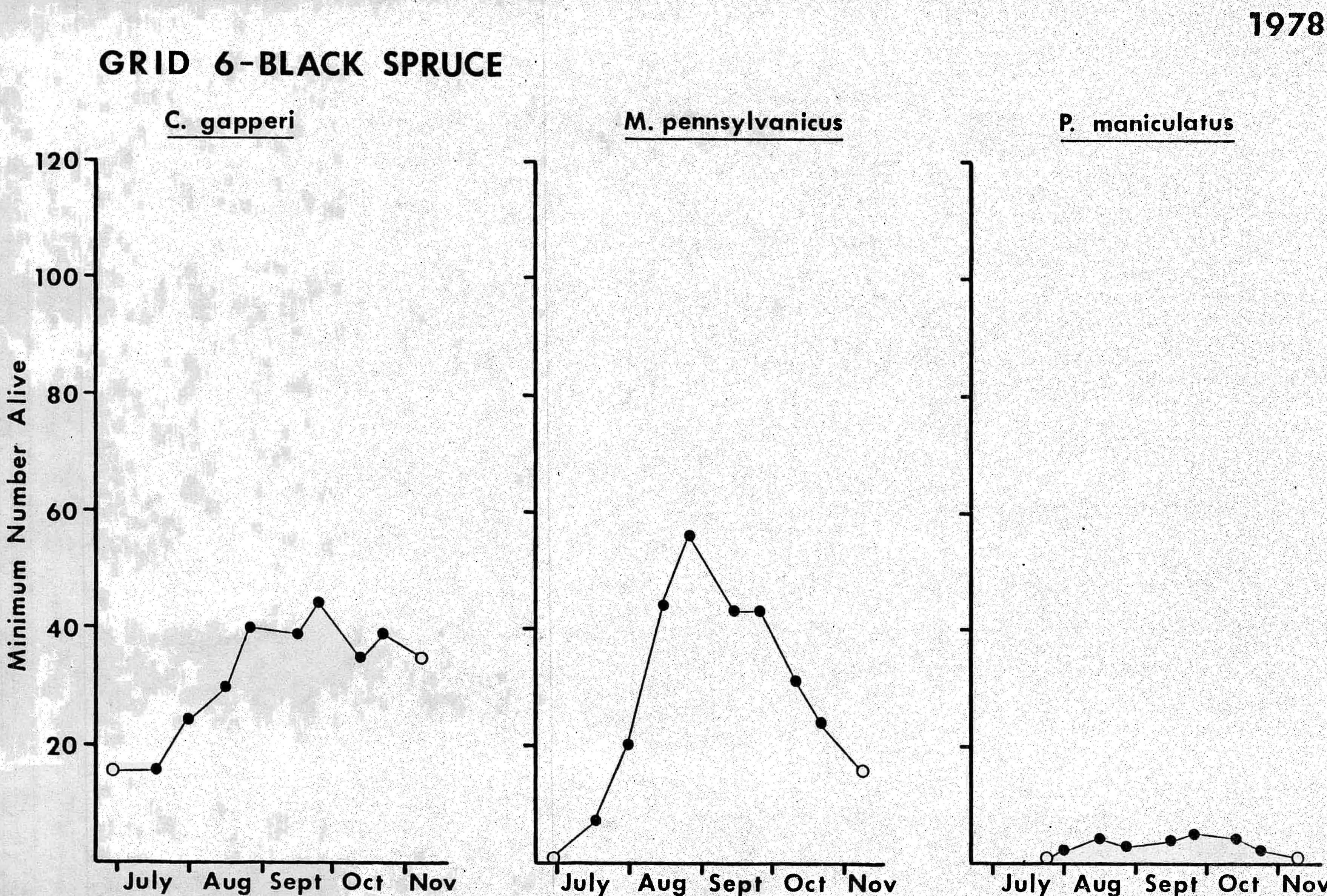

Figure 11. The minimum number (MNA) of the major species of small rodent on the Black spruce grid. (Open points indicate that the estimate is based on the number of animals actually captured during that trapping period. Solid points indicate the estimate is based on the MNA.)

GRID 7 THICKWOODS CUTLINE

1978

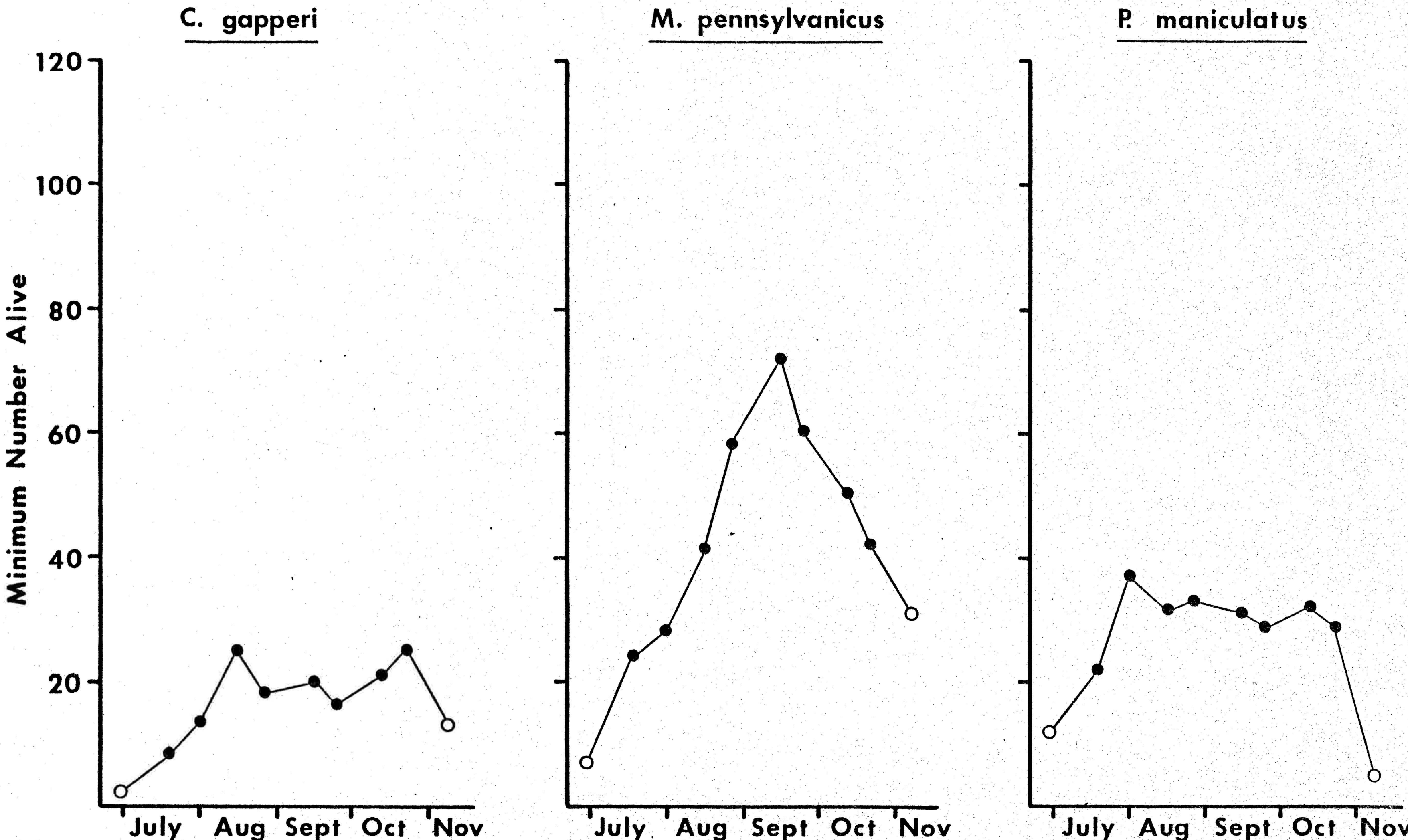

Figure 12. The minimum number (MNA) of the major species of small rodent on the Thickwoods cutline grid. (Open points indicate that the estimate is based on the number of animals actually captured during that trapping period. Solid points indicate the estimate is based on the MNA.)

1978

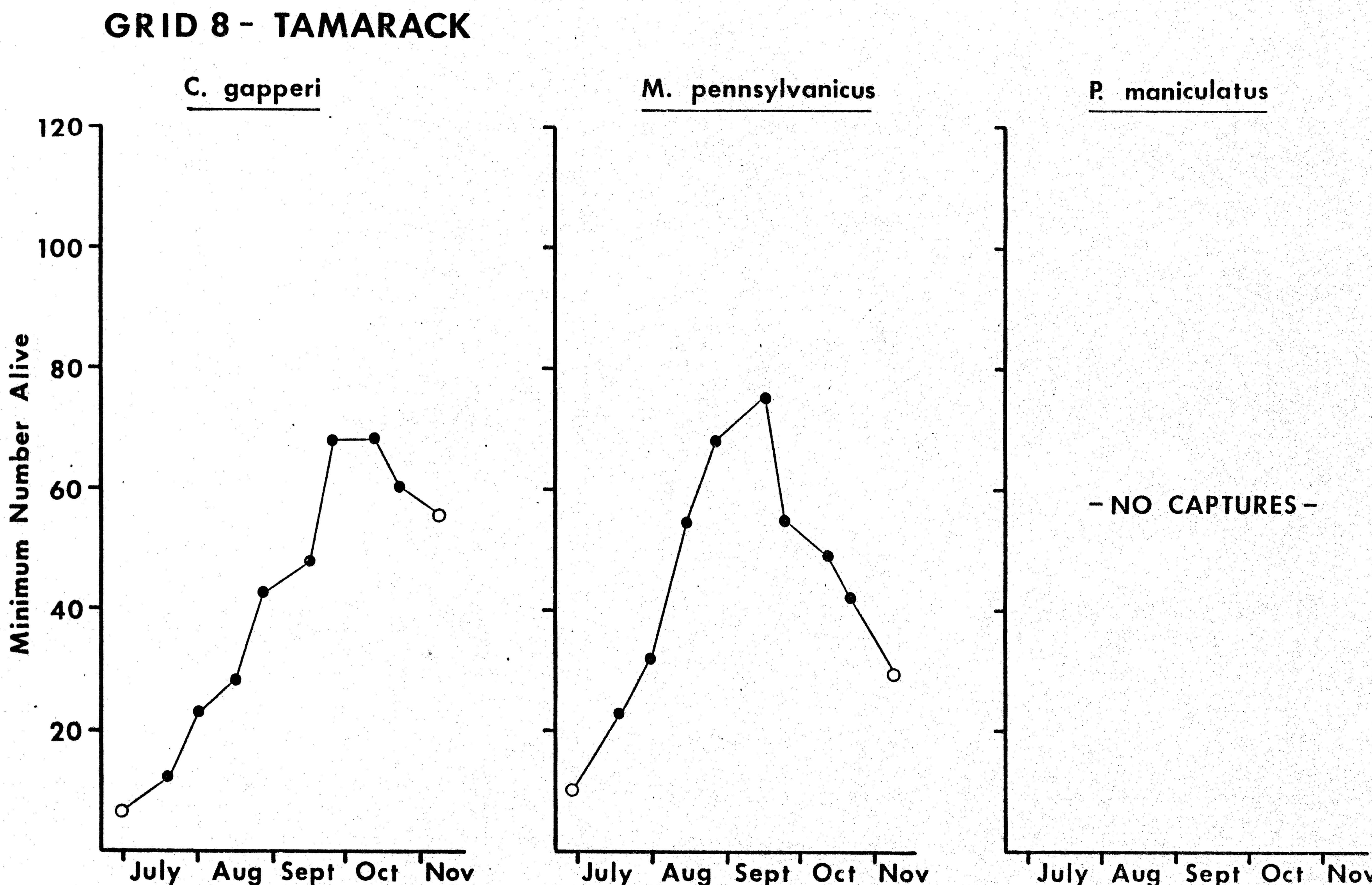

Figure 13. The minimum number (MNA) of the major species of small rodent on the Tamarack grid. (Open points indicate that the estimate is based on the number of animals actually captured during that trapping period. Solid points indicate the estimate is based on the MNA.)

2. *M. pennsylvanicus* was the most abundant species on the Willow, Poplar Creek cutline and Thickwoods cutline grids; it was also abundant on the Black spruce and Tamarack grids. *M. pennsylvanicus* populations reached high numbers on the Poplar Creek cutline, Thickwoods cutline and Tamarack grids.
3. *P. maniculatus* was present in moderate densities on the Balsam poplar and Thickwoods cutline grids. It was never the most abundant species on any grid. No *P. maniculatus* were captured on the Willow or Tamarack grids.
4. *C. gapperi* populations increased gradually throughout the summer and fall on all plots except the Poplar Creek cutline grid. Most populations began to decline in October.
5. *M. pennsylvanicus* populations on the Willow, Poplar Creek cutline, Black spruce, Thickwoods cutline and Tamarack grids increased rapidly until late August to late September, then began to gradually decline. Populations on the Aspen, Jack pine and Balsam poplar grids showed little change in population size throughout the summer.
6. *P. maniculatus* populations were generally small and showed moderate increases in population size until mid-August. Most populations then declined throughout the fall period.

3.1.3 Snap-trap Indices of Population Change

Snap-trap censuses provide crude indices of the population densities of small mammals--however, it is not possible to transform data obtained from linear snap-trap censuses to estimates of density per unit area (Calhoun and Casby 1958; Tanaka 1960; Yang *et al.* 1970).

Mean numbers of animals captured per 100 trap-nights (TN) are shown in Table 4 for four specific geographic areas of the AOSERP study area. Results for other species of small mammals are provided in Appendix 1. The relationship between major habitat types and snap-trap indices of small mammal densities are discussed later in this report.

Indices of small mammal densities show several trends:

1. *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* were most abundant in October and, except for *M. pennsylvanicus*, densities increased gradually over the summer.
2. *C. gapperi* is the most abundant small rodent species in all areas except the Richardson Sand Dunes, where *P. maniculatus* was the most abundant species.

3.1.4 Summary: Population Changes

Estimates of trappability generally exceeded 50% indicating that MNA estimates are acceptable. *C. gapperi* was the most abundant species in most mature forested areas whereas *M. pennsylvanicus* were most abundant in willow scrub and in the two naturally revegetating plots. *P. maniculatus* did not occur in the willow or tamarack areas and was only moderately abundant in the remaining habitats. Most populations of *C. gapperi* and *M. pennsylvanicus* increased throughout July, August and early September, then showed a gradual decline in numbers throughout October and November. Most *P. maniculatus* populations, however, increased slightly during July, then began to decline in August. By late October and November, all *P. maniculatus* populations had declined to low densities.

Table 4. Mean number of animals caught per 100 trap-nights.

Area	Mean Number per 100 Trap-nights					
	July	TN	August	N	October	N
C. gapperi						
Athabasca River Valley	6.06 ± 1.87	1748	10.49 ± 1.93	3231	23.82 ± 3.43	1205
Birch Mountains	2.90 ± 0.70	862	-		-	
Muskeg Mountain	-		3.63 ± 1.33	853	-	
Richardson Sand Dunes	-		-		0.79 ± 0.49[1]	1012
All areas combined	5.02 ± 1.25	2610	9.06 ± 1.63	4084	23.82 ± 3.43	1205
M. pennsylvanicus						
Athabasca River Valley	1.83 ± 0.57	1748	1.30 ± 0.33	3231	2.90 ± 1.26	1205
Birch Mountains	0.12 ± 0.10	862	-		-	
Muskeg Mountain	-		0.0	853	-	
Richardson Sand Dunes	-		-		0.0[1]	1012
All areas combined	12.60 ± 0.40	2610	1.03 ± 0.28	4084	2.90 ± 1.26	1205
P. maniculatus						
Athabasca River Valley	1.54 ± 0.66	1748	1.49 ± 0.47	3231	2.99 ± 1.60	1205
Birch Mountains	0.23 ± 0.22	862	-		-	
Muskeg Mountain	-		0.0	853	-	
Richardson Sand Dunes	-		-		1.38 ± 0.26[1]	1012
All areas combined	1.07 ± 0.44	2610	1.18 ± 0.39	4084	2.99 ± 1.59	1205

[1]Richardson Sand Dunes actually trapped 19-22 September 1978.

3.2 POPULATION STRUCTURE

3.2.1 Determination of Age Classes

The determination of the age structure of a population is an important aspect of any demographic study. Small mammals present a problem, however, in that no reliable techniques are available to accurately age live cricetid rodents from wild populations. In this study, I have used body weight as an index of chronological age (Krebs *et al.* 1969; Keller and Krebs 1970).

Weights at sexual maturity were determined from reproductive and morphological information (together with weights) from autopsied animals. For each of the three main cricetid rodents (*M. pennsylvanicus*, *C. gapperi* and *P. maniculatus*), each sex was grouped into 2 g weight classes. Weights of pregnant females were corrected by subtracting the weight of the uterus and embryos from the total body weight. Males were considered mature if their testes were scrotal and their epididymus tubules were visible to the naked eye (Hamilton 1941; Jameson 1950). Because the breeding condition of male cricetid rodents varies seasonally, only males captured in July and August were included in the analysis. Females were considered mature if their nipples were enlarged, if their uterus was swollen, if placental scars were visible or if embryos were present. Some indicators of female breeding condition (lactation, pregnancy) also vary with season, but other indices of maturity (placental scars, uterus size) can be used to determine maturity throughout the year. All females captured and autopsied were included in the analysis.

I recognized three age classes; juveniles, sub-adults and adults. The juvenile age class included the lower weight classes in which no animals were sexually mature. The weight division for sub-adults and adults was more complex and was determined on the basis of two criteria. Generally the adult age class was defined as the upper weight classes in which 50% or more of the animals were sexually mature. If there was some doubt using the above definition, the median weight at sexual maturity (calculated using the techniques of Leslie *et al.* [1945] was also employed). The weight class falling mid-way between the weight at which 50% of the animals were mature and the median body weight was then used as the weight division between sub-adults and adults.

Weight distributions and median weights for male and female *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* are shown in Figures 14, 15 and 16 respectively. Except for *C. gapperi*, there were an insufficient number of breeding males to determine weight at sexual maturity (regressions for calculation of median weights at sexual maturity were indeterminate). As a result samples for both females and males were combined and a single weight division for age classifications was calculated. The weight divisions for juvenile, sub-adult and adult weight classes in *M. pennsylvanicus*, *C. gapperi* and *P. maniculatus* derived by these methods are given in Table 5.

3.2.2 Age Distributions

Age distributions reflect the intrinsic rate of increase of a population (Cole 1954). Increasing populations are commonly characterized by a predominance of younger age classes while stable or declining populations are not (Krebs 1978).

3.2.2.1 Live-trapping Areas. The age distribution for each species on each of the live-trapping grids was derived using the above-described weight divisions for age class determinations. Because age classifications are based on body weight, only those animals captured and weighed during each live-trapping period are included in the analysis for that period. Age distributions for each bi-weekly trapping period for *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* on each of the six natural habitat plots and the two naturally-revegetating plots are provided in Appendices 2-9; representative age distributions for each species are shown in Figures 17, 18 and 19.

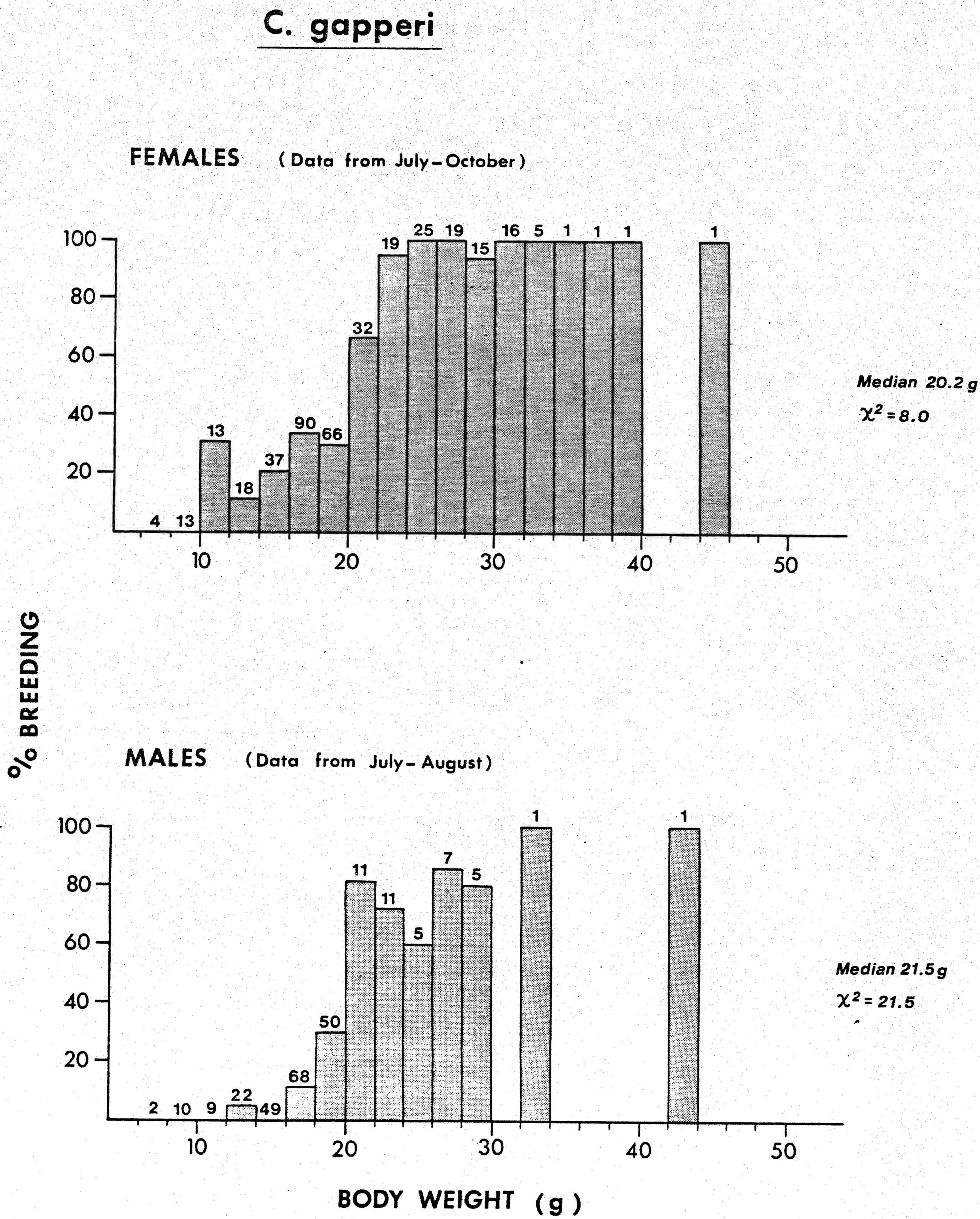

Figure 14. Proportions of male and female *C. gapperi* that were sexually mature. (Based on animals captured on all snap-trap census lines in natural habitats, July-October 1978).

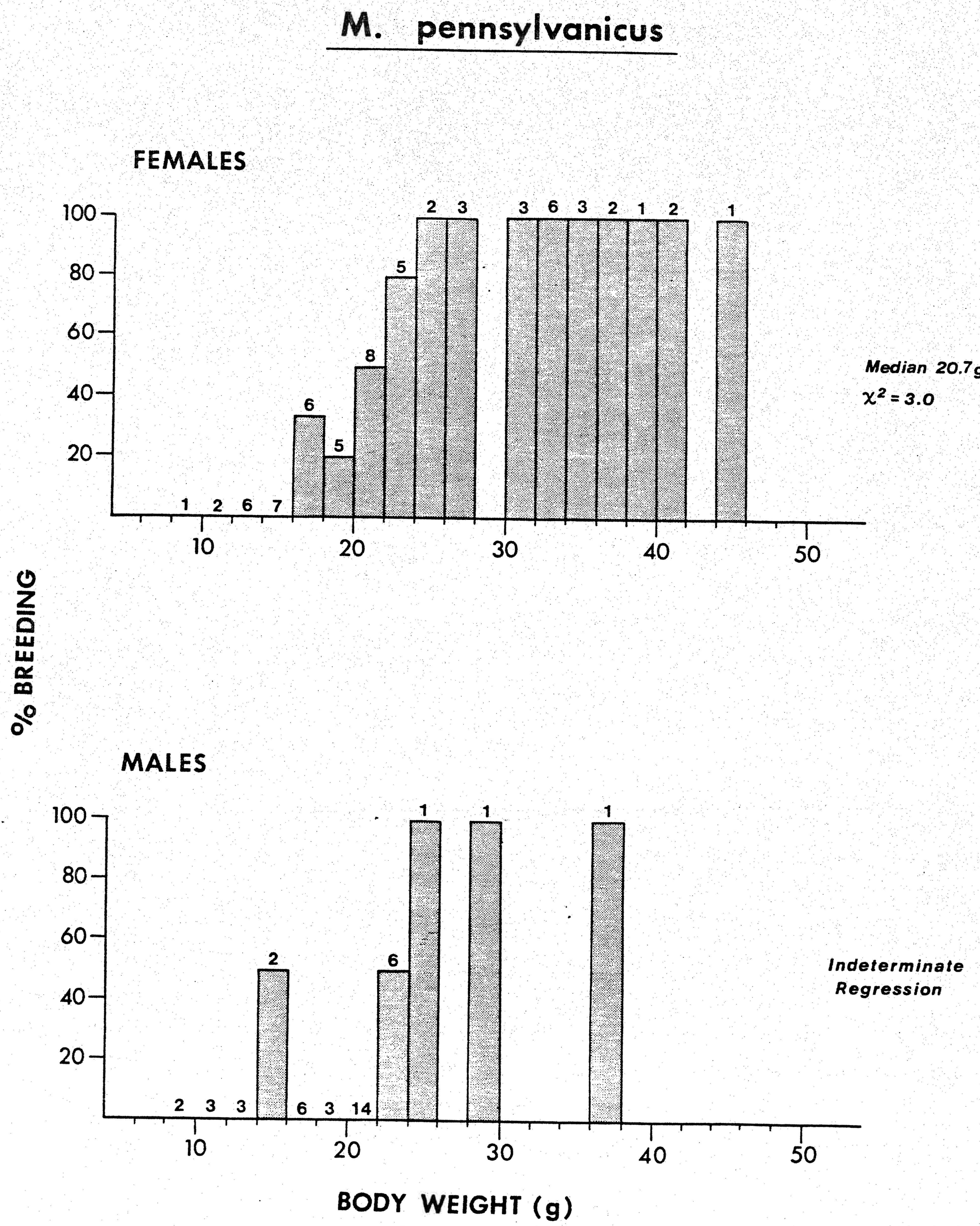

Figure 15. Proportions of male and female *M. pennsylvanicus* that were sexually mature. (Based on animals captured on all snap-trap census lines in natural habitats, July-October 1978.)

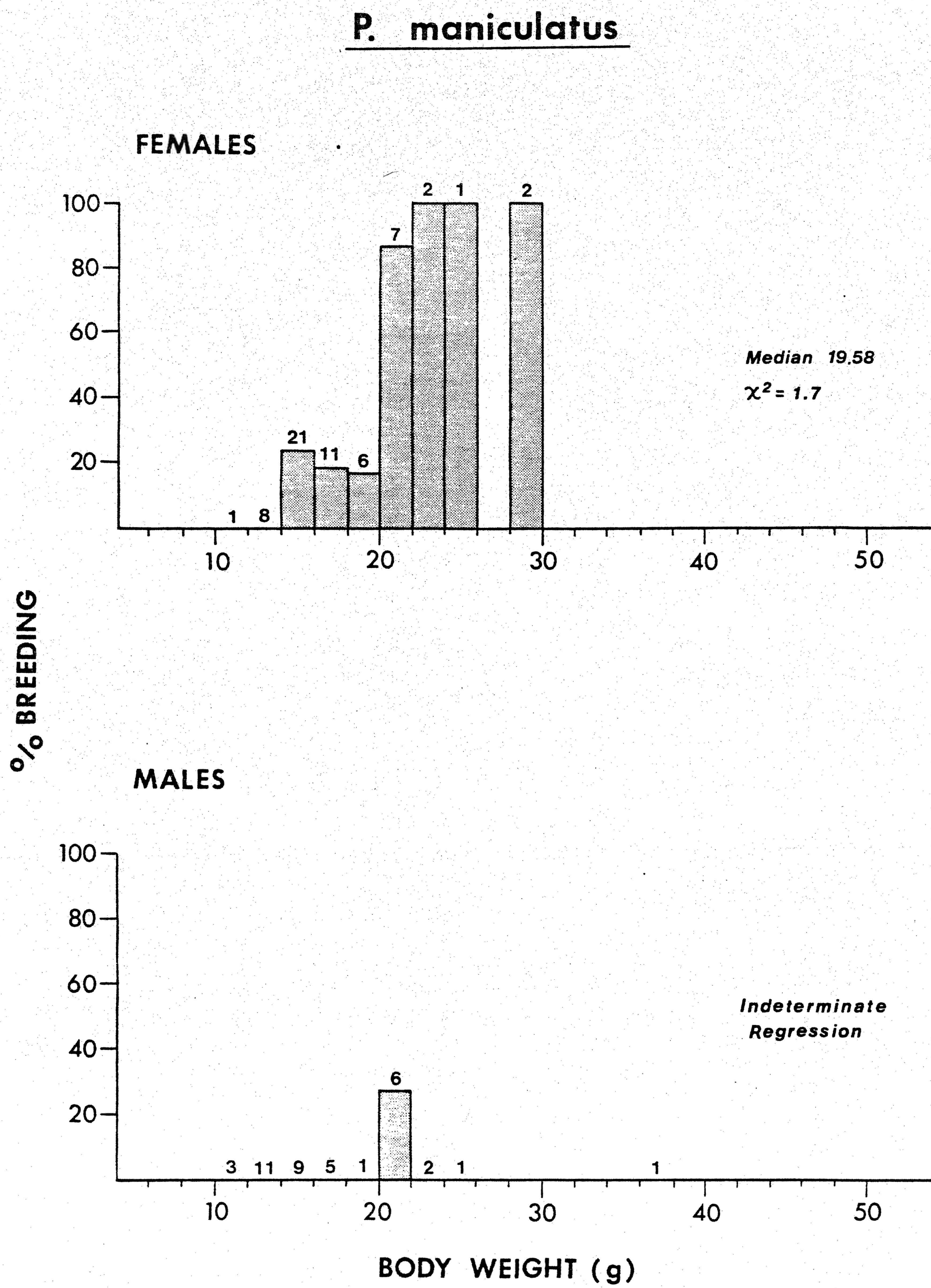

Figure 16. Proportions of male and female *P. maniculatus* that were sexually mature. (Based on animals captured on all snap-trap census lines in natural habitats, July-October 1978.)

Table 5. Weight divisions for the determination of age classes (based on weight distributions and median weights at sexual maturity). (Median weights of females at sexual maturity are based on data from July to October; median weights of males at sexual maturity are based on data from July and August. Weight divisions are based on the combined data sets for males [July to August] and females [July to October].)

	Weight Divisions			Median Weight at Sexual Maturity			
	Juveniles	Sub-Adults	Adults		N	Wt.	χ^2
C. gapperi	$\leq$ 10 g	10 g<wt.$\leq$20 g	> 20 g	F[1]	386	20.2 g	7.96[2]
				M	251	21.5 g	11.32
M. pennsylvanicus	$\leq$ 16 g	16 g<wt.$\leq$20 g	> 20 g	F	63	20.7 g	3.00
				M	42	22.2 g	0.73
P. maniculatus	$\leq$ 14 g	14 g<wt.$\leq$20 g	> 20 g	F	59	19.6 g	0.67
				M	39	-[3]	-

[1]M: males
F: females

[2]χ^2 value for a chi-square test of goodness of fit of the regression line to the data.

[3]No stable regression was obtained for males.

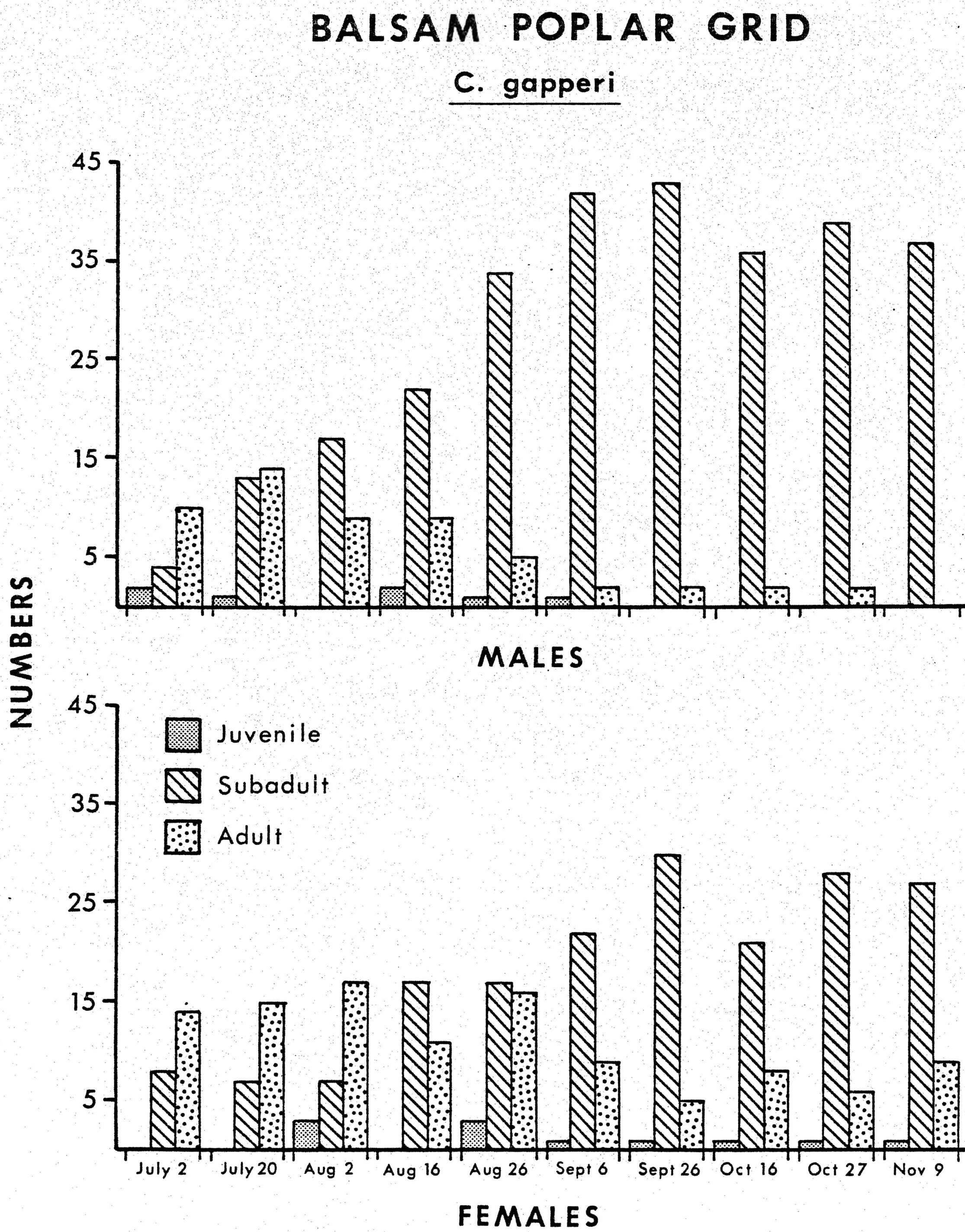

Figure 17. Age distribution of male and female *C. gapperi* on the Balsam poplar grid.

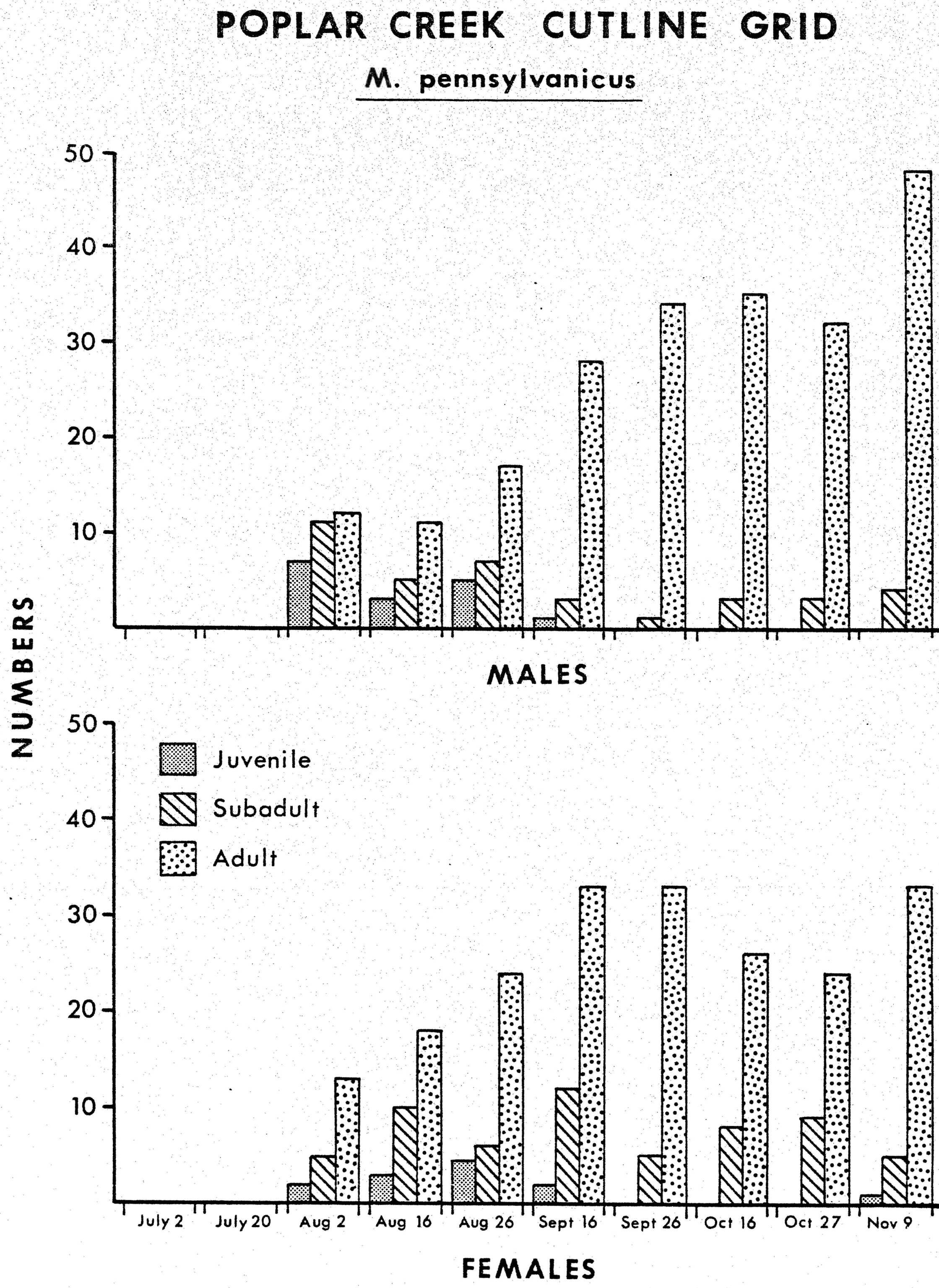

Figure 18. Age distribution of male and female *M. pennsylvanicus* on the Poplar Creek cutline grid.

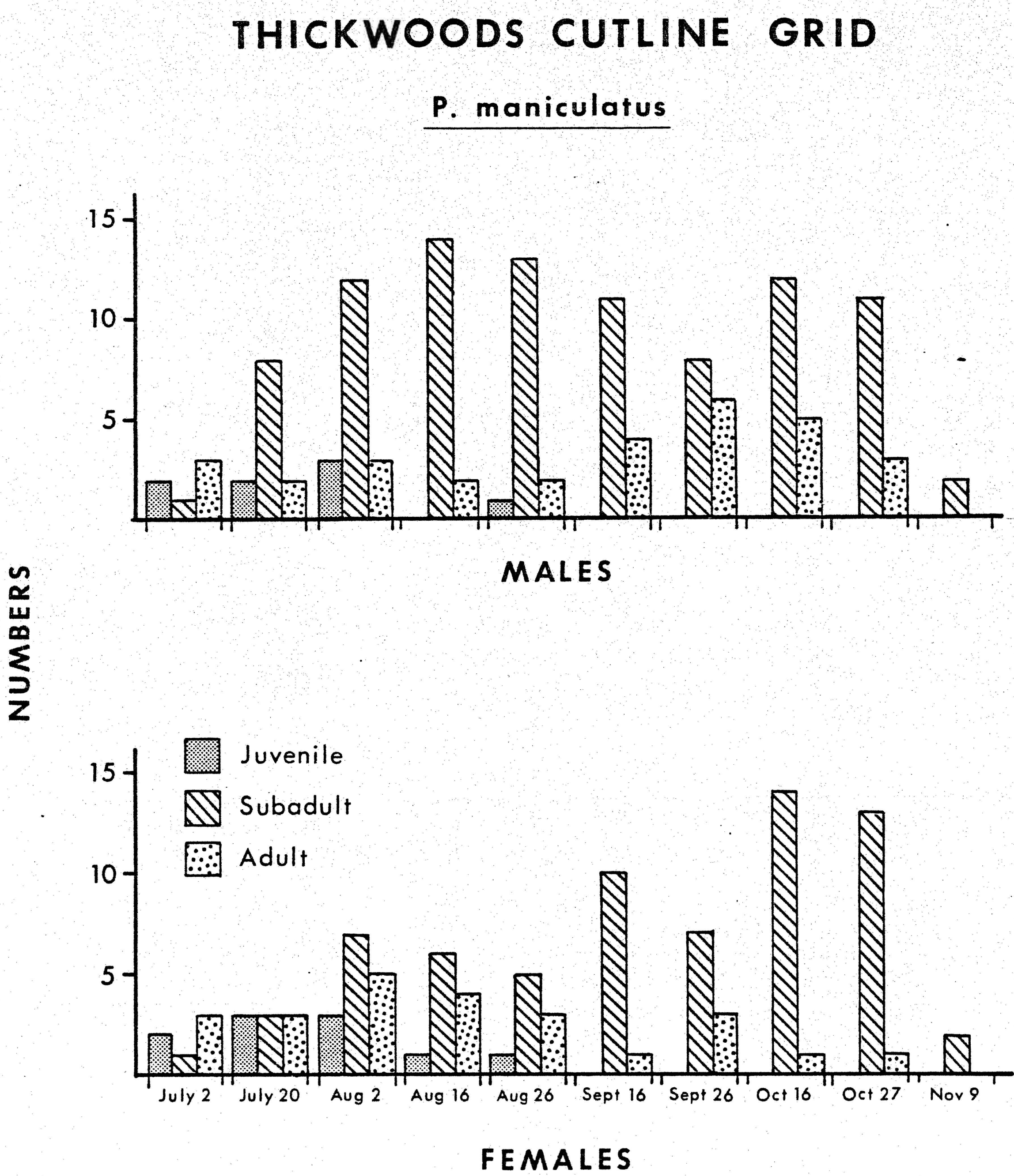

Figure 19. Age distribution of male and female *P.maniculatus* on the Thickwoods cutline grid.

C. gapperi populations in all areas showed similar trends in age distributions. Very few juvenile animals were captured during the trapping program (Figure 17). Sub-adult animals were moderately abundant in the early summer but gradually increased in number throughout the summer and fall periods until most of the population in October and November was comprised of sub-adults. Adults were most abundant in July and gradually disappeared from the population throughout the fall period.

Trends in age distributions of *M. pennsylvanicus* were similar on the Poplar Creek cutline, Black spruce, Thickwoods cutline and Tamarack grids. Juvenile animals were generally present in low numbers in July-early September (Figure 18). The number of sub-adults increased slightly over the summer and showed little change or slight decreases in the fall. Adults, however, became increasingly more common throughout the summer and fall and dominated most populations in the fall period. The *M. pennsylvanicus* population on the Aspen and Jack pine grids, however, showed very mixed age distributions throughout the summer and fall. The *M. pennsylvanicus* population on the Willow grid was made up of a moderate number of juveniles throughout the summer-fall period. Sub-adult animals became gradually more abundant until late September. The numbers of adult animals tended to vary slightly during the July-November period but showed no consistent increasing or decreasing trend.

P. maniculatus populations were consistently composed largely of sub-adult animals. The number of sub-adult animals generally increased until late August to early September (Figure 19). Overall few juveniles were captured--in most cases, the few juveniles captured were trapped in July and August (exceptions to this were the continued presence of juvenile deer mice on the Aspen grid until November and on the Balsam poplar grid until late September). Adult deer mice were present in low numbers in all populations during the summer and fall periods.

3.2.2.2 Snap-trapping Areas. The age distributions of *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* captured during the snap-trap censuses in natural areas (July-October 1978) were determined using the above-described weight divisions. The proportions of juvenile, sub-adult and adult males and females captured are shown in Table 6. Most *C. gapperi* were sub-adults. Very few of the *C. gapperi* captured were juveniles. Most *M. pennsylvanicus* captured were adults but moderate numbers of juveniles and sub-adults were also captured. Close to two thirds of the *P. maniculatus* captured were sub-adults. Few juvenile deer mice were captured, most of the remaining *P. maniculatus* were adults.

3.2.3 Sex Ratio

Changes in sex ratios are an important factor of population structure because shifts in sex ratios can affect the potential reproductive rate of a population (Wilson 1975). Changes in sex ratios may also influence social interactions that are involved in population regulation.

3.2.3.1 Live-trapping areas. Sex ratios, expressed as the proportion of the total population (MNA) that is male, were calculated for each species in each trapping period within each area. Sex ratios for *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* on each of the plots in the six natural vegetation types are shown in Figures 20, 21 and 22 respectively. Sex ratios for each of these species on the two naturally revegetating areas are shown in Figure 23. In all cases, sex ratios were not significantly different from 0.5.

3.2.3.2 Snap-trapping areas. Sex ratios for *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* were calculated based on the total number of males captured in all snap-trap censuses in natural habitats--sex ratios of 0.52 (N=787), 0.53 (N=133) and 0.54 (N=129) respectively were obtained. None of these ratios was significantly different from 0.5.

Table 6. Age distributions of animals captured during snap-trap censuses. (Based on the total number of animals captured during all snap-trap censuses in natural areas; July-October 1978.)

Species	Sex	Proportion of Juveniles	Proportion of Sub-adults	Proportion of Adults	N
C. gapperi	Male	0.032	0.791	0.17	411
	Female	0.045	0.596	0.359	376
M. pennsylvanicus	Male	0.186	0.228	0.586	70
	Female	0.254	0.175	0.571	63
P. maniculatus	Male	0.057	0.614	0.329	70
	Female	0.153	0.644	0.203	59

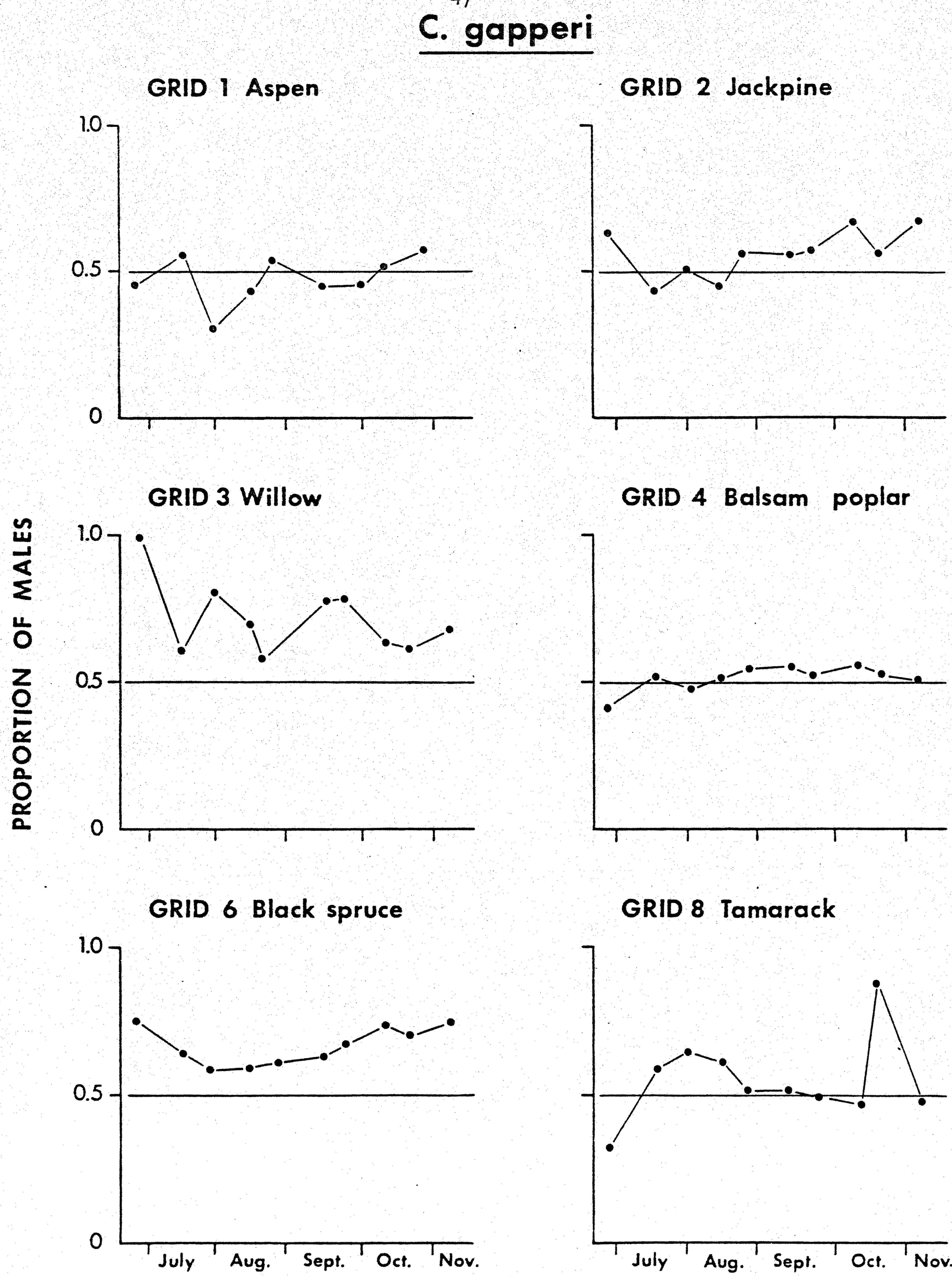

Figure 20. Sex ratios of *C. gapperi*. (Sex ratios are expressed as the proportion of the population that is male.

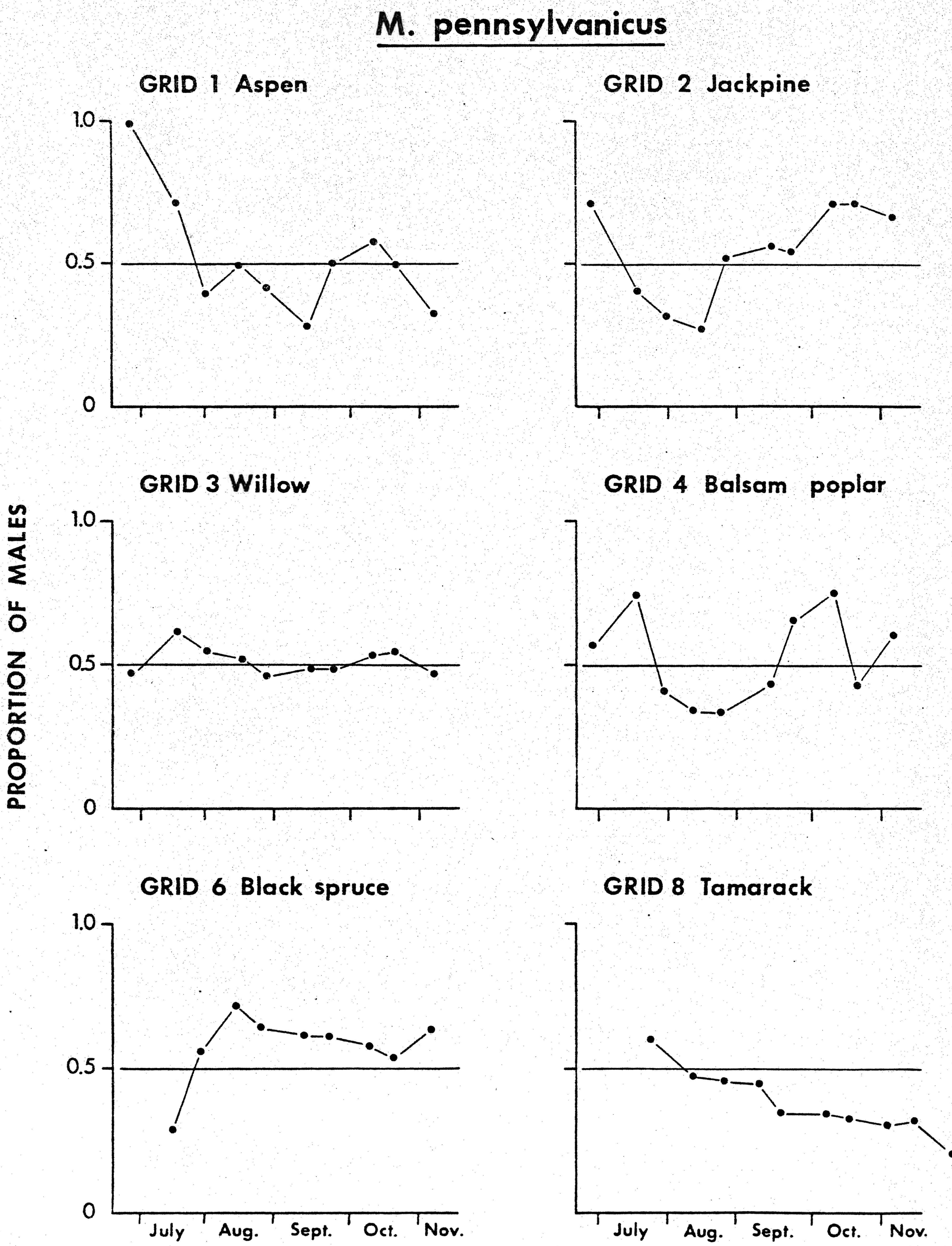

Figure 21. Sex ratios of *M. pennsylvanicus*. (Sex ratios are expressed as the proportion of the population that is male.)

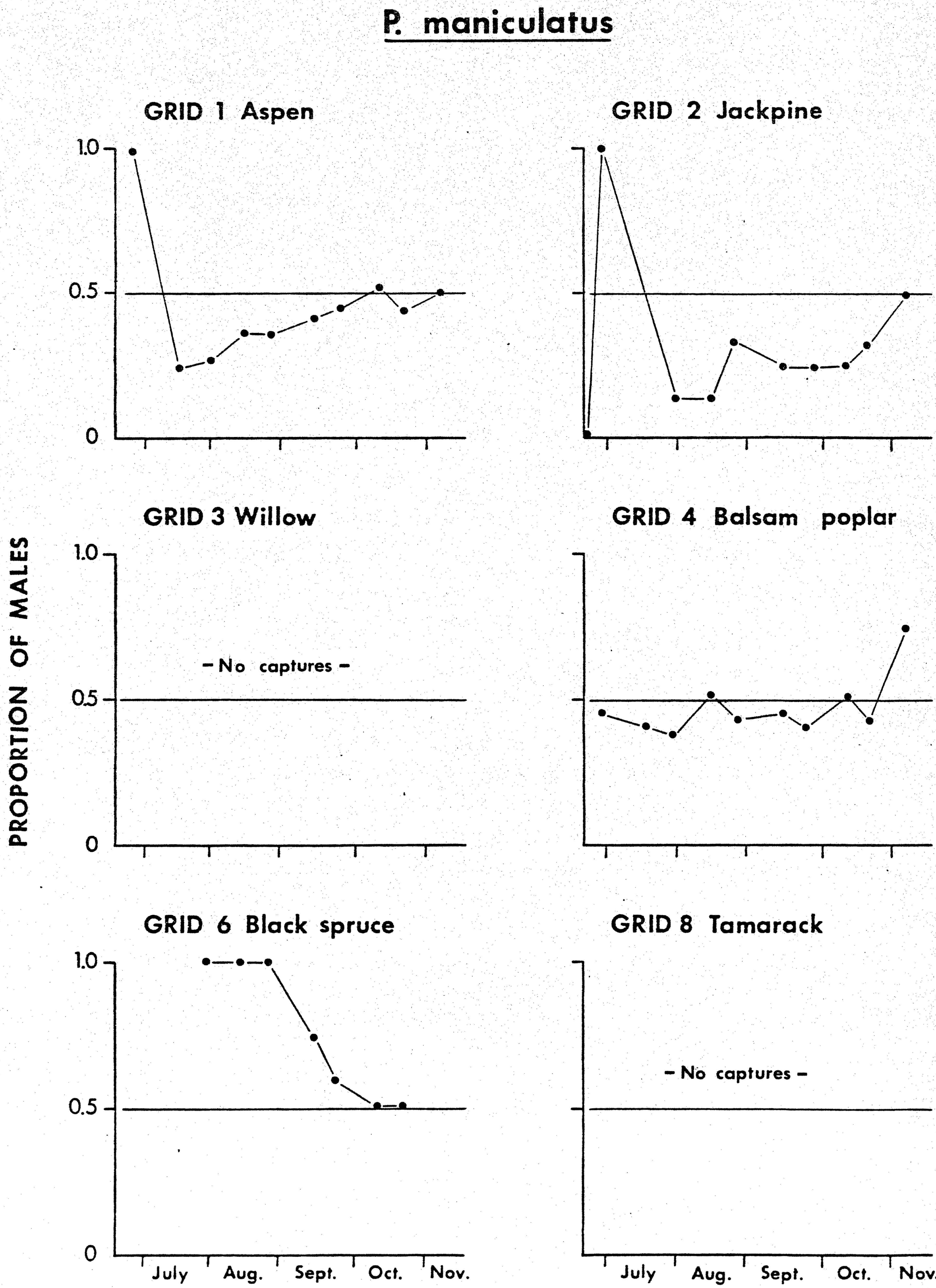

Figure 22. Sex ratios of *P. maniculatus*. (Sex ratios are expressed as the proportion of the total population that is male.)

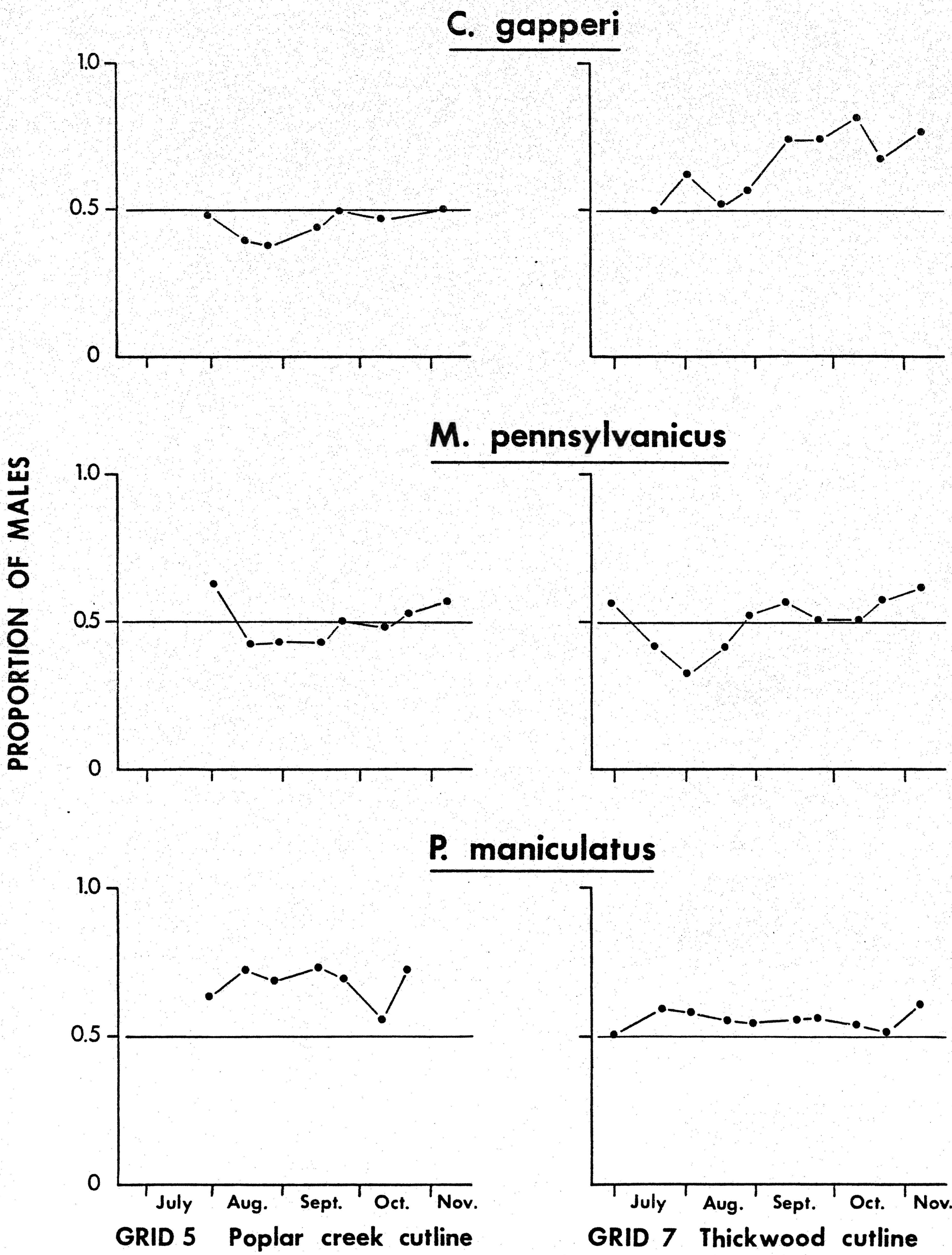

Figure 23. Sex ratios of *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* on the two naturally-revegetating plots. (Sex ratios are expressed as the proportion of the total population that is male.)

3.2.4 Summary: Population Structure

Two aspects of population structure (age distributions and sex ratios) have been examined. Weight divisions for defining age classes in *C. gapperi, M. pennsylvanicus* and *P. maniculatus* were determined on the basis of the proportion of animals in each weight class (captured in snap-trap censuses) that were sexually mature. *C. gapperi* and *P. maniculatus* populations tended to be comprised largely of sub-adult animals. However, a predominance of adults in *M. pennsylvanicus* populations was noted in four of the eight trapping areas. Few juvenile animals of any species were captured in the summer or fall. Sex ratios did not deviate significantly from 0.5.

3.3 REPRODUCTION

Reproductive information for each of the three major small mammal species on the reclamation sites was assessed using both autopsy information from snap-trapped animals and information based on external indices of reproduction that was gathered during live-trapping. In this report I will limit the discussion of reproduction to breeding condition, pregnancy rates, and litter sizes.

3.3.1 Breeding Condition: Live-trapping Areas

Male animals captured on live-trapping plots were considered to be in breeding condition if their testes were scrotal. Females were considered to be in breeding condition if the vagina was obviously perforate, if the nipples were enlarged, and/or if the pubic symphysis was open (the pubic symphysis opening could not be accurately judged in *P. maniculatus*). The weighted mean proportions of male and female animals of each species that were in breeding condition on the eight study plots are shown in Table 7. The proportions of male and female animals that were in breeding condition in each trapping period on the eight study plots are provided in Appendices 10-17.

Most adult male *C. gapperi* were in breeding condition in July and August. By mid-September, most adult male *C. gapperi* had

Table 7. Weighted mean proportion of adult and sub-adult males and females in breeding condition. (Bi-weekly weighted means are shown for *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* on all eight study areas. Total sample sizes are shown for each bi-weekly trapping period.)

Species	Class	2 July		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.	
		Prop.[1]	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N
C. gapperi	Adult males	0.95	21	0.80	30	1.00	22	0.88	26	0.94	16	0.27	11	0.23	13	0.08	12	0.00	10	0.00	6
	Sub-adult males	0.71	7	0.62	21	0.19	53	0.03	76	0.07	107	0.02	148	0.00	170	0.00	159	0.00	172	0.00	171
	Adult females	0.89	18	0.70	30	0.83	42	0.79	43	0.83	42	0.81	31	0.57	23	0.22	27	0.26	19	0.07	14
	Sub-adult females	0.62	21	0.46	13	0.30	20	0.09	55	0.06	65	0.07	94	0.06	117	0.01	112	0.01	133	0.01	113
M. pennsylvanicus	Adult males	0.94	35	0.91	33	0.78	41	0.71	49	0.59	61	0.20	82	0.07	98	0.01	70	0.00	64	0.00	69
	Sub-adult males	1.00	1	0.50	16	0.16	32	0.05	37	0.02	52	0.00	49	0.06	33	0.00	34	0.00	46	0.00	40
	Adult females	0.68	22	0.68	45	0.80	64	0.79	76	0.66	91	0.52	81	0.40	84	0.05	60	0.02	48	0.02	57
	Sub-adult females	0.00	1	0.00	1	0.09	11	0.00	20	0.00	50	0.00	52	0.00	47	0.00	40	0.00	47	0.00	36
P. maniculatus	Adult males	1.00	6	0.80	5	0.50	6	0.00	5	0.11	9	0.00	11	0.07	15	0.00	17	0.00	14	0.00	6
	Sub-adult males	0.00	8	0.18	17	0.15	27	0.03	38	0.00	36	0.00	39	0.00	29	0.00	25	0.00	25	0.00	7
	Adult females	0.43	7	0.71	7	1.00	5	0.38	8	0.17	6	0.50	2	0.25	4	0.00	1	0.00	1	-	0
	Sub-adult females	0.07	14	0.04	23	0.10	29	0.00	21	0.03	31	0.00	26	0.00	30	0.04	28	0.06	33	0.00	7

[1] Prop. = Weighted mean proportion in breeding condition.

regressing testes and by late October, no adult males were in breeding condition. Except in July, most sub-adult males were not reproductively active. A high proportion of adult female *C. gapperi* were reproductively active until mid-September--breeding activity then declined slowly through the fall period. Most sub-adult females also were not reproductively active.

Most adult male *M. pennsylvanicus* were in breeding condition in July. Adult male breeding activity began to decline in August and, by late September, very few adult males were reproductively active. Most sub-adult male *M. pennsylvanicus* were not in breeding condition. Adult female breeding activity was moderate in July and August (only 66-80% of the adult females captured were in breeding condition) and most adult females had ceased breeding by early October. Breeding activity of sub-adult female *M. pennsylvanicus* was very limited (one breeding sub-adult female was captured on the Poplar Creek cutline grid in early August.

Adult male *P. maniculatus* were reproductively active in July; by mid-August most had regressing testes. Almost all sub-adult males were non-breeding animals. Adult female *P. maniculatus* also were in breeding condition in July but by mid-August most were reproductively inactive. Very few breeding sub-adult female deer mice were captured in the summer or fall periods.

3.3.2 Breeding Condition: Snap-trapping Areas

Male animals captured in snap-trap censuses were considered to be in breeding condition if epididymus tubules were visible to the naked eye. Females were considered to be in breeding condition if the vagina was perforate, if nipples were enlarged and/or if embryos were visible in the uterus. For each species, the proportion of sub-adult and adult males and females that were in breeding condition in each monthly period are shown in Table 8.

Similar seasonal trends in the reproductive activity of male *C. gapperi, M. pennsylvanicus* and *P. maniculatus* were observed.

Table 8. Proportion of males and females captured in snap-trap censuses that were in breeding condition.

Species	Area	Males[1]						Females[2]					
		July		August		October		July		August		October	
		P[3]	N[4]	P	N	P	N	P[1]	N[2]	P	N	P	N
C. gapperi	Athabasca Valley	0.37	63	0.08	154	.03	158	0.50	44	0.38	133	0.79	175
	Birch Mountains	0.42	12	-	-	-	-	0.56	9	-	-	-	-
	Muskeg Mountain	-	-	0.71	21	-	-	-	-	0.60	10	-	-
	All Areas	0.37	75	0.16	175	.03	158	0.51	53	0.40	143	0.79	175
M. pennsylvanicus	Athabasca Valley	0.28	18	0.09	22	.04	23	0.62	13	0.36	22	0.33	24
	Birch Mountains	0.50	2	-	-	-	-	1.00	1	-	-	-	-
	Muskeg Mountain	-	-	-	0	-	-	-	-	-	0	-	-
	All Areas	0.30	20	0.09	22	.04	23	0.64	14	0.36	22	0.33	24
P. maniculatus	Athabasca Valley	0.19	16	0.00	23	0.00	28	0.10	10	0.21	19	0.19	27
	Birch Mountains	0.00	1	-	-	-	-	0.50	2	-	-	-	-
	Muskeg Mountain	-	-	-	0	-	-	-	-	-	0	-	-
	All Areas	0.18	17	0.00	23	0.00	28	0.17	12	0.21	19	0.19	27

[1] Males were termed breeding if epididymus tubules were visible.

[2] Females were termed breeding if embryos were visible, if vagina was perforate and/or if nipples were enlarged.

[3] Proportion of the total number of sub-adult and adult animals in breeding condition.

[4] Total number of sub-adult and adult animals captured in that period.

Moderate to low proportions of males were breeding in July but by August breeding activity had declined to low levels. By October, most males were no longer reproductively active. Notably, a high proportion of *C. gapperi* captured at Muskeg Mountain were in breeding condition.

Moderate proportions of female *C. gapperi* and *M. pennsylvanicus* were reproductively active in July whereas relatively few *P. maniculatus* were breeding during this period. Reproductive activity remained high in *C. gapperi* but declined in *M. pennsylvanicus*. Breeding activity of female *P. maniculatus* changed little over the period of the census.

3.3.3 Pregnancy Rates

Pregnancy rates are an important index of reproductive condition in polyestrous mammals such as microtine and cricetine rodents. Bi-weekly pregnancy rates were calculated for the three major small rodent species on the live-trapping areas, based on the proportion of sub-adult and adult females captured that were obviously pregnant (i.e., obvious abdominal swelling). Pregnancy rates for each species captured during the snap-trap census were also calculated based on the presence of visible embryos in the uterus.

Bi-weekly pregnancy rates for *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* on the eight study areas are shown in Table 9. Pregnancy rates were generally low in all species in July to August. No pregnant females were captured on any grid in September to November. Few *C. gapperi* were pregnant except on the Jack pine grid, Balsam poplar and Poplar Creek cutline grids. Low to moderate proportions of *M. pennsylvanicus* were pregnant on all grids except the Aspen and Jack pine grid. Pregnant *P. maniculatus* were captured only on the Thickwoods cutline in July.

Pregnancy rates of females captured in the snap-trap censuses and later autopsied are provided in Table 10. Pregnancy rates of these animals generally were, of course, higher than the rates

Table 9. Bi-weekly pregnancy rates. (No pregnant females were captured in the September to November period.)

Grid	Species	2 July[1]		20 July		2 Aug.		16 Aug.		28 Aug.	
		P[2]	N[3]	P	N	P	N	P	N	P	N
Aspen	*C. gapperi*	0.00	7	0.00	6	0.00	8	0.14	7	0.33	9
	M. pennsylvanicus	-	0	0.00	2	0.00	3	-	0	0.00	4
	P. maniculatus	-	0	0.00	5	0.00	2	0.00	5	0.00	9
Jack pine	*C. gapperi*	0.33	1	0.00	4	0.00	3	0.00	4	0.67	3
	M. pennsylvanicus	0.00	2	0.00	3	0.20	5	0.00	3	0.33	3
	P. maniculatus	-	0	0.00	2	0.00	5	0.00	2	0.00	5
Willow	*C. gapperi*	-	0	0.00	2	-	0	0.00	3	0.00	4
	M. pennsylvanicus	0.25	8	0.22	9	0.10	10	0.10	10	0.00	20
Balsam poplar	*C. gapperi*	0.05	22	0.09	22	0.08	24	0.04	28	0.00	33
	M. pennsylvanicus	0.33	3	0.00	2	0.00	2	0.50	2	0.00	4
	P. maniculatus	0.00	14	0.00	17	0.00	13	0.00	12	0.00	13
Poplar Creek cutline	*C. gapperi*	-	-	-	-	0.10	10	0.10	31	0.00	25
	M. pennsylvanicus	-	-	-	-	0.06	18	0.04	28	0.03	30
	P. maniculatus	-	-	-	-	0.00	3	-	0	0.00	1
Black spruce	*C. gapperi*	-	0	0.00	4	0.00	6	0.00	8	0.00	13
	M. pennsylvanicus	0.67	3	0.00	6	0.00	10	0.00	11	0.00	19
	P. maniculatus	-	0	-	0	-	0	-	0	-	0
Thickwoods cutline	*C. gapperi*	0.00	2	0.00	2	0.00	3	0.00	11	0.00	5
	M. pennsylvanicus	0.00	3	0.14	14	0.18	17	0.45	20	0.04	24
	P. maniculatus	0.25	4	0.17	6	0.00	11	0.00	10	0.00	8
Tamarack	*C. gapperi*	0.00	4	0.00	3	0.00	6	0.00	6	0.00	19
	M. pennsylvanicus	0.00	4	0.00	10	0.10	10	0.13	23	0.00	37

[1] Mid-date of each trapping period is shown.

[2] Proportion of total number of sub-adult and adult females that were pregnant (based on external swelling).

[3] Total number of sub-adult and adult females captured.

Table 10. Proportion of breeding sub-adult and adult females captured in snap-trap censuses that were pregnant.

Species	Area	July		August		October	
		P[1]	N[2]	P	N	P	N
C. gapperi	Athabasca Valley	0.72	22	0.53	51	0.03	39
	Birch Mountains	0.60	5	-	-	-	-
	Muskeg Mountain	-	-	1.00	6	-	-
	All Areas	0.70	27	0.58	57	0.03	39
M. pennsylvanicus	Athabasca Valley	0.75	8	0.25	8	0.00	8
	Birch Mountains	1.00	1	-	-	-	-
	Muskeg Mountain	-	-	-	0	-	-
	All Areas	0.78	9	0.25	8	0.00	8
P. maniculatus	Athabasca Valley	0.00	1	0.00	4	0.00	5
	Birch Mountains	0.00	1	-	-	-	-
	Muskeg Mountain	-	-	-	0	-	-
	All Areas	0.00	2	0.00	4	0.00	5

[1] Proportion of total number of breeding sub-adults and adult females that were pregnant (i.e., embryos visible in uterus).

[2] Total number of breeding sub-adult and adult females.

[3] Actually trapped 19-22 September, but totals included in October.

based on live-trapping populations (because of the more accurate assessment of pregnancies based on examination of the uterus). Relatively high proportions of female *C. gapperi* and *M. pennsylvanicus* were pregnant in July. Pregnancy rates of *C. gapperi* and *M. pennsylvanicus* declined in August and by October very few females were pregnant. No pregnant *P. maniculatus* were captured in any area in July, August or October.

3.3.4 Litter Sizes

Few females captured on the live-trapping grids littered in a trap. Estimates of litter sizes are consequently based on actual counts of embryos from autopsied animals (resorbing embryos were not included in the counts). Litter sizes for primiparous (first breeders) and multiparous females (females which have produced more than one litter) are shown for *C. gapperi* and *P. maniculatus* in Table 11. No *P. maniculatus* females with visible placental scars were captured.

3.3.5 Summary: Reproduction

Breeding condition, pregnancy rates and litter sizes of the three major small rodent species were examined. Male *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* were reproductively active until late August. Females, however, remained reproductively active until late September to early October. The late cessation of breeding in females reflects the period of reproductive activity (associated with the 3 week gestation period and the 2-3 week weaning period) of females that bred in late August. Based on the pregnancy rates of animals on live-trapping and snap-trapping areas, the breeding success of *C. gapperi* and *M. pennsylvanicus* was moderate in July and August and low in September and October. No female *P. maniculatus* successfully bred, however, during the late summer and fall period.

Table 11. Mean litter sizes based on the number of new placental scars. (The number of breeding primiparous and multiparous females captured in each period are indicated. No *P. maniculatus* with visible placental scars were captured.)

Area	Primiparous						Multiparous					
	July		Aug.		Oct.		July		Aug.		Oct.	
	Y/L[1]	N	Y/L	N	Y/L	N	Y/L	N	Y/L	N	Y/L	N
C. gapperi												
Athabasca River Valley	5.67	17	4.92	25	0.00	14	6.25	5	4.79	26	8.00	25
Birch Mountains	6.00	4	-	0	-	0	5.00	1	-	0	-	0
Muskeg Mountain	-	0	6.00	3	-	0	-	0	5.33	3	-	0
All areas combined	5.71	21	5.13	28	0.00	14	6.00	6	4.88	29	8.00	25
M. pennsylvanicus												
Athabasca River Valley	4.00	4	0.00	1	0.00	3	5.25	4	3.00	7	0.00	5
Birch Mountains	-	0	-	0	-	0	6.00	1	-	0	-	0
Muskeg Mountain	-	0	-	0	-	0	-	0	-	0	-	0
All areas combined	4.00	4	0.00	1	0.00	3	5.40	5	3.00	7	0.00	5

[1] Mean number of young per litter.

3.4 CONDITION

Habitat use may reflect the availability and quality of food resources in an area. In turn the quality and quantity of food resources may influence the 'condition' of animals from different habitats. I have used body weight and instantaneous relative growth rates as indices of condition. Body weight distributions were obtained from the live-trapping program and from snap-trap censuses. Instantaneous relative growth rates were obtained from animals on live-trapping areas.

3.4.1 Body Weight Distributions

Bi-weekly mean body weights of *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* captured on the eight study plots are shown in Figures 24-31. Because each bi-weekly sample is not independent of other samples (i.e., one animal may be included in several bi-weekly means), differences in body weights (by species) between grids for male animals and female animals separately were compared using Friedman's two-way analysis of variance (Siegel 1956).

Overall, body weights of male *C. gapperi* varied significantly among grids (χ^2=17.02; N=8; K=8; 0.05>p>0.02)--differences in the body weights of males on the Willow grid and Thickwoods cutline grid accounted for most of the variance (animals on the Willow grid were smaller than those on the Thickwoods cutline grid). Overall differences in the body weights of female *C. gapperi* were not significant (χ^2=14.09; N=8; K=8; 0.10>p>0.05) but females on the Aspen and Tamarack grid were significantly smaller than those on the Thickwoods cutline grid.

Male and female *M. pennsylvanicus* showed highly significant differences in body weight among grids (for males, χ^2=41.4; N=8; K=7, p< 0.001 and for females, χ^2=28.6; N=8; K=6; p<0.001). Male *M. pennsylvanicus* on the Jack Pine grid were smaller than males on the Black spruce, Tamarack, Thickwoods cutline and Poplar Creek cutline grid. Males on the Aspen grid were smaller than males on the Tamarack,

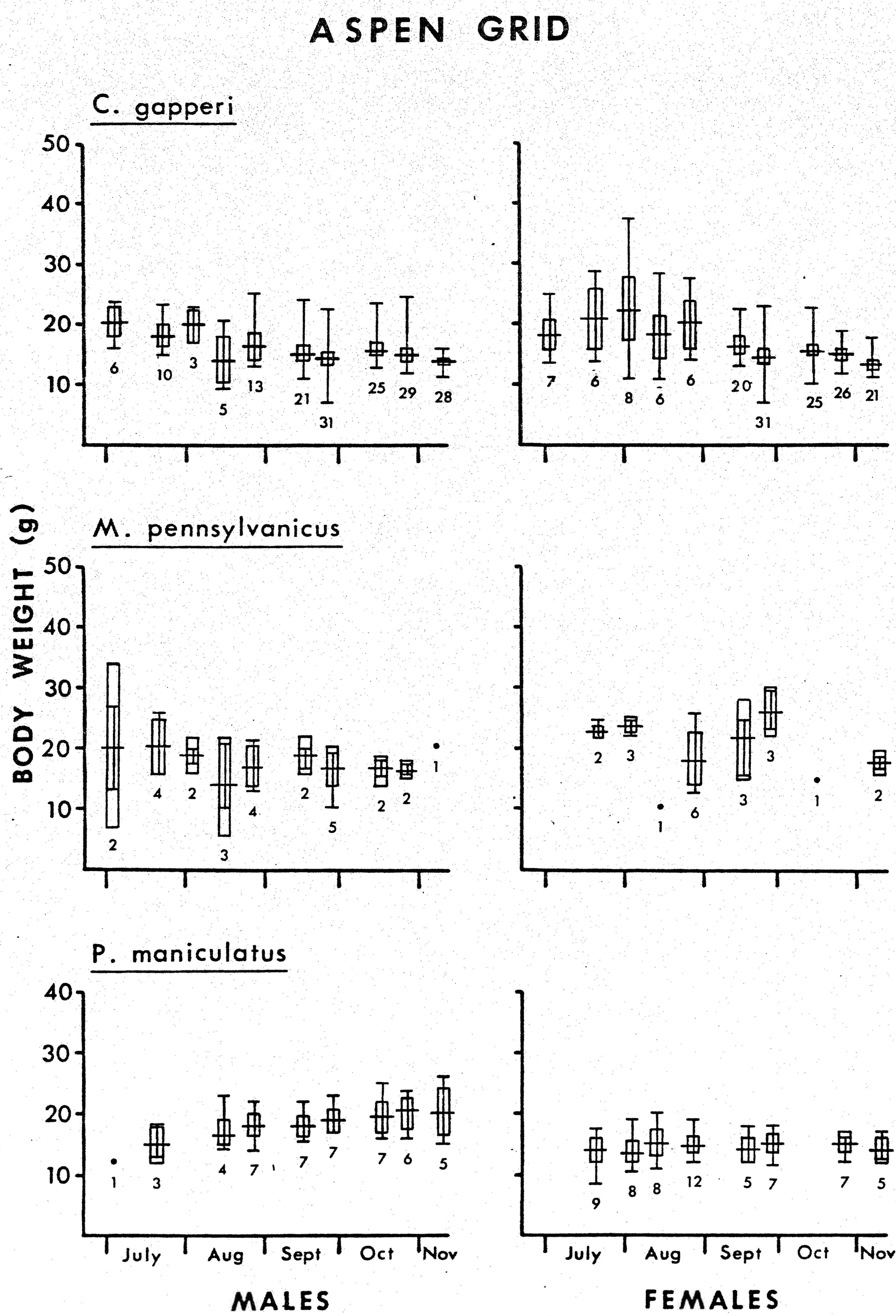

Figure 24. Body weight distributions of males and females on the Aspen grid. (Mean body weights are indicated by the crossbars, ± 1 S.E. by the enclosures and the range of values by the vertical lines. Sample sizes for each mean are shown.)

JACK PINE GRID

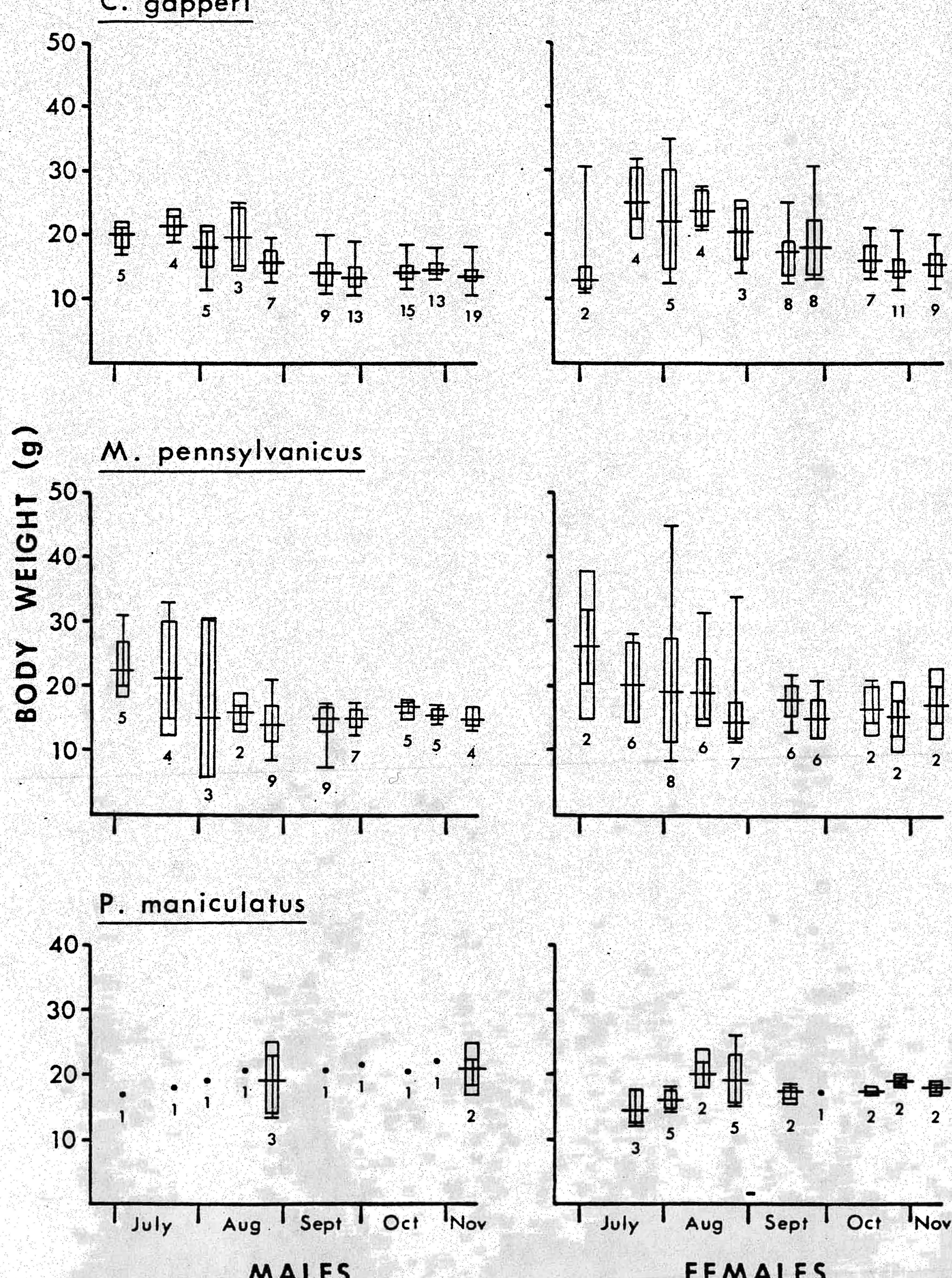

Figure 25. Body weight distributions of males and females on the Jack pine grid. (Mean body weights are indicated by the crossbars, ± 1 S.E. by the enclosures and the range of values by the vertical lines. Sample sizes for each mean are shown.)

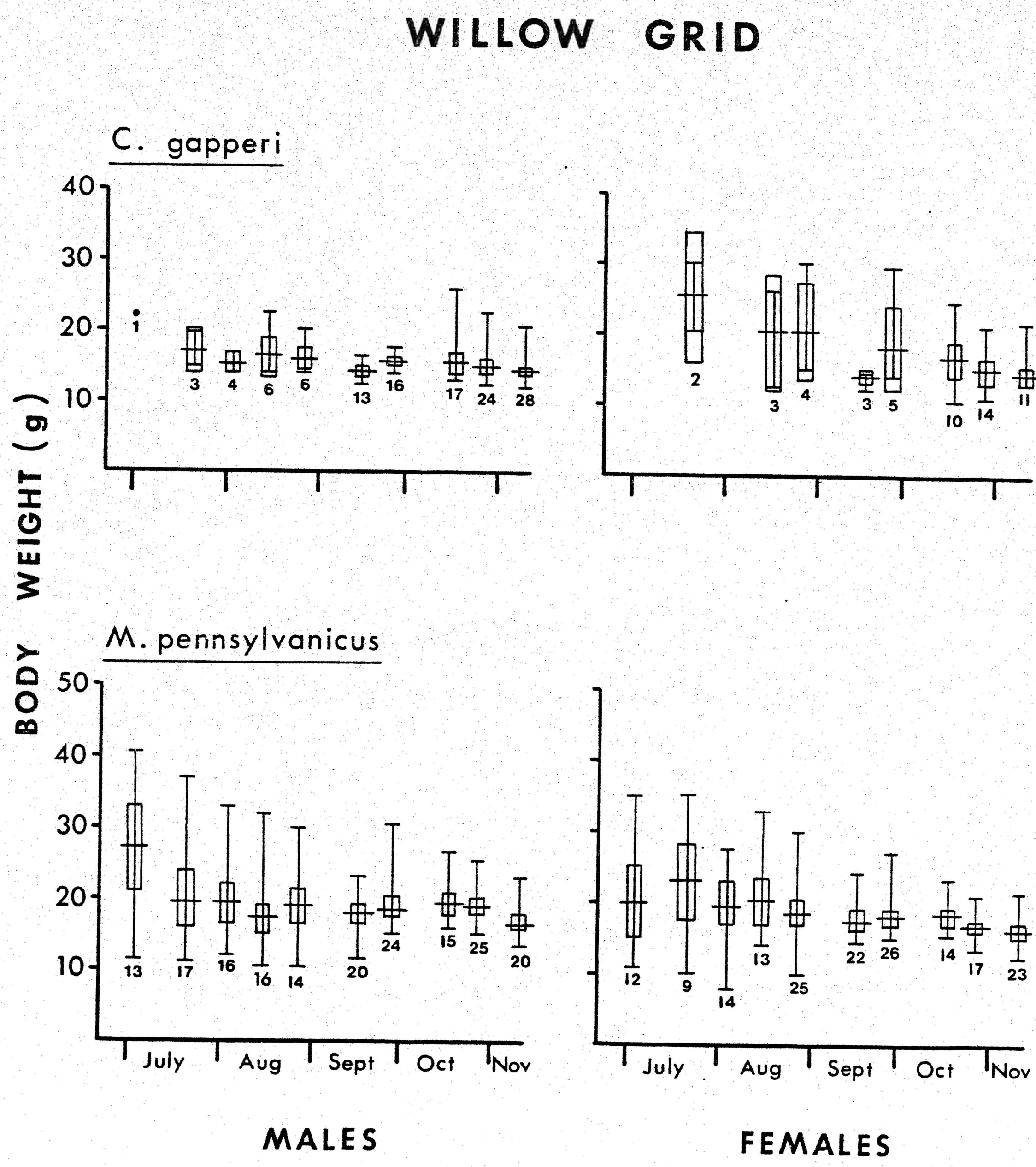

Figure 26. Body weight distributions of males and females on the Willow grid. (Mean body weights are indicated by the crossbars, ± 1 S.E. by the enclosures and the range of values by the vertical lines. Sample sizes for each mean are indicated.)

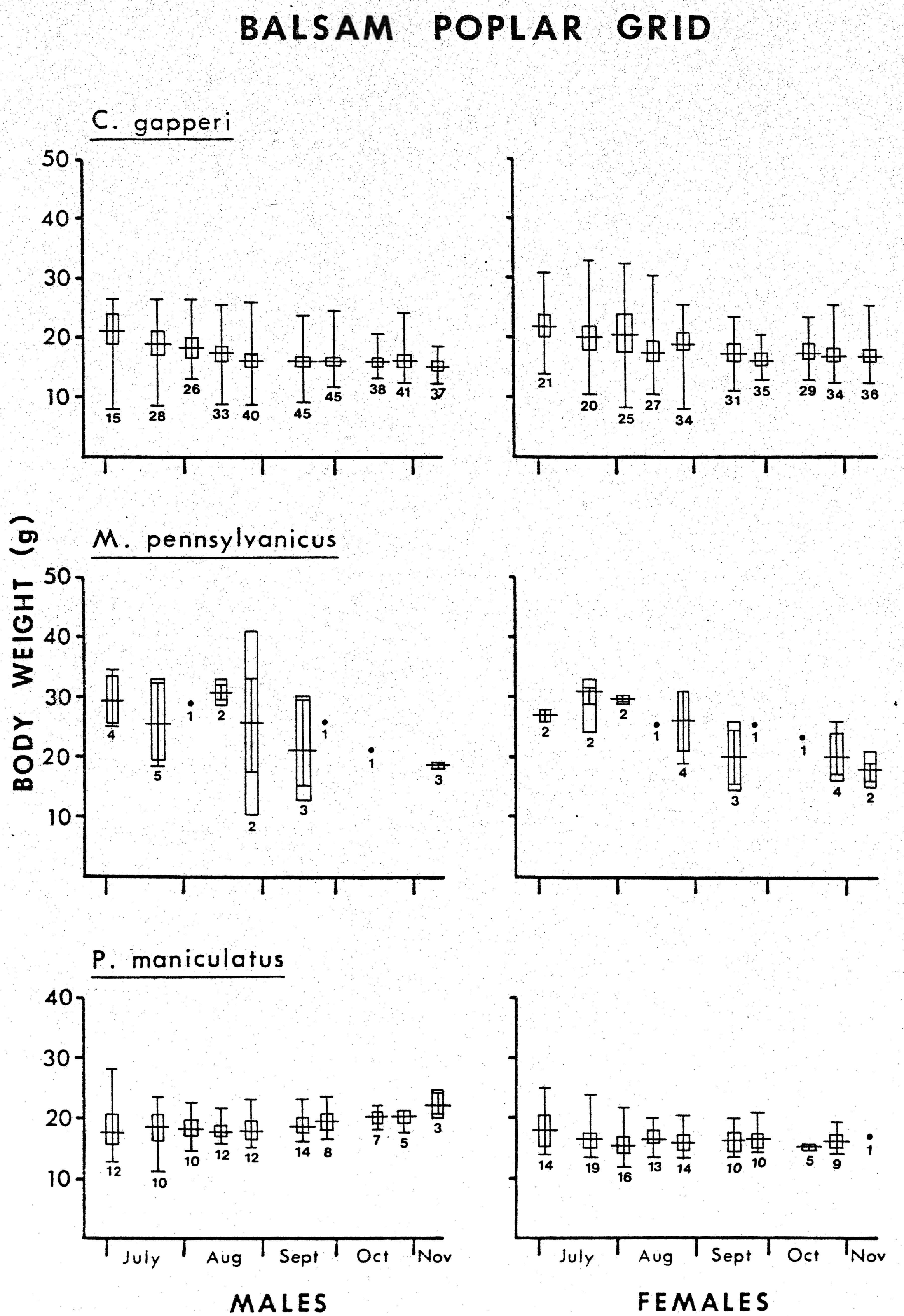

Figure 27. Body weight distributions of males and females on the Balsam poplar grid. (Mean weights are indicated by the crossbars, ± 1 S.E. by the enclosures and the range of values by the vertical lines. Sample sizes for each mean are shown.)

POPLAR CREEK GRID

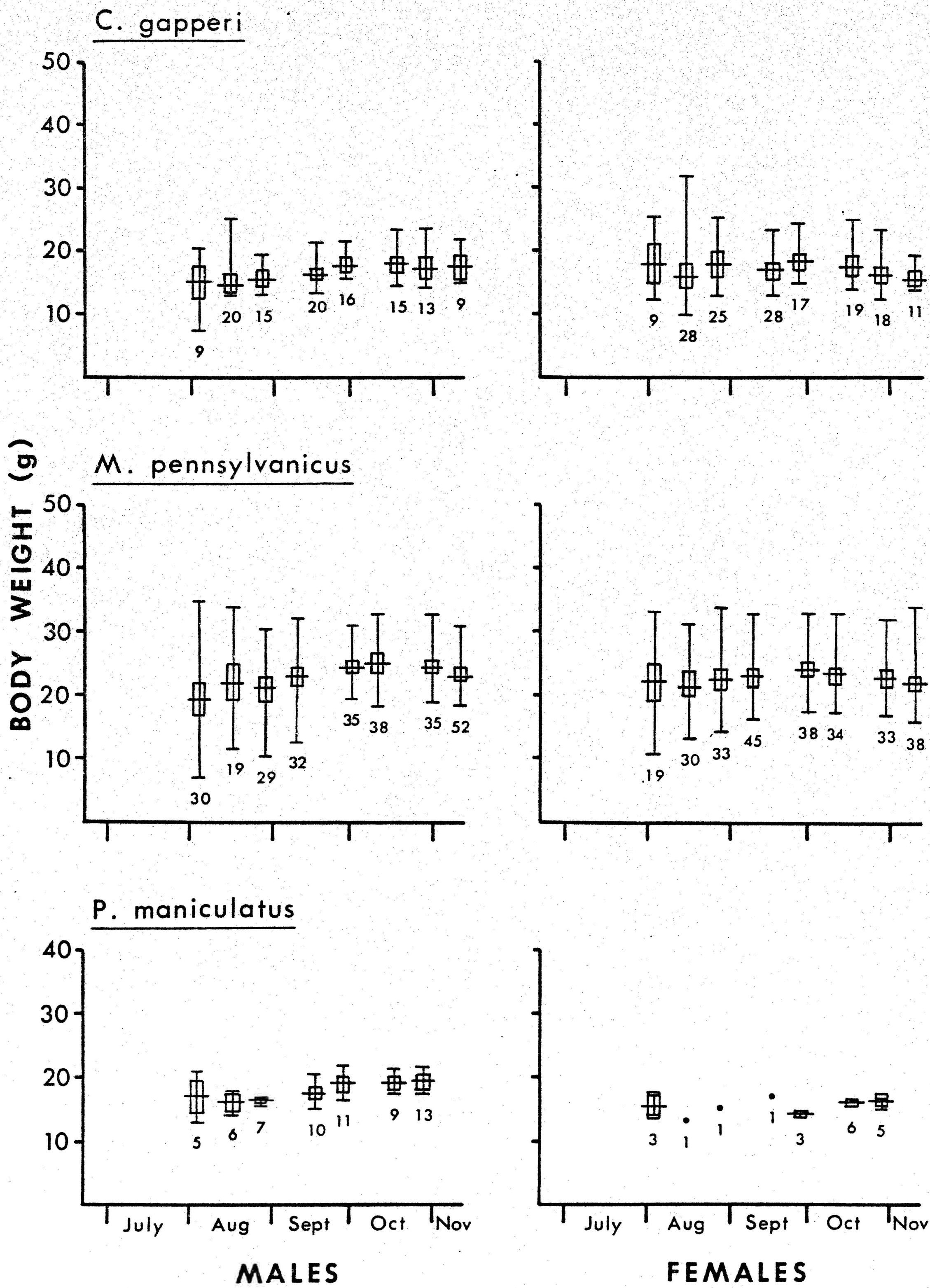

Figure 28. Body weight distributions of males and females on the Poplar Creek cutline. (Mean body weights are indicated by the crossbars, ± 1 S.E. by the enclosures and the range of values by the vertical lines. Sample sizes for each mean mean are shown.)

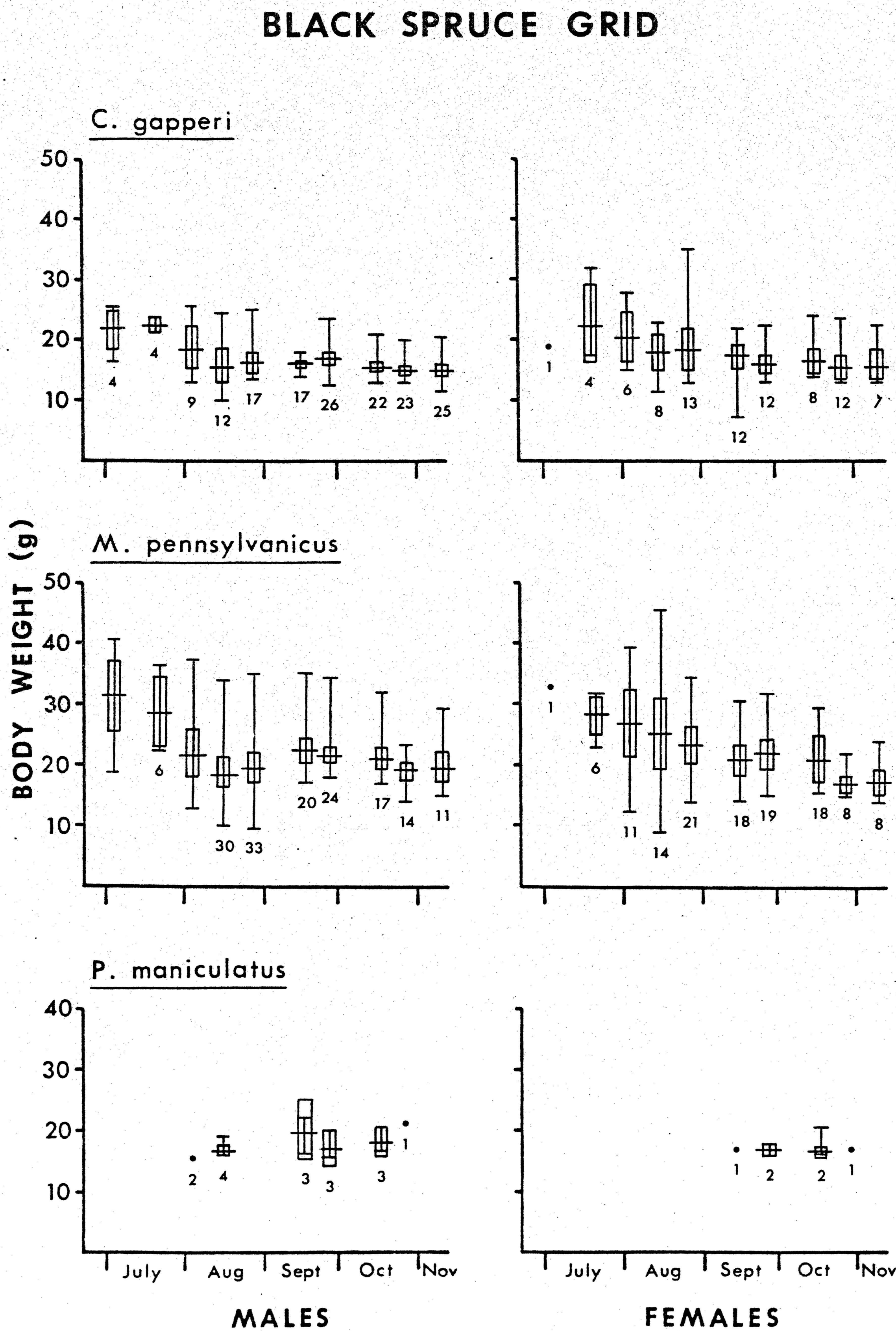

Figure 29. Body weight distributions of males and females on the Black spruce grid. (Mean body weights are indicated by the crossbars, ± 1 S.E. by the enclosures and the range of values by the vertical lines. Sample sizes for each mean are shown.)

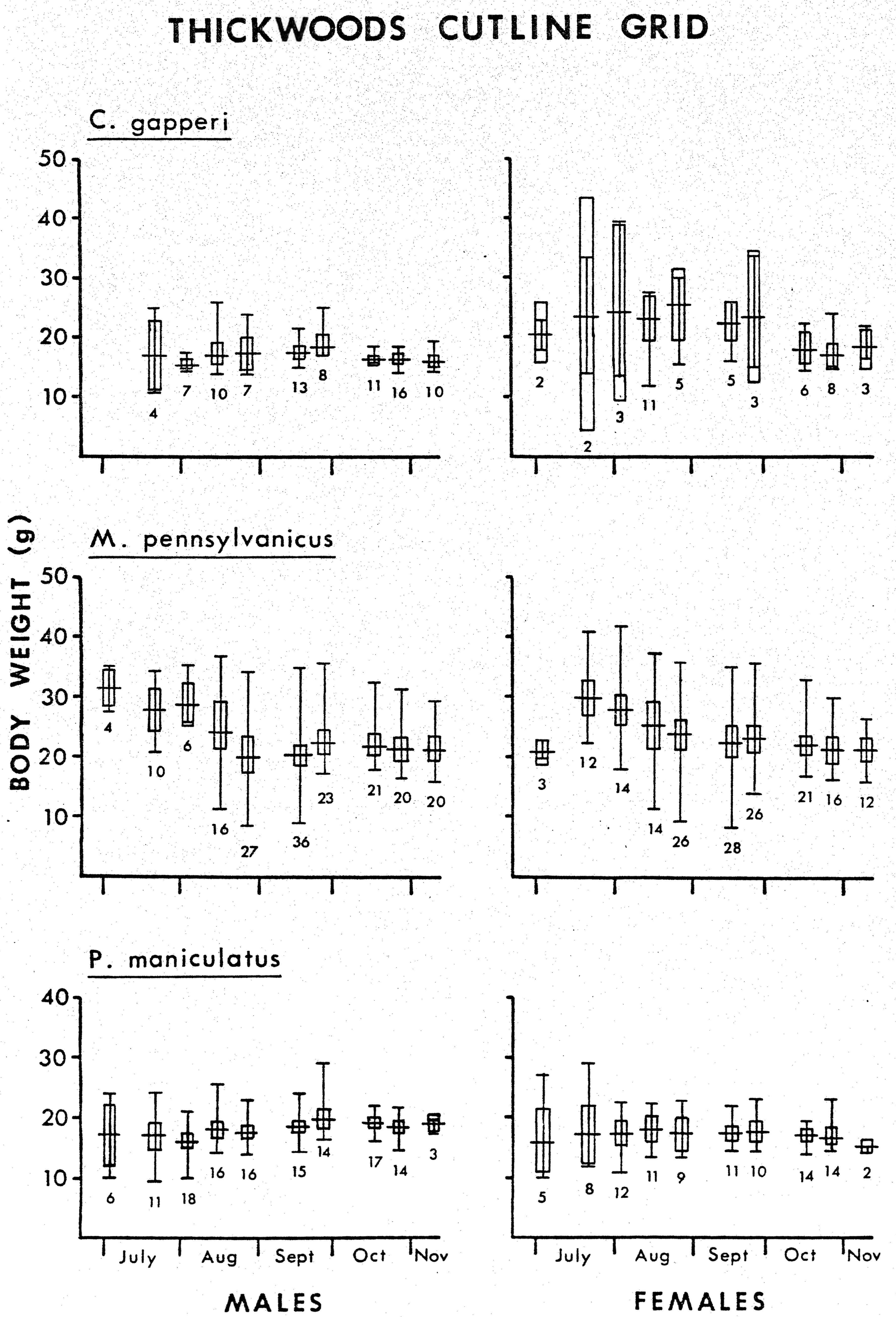

Figure 30. Body weight distributions of males and females on the Thickwoods cutline. (Mean body weights are indicated by the crossbars, ± 1 S.E. by the enclosures and the range of values by the vertical lines. Sample sizes for each mean are shown.)

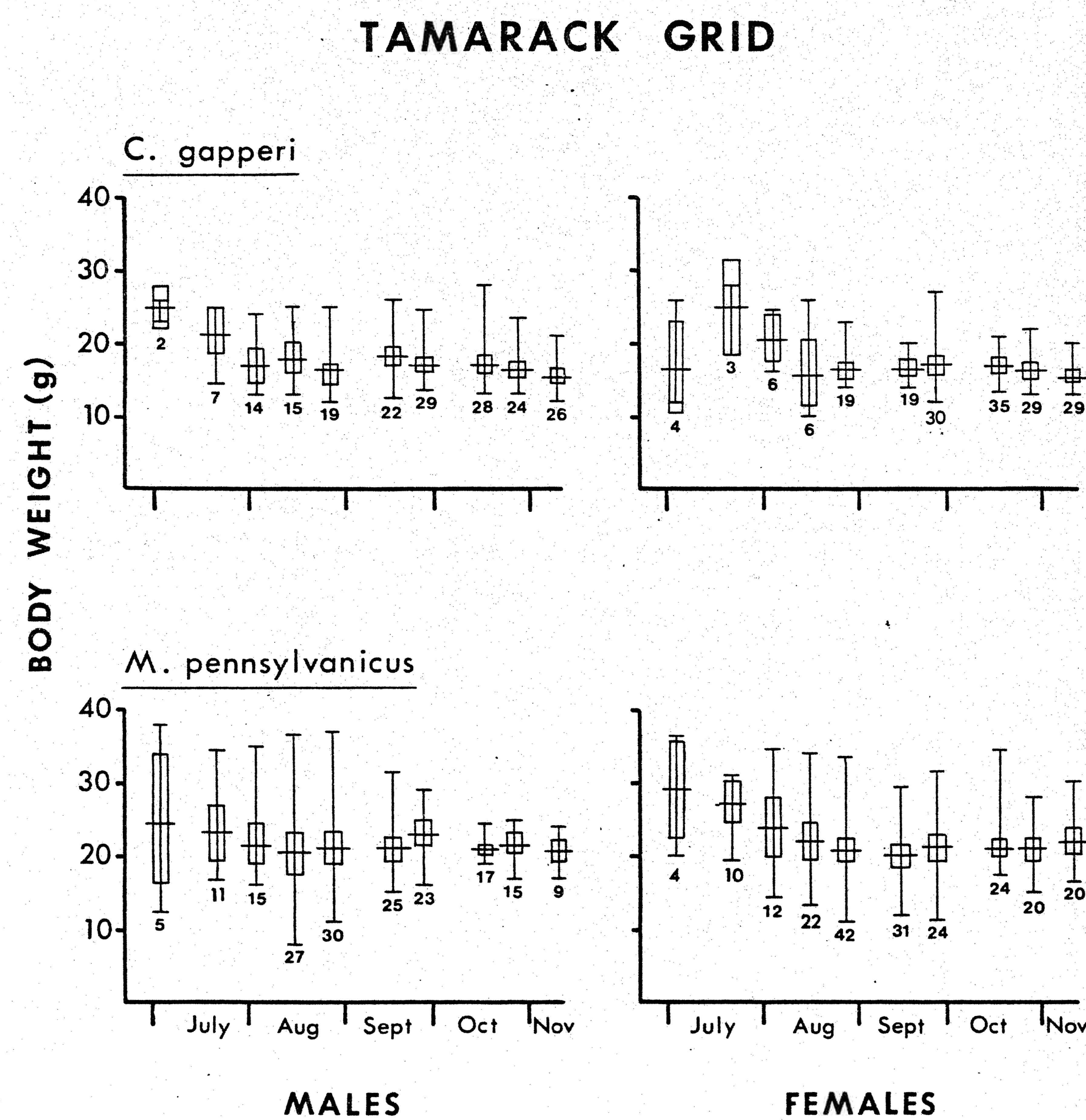

Figure 31. Body weight distributions of males and females on the Tamarack grid. (Mean body weights are indicated by the crossbars, ± 1 S.E. by the enclosures and the range of values by the vertical lines. Sample sizes for each mean are shown.)

Thickwoods cutline or Poplar Creek cutline grid. Males on the Willow grid were smaller than males on the Poplar Creek cutline grid. Female *M. pennsylvanicus* on the Jack pine and Willow grids were smaller than females on the Thickwoods cutline and the Black spruce grid.

Overall, male *P. maniculatus* showed no significant differences in body weights (χ^2=9.3; N=6; K=5; 0.10>p>0.05) whereas female *P. maniculatus* did show significant differences in body weight between grids (χ^2=16.2; N=6; K=4; 0.01>p>0.001). Females on the Aspen grid were significantly smaller than females on either the Jack pine or Thickwoods cutline grid.

3.4.2 Growth Rates

Growth rates have been used as indices of condition in several species of *Microtus* and in *C. gapperi* (Krebs *et al.* 1969; Krebs *et al.* 1973; Fuller 1977). For each sex and species on each study area, weight changes over a 4-week period were used to calculate regressions of instantaneous relative growth rates versus body weights (Brody 1945). Animals that missed a trapping period or for which weights were not obtained within each 4-week interval were not included in the analysis for that period. Mean instantaneous relative growth rates have been expressed as the proportionate change per day for a standard 25 g mouse (Tables 12-14).

Based on mean instantaneous growth rates for each month, all species on all grids showed very little change in body weight. Generally growth rates were highest in July-September and declined in October and November (very low increases in body weight, no change in body weight or negative growth rates were typical of all species in October and November). Mean growth rates for males and for females were compared between grids for each species. Overall, there were no significant differences in growth rates between grids (Friedman's two-way analysis of variance).

Table 12. Instantaneous relative growth rates of *C. gapperi*. (A mean instantaneous growth rate [proportionate increase/day] was calculated for each sex and species and is expressed as an adjusted mean growth rate for a hypothetical 25 g standard animal. Samples sizes [N] and standard deviations [SD] are indicated.)

Grid	Period[1]	Males			Females		
		Rate	SD	N	Rate	SD	N
Aspen	July 11	0.002	0.006	4	0.018	0.011	9
	Aug. 9	0.006	0.009	8	0.011	0.013	6
	Sept. 10	0.001	0.004	22	-0.012	0.007	16
	Oct. 10	-0.001	0.006	46	-0.001	0.010	42
	Nov. 3	-0.005	0.004	26	-0.006	0.004	20
Jack pine	July 11	0.001	0.006	5	0.013	0.014	3
	Aug. 9	0.002	0.007	6	0.003	0.008	4
	Sept. 10	-0.003	0.007	13	0.001	0.009	7
	Oct. 10	0.003	0.006	23	-0.003	0.008	12
	Nov. 3	-0.004	0.005	14	0.000	0.005	6
Willow	July 11	-0.007	0.003	3	-	-	0
	Aug. 9	0.006	0.003	5	0.009	0.017	3
	Sept. 10	0.004	0.009	14	0.000	0.011	5
	Oct. 10	-0.002	0.006	31	-0.004	0.006	12
	Nov. 3	-0.003	0.008	21	-0.004	0.004	11
Balsam poplar	July 11	-0.001	0.010	29	0.002	0.012	29
	Aug. 9	0.000	0.009	37	-0.001	0.009	33
	Sept. 10	0.004	0.007	60	0.000	0.007	45
	Oct. 10	-0.002	0.006	67	0.000	0.006	51
	Nov. 3	0.000	0.003	28	0.000	0.003	28
Poplar Creek cutline	July 11	no trapping in this period					
	Aug. 9	0.005	0.010	12	0.002	0.008	21
	Sept. 10	0.004	0.006	23	0.002	0.006	31
	Oct. 10	0.002	0.005	26	-0.003	0.005	32
	Nov. 3	0.001	0.005	9	0.001	0.005	10
Black spruce	July 11	0.001	0.006	5	0.005	0.016	5
	Aug. 9	0.005	0.011	16	0.002	0.015	12
	Sept. 10	0.002	0.006	29	-0.000	0.009	19
	Oct. 10	-0.004	0.005	36	-0.002	0.005	14
	Nov. 3	-0.002	0.006	21	-0.001	0.003	7
Thickwoods cutline	July 11	-	-	1	-	-	1
	Aug. 9	0.006	0.002	4	-0.005	0.019	4
	Sept. 10	0.004	0.005	10	0.001	0.013	6
	Oct. 10	0.000	0.004	18	-0.004	0.009	7
	Nov. 3	0.003	0.004	8	-	-	1
Tamarack	July 11	-0.003	0.004	7	0.002	0.002	4
	Aug. 9	0.000	0.004	15	0.000	0.009	8
	Sept. 10	0.001	0.007	31	0.001	0.006	31
	Oct. 10	-0.001	0.006	43	-0.003	0.007	52
	Nov. 3	-0.001	0.005	21	-0.002	0.005	26

[1] Midpoint of each 4-week period is indicated.

Table 13. Instantaneous relative growth rate of *M. pennsylvanicus*. (A mean instantaneous growth rate [proportionate increase/day] was calculated for each sex and species and is expressed as an adjusted mean growth rate for a hypothetical 25 g standard animal. Samples sizes [N] and standard deviations [SD] are indicated.)

Grid	Period[1]	Males			Females		
		Rate	SD	N	Rate	SD	N
Aspen	July 11	-	-	2	-	-	2
	Aug. 9	0.018	0.005	4	-0.003	0.004	3
	Sept. 10	-	-	2	0.006	0.009	6
	Oct. 10	0.005	0.006	4	-	-	0
	Nov. 3	-	-	0	-	-	0
Jack pine	July 11	-	-	2	0.029	0.018	6
	Aug. 9	-	-	1	0.013	0.013	7
	Sept. 10	0.011	0.010	13	0.009	0.012	6
	Oct. 10	0.000	0.007	10	-0.005	0.006	4
	Nov. 3	-0.002	0.003	4	-	-	0
Willow	July 11	0.002	0.009	9	0.008	0.012	10
	Aug. 9	0.006	0.009	14	0.006	0.008	20
	Sept. 10	0.004	0.007	31	0.002	0.010	36
	Oct. 10	-0.001	0.006	31	-0.002	0.007	30
	Nov. 3	-0.007	0.005	19	-0.003	0.007	17
Balsam poplar	July 11	-	-	1	-	-	2
	Aug. 9	-	-	2	-	-	2
	Sept. 10	-	-	1	-	-	2
	Oct. 10	-	-	0	-	-	2
	Nov. 3	-	-	1	-	-	2
Poplar Creek cutline	July 11			no trapping in this period			
	Aug. 9	0.007	0.008	14	0.002	0.009	27
	Sept. 10	0.005	0.007	29	0.004	0.006	56
	Oct. 10	0.001	0.007	48	-0.001	0.006	52
	Nov. 3	-0.002	0.006	25	-0.001	0.006	22
Black spruce	July 11	-0.003	0.005	9	0.003	0.015	6
	Aug. 9	0.009	0.012	31	0.004	0.018	20
	Sept. 10	0.004	0.011	38	0.004	0.008	29
	Oct. 10	-0.004	0.009	26	-0.001	0.008	16
	Nov. 3	0.001	0.003	9	0.002	0.003	4
Thickwoods cutline	July 11	0.002	0.004	7	0.005	0.013	11
	Aug. 9	0.002	0.006	18	0.000	0.008	18
	Sept. 10	0.006	0.007	38	0.003	0.008	38
	Oct. 10	-0.001	0.006	38	-0.001	0.008	29
	Nov. 3	0.001	0.005	14	-0.003	0.004	10
Tamarack	July 11	0.007	0.011	7	0.002	0.009	9
	Aug. 9	0.006	0.010	26	0.004	0.010	28
	Sept. 10	0.003	0.008	35	0.005	0.009	41
	Oct. 10	-0.001	0.006	28	0.000	0.008	36
	Nov. 3	0.000	0.006	8	0.001	0.010	17

[1] Midpoint of each 4-week period is indicated.

Table 14. Instantaneous relative growth rates of *P. maniculatus*. (A mean instantaneous growth rate [proportionate increase/day] was calculated for each sex and species and is expressed as an adjusted mean growth rate for a hypothetical 25 g standard animal. Samples sizes [N] and standard deviations [SD] are indicated.)

Grid	Period[1]	Males			Females		
		Rate	SD	N	Rate	SD	N
Aspen	July 11	-	-	1	0.005	0.003	6
	Aug. 9	0.004	0.016	4	0.005	0.005	13
	Sept. 10	0.003	0.005	10	-0.004	0.003	11
	Oct. 10	0.001	0.005	11	0.000	0.002	4
	Nov. 3	0.003	0.006	5	-0.002	0.003	4
Jack pine	July 11	-	-	1	0.007	0.009	3
	Aug. 9	-	-	2	0.005	0.014	5
	Sept. 10	-	-	2	0.002	0.005	3
	Oct. 10	-	-	2	0.003	0.001	3
	Nov. 3	-	-	1	-	-	2
Willow	July 11						
	Aug. 9						
	Sept. 10			no *P. maniculatus*			
	Oct. 10						
	Nov. 3						
Balsam poplar	July 11	0.001	0.005	12	0.001	0.010	24
	Aug. 9	0.001	0.004	20	-0.001	0.007	22
	Sept. 10	0.003	0.005	18	0.004	0.006	15
	Oct. 10	0.001	0.003	11	0.000	0.003	9
	Nov. 3	-	-	2	-	-	2
Poplar Creek cutline	July 11			no trapping in this period			
	Aug. 9	0.003	0.004	6	-	-	1
	Sept. 10	0.003	0.004	13	-	-	2
	Oct. 10	0.001	0.004	17	0.005	0.006	5
	Nov. 3	-	-	0	-	-	0
Black spruce	July 11	-	-	0	-	-	0
	Aug. 9	0.004	0.003	3	-	-	0
	Sept. 10	0.000	0.000	4	-	-	1
	Oct. 10	0.003	0.001	4	0.002	0.003	3
	Nov. 3	-	-	0	-	-	0
Thickwoods cutline	July 11	0.004	0.009	13	0.004	0.017	9
	Aug. 9	0.006	0.008	28	0.002	0.006	17
	Sept. 10	0.003	0.006	27	0.002	0.007	18
	Oct. 10	-0.002	0.007	28	-0.001	-0.004	25
	Nov. 3	0.000	0.002	3	-	-	2
Tamarack	July 11						
	Aug. 9						
	Sept. 10			no *P. maniculatus*			
	Oct. 10						
	Nov. 3						

[1] Midpoint of each 4-week period is indicated.

3.4.3 Summary: Condition

Body weight and growth rates were used as indices of nutritional condition of small rodents on each study area. Comparisons of the weight distributions of *C. gapperi*, *M. pennsylvanicus* and *P. maniculatus* indicated that some populations weighed significantly more or less than other populations. Specifically:

1. Male *C. gapperi* on the Thickwoods cutline grid were significantly larger than males on the Willow grid. Females on the Thickwoods cutline grid were also larger than females on the Aspen and Tamarack grids.
2. Male *M. pennsylvanicus* on the Jack pine, Aspen and Willow grids tended to be significantly smaller than those on the Poplar Creek cutline grid. Females on the Jack pine and Willow grids were smaller than females on the Thickwoods cutline and Black spruce grids.
3. Weight distributions of male *P. maniculatus* did not differ significantly between grids. Females on the Aspen grid, however, were smaller than those on the Jack pine and Thickwoods cutline grids.

Differences in weight distributions suggest that populations in some areas are in poorer condition than populations in other areas. Mean instantaneous growth rates for male and female animals on each grid, however, did not differ significantly between grids for any of the major small rodent species.

3.5 POPULATION LOSSES AND RECRUITMENT

Changes in the population densities of small mammals within a habitat are the result of populations losses (mortality and emigration) and recruitment (births and immigration). If population densities are used as an index of habitat utilization, it is important to understand how these sources of population loss or recruitment affect population change (e.g., are animals in a particular habitat transient or resident animals?). Two indices of population loss and recruitment have been used-- (1) bi-weekly survival and recruitment rates and (2) the proportion of animals within each population that is resident.

3.5.1 Survival and Recruitment Rates

Minimum survival rates were calculated as the proportion of animals caught in trapping period (t+1; or later on the same grid) that were also caught in trapping period t. Minimum bi-weekly recruitment rates for each grid were calculated as the proportion of the MNA that were first captured on each grid during that period. Minimum bi-weekly recruitment rates and minimum bi-weekly survival rates for each species on the eight study plots are given in Appendix 16--an example of these trends in survival and recruitment rates is shown in Figure 32.

The following overall trends were apparent:

1. Survival of *C. gapperi* was consistently high but showed some variation. Recruitment was high in July and August, then generally decreased throughout September and October. Low recruitment rates were typical of all *C. gapperi* populations in late October-early November.
2. Survival rates of *M. pennsylvanicus* were usually high throughout the summer and fall. Survival rates of *M. pennsylvanicus* on the Aspen, Jack pine, Willow and Balsam poplar grids were quite variable but were always moderate to high. Recruitment was generally moderate to high in July and August, then decreased throughout September to low levels in October.
3. Recruitment rates of *M. pennsylvanicus* on the Balsam poplar grid were atypical in that recruitment was quite low in July and August, then increased to high levels in October.

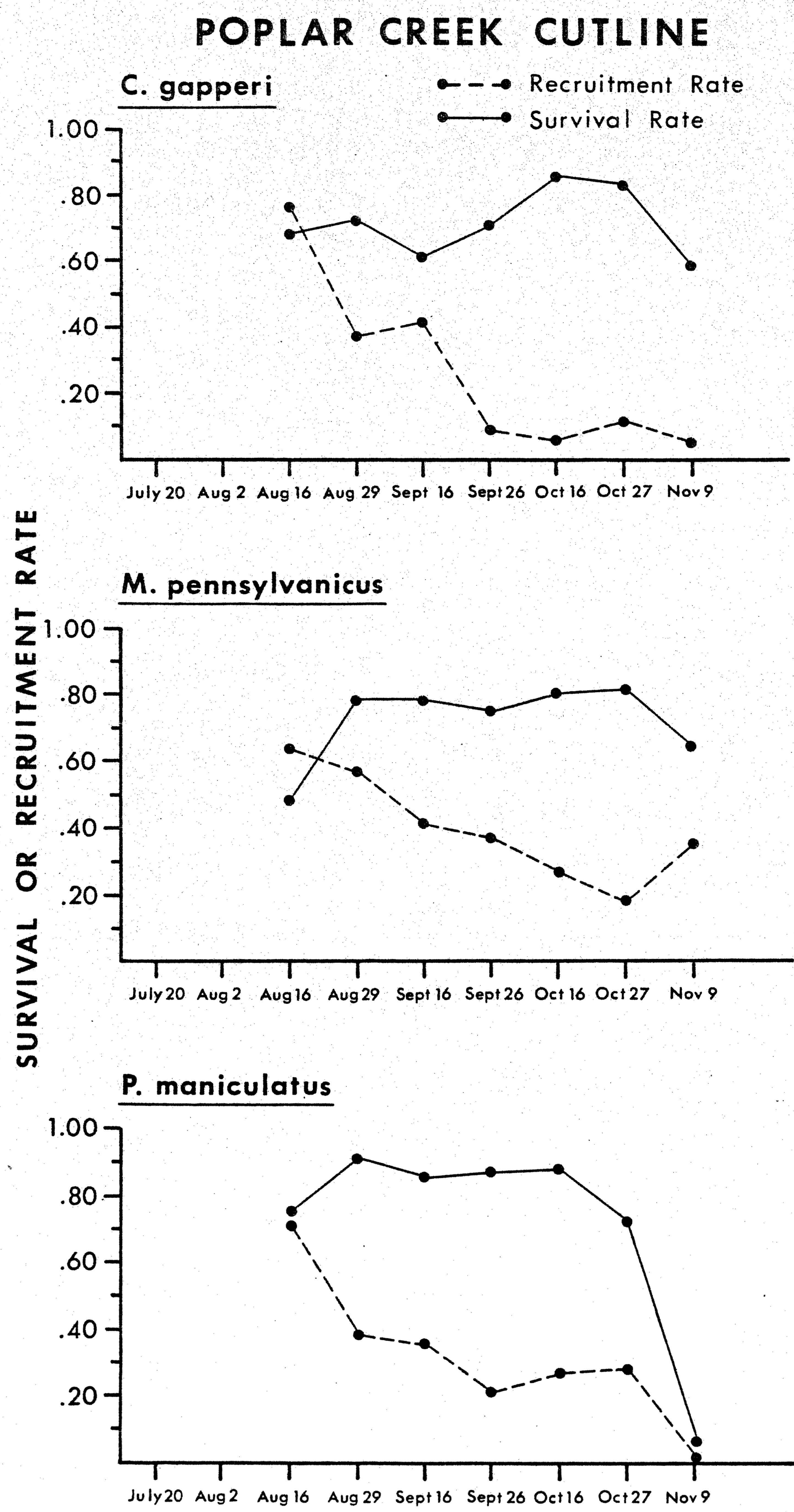

Figure 32. Bi-weekly estimates of minimum survival rates and minimum recruitment rates on the Poplar Creek cutline grid.

4. Survival rates of *P. maniculatus* populations were high on all grids throughout July to mid-October. However, populations on the Balsam poplar, Poplar Creek cutline, Black spruce and Thickwoods cutline showed sharp declines in survival in late October. Recruitment rates were moderate in July and early August but declined to low numbers by late September to early October.
5. Recruitment rates of *P. maniculatus* on the Black spruce grid were atypical; recruitment rates increased in October.

3.5.2 Resident and Transient Animals

Animals that remained on a grid for a period of at least 6 weeks (4 or more trapping periods) have been termed residents; those remaining on a grid less than six weeks were termed transients. Only animals tagged during or before the fourth from the last trapping period during the 1978 season were included in the analysis. Animals that died in a trap were only included in the analysis if they had been present for four or more trapping periods. Because transient animals may disappear from a grid as a result of death or emigration, changes in the resident:transient ratio will reflect both changes in mortality and emigration. Although it is not possible to differentiate between the effects of mortality and emigration on the residency ratio, this ratio will still reflect the rate of turn-over of animals in a population and will provide a comparative index of population stability between study areas. Low residency ratios indicate a high turn-over whereas high residency ratios reflect a slow turn-over of animals in a population. The numbers of residents and transients of each species on each study area are shown in Table 15. The proportions of resident and transient animals of each sex were compared using a Fisher exact test. Differences in the number of resident and transient male and female animals for each

Table 15. Number of resident (R) and transient (T) animals on each of the eight study plots. (See text for definition of resident and transient animals.)

Area	Species	Males R	Males T	Females R	Females T	Total R	Total T	Residency Ratio[1]
Aspen	*C. gapperi*	23	30	22	26	45	48	0.48
	M. pennsylvanicus	3	10	5	2	8	12	0.40
	P. maniculatus	9	5	11	8	20	13	0.61
Jack pine	*C. gapperi*	11	9	6	10	17	19	0.47
	M. pennsylvanicus	6	16	5	14	11	30	0.27
	P. maniculatus	1	3	6	1	7	4	0.64
Willow	*C. gapperi*	14	12	5	3	19	15	0.56
	M. pennsylvanicus	26	34	26	20	52	54	0.49
Balsam poplar	*C. gapperi*	47	50	43	36	90	86	0.51
	M. pennsylvanicus	4	9	2	8	6	17	0.26
	P. maniculatus	14	11	22	9	36	20	0.64
Poplar Creek cutline	*C. gapperi*	14	28	19	35	33	63	0.34
	M. pennsylvanicus	35	60	45	30	80	90	0.47
	P. maniculatus	7	11	4	1	11	12	0.48
Black spruce	*C. gapperi*	22	14	11	10	33	24	0.58
	M. pennsylvanicus	25	30	19	14	44	44	0.50
	P. maniculatus	2	1	1	1	3	2	0.60
Thickwoods cutline	*C. gapperi*	12	18	6	13	18	31	0.37
	M. pennsylvanicus	26	28	24	27	50	55	0.48
	P. maniculatus	15	13	13	6	28	19	0.60
Tamarack	*C. gapperi*	30	25	25	18	55	43	0.56
	M. pennsylvanicus	20	43	26	38	46	81	0.36

1. Proportion of all animals captured that were residents.

species on each grid were not significant--the only exceptions to this this were *M. pennsylvanicus* on the Poplar Creek cutline grid (p=0.002) and on the Aspen grid (p=0.052). In both instances a higher proportion of females were resident animals.

Differences between habitat types may directly or indirectly influence population structure. For example, some habitats may support resident populations while other habitats may only contain largely transient populations. Comparisons of the numbers of resident and transient animals on each grid for each species showed the following trends:

1. The number of resident and transient *C. gapperi* differed significantly among habitats (χ^2=22.49; df=7; 0.01>p>0.001). Residency ratios of populations on the Poplar Creek cutline and Thickwoods cutline grids were low in comparison to other areas, suggesting that these populations were more transient than populations in mature forested areas.
2. The number of resident and transient *M. pennsylvanicus* also differed between habitats (χ^2=16.21; df=7; 0.05>p>0.02). Residency ratios indicated that populations on the Balsam poplar, Jack pine, Tamarack and Aspen grids had more transient animals than grids in the Willow, black spruce or naturally-revegetating areas.
3. The number of resident and transient *P. maniculatus* was similar among areas (χ^2=1.92; df=7; 0.98>p>0.95).

3.5.3 Summary: Population Losses and Recruitment

Survival rates of most populations of *C. gapperi* and *M. pennsylvanicus* on the eight study areas were generally moderate to high throughout the summer period then declined gradually through the fall period. Survival rates of *P. maniculatus* on most areas were high throughout the summer and fall period--however, survival rates dropped sharply in late October. Most populations of all three species showed moderate to good recruitment rates in July and August followed by a gradual decline in recruitment throughout September to low levels in October. *M. pennsylvanicus* on the Balsam poplar grid and *P. maniculatus* on the Black spruce grid were atypical in that recruitment increased in the late fall.

Residency ratios (proportion of animals captured that were residents) indicated that *C. gapperi* populations on the Poplar Creek cutline and the Thickwoods cutline grids were composed largely of transient animals. Similarly, *M. pennsylvanicus* populations on the Balsam poplar and Jack pine grids were mostly transient animals. The number of resident animals and transient animals in populations of *P. maniculatus* did not appear to differ significantly among the grids.

3.6 HABITAT USE

Preliminary analyses of small mammal distribution and abundance in relation to habitat types and vegetation structure have included analyses of correlation between specific habitat variables and small mammal abundance, comparisons of small mammal densities in natural habitats and naturally-revegetating grids, and comparison of snap-trap captures within habitats to habitat availability. Results of correlation analyses will be discussed in the final report, following the collection of a more substantial data base. Preliminary results of the latter two analyses follow.

3.6.1 Small Rodent Densities on Live-trapping Areas

Indices of habitat use were obtained for each species on each area by calculating peak population densities. This of course assumes that local population densities are an adequate index of habitat use. Peak population densities for each species on each grid are shown in Table 16.

Table 16. Peak population densities (animals/ha) for each study area.

Grid	Peak Densities (animals/ha)[1]		
	C. gapperi	*M. pennsylvanicus*	*P. maniculatus*
Aspen	84.0	14.8	27.2
Jack pine	34.6	21.0	11.1
Willow	48.1	70.4	0.0
Balsam poplar	116.0	9.9	48.1
Poplar Creek cutline	73.2	154.9	25.4
Black spruce	54.3	69.1	6.2
Thickwoods cutline	35.2	101.4	52.1
Tamarack	84.0	96.3	0

[1] Based on a trapping grid size of 0.81 ha (except for the two cutline grids which were 0.76 ha in size).

C. gapperi were most abundant in areas dominated by balsam poplar (*Populus balsamifera*), followed by tamarack forest (*Larix laricina*), aspen-white spruce forest (*Populus tremuloides* and *Picea glauca* respectively, older naturally revegetating areas, black spruce (*Picea mariana*) willow scrub (*Salix* sp.), younger naturally revegetating areas and jack pine (*Pinus banksiana*) forest. *M. pennsylvanicus* were most abundant in naturally-revegetating areas followed by tamarack forest, willow scrub and black spruce. Jack pine forest, aspen-white spruce forest and balsam poplar woods were not heavily used by this species. *P. maniculatus* was most abundant in the young naturally-revegetating area and in balsam poplar forests. This species was moderately common in aspen-white spruce forest and in the older naturally-revegetating area. Use of willow scrub and jack pine, black spruce, and tamarack forest by *P. maniculatus* was limited.

3.6.2 Habitat Use and Availability

Habitat use by small rodents in relation to habitat availability was assessed using capture data and vegetation information from snap-trap censuses. For each of the major species of small rodents (*C. gapperi*, *M. pennsylvanicus* and *P. maniculatus*), the total number captured in nine different types of tree cover (aspen, balsam poplar, white spruce, black spruce, tamarack, balsam fir [*Abies balsamea*], jack pine, birches [*Betula* spp.] and no trees) was determined (Tables 17-19). The availability of each habitat type (as defined by the dominant tree cover) was determined by calculating the proportion of the 1235 habitat sampling points for snap-trap censuses (19 sampling points per snap-trap line), represented by that cover type. A χ^2 test for goodness of fit indicated that a significantly disproportionate number of each of the three small rodent species were captured in areas dominated by certain tree species (*C. gapperi*: χ^2=170.6; df=8, p<0.001; N=805; *M. pennsylvanicus*: χ^2=82.83; df=8; p<0.001; N=144). The results indicate that these small rodent species selected or avoided certain habitat types.

Table 17. Occurrence of *C. gapperi* in relation to habitat types and relative habitat use (using the Bonferoni z statistic with a 95% confidence coefficient).

Tree Cover Type	Proportion of All Habitats Sampled[1]	Number of Captures	Proportion of Total Captures	Habitat Use[2]
Trembling aspen	0.13	111	0.14	0
Balsam poplar	0.03	29	0.04	0
White spruce	0.18	185	0.23	+
Black spruce	0.29	182	0.22	-
Tamarack	0.02	29	0.04	0
Balsam fir	0.08	88	0.11	+
Jack pine	0.14	22	0.03	-
Birches[3]	0.04	81	0.10	+
No trees	0.09	78	0.09	0
Total	1.00	805	1.00	

[1] The proportion of 1235 habitat sampling points represented by the tree cover type.

[2] Habitat use related to habitat availability:
- 0 use equivalent to availability
- \- use significantly less than availability
- \+ use significantly more than availability

[3] Includes *Betula papyrifera*, *Betula neoalaskana* and *Betula occidentalis*.

Table 18. Occurrence of *M. pennsylvanicus* in relation to habitat types and relative habitat use (using the Bonferoni z statistic with a 95% confidence coefficient).

Tree Cover Type	Proportion of All Habitats Sampled[1]	Number of Captures	Proportion of Total Captures	Habitat Use[2]
Trembling aspen	0.13	16	0.13	0
Balsam poplar	0.03	0	0.00	[4]
White spruce	0.18	30	0.24	0
Black spruce	0.29	13	0.10	-
Tamarack	0.02	2	0.02	0
Balsam fir	0.08	7	0.06	0
Jack pine	0.14	2	0.02	-
Birches[3]	0.04	6	0.05	0
No trees	0.09	47	0.38	+

[1] The proportion of 1235 habitat sampling points represented by the tree cover type.

[2] Habitat use related to habitat availability:

- 0 use equivalent to availability
- \- use significantly less than availability
- \+ use significantly more than availability

[3] Includes *Betula papyrifera, Betula neoalaskana* and *Betula occidentalis*.

[4] Confidence interval cannot be calculated for a zero value.

Table 19. Occurrence of *P. maniculatus* in relation to habitat types and relative habitat use (using the Bonferoni z statistic with a 95% confidence coefficient).

Tree Cover Type	Proportion of All Habitats Sampled[1]	Number of Captures	Proportion of Total Captures	Habitat Use[2]
Trembling aspen	0.13	27	0.19	0
Balsam poplar	0.03	12	0.08	0
White spruce	0.18	33	0.23	0
Black spruce	0.29	3	0.02	-
Tamarack	0.02	0	0.00	[4]
Balsam fir	0.08	16	0.11	0
Jack pine	0.14	15	0.10	0
Birches[3]	0.04	18	0.13	+
No trees	0.09	20	0.14	0

[1] The proportion of 1235 habitat sampling points represented by the tree cover type.

[2] Habitat use related to habitat availability:
- 0 use equivalent to availability
- \- use significantly less than availability
- \+ use significantly more than availability

[3] Includes *Betula papyrifera, Betula neoalaskana* and *Betula occidentalis.*

[4] Confidence interval cannot be calculated for a zero value.

The specific habitat types that were selected or avoided were determined using a Bonferroni z statistic (Neu *et al.* 1974) (a 95% confidence coefficient was used in all analyses). *C. gapperi* preferred areas dominated by white spruce, balsam fir or birches more than the remaining habitat types and tended to avoid black spruce and jack pine habitat (Table 17). *M. pennsylvanicus* selected areas with no tree cover (e.g., grassland, marsh edges, clearings) and also tended to avoid black spruce and jack pine forests (Table 18). Use of most habitats by *P. maniculatus* was proportionate to their availability--however, areas dominated by *Betula* spp. were selected over other habitats and black spruce areas were avoided (Table 19).

3.6.3 Summary: Habitat Use

Peak population densities on the eight live-trapping areas and the number of captures in nine different habitat types (as defined by the dominant tree species) were used as indices of habitat use. *C. gapperi* on live-trapping areas were most abundant in balsam poplar, tamarack and aspen-white spruce forest. *C. gapperi* captured in snap-trap censuses showed significant preferences for white spruce, balsam fir and birch forests. *M. pennsylvanicus* on live-trapping areas were most abundant in the two naturally-revegetating sites and in tamarack forest. Captures of *M. pennsylvanicus* in snap censuses indicated this species occurred significantly more often in areas with no tree cover. *P. maniculatus* was most abundant in the younger (more open) naturally revegetating area and was also abundant in the Balsam poplar plot. Snap-trap captures of *P. maniculatus* indicated that this species occurred in a number of habitats (in proportions roughly equivalent to habitat availability). However, *P. maniculatus* did show a preference for birch woods.

3.7 DENSITY OF WOODY-STEMMED PLANTS AND SMALL MAMMAL DAMAGE

Densities of trees and shrubs encountered in the vegetation sampling plots on each grid and levels of old and new small mammal damage (girdling and browing) for each species are shown in Tables 20-27. No small rodent damage was recorded for any tree species on the Aspen, Jack pine, Balsam poplar, Poplar Creek cutline, or Thickwoods cutline grids. On the Willow grid, 40% of the *B. glandulosa* showed evidence of old Type 4 (75-100% of the stem circumference was girdled) damage. In terms of all woody stems present, however, only 5% of the available stems were damaged. On the Black spruce grid, 10% of all *L. laricina* sampled showed evidence of new Type 1 damage (0-25% girdling). Ten percent of all *P. tremuloides* sampled showed old Type 1 or Type 2 (25-50% girdling) girdling damage. These three types of damage represent a level of damage for all woody stems of 4%. One percent of all *L. laricina* sampled on the Tamarack grid were damaged (complete girdling or Type 5 damage)--this represents an overall level of damage of only 0.3%. It appears that small rodent girdling damage is a rare phenomena in natural forest habitats or in naturally revegetating areas.

Table 20. Mean density of trees and shrubs and mean percentages of old and new small mammal damage on the Aspen grid. (Damage is expressed as the mean percentage of all stems counted showing damage in the 30 sample plots per grid.)

Grid	Species	Density[1]	% Saplings Newly Damaged					Hare Damage	% Saplings Old Damage					Hare Damage
			Girdling Class[2]						Girdling Class[2]					
			1	2	3	4	5		1	2	3	4	5	
Aspen	*Populus tremuloides*	9083	-	-	-	-	-	-	-	-	-	-	-	-
	Picea glauca	354	-	-	-	-	-	-	-	-	-	-	-	-
	Pinus banksiana	62	-	-	-	-	-	-	-	-	-	-	-	-
	Salix spp.	1479	-	-	-	-	-	trace	-	-	-	-	-	0.5
	Betula glandulosa	667	-	-	-	-	-	-	-	-	-	-	-	0.3
	Alnus spp.	854	-	-	-	-	-	-	-	-	-	-	-	1.2
	Amelanchier alnifolia	6604	-	-	-	-	-	-	-	-	-	-	-	0.1
	Prunus virginiana	42	-	-	-	-	-	-	-	-	-	-	-	0.1
	Rosa woodsii	1583	-	-	-	-	-	-	-	-	-	-	-	0.2
	Betula pumila	21	-	-	-	-	-	-	-	-	-	-	-	-

[1] Density is expressed as the mean number of stems/ha (based on 30 samples/grid).

[2] Girdling classes:
1. 0% < girdling ≤ 25%
2. 25% < girdling ≤ 50%
3. 50% < girdling ≤ 75%
4. 75% < girdling ≤ 100%
5. girdling = 100%

Table 21. Mean density of trees and shrubs and mean percentage of old and new small mammal damage on the Jack pine grid. (Damage is expressed as the mean percentage of all stems counted showing damage in the 30 sample plots per grid.)

Grid	Species	Density[1]	% Saplings Newly Damaged					Hare Damage	% Saplings Old Damage					Hare Damage
			Girdling Class[2]						Girdling Class[2]					
			1	2	3	4	5		1	2	3	4	5	
Jack pine	*Populus tremuloides*	1354	-	-	-	-	-	-	-	-	-	-	-	0.1
	Picea glauca	1125	-	-	-	-	-	-	-	-	-	-	-	0.0
	Salix spp.	333	-	-	-	-	-	-	-	-	-	-	-	0.1
	Betula glandulosa	21	-	-	-	-	-	-	-	-	-	-	-	-
	Alnus spp.	125	-	-	-	-	-	-	-	-	-	-	-	0.2
	Amelanchier alnifolia	2342	-	-	-	-	-	-	trace	-	-	-	-	3.7
	Prunus pensylvanica	21	-	-	-	-	-	-	-	-	-	-	-	-
	Rosa woodsii	7083	-	-	-	-	-	-	-	-	-	-	-	0.6
	Sheperdia canadensis	4437	-	-	-	-	-	0.1	-	trace	-	-	-	0.8
	Lonicera spp.	3333	-	-	-	-	-	-	-	-	-	-	-	0.0
	Symphoricarpos alba	3917	-	-	-	-	-	-	-	-	-	-	-	-
	Vibernum edule	3042	-	-	-	-	-	-	-	-	-	-	-	-
	Rubus melanolasius	21	-	-	-	-	-	-	-	-	-	-	-	-

[1] Density is expressed as the mean number of stems/ha (based on 30 samples/grid).

[2] Girdling classes:
1. $0\% < \text{girdling} \leq 25\%$
2. $25\% < \text{girdling} \leq 50\%$
3. $50\% < \text{girdling} \leq 75\%$
4. $75\% < \text{girdling} \leq 100\%$
5. girdling = 100%

Table 22. Mean density of trees and shrubs and mean percentages of old and new small mammal damage on the Willow grid. (Damage is expressed as the mean percentage of all stems counted showing damage in the 30 sample plots per grid.)

Grid	Species	Density[1]	% Saplings Newly Damaged					Hare Damage	% Saplings Old Damage					Hare Damage
			Girdling Class[2]						Girdling Class[2]					
			1	2	3	4	5		1	2	3	4	5	
Willow	*Populus tremuloides*	333	-	-	-	-	-	-	trace	trace	-	-	-	0.1
	Populus balsamifera	42	-	-	-	-	-	-	-	-	-	-	-	-
	Picea glauca	62	-	-	-	-	-	-	-	-	-	-	-	-
	Picea mariana	875	-	-	-	-	-	-	-	-	-	-	-	-
	Salix spp.	8542	-	-	-	-	-	-	-	-	-	-	-	0.9
	Betula glandulosa	1408	-	-	-	-	-	trace	-	-	trace	0.4	-	6.3
	Rosa woodsii	83	-	-	-	-	-	-	-	-	-	-	-	-
	Ribes hirtellum/ oxycanthoides	21	-	-	-	-	-	-	-	-	-	-	-	-

[1] Density is expressed as the mean number of stems/ha (based on 30 samples/grid).

[2] Girdling classes:
1. $0\% <$ girdling $\leq 25\%$
2. $25\% <$ girdling $\leq 50\%$
3. $50\% <$ girdling $\leq 75\%$
4. $75\% <$ girdling $\leq 100\%$
5. girdling = 100%

Table 23. Mean density of trees and shrubs and mean percentages of old and new small mammal damage on the Balsam poplar grid. (Damage is expressed as the mean percentage of all stems counted showing damage in the 30 sample plots per grid.)

Grid	Species	Density[1]	% Saplings Newly Damaged					Hare Damage	% Saplings Old Damage					Hare Damage
			Girdling Class[2]						Girdling Class[2]					
			1	2	3	4	5		1	2	3	4	5	
Balsam poplar	*Populus tremuloides*	500	-	-	-	-	-	-	-	-	-	-	-	0.1
	Populus balsamifera	1062	-	-	-	-	-	0.1	-	-	-	-	-	0.2
	Picea glauca	42	-	-	-	-	-	-	-	-	-	-	-	-
	Betula neoalaskana	21	-	-	-	-	-	-	-	-	-	-	-	-
	Alnus spp.	7771	-	-	-	-	-	trace	-	-	-	-	-	4.0
	Rosa woodsii	4229	-	-	-	-	-	0.1	-	-	-	-	-	0.3
	Cornus stolonifera	5792	-	-	-	-	-	0.1	-	-	-	-	-	1.2
	Ribes hirtellum/ oxycanthoides	4063	-	-	-	-	-	-	-	-	-	-	-	-
	Symphoricarpos alba	458	-	-	-	-	-	-	-	-	-	-	-	-
	Vibernum edule	2417	-	-	-	-	-	-	-	-	-	-	-	0.2
	Vibernum trilobum	458	-	-	-	-	-	-	-	-	-	-	-	trace
	Rubus melanolasius	1398	-	-	-	-	-	0.9	-	-	-	-	-	0.4
	Ribes triste	5500	-	-	-	-	-	0.3	-	-	-	-	-	0.1
	Ribes americanum	2208	-	-	-	-	-	-	-	-	-	-	-	-

[1] Density is expressed as the mean number of stems/ha (based on 30 samples/grid).

[2] Girdling classes:
1. $0\% < \text{girdling} \leq 25\%$
2. $25\% < \text{girdling} \leq 50\%$
3. $50\% < \text{girdling} \leq 75\%$
4. $75\% < \text{girdling} \leq 100\%$
5. $\text{girdling} = 100\%$

Table 24. Mean density of trees and shrubs and mean percentages of old and new small mammal damage on the Poplar Creek cutline grid. (Damage is expressed as the mean percentage of all stems counted showing damage in the 30 sample plots per grid.)

Grid	Species	Density[1]	% Saplings Newly Damaged					Hare Damage	% Saplings Old Damage					Hare Damage
			Girdling Class[2]						Girdling Class[2]					
			1	2	3	4	5		1	2	3	4	5	
Poplar Creek cutline	*Populus tremuloides*	271	-	-	-	-	-	-	-	-	-	-	-	-
	Populus balsamifera	1417	-	-	-	-	-	-	-	-	-	-	-	-
	Picea glauca	62	-	-	-	-	-	-	-	-	-	-	-	-
	Betula occidentalis	21	-	-	-	-	-	-	-	-	-	-	-	-
	Salix spp.	3396	-	-	-	-	-	-	-	trace	-	-	-	-
	Alnus spp.	479	-	-	-	-	-	-	-	-	-	-	-	-
	Amelanchier alnifolia	83	-	-	-	-	-	-	-	-	-	-	-	-
	Rosa woodsii	6187	-	-	-	-	-	-	-	-	-	-	-	-
	Ribes hirtellum/ oxycanthoides	83	-	-	-	-	-	-	-	-	-	-	-	-
	Ribes americanum	62	-	-	-	-	-	-	-	-	-	-	-	-
	Shepherdia canadensis	42	-	-	-	-	-	-	-	-	-	-	-	-
	Lonicera spp.	104	-	-	-	-	-	-	-	-	-	-	-	-
	Symphoricarpos alba	125	-	-	-	-	-	-	-	-	-	-	-	-
	Vibernum trilobum	1500	-	-	-	-	-	-	-	-	-	-	-	-
	Rubus melanolasius	2771	-	-	-	-	-	-	-	-	-	-	-	-
	Ribes triste	583	-	-	-	-	-	-	-	-	-	-	-	-

[1] Density is expressed as the mean number of stems/ha (based on 30 samples/grid).

[2] Girdling classes:
1. 0% < girdling ≤ 25%
2. 25% < girdling ≤ 50%
3. 50% < girdling ≤ 100%
4. Girdling = 100%

Table 25. Mean density of trees and shrubs and mean percentages of old and new small mammal damage on the Black spruce grid. (Damage is expressed as the mean percentage of all stems counted showing damage in the 30 sample plots per grid.)

Grid	Species	Density[1]	% Saplings Newly Damaged					Hare Damage	% Saplings Old Damage					Hare Damage
			Girdling Class[2]						Girdling Class[2]					
			1	2	3	4	5		1	2	3	4	5	
Black spruce	*Populus tremuloides*	1583	trace	trace	-	-	-	trace	0.1	0.1	trace	-	-	1.0
	Populus balsamifera	42	-	-	-	-	-	-	-	-	-	-	-	trace
	Picea glauca	1146	-	-	-	-	-	0.2	-	-	-	-	-	0.1
	Picea mariana	1021	-	-	-	-	-	-	-	-	-	-	trace	-
	Larix laricina	729	0.1	trace	-	-	-	0.2	-	-	-	-	-	0.6
	Betula neoalaskana	21	-	-	-	-	-	-	-	-	-	-	-	-
	Salix spp.	1004	-	-	-	-	-	0.3	-	-	-	-	-	1.2
	Betula glandulosa	1250	-	-	-	-	0.1	0.2	-	-	-	-	-	0.9
	Rosa woodsii	3521	-	-	-	-	-	-	-	-	-	-	-	0.2
	Ribes hirtellum/ oxycanthoides	21	-	-	-	-	-	-	-	-	-	-	-	-
	Shepherdia canadensis	42	-	-	-	-	-	-	-	-	-	-	-	-
	Ribes triste	146	-	-	-	-	-	trace	-	-	-	-	-	-

[1] Density is expressed as the mean number of stems/ha (based on 30 samples/grid).

[2] Girdling classes:
1. 0% < girdling ≤ 25%
2. 25% < girdling ≤ 50%
3. 50% < girdling ≤ 75%
4. 75% < girdling ≤ 100%
5. girdling = 100%

Table 26. Mean density of trees and shrubs and mean percentages of old and new small mammal damage on the Thickwoods cutline grid. (Damage is expressed as the mean percentage of all stems counted showing damage in the 30 sample plots per grid.)

Grid	Species	Density[1]	% Saplings Newly Damaged					Hare Damage	% Saplings Old Damage					Hare Damage
			Girdling Class[2]						Girdling Class[2]					
			1	2	3	4	5		1	2	3	4	5	
Thickwoods cutline	*Populus tremuloides*	1396	-	-	-	-	-	-	-	-	-	-	-	-
	Populus balsamifera	208	-	-	-	-	-	-	-	-	-	-	-	-
	Abies balsamea	21	-	-	-	-	-	-	-	-	-	-	-	-
	Salix spp.	604	-	-	-	-	-	-	-	-	-	-	-	-
	Alnus spp.	167	-	-	-	-	-	-	-	-	-	-	-	-
	Rosa woodsii	8521	-	-	-	-	-	-	-	-	-	-	-	-
	Ribes americanum	21	-	-	-	-	-	-	-	-	-	-	-	-
	Ribes melanolasius	3083	-	-	-	-	-	-	-	-	-	-	-	-
	Ribes triste	625	-	-	-	-	-	-	-	-	-	-	-	-

[1] Density is expressed as the mean number of stems/ha (based on 30 samples/grid).

[2] Girdling classes:
1. 0% < girdling ≤ 25%
2. 25% < girdling ≤ 50%
3. 50% < girdling ≤ 75%
4. 75% < girdling ≤ 100%
5. Girdling = 100%

Table 27. Mean density of trees and shrubs and mean percentages of old and new small mammal damage on the Tamarack grid. (Damage is expressed as the mean percentage of all stems counted showing damage in the 30 sample plots per grid.)

Grid	Species	Density[1]	% Saplings Newly Damaged					Hare Damage	% Saplings Old Damage					Hare Damage
			Girdling Class[2]						Girdling Class[2]					
			1	2	3	4	5		1	2	3	4	5	
Tamarack	*Populus tremuloides*	1604		-	-	-	-	-	-	-	-	-	-	-
	Picea mariana	2042	-	-	-	-	-	-	-	-	-	-	-	0.6
	Larix laricina	5667	-	-	-	-	-	0.3	-	-	trace	trace	1.1	3.6
	Abies balsamea	21	-	-	-	-	-	-	-	-	-	-	-	-
	Betula neoalaskana	125	-	-	-	-	-	-	-	-	-	trace	-	-
	Salix spp.	4979	-	-	-	-	-	0.3	-	-	-	-	-	1.5
	Betula glandulosa	437	-	trace	-	-	-	2.7	-	-	-	-	-	14.4

[1] Density is expressed as the mean number of stems/ha (based on 30 samples/grid).

[2] Girdling classes:
1. 0% < girdling $\leq$ 25%
2. 25% < girdling $\leq$ 50%
3. 50% < girdling $\leq$ 75%
4. 75% < girdling $\leq$ 100%
5. Girdling = 100%

4. RESULTS: *LEPUS AMERICANUS*

4.1 POPULATION CHANGES

Snowshoe hare populations were live-trapped at bi-weekly intervals to obtain estimates of population density--I have used MNA estimates of population size (as previously described for small rodents). Because population estimates of *L. americanus* are subject to biases similar to those already described for small rodents, I again attempted to minimize these biases by (1) ensuring that each area was saturated with traps (i.e., by using a small inter-trap distance) and (2) by only using MNA estimates when the trappability exceeded 50%.

4.1.1 Trappability

Estimates of trappability were derived for snowshoe hares on the four snowshoe hare study plots to provide an indication of the reliability of MNA estimates of population size. Minimum unweighted trappabilities were calculated for each population (using the formula already described for small rodents) for the summer period (30 June-20 September) and the fall period (21 September-17 November). These are shown in Table 28.

Estimates of trappability for the total population always exceeded 50%--MNA estimates should consequently underestimate the trappable population size by acceptably small amounts. Although the trappability of male *L. americanus* on the Jack pine grid in the summer period was very low, this was based on a small sample (N=4).

4.1.2 Changes in Population Size

MNA estimates of population size for snowshoe hares on the four study plots are shown in Figure 33. Because young animals or trap-shy animals may be excluded from traps, MNA estimates apply only to the trappable population. Changes in the MNA estimates of the trappable population suggest several important trends:

Table 28. Seasonal estimates of minimum unweighed trappability (MUT), 30 June-15 November 1978.

Grid	Species	SUMMER (30 JUNE-20 SEPT.)					FALL (21 SEPT.-15 NOV.)				
		MALES		FEMALES			MALES		FEMALES		
		MUT	N	MUT	N	TOTAL	MUT	N	MUT	N	TOTAL
Jackpine Grid	*L. americanus*	25.0	4	91.67	4	58.33	77.78	3	62.50	4	69.05
Aspen Grid	"	50.0	2	64.29	7	61.11	50.00	2	66.67	3	60.00
Balsam Poplar	"	71.11	6	65.63	8	67.98	89.58	8	88.10	7	88.89
Black Spruce	"	79.25	20	60.65	18	70.44	64.86	16	96.67	14	79.10

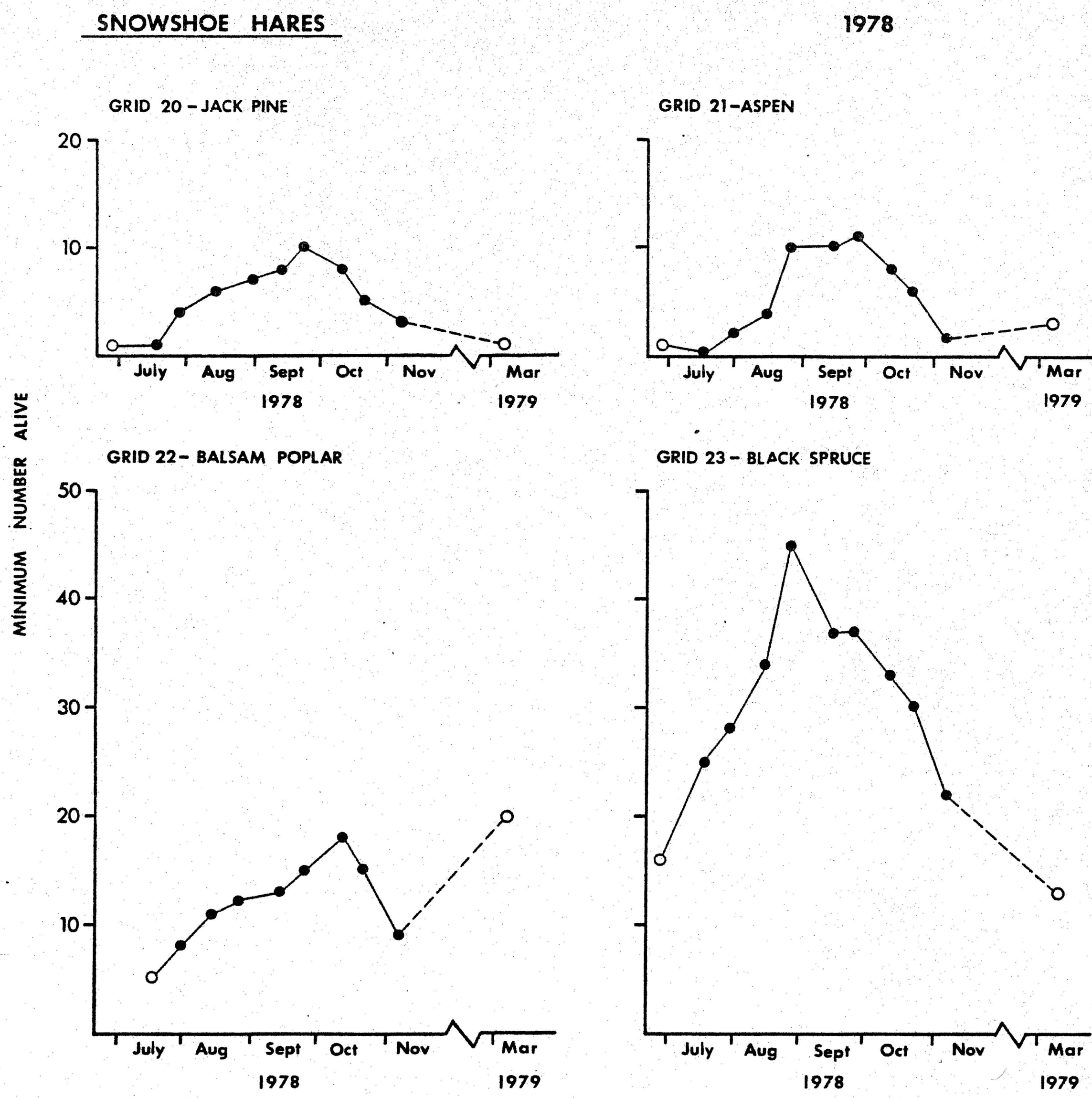

Figure 33. The minimum number shown to be alive (MNA) of *L. americanus* on the four study plots. (Open points indicate that the estimate is based only on the actual number of animals captured during that trapping period. The solid points indicate the estimate is based on the MNA.)

1. Snowshoe hares were most abundant in black spruce habitat followed by balsam poplar, aspen and jack pine forest.
2. Snowshoe hare populations on the Jack pine, Aspen and Balsam poplar grids increased gradually over the summer, reaching a seasonal peak in late September to mid-October. These populations then declined through late October and early November.
3. The snowshoe hare population on the Black spruce grid increased rapidly from July to mid-August, then declined throughout the fall period.
4. Populations on the Black spruce grid declined over winter whereas populations on the Balsam poplar grid increased over winter. Populations on the Jack pine and Aspen grid showed little change over winter.

4.2 POPULATION STRUCTURE

4.2.1 Age Distributions

Two age classes of snowshoe hares were recognized, juveniles and adults. Juveniles were defined as animals weighing less than 1100 g. Animals weighing more than 1100 g were defined as adults. Age distributions of snowshoe hares for each bi-weekly period on the four study areas are shown in Table 29.

Most snowshoe hares on the Jack pine and Balsam poplar grids were adults. Few juveniles were captured on either grid. Conversely, most snowshoe hares on the Aspen and Black spruce grids were juveniles. Notably, juveniles snowshoe hares were quite abundant throughout July and August on the Black spruce grid. Number of juveniles on the Aspen grid, however, were highest in late August to late September.

Table 29. Age distribution of snowshoe hares (July-November 1978 and March 1979). (Adults [A] were animals weighing more than 1100 g, juveniles [J] were animals weighing less than 1100 g.)

Area	2 July		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.		2 March	
	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J
Jack pine	0	1	1	0	3	1	3	0	4	1	7	0	8	1	7	0	3	0	3	0	1	0
Aspen	0	1	0	0	1	1	1	2	4	6	2	5	4	5	4	2	4	2	0	0	3	0
Balsam poplar	1	5	3	2	3	4	9	0	5	3	7	2	9	2	12	16	10	4	7	1	18	0
Black spruce	2	14	3	17	7	16	11	14	16	17	17	11	22	9	20	8	20	7	14	7	13	0

4.2.2 Sex Ratios

Sex ratios, expressed as the proportion of the total number of animals of the appropriate class that were males, were calculated for juveniles and for adult snowshoe hares. Sex ratios for each trapping period are shown in Table 30. In all cases, sex ratios did not differ significantly from 0.5

4.3 REPRODUCTION

Reproductive attributes of snowshoe hare populations on each of the study areas were assessed using information about external indices of reproduction that was gathered during live-trapping. Male hares captured on live-trapping plots were considered to be in breeding condition if their testes were scrotal. Females were considered to be in breeding condition if their nipples were enlarged. Females were noted as being pregnant if the abdomen was obviously distended and/or if embryos were present (by palpation of the abdomen). The proportions of adult males and of adult females that were in breeding condition during each trapping period are shown in Table 31. Generally, most adult males were reproductively active up until mid-August and, by October, no males were in breeding condition. Moderate to high numbers of female snowshoe hares were in breeding condition in July and August but by mid-September most females were no longer breeding. Females on the Black spruce grid were exceptional, however, in that some females were reproductively active until mid-October. One breeding female was also captured on the Jack pine grid in September. No obviously pregnant females were captured on the Jack pine, Aspen or Balsam poplar grids. One pregnant snowshoe hare was captured on the Black spruce grid in mid-August.

4.4 DISTRIBUTION OF BODY WEIGHTS

Body weight was used as an index of nutritional condition (Table 32). Comparisons of the mean body weights of adult snowshoe hares and of juvenile snowshoe hares on each study area indicated that body weights of adult and juvenile snowshoe hares did not differ significantly among the 4 study areas (Friedman's two-way analysis of

Table 30. Sex ratios of juvenile (J) and adult (A) snowshoe hares on the four study areas. (Sex ratios are expressed as the proportion of the animals of the appropriate age class captured that were males. Sample sizes are identical to those shown in Table 29.)

Grid	2 July		20 July		2 Aug.		16 Aug.		29 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.		2 March	
	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J
Jack pine	-	0.00	1.00	-	0.67	0.00	0.67	-	0.25	1.00	0.43	-	0.50	1.00	0.43	-	0.33	-	0.67	-	1.00	-
Aspen	-	1.00	-	-	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.20	0.50	0.20	0.50	0.50	0.25	0.50	0.00	0.50	0.67	-
Balsam poplar	-	0.50	0.00	0.50	0.00	0.67	0.33	0.00	0.40	0.50	0.54	0.50	0.44	1.00	0.50	0.50	0.50	0.50	0.54	1.00	0.25	-
Black spruce	0.00	0.29	0.67	0.53	0.57	-.56	0.54	0.64	0.38	0.53	0.53	0.54	0.41	0.56	0.45	0.50	0.50	0.57	0.64	0.43	0.62	-

Table 31. Proportion of male and female adult *L. americanus* in breeding condition. (Numbers of each sex captured in each period are indicated.)

Sex	Grid	2 July		20 July		2 Aug		16 Aug		28 Aug		16 Sept		26 Sept		16 Oct		27 Oct		9 Nov	
		Prop	N	Prop	N	Prop	N	Prop	N	Prop	N	Prop	N	Prop	N	Prop	N	Prop	N	Prop	N
Males	Jack pine	-	0	-	0	0.50	2	0.00	1	1.00	1	0.00	3	0.25	4	0.00	3	0.00	1	0.00	2
	Aspen	-	0	-	0	-	0	-	0	0.50	2	-	0	0.00	2	0.00	2	0.00	1	-	0
	Balsam poplar	-	0	-	0	-	0	0.67	3	0.00	1	0.00	4	0.00	4	0.00	6	0.00	5	0.00	4
	Black spruce	-	0	1.00	2	0.75	4	0.33	2	0.00	6	0.00	9	0.00	9	0.00	9	0.00	10	0.00	9
Females	Jack pine	-	0	-	0	1.00	1	0.50	2	0.33	3	0.00	4	0.25	4	0.00	4	0.00	1	0.00	1
	Aspen	-	0	-	0	1.00	1	1.00	1	1.00	2	0.00	2	0.00	2	0.00	2	0.00	3	-	0
	Balsam poplar	0.00	1	0.00	3	0.67	3	0.17	6	0.33	3	0.00	3	0.20	5	0.00	6	0.00	5	0.00	5
	Black spruce	1.00	2	1.00	1	0.67	3	0.60	5	0.30	10	0.13	8	0.31	13	0.09	11	0.00	10	0.00	5

Table 32. Mean bi-weekly weights of adult and juvenile snowshoe hares. (The mean weight and sample size are shown. The standard error of the mean is included in parentheses.)

Age Class	Area	2 July		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.		2 March	
		$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N
Adults	Jack pine	-	0	1555	1	1350 (270)	3	1353 (193)	3	1423 (83)	4	1411 (66)	5	1436 (142)	8	1481 (150)	7	1370 (240)	2	1456 (76)	3	1490	1
	Aspen	-	0	-	0	1150	1	1535	1	1441 (125)	4	1498 (11)	2	1328 (75)	4	1290 (108)	4	1228 (78)	4	-	0	1363 (20)	3
	Balsam poplar	-	0	1708 (189)	3	1442 (255)	3	1361 (111)	9	1336 (147)	5	1332 (100)	7	1340 (94)	9	1365 (94)	12	1324 (106)	10	1319 (135)	7	1307 (101)	18
	Black spruce	-	0	1592 (382)	3	1347 (115)	5	1366 (232)	11	1314 (189)	16	1326 (129)	17	1388 (133)	22	1376 (129)	20	1353 (126)	23	1388 (114)	14	1345 (102)	13
Juveniles	Jack pine	195	1	-	0	1050	1	-	0	530	1	-	0	880	1	-	0	-	0	-	0	-	0
	Aspen	785	1	-	0	1025	1	398	2	561 (175)	6	894 (120)	5	910 (71)	5	1090 (0)	2	1065 (35)	2	-	0	-	0
	Balsam poplar	772 (34)	5	963 (18)	2	919 (263)	4	-	0	813 (180)	3	930 (106)	2	765 (177)	2	1019 (51)	6	927 (22)	3	980	1	-	0
	Black spruce	683 (147)	12	756 (291)	17	810 (209)	17	768 (297)	13	780 (253)	16	685 (191)	12	773 (121)	9	913 (66)	7	945 (50)	7	946 (83)	5	-	0

variance; for adults: $\chi^2=4.60$; $N_r=9$; $K=4$; $0.30>p>0.20$ and for juveniles: $\chi^2=4.57$: $N_r=7$: $K=3$; $0.80>p>0.70$). Juveniles on the Jack pine grid were not included in the analysis because of the high number of trapping periods on this area when no juveniles were captured.

4.5 POPULATION LOSSES AND RECRUITMENT

As already discussed for small rodents, it is important to understand how mortality, natality, emigration and immigration affect population changes within a habitat, particularly if population densities are used as an index of habitat utilization. Analyses of survival and recruitment rates and an examination of the proportion of animals within each population that were resident were used as indices of these sources of population loss and recruitment.

4.5.1 Survival and Recruitment Rates

Survival rates and recruitment rates were calculated according to the methods already described for small rodents and are shown in Table 33. Total survival rates for *L. americanus* on the Jack pine grid were high throughout the summer and early fall then declined slowly to moderately low rates in November. Survival rates of snowshoe hares on the Aspen grid remained moderate throughout the summer and fall (except in early September when survival rose to 90%) whereas survival rates of snowshoe hares on the Balsam poplar and Black spruce grids remained high throughout the same period. Recruitment rates on all areas were moderate to high in August, declined in September and were low in October.

4.5.2 Resident and Transient Animals

The number of resident and transient animals in each study population of snowshoe hares was determined using the criteria already described for small rodents. The numbers of resident and transient animals on each study area are shown in Table 34. Differences in the numbers of resident and transient male and female snowshoe hares on

Table 33. Bi-weekly estimates of minimum survival rates (S) and recruitment rates (R) for male and female *L. americanus*.

Grid	Sex	20 July		2 Aug.		16 Aug.		29 Aug.		16 Sept.		26 Sept.		6 Oct.		27 Oct.		9 Nov.	
		S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
Jack pine																			
	Males	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.50	1.00	0.00	0.75	0.40	0.60	0.00	1.00	0.00	0.67	0.00
	Females	0.00	0.00	0.00	1.00	1.00	0.50	1.00	0.33	1.00	0.25	1.00	0.25	0.80	0.25	0.40	0.00	0.00	1.00
	Total	0.00	0.00	0.00	1.00	1.00	0.66	1.00	0.40	1.00	0.14	0.88	0.33	0.70	0.14	0.63	0.00	0.40	0.33
Aspen	Males	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.50	1.00	1.00	0.66	0.75	0.33	0.50	0.00	0.00	0.00
	Females	0.00	1.00	0.00	1.00	0.50	1.00	0.75	0.75	1.00	0.00	0.63	0.33	0.71	0.00	0.75	0.25	0.00	0.00
	Total	0.00	1.00	0.00	1.00	0.50	1.00	0.75	0.80	0.90	0.14	0.70	0.44	0.73	0.16	0.63	0.16	0.00	0.00
Balsam poplar	Males	0.33	0.00	1.00	0.66	0.67	0.66	1.00	0.33	0.80	0.40	0.83	0.40	0.86	0.33	0.78	0.00	0.71	0.00
	Females	0.33	0.75	0.75	0.25	0.80	0.50	0.57	0.60	0.86	0.25	0.86	0.33	0.88	0.22	0.89	0.00	0.50	0.00
	Total	0.33	0.60	0.80	0.43	0.75	0.55	0.73	0.50	0.83	0.33	0.85	0.36	0.87	0.29	0.83	0.00	0.60	0.00
Black spruce	Males	1.00	0.73	0.83	0.38	0.93	0.33	0.89	0.33	0.86	0.06	0.79	0.28	0.79	0.23	0.89	0.00	0.53	0.16
	Females	0.75	0.44	0.69	0.50	0.93	0.30	0.88	0.55	0.71	0.08	0.78	0.23	0.83	0.00	0.73	0.15	0.69	0.11
	Total	0.81	0.60	0.76	0.43	0.93	0.32	0.88	0.45	0.78	0.07	0.78	0.26	0.81	0.11	0.82	0.15	0.60	0.14

Table 34. Numbers of resident (R) and transient (T) *L. americanus* on each study area.

Grid	Males		Females		Total		Residency[1] Ratio
	R	T	R	T	R	T	
Jack pine	2	5	3	3	5	8	0.38
Aspen	1	5	4	7	5	12	0.29
Balsalm poplar	5	7	9	6	14	13	0.52
Black spruce	18	13	18	20	36	33	0.52

[1] Proportion of all animals captured that were residents.

each grid were not significant. Comparisons of the total number of transient and resident animals on each grid indicated that there were no significant inter-grid differences (χ^2=3.33; df=6; 0.80>p>0.70). It would appear that most snowshoe hare populations are composed of approximately equal proportions of resident and transient animals.

4.6 HABITAT USE

Indices of habitat use by *L. americanus* were obtained by comparing peak population densities on each study area. As discussed earlier for small rodents, this assumes that population densities are an adequate index of habitat use. Peak population densities for snowshoe hare populations on the Jack pine, Aspen, Balsam poplar and Black spruce grids were 1.8, 1.9, 3.6 and 7.9 hares/ha respectively. This suggests that *L. americanus* most commonly inhabit black spruce areas in the summer and fall periods, followed by balsam poplar, aspen and jack pine forests. Spring densities on the four study areas (early March) were 0.2, 0.5, 4.0 and 2.3 hares/ha respectively suggesting that balsam poplar habitat is used frequently throughout the year.

4.7 DENSITY OF WOODY-STEMMED PLANTS AND DAMAGE BY SNOWSHOE HARES

Densities of trees and shrubs encountered on each study plot and levels of old and new small mammal damage have already been described for small rodents (Tables 20-27). New browsing of trees and shrubs was most common on the Tamarack grid (0.23% of all woody plants were browsed), followed by Balsam poplar (0.10%), Black spruce (0.09%) and Jack pine (0.01%) grids. Trace levels of new girdling damage were observed on the Aspen and Willow grids. No woody-stemmed plants on the two cutline grids showed evidence of browsing by snowshoe hares. Evidence of recent browsing was most frequently found on *Salix* spp., *B. glandulosa*, *R. melanolasius* and *L. laricina*. Old browsing of trees and shrubs was also most common on the Tamarack grid

(2.3% of all woody stems were damaged) followed by the Willow (1.7%), Jack pine (0.6%), Black spruce (0.5%), Balsam poplar (0.3%) and Aspen (0.1%) grids. Again, no evidence of browsing of woody plants by snowshoe hares was found on the two cutline grids. Evidence of old snowshoe hare browse was most frequent on *B. glandulosa*, *Salix* spp. *A. alnifolia*, *L. laricina*, *S. canadensis* and *C. stolonifera*.

5. DISCUSSION

5.1 LIMITS OF THE ANALYSIS

The 5-month field study of small mammal populations in natural habitats and in naturally revegetating areas has provided detailed information on the density, population structure, reproduction, nutritional condition, population losses and recruitment of *C. gapperi*, *M. pennsylvanicus*, *P. maniculatus* and *L. americanus* during the summer and fall periods. The early spring to early summer period is an extremely important period of the year in terms of the demography (particularly reproduction) and nutritional conditions of small mammals (Fuller 1969; Keith and Winberg 1978; Green 1979a). Because small mammal populations have not yet been sampled during the spring period, full seasonal comparisons of population change, reproduction, recruitment (birth and immigration), population losses (death and emigration) and nutritional condition are not possible. As a result, analyses of small mammal demographic data and habitat structure information presented in this report are preliminary in nature and conclusions based on these analyses are tentative.

5.2 DEMOGRAPHIC TRENDS AND HABITAT USE

5.2.1 *Clethrionomys gapperi*

The characteristics of *C. gapperi* populations in the six natural habitat and two naturally revegetating areas are shown in Table 35. On the basis of peak population densities on each study plot, the most heavily utilized habitats were mature balsam poplar forest, mixed aspen-white spruce forest and tamarack-black spruce bog. Snap-trap indices of habitat use, however, indicated that the proportion of *C. gapperi* captured in areas dominated by balsam poplar, aspen or tamarack tree cover was equivalent to the availability of that habitat type. Significantly greater proportions of the total number of *C. gapperi* captured were taken in areas dominated by white spruce, balsam fir or birch tree cover suggesting that *C. gapperi* prefer these habitats.

Table 35. Population characteristics of *C. gapperi* on the eight study areas (July-November, 1978).

Characteristic	Aspen	Jack pine	Willow	Balsam Poplar	Black Spruce	Tamarack	Poplar Creek cutline	Thickwoods cutline
Population trends	- increase to late Sept., decrease in Oct.	- gradual increase to late Oct.	- gradual increase to late Oct.	- increase to high peak in late Sept., small decline in Oct.	- increase to Sept., small decline in Oct.	- study increase to high peak in Sept., small decline in Oct.	- moderate numbers in summer, in fall.	- small increase to early Aug., moderate numbers until Oct.
Peak density (animals/ha)	84.0	34.6	48.1	116.0	54.3	84.0	73.2	35.2
Predominant age class[1]	- SA & A in summer. - SA in fall.	- A in July, SA in Aug. - Oct.	- steady increase in SA	- A in July; increase SA in fall.	- A in July; increase SA in fall.	- mostly SA	- mostly SA, some A.	- mostly SA
Sex ratio[2]	- equal	- equal	- More males	- equal	- more males	- more males	- equal	- more males
Cessation of breeding[3]								
Males	- late Aug.	- mid-Aug.	- late Aug.	- mid-Oct.	- late Aug.	- late Aug.	- late Aug.	- mid-Sept.
Females	- late Sept.	- late Sept.	- late Oct.	- mid-Sept.	- late Sept.	- late Sept.	- late Sept.	- late Sept.
Pregnancy rates	- no pregnancies	- moderate	- no pregnancies	- low	- no pregnancies	- no pregnancies	- low	- no pregnancies
Condition: Body Weight[4]	- smaller	- average	- smaller	- average	- average	- smaller	- average	- larger
Survival	- moderate to high	- high	- moderate increasing to high	- high	- moderate to high	- high	- moderate	- moderate to high
Recruitment	- moderate to high	- moderate; decreasing	- moderate, decreasing in fall	- moderate	- high, steady decline to Oct.	- high, steady decline to Oct.	- moderate, steady decline to late Sept.	- high, steady decrease to Sept.
Residency Ratio[5]	0.48	0.47	0.56	0.51	0.58	0.56	0.34	0.37

[1] J = juveniles; SA = sub-adults; A = adults.

[2] No sex ratios were significantly different from 1:1 but consistent trends in data are indicated.

[3] Dates shown are the last period of the summer/fall period in which at least 50% of the animals were breeding.

[4] Based on comparisons of bi-weekly near body weight (Section 3.4.1).

[5] Number of resident animals/total number of animals.

The characteristics of *C. gapperi* populations in each habitat type will not be evaluated until a more complete data base has been obtained for the full early spring to early winter period. Preliminary data (Table 35) suggest that populations of *C. gapperi* in most mature forested areas are relatively stable (i.e., a high proportion of resident animals) whereas populations on recently-disturbed but naturally-revegetating areas are more transient (i.e., a high proportion of animals remained on the area for only 6 weeks or less). No clear trends in population structure, reproduction, condition, survival or recruitment were apparent between different habitat types.

5.2.2 *Microtus pennsylvanicus*

The characteristics of *M. pennsylvanicus* populations in each of the six natural habitat and two successional areas are summarized in Table 36. Based on comparisons of peak population densities on each grid, *M. pennsylvanicus* most commonly utilized early successional areas and tamarack forest. This agrees well with the results of snap-trap censuses which indicated that proportionately greater numbers of *M. pennsylvanicus* were captured in areas lacking tree cover (e.g., grass meadows, marsh areas, edges of water courses or waterbodies, willow scrub) than would be expected according to habitat availability. However, snap-trap indices of habitat use did not indicate a preference for tamarack habitat.

Populations in black spruce forest, willow scrub and early successional areas (i.e., the two cutline grids) had the highest proportions of resident animals. Populations in balsam poplar and jack pine forests, however, were composed largely of transient animals. More detailed analyses will be conducted following the collection of a more substantial data base in 1979.

5.2.3 *Peromyscus maniculatus*

The characteristics of *P. maniculatus* populations on each of the eight study areas are shown in Table 37. The highest densities

Table 36. Population characteristics of *M. pennsylvanicus* on the eight study areas (July-November, 1978).

Characteristic	Aspen	Jack pine	Willow	Balsam Poplar	Black Spruce	Tamarack	Poplar Creek cutline	Thickwoods cutline
Population trends	- low numbers	- low numbers, small peak in late Aug.	- increase to early Sept., small fall decline	- low numbers	- rapid increase to mid-Aug., decline to Oct.	- steady increase to moderate peak in early Sept., rapid decline in Oct.	- rapid increase to high numbers in early Sept., small decline in Oct.	- rapid increase to high peak in early Sept., decline in Oct.
Peak density (animals/ha)	14.8	21.0	70.4	9.9	69.1	96.3	154.9	101.4
Predominant age class[1]	- low numbers of all age classes	- J & A in July - J & SA in fall	- mixed in July; increase in SA.	- mostly A.	- mixed in July; mostly A in fall.	- mostly A.	- increasing A.	- mostly A in July; SA & A in fall.
Sex ratio[2]	- equal	- equal	- equal	- equal	- more males	- more females	- equal	- equal
Cessation of breeding[3]								
Males	- mid-Sept.	- late Aug.	- mid-Aug.	- mid-Sept.	- late Aug.	- late Aug.	- late Aug.	- late Aug.
Females	- late Sept.	- mid-Sept.	- mid-Sept.	- mid-Aug.	- mid-Sept.	- mid-Aug. (mid-Sept.)	- late Aug.	- late Sept.
Pregnancy rates	- no pregnancies	- no pregnancies	- moderate to low	- moderate	- high	- low	- low	- low
Condition: Body Weight[4]	- smaller	- smaller	- smaller	- average	- larger	- larger	- larger	- larger
Survival	- moderate	- moderate	- moderate increasing to high	- high but variable	- high but variable	- moderate to high	- high	- high
Recruitment	- moderate to low	- moderate to high in Aug., low in fall.	- high, decreasing to low in Sept.	- moderate increasing in fall.	- high in Aug., decline to low levels in Sept.	- high, declining to Sept.	- steady decline to Sept.	- moderate to low
Residency Ratio[5]	0.40	0.27	0.49	0.26	0.50	0.36	0.47	0.48

[1] J = juveniles; SA = sub-adults; A = adults.

[2] No sex ratios were significantly different from 1:1 but consistent trends in data are indicated.

[3] Dates shown are the last period of the summer/fall period in which at least 50% of the animals were breeding.

[4] Based on comparisons of bi-weekly near body weight (Section 3.4.1).

[5] Number of resident animals/total number of animals.

Table 37. Population characteristics of *P. maniculatus* on the eight study areas (July-November, 1978).

Characteristic	Aspen	Jack pine	Willow	Balsam Poplar	Black Spruce	Tamarack	Poplar Creek cutline	Thickwoods cutline
Population trends	- moderate increase to Aug., gradual decline to Oct.	- low numbers	- no captures	- small increase to early Aug., steady decline to Oct.	- low numbers	- no captures	- gradual increase to low peak in early Oct., rapid decline in late Oct.	- moderate numbers all summer and fall, rapid decline in Oct.
Peak density (animals/ha)	27.2	11.1	0.0	48.1	6.2	0.0	25.4	52.1
Predominant age class[1]	- J & SA in summer; SA in fall	- low numbers of SA & A	-	- mostly SA	- mostly SA; some A.	-	- mostly SA	- mostly SA; some A.
Sex ratio[2]	- more females	- more females	-	- equal	- more males	-	- more males	- more males
Cessation of breeding[3]								
Males	- late Aug.(?)	- no breeding	-	- early Aug.	- no breeding	-	- early Aug.	- mid-July
Females	- mid-Aug.(?)	- no breeding	-	- early Aug.	- no breeding	-	- no breeding	- mid-Aug.
Pregnancy rates	- no pregnancies	- no pregnancies	-	- no pregnancies	- no pregnancies	-	- no pregnancies	- moderate to low
Condition: Body Weight[4]	- smaller	- larger	-	- average	- average	-	- average	- larger
Survival	- high	- moderate to high	-	- high, rapid decline in Oct.	- high but variable, rapid drop in Oct.	-	- high, sharp drop in Oct.	- high, sharp drop in Oct.
Recruitment	- moderate; declined in Sept.	- high in July, low in Aug. - Oct.	-	- low	- low to moderate in Aug. & Sept., increase in Oct.	-	- moderate	- moderate in July, low Aug. to Oct.
Residency Ratio[5]	0.61	0.64	-	0.64	0.60	-	0.48	0.60

[1] J = juveniles; SA = sub-adults; A = adults.

[2] No sex ratios were significantly different from 1:1 but consistent trends in data are indicated.

[3] Dates shown are the last period of the summer/fall period in which at least 50% of the animals were breeding.

[4] Based on comparisons of bi-weekly near body weight (Section 3.4.1).

[5] Number of resident animals/total number of animals.

of *P. maniculatus* were observed in young successional, balsam poplar, aspen and older successional habitats. Snap-trap indices of habitat use indicated, however, that most habitats (with the exception of areas dominated by birches) were used to approximately the same extent as would be expected on the basis of the availability of habitat. This is in agreement with the well-described capability of *P. maniculatus* to adapt to a wide range of habitat conditions (Harris 1952; Klein 1960; Getz 1961; Wecker 1963; M'Closkey 1975; Deuser and Shugart 1978). Residency ratios were very similar in the six study areas supporting populations of *P. maniculatus*--resident animals generally were more abundant than transient animals (the Poplar Creek cutline population was the only exception).

5.2.4 *Lepus americanus*

The characteristics of *L. americanus* populations on each of the 4 study areas are summarized in Table 38. On the basis of peak population densities, snowshoe hares most heavily utilized black spruce habitats in the summer and fall followed by balsam poplar, aspen and jack pine habitat. Peak spring densities, however, indicated snowshoe hares most commonly used balsam poplar habitat followed by black spruce, aspen and jack pine forests. These shifts in density may be the result of differential over-winter mortality in each habitat but may also reflect seasonal shifts in habitat use. Populations on the Black spruce and Balsam poplar grids were composed of approximately equal numbers of resident and transient animals whereas the jack pine and aspen areas supported more transient populations. Further analyses of population characteristics within each habitat type will be conducted following the collection of detailed population data throughout the spring to winter period of 1979.

Table 38. Population characteristics of *L. americanus* on the four study areas (July-November, 1978).

Characteristic	Jack Pine	Aspen	Balsam poplar	Black Spruce
Population trends	- moderate increase to Sept., decrease until Nov., low over-wintering population.	- increase to August, high until Oct., then decrease to Nov., low over-wintering population.	- moderate increase to Oct., decline to Nov., increase over-winter.	- rapid increase in July/August, followed by a steady decline to March.
Peak population densities (hares/ha)				
Summer/Fall	1.8	1.9	3.6	7.9
Spring	0.2	0.5	4.0	2.3
Predominant age class[1]	- mostly adults	- mostly juveniles in July & Aug. - more adults in fall.	- mostly adults	- mostly juveniles in July-Aug., more adults in fall.
Sex ratio[2]	- equal	- slight tendency towards more females	- slight tendency towards more females	- slight tendency towards more males
Cessation of breeding[3]				
Males	- 2 Aug.	- 28 Aug.	- 16 Aug.	- 2 Aug.
Females	- 16 Aug.	- 28 Aug.	- 2 Aug.	- 16 Aug.
Body weight	----------no significant differences between habitats----------			
Survival	- high in summer, decline in fall	- moderate	- high	- high
Recruitment	- moderate in Aug. decline in fall.	- high in July & Aug., decline in fall.	- moderate in July & Aug., decline in fall.	- moderate in July & Aug. decline in fall.
Residency Ratio[4]	0.38	0.29	0.52	0.52

[1] J = juveniles; SA = sub-adults; A = adults.

[2] No sex ratios were significantly different from 1:1 but consistent trends in data are indicated.

[3] Dates shown are the last period of the summer/fall period in which at least 50% of the animals were breeding.

[4] Based on comparisons of bi-weekly near body weight (Section 3.4.1).

[5] Number of resident animals/total number of animals.

6. CONCLUSIONS

The relatively short field season and the lack of complete seasonal information on changes in the demography and habitat use of small mammals preclude the formulation of final conclusions at this stage of the research program.

Preliminary analyses of live-trapping and snap-trapping data from natural areas and naturally revegetating areas suggest:

1. *C. gapperi* is most common in mature forested areas (specifically areas with white spruce, balsam fir, birch, balsam poplar or aspen tree cover).
2. *M. pennsylvanicus* most commonly inhabits areas with little or no tree cover--both live-trapping and snap-trapping indices indicate that *M. pennsylvanicus* prefers successional areas or grass-dominated areas (e.g. willow scrub, grass meadows, marshes, edges of waterbodies). Tamarack-black spruce bog was also heavily used.
3. *P. maniculatus* was most abundant in balsam poplar, aspen and successional areas but generally showed no preferences for any particular habitat (except areas dominated by birches).
4. *L. americanus* was most numerous in black spruce forest in the summer and fall followed by balsam poplar, aspen and jack pine forests. In the early spring, however, balsam poplar habitat was most heavily utilized.
5. Data on other species of small mammals (red squirrels, flying squirrels, chipmunks, various species of small rodents and shrews) were insufficient for determination of habitat preferences or analyses of population changes.

Continued research in each study area, particularly in the early spring period, is required.

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8. APPENDICES

Appendix 1. Mean number of animals caught per 100 trap-nights.

Area	Mean Number per 100 Trap-nights					
	July	TN	August	N	October	N
Z. hudsonicus						
AOSERP	0.11 ± 0.069	1748	0.15 ± 0.073	3231	0.0 0.0	1205
Birch Mountain	0.0 0.0	862	-		-	
Muskeg Mountain	-		0.0 0.0	853	-	
Sandune	-		-		0.0 0.0[1]	1012
All areas combined	0.08 ± 0.045	2610	0.12 ± 0.059	4084	0.0 0.0	1205
E. minimus						
AOSERP	0.51 ± 0.226	1748	0.03 ± 0.038	3231	0.0 0.0	1205
Birch Mountain	0.0 0.0	862	-		-	
Muskeg Mountain	-		0.12 ± 0.129	853	-	
Sandune	-		-		0.10 ± 0.098[1]	1012
All areas combined	0.34 ± 0.152	2610	0.05 ± 0.040	4084	-	
P. intermedius						
AOSERP	0.0 0.0	1748	0.03 ± 0.030	3231	0.0 0.0	1205
Birch Mountain	0.23 ± 0.204	862	-		-	
Muskeg Mountain	-		0.0 0.0	853		
Sandune	-		-		0.0 0.0[1]	1012
All areas combined	0.08 ± 0.075	2610	0.02 ± 0.024	4084	0.0 0.0	1205
S. cinerius/hoyi						
AOSERP	0.11 ± 0.132	1748	1.80 ± 0.379	3231	2.24 ± 0.652	1205
Birch Mountain	0.0 0.0	862	-		-	
Muskeg Mountain	-		1.17 ± 0.612	853	-	
Sandune	-		-		0.30 ± 0.201[1]	1012
All areas combined	0.08 ± 0.084	2610	-		2.24 ± 0.652	1205
S. arcticus/obscurus						
Birch Mountain	0.0 0.0	862	-		-	
Muskeg Mountain	-		0.0 0.0	853	-	
Sandune	-		-		0.0 0.0[1]	1012
All areas combined	0.0 0.0	2610	0.02 ± 0.027	4084	0.08 ± 0.067	1205

[1]Richardson Sand Dunes actually trapped 19-22 September.

Appendix 2. Age distribution of small rodents on the Aspen grid.

		July 2[1]			July 20			Aug. 2			Aug. 16			Aug. 28			Sept. 16			Sept. 26			Oct. 16			Oct. 27			Nov. 9		
Sex	Species	J[2]	S[3]	A[4]	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A
Males	*C. gapperi*	0	3	3	0	8	2	0	1	2	1	3	1	1	11	2	1	20	1	1	29	1	0	24	1	0	28	1	1	28	0
	M. pennsylvanicus	1	0	1	1	3	1	0	1	1	2	0	1	1	2	1	0	1	1	2	3	0	1	1	0	0	2	0	0	0	1
	P. maniculatus				1	2	0	0	1	0	0	4	0	0	5	2	0	5	2	0	5	2	0	5	2	0	3	3	0	3	2
Females	*C. gapperi*	0	6	1	0	3	3	0	1	7	0	3	4	0	3	6	0	15	5	4	29	1	0	21	4	1	26	0	0	21	0
	M. pennsylvanicus	0	0	0	0	0	2	0	0	3	1	0	0	2	2	2	1	0	2	0	0	3	1	0	0	0	0	0	0	2	0
	P. maniculatus				4	5	0	6	2	0	3	4	1	3	9	0	2	3	0	4	4	0	0	0	0	3	4	0	3	2	0

[1]Date shown is the mid-point for that trapping period on the eight grids.

[2]J=Juvenile

[3]S=Sub-adult

[4]A=Adult

Appendix 3. Age distribution of small rodents on the Jack pine grid.

Sex	Species	July 2[1]			July 20			Aug. 2			Aug. 16			Aug. 28			Sept. 16			Sept. 26			Oct. 16			Oct. 27			Nov. 9		
		J[2]	S[3]	A[4]	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A
Males	*C. gapperi*	0	2	3	0	1	3	0	3	2	0	1	2	0	7	0	0	9	0	0	13	0	0	15	0	1	13	0	0	19	0
	M. pennsylvanicus	0	0	5	2	0	2	2	0	1	1	1	0	7	1	1	4	5	0	5	2	0	1	4	0	4	1	0	3	1	0
	P. maniculatus	0	1	0	0	1	0	0	0	1	1	0	2	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	1	1
Females	*C. gapperi*	0	2	1	1	0	4	0	2	3	0	0	4	0	1	2	0	6	2	0	5	3	1	6	1	0	10	1	0	8	1
	M. pennsylvanicus	0	0	2	3	0	3	4	0	5	3	1	2	5	0	3	3	2	2	4	1	1	1	1	0	1	1	0	1	0	1
	P. maniculatus	1	2	0	0	5	0	0	1	1	0	4	1	0	2	0	0	1	0	0	1	0	0	2	0	0	2	0	0	2	0

[1]Date shown is the mid-point for that trapping period on the eight grids.

[2]J=Juvenile

[3]S=Sub-adult

[4]A=Adult

Appendix 4. Age distribution of small rodents on the Willow grid.

Sex	Species	July 2[1]			July 20			Aug. 2			Aug. 16			Aug. 28			Sept. 16			Sept. 26			Oct. 16			Oct. 27			Nov. 9		
		J[2]	S[3]	A[4]	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A
Males	*C. gapperi*				0	2	1	0	4	0	0	5	1	0	5	1	1	13	0	1	16	0	1	16	1	0	23	1	0	22	1
	M. pennsylvanicus	3	0	10	6	7	4	3	8	5	5	9	2	2	8	4	5	11	4	3	14	7	0	9	6	1	17	7	6	13	1
	P. maniculatus													No *P. maniculatus*																	
Females	*C. gapperi*				0	0	2	0	0	0	0	1	2	0	2	2	0	3	0	0	4	1	0	8	2	0	12	2	0	10	1
	M. pennsylvanicus	6	1	7	2	0	9	5	3	7	4	3	7	5	12	8	8	10	4	1	21	4	2	10	2	7	11	4	10	10	3
	P. maniculatus													No *P. maniculatus*																	

[1] Date shown is the mid-point for that trapping period on the eight grids.

[2] J=Juvenile

[3] S-Sub-adult

[4] A=Adult

Appendix 5. Age distribution of small rodents on the Balsam poplar grid.

		July 2[1]			July 20			Aug. 2			Aug. 16			Aug. 28			Sept. 16			Sept. 26			Oct. 16			Oct. 27			Nov. 9		
Sex	Species	J[2]	S[3]	A[4]	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A
Males	*C. gapperi*	2	4	10	1	13	14	0	17	9	2	22	9	1	34	5	1	42	2	1	43	2	0	36	2	0	39	2	0	37	0
	M. pennsylvanicus	0	0	4	0	2	3	0	0	1	0	0	2	0	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	3	0
	P. maniculatus	2	7	3	1	6	3	0	8	2	0	10	2	0	10	2	0	12	2	0	7	1	0	3	4	1	3	2	0	0	3
Females	*C. gapperi*	0	8	14	0	7	15	3	7	17	0	17	11	3	17	16	1	22	9	1	30	5	1	21	8	1	28	6	1	27	9
	M. pennsylvanicus	0	0	3	0	0	2	0	0	2	0	0	2	0	1	3	2	0	2	0	0	1	0	0	1	0	3	1	0	2	0
	P. maniculatus	0	10	4	2	13	4	4	12	1	2	10	2	3	11	2	1	8	1	2	9	1	0	5	0	0	9	0	0	1	0

[1]Date shown is the mid-point for that trapping period on the eight grids.

[2]J=Juvenile

[3]S=Sub-adult

[4]A=Adult

Appendix 6. Age distribution of small rodents on the Poplar Creek cutline grid.

		July 2[1]			July 20			Aug. 2			Aug. 16			Aug. 28			Sept. 16			Sept. 26			Oct. 16			Oct. 27			Nov. 9		
Sex	Species	J[2]	S[3]	A[4]	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A
Males	*C. gapperi*							2	6	1	0	18	2	1	3	2	0	18	2	0	14	2	0	13	2	2	10	3	0	7	2
	M. pennsylvanicus							7	11	12	3	5	11	5	7	17	1	3	28	0	1	34	0	3	35	0	3	32	0	4	48
	P. maniculatus							1	3	1	0	6	0	0	7	0	0	9	0	0	7	4	0	5	4	0	8	5			
Females	*C. gapperi*								5	5	0	21	10	0	17	10	0	23	5	0	13	4	0	14	5	0	15	3	0	11	0
	M. pennsylvanicus							2	5	13	3	10	18	4	6	24	2	12	33	0	5	33	0	8	26	0	9	24	1	5	33
	P. maniculatus							0	3	0	1	0	0	0	1	0	0	1	1	0	3	0	0	6	0	0	5	0			

[1]Date shown is the mid-point for that trapping period on the eight grids.

[2]J=Juvenile

[3]S=Sub-adult

[4]A=Adult

Appendix 7. Age distribution of small rodents on the Black spruce grid.

		July 2[1]			July 20			Aug. 2			Aug. 16			Aug. 28			Sept. 16			Sept. 26			Oct. 16			Oct. 27			Nov. 9		
Sex	Species	J[2]	S[3]	A[4]	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A
Males	*C. gapperi*	0	1	3	2	0	4	0	5	4	0	8	4	0	15	2	0	17	0	0	24	2	1	21	1	2	22	1	0	23	2
	M. pennsylvanicus	0	1	7	0	0	6	4	5	7	12	10	9	8	13	13	0	5	15	1	2	22	0	7	10	1	10	3	2	5	4
	P. maniculatus							0	2	0	0	4	0	0	1	1	0	2	1	0	2	1	0	2	0	0	0	1			
Females	*C. gapperi*	0	1	0	0	1	3	1	2	4	0	4	4	0	9	4	1	7	4	0	10	2	2	7	1	0	10	2	0	6	1
	M. pennsylvanicus	0	0	3	0	0	6	2	1	9	3	0	11	2	8	11	3	6	9	1	6	12	1	4	3	2	6	1	3	4	1
	P. maniculatus							0	0	0	0	0	0	0	1	0	0	2	0	0	2	0	0	2	0	0	1	0			

[1]Date shown is the mid-point for that trapping period on the eight grids.

[2]J=Juvenile

[3]S=Sub-adult

[4]A=Adult

Appendix 8. Age distribution of small rodents on the Thickwoods cutline.

Sex	Species	July 2[1]			July 20			Aug. 2			Aug. 16			Aug. 28			Sept. 16			Sept. 26			Oct. 16			Oct. 27			Nov. 9		
		J[2]	S[3]	A[4]	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A
Males	*C. gapperi*	0	0	0	0	3	1	0	7	0	0	8	2	1	6	1	1	11	2	0	6	2	1	11	0	0	16	0	0	10	0
	M. pennsylvanicus	0	0	4	0	0	10	0	0	6	2	4	10	8	9	10	4	16	16	0	9	14	0	6	15	0	9	11	0	12	8
	P. maniculatus	2	1	3	2	8	2	3	12	3	0	14	2	1	13	2	0	11	4	0	8	6	0	12	5	0	11	3	0	3	0
Females	*C. gapperi*	0	1	1	0	1	1	0	1	2	0	4	7	0	1	4	0	1	4	0	1	2	0	4	2	0	7	1	0	2	1
	M. pennsylvanicus	0	0	3	0	0	14	0	1	16	3	0	20	3	6	18	5	6	17	6	4	17	0	7	14	0	9	7	0	5	7
	P. maniculatus	2	1	3	3	3	3	3	7	4	1	6	4	1	5	3	0	10	1	0	7	3	0	14	1	0	13	1	0	2	0

[1]Date shown is the mid-point for that trapping period on the eight grids.

[2]J=Juvenile

[3]S=Sub-adult

[4]A=Adult

Appendix 9. Age distribution of small rodents on the Tamarack grid.

		July 2[1]			July 20			Aug. 2			Aug. 16			Aug. 28			Sept. 16			Sept. 26			Oct. 16			Oct. 27			Nov. 9		
Sex	Species	J[2]	S[3]	A[4]	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A	J	S	A
Males	*C. gapperi*	0	0	2	0	2	5	0	10	4	1	10	5	0	16	3	0	18	4	0	25	4	0	23	5	1	21	3	0	25	1
	M. pennsylvanicus	2	0	4	0	4	7	0	7	8	5	8	14	6	11	14	1	7	17	0	2	21	0	4	13	1	4	11	0	2	7
	P. maniculatus													No *P. maniculatus*																	
Females	*C. gapperi*	0	3	1	0	1	2	0	2	4	0	5	1	0	15	4	0	17	2	1	25	5	0	31	4	1	15	4	0	28	1
	M. pennsylvanicus	0	0	4	0	1	9	4	1	9	2	7	16	5	15	22	3	16	12	2	10	13	1	10	14	1	8	11	0	8	12
	P. maniculatus													No *P. maniculatus*																	

[1]Date shown is the mid-point for that trapping period on the eight grids.

[2]J=Juvenile

[3]S=Sub-adult

[4]A=Adult

Appendix 10. Proportion of male *C. gapperi* that were in breeding condition. (Proportions of sub-adults and adults in breeding condition on each grid are indicated.)

Age Class	Grid	2 July[1]		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.	
		Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N
Adults	Aspen	1.00	3	0.50	2	1.00	2	1.00	1	1.00	2	0.00	1	0.00	1	0.00	1	0.00	1	-	0
	Jack pine	0.67	3	0.67	3	1.00	2	1.00	2	-	0	-	0	-	-	-	0	-	0	-	0
	Willow	-	0	1.00	1	-	0	1.00	1	1.00	1	-	0	-	0	0.00	1	0.00	1	0.00	1
	Balsam poplar	1.00	10	1.00	14	1.00	9	0.89	9	1.00	5	0.50	2	1.00	2	0.50	2	0.00	2	-	0
	Poplar Creek					1.00	1	0.50	2	0.50	2	0.00	2	0.00	2	0.00	2	0.00	3	0.00	2
	Black spruce	1.00	3	1.00	4	1.00	4	0.75	4	1.00	2	-	0	0.00	2	0.00	1	-	0	0.00	2
	Thickwoods	-	0	1.00	1	-	0	1.00	2	1.00	1	0.50	2	0.00	2	-	0	-	0	-	0
	Tamarack	1.00	2	1.00	5	1.00	4	1.00	5	1.00	3	0.25	4	0.25	4	0.00	5	0.00	3	0.00	1
	$\bar{x}$	0.95	21	0.80	30	1.0	22	0.88	26	0.94	16	0.27	11	0.23	13	0.08	12	0.00	10	0.00	6
Sub-adults	Aspen	1.00	3	0.88	8	1.00	1	0.00	3	0.18	11	0.00	20	0.00	29	0.00	24	0.00	28	0.00	28
	Jack pine	0.50	2	1.00	1	0.67	3	0.00	2	0.29	7	0.22	9	0.00	13	0.00	15	0.00	13	0.00	19
	Willow	-	0	0.50	2	0.50	4	0.20	5	0.20	5	0.00	13	0.00	16	0.00	16	0.00	23	0.00	22
	Balsam poplar	0.75	4	0.31	13	0.18	17	0.05	22	0.06	34	0.00	42	0.00	43	0.00	36	0.00	39	0.00	37
	Poplar Creek					0.17	6	0.00	18	0.00	13	0.00	18	0.00	14	0.00	13	0.00	10	0.00	7
	Black spruce	1.00	1	-	0	0.20	5	0.00	8	0.00	15	0.00	17	0.00	24	0.00	21	0.05	22	0.00	23
	Thickwoods	-	0	0.00	3	0.00	7	0.00	8	0.00	6	0.00	11	0.00	6	0.00	11	0.00	16	0.00	10
	Tamarack	-	0	0.00	2	0.10	10	0.00	10	0.00	16	0.00	18	0.00	25	0.00	23	0.00	21	0.00	25
	$\bar{x}$	0.71	7	0.62	21	0.19	53	0.03	76	0.07	107	0.02	148	0.00	170	0.00	159	0.00	172	0.00	171

[1] The mid-point of each trapping period is indicated.

Appendix 11. Proportions of female *C. gapperi* that were in breeding condition. (Proportions of sub-adults and adults in breeding condition on each grid are indicated.)

Age Class	Grid	2 July[1]		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.	
		Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N
Adults	Aspen	1.00	1	1.00	3	0.86	7	0.75	4	0.67	6	1.00	5	1.00	1	0.25	4	-	0	-	0
	Jack pine	1.00	1	1.00	4	1.00	3	0.75	4	1.00	2	1.00	2	1.00	3	0.00	1	0.00	1	0.00	1
	Willow	1.00	1	0.50	2	-	0	0.50	2	0.50	2	-	0	1.00	1	0.50	2	0.50	2	0.00	1
	Balsam poplar	0.86	14	0.53	15	0.83	17	0.90	11	0.69	16	0.78	9	0.40	5	0.25	8	0.17	6	0.11	9
	Poplar Creek					0.80	5	0.50	10	0.88	8	0.60	5	0.50	4	0.20	5	0.67	3	-	0
	Black spruce	-	0	1.00	3	1.00	4	1.00	4	0.75	4	0.75	4	0.00	2	0.00	1	0.00	2	0.00	1
	Thickwoods	0.00	1	1.00	1	0.50	2	1.00	7	1.00	4	0.75	4	0.50	2	0.00	2	0.00	1	0.00	1
	Tamarack	1.00	1	0.50	2	0.75	4	1.00	1	0.75	4	1.00	2	0.60	5	0.25	4	0.25	4	0.00	1
	$\bar{x}$	0.89	18	0.70	30	0.83	42	0.79	43	0.83	42	0.81	31	0.57	23	0.22	27	0.26	19	0.07	14
Sub-adults	Aspen	0.84	6	0.67	3	1.00	1	0.67	3	0.33	3	0.20	15	0.07	29	0.05	21	0.04	26	0.00	21
	Jack pine	1.00	2	-	0	1.00	2	-	0	0.00	1	0.17	6	0.00	5	0.00	6	0.00	10	0.13	8
	Willow	-	0	-	0	-	0	0.00	1	0.00	2	0.00	3	0.00	4	0.00	8	0.00	12	0.00	10
	Balsam poplar	0.75	8	0.43	7	0.14	7	0.06	17	0.06	17	0.05	22	0.17	30	0.00	21	0.00	28	0.00	27
	Poplar creek					0.00	5	0.05	21	0.06	17	0.09	23	0.00	13	0.00	14	0.00	15	0.00	11
	Black spruce	0.00	1	0.00	1	0.50	2	0.00	4	0.11	9	0.00	7	0.00	10	0.00	7	0.00	10	0.00	6
	Thickwoods	0.00	1	0.00	1	0.00	1	0.25	4	0.00	1	0.00	1	0.00	1	0.00	4	0.00	8	0.00	2
	Tamarack	0.00	3	1.00	1	0.50	2	0.00	5	0.00	15	0.00	17	0.00	25	0.00	31	0.00	25	0.00	28
	$\bar{x}$	0.62	21	0.46	13	0.30	20	0.09	55	0.06	65	0.07	94	0.96	117	0.01	112	0.01	133	0.01	113

[1] The mid-point of each trapping period is indicated.

Appendix 12. Proporitions of male *M. pennsylvanicus* that were in breeding condition. (Proportions of sub-adults and adults in breeding condition on each grid are indicated.)

Age Class	Grid	2 July		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.	
		Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N
Adults	Aspen	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	-	0	-	0	-	0	0.00	1
	Jack pine	0.80	5	0.50	2	1.00	1	-	0	1.00	1	-	0	-	0	-	0	-	0	-	0
	Willow	1.00	10	0.75	4	0.60	5	1.00	2	0.25	4	0.00	4	0.14	7	0.00	6	0.00	7	0.00	1
	Balsam poplar	1.00	4	1.00	3	1.00	1	1.00	2	1.00	1	1.00	1	-	0	1.00	1	-	0	-	0
	Poplar Creek					0.75	12	0.81	11	0.59	17	0.21	28	0.00	34	0.00	35	0.00	32	0.00	48
	Black spruce	0.86	7	0.83	6	0.86	7	0.56	9	0.46	13	0.20	15	0.05	22	0.00	10	0.00	3	0.00	4
	Thickwoods	1.00	4	1.00	10	1.00	6	0.80	10	0.60	10	0.19	16	0.14	14	0.00	15	0.00	11	0.00	8
	Tamarack	1.00	4	1.00	7	0.75	8	0.71	14	0.64	14	0.12	17	0.14	21	0.00	13	0.00	11	0.00	7
	$\bar{x}$	0.94	35	0.91	33	0.78	41	0.71	49	0.59	61	0.20	82	0.07	98	0.01	70	0.00	64	0.00	69
Sub-adults	Aspen	-	0	1.00	3	1.00	1	-	0	0.00	2	0.00	1	0.00	3	0.00	1	0.00	2	-	0
	Jack pine	-	0	-	0	-	0	0.00	1	0.00	1	0.00	5	0.00	2	0.00	4	0.00	1	0.00	1
	Willow	-	0	0.29	7	0.25	8	0.22	9	0.13	8	0.00	11	0.00	14	0.00	9	0.00	17	0.00	13
	Balsam poplar	-	0	0.00	2	-	0	-	0	0.00	1	0.00	1	-	0	-	0	-	0	0.00	3
	Poplar Creek					0.09	11	0.00	5	0.00	7	0.00	3	0.00	1	0.00	3	0.00	3	0.00	4
	Black spruce	1.00	1	-	0	0.20	5	0.00	10	0.00	13	0.00	5	0.00	2	0.00	7	0.00	10	0.00	5
	Thickwoods	-	0	-	0	-	0	0.00	4	0.00	9	0.00	16	0.11	9	0.00	6	0.00	9	0.00	12
	Tamarack	-	0	0.75	4	0.00	7	0.00	8	0.00	11	0.00	7	0.00	2	0.00	4	0.00	4	0.00	2
	$\bar{x}$	1.00	1	0.50	16	0.16	32	0.05	37	0.02	52	0.00	49	0.06	33	0.00	34	0.00	46	0.00	40

Appendix 13. Proportion of female *M. pennsylvanicus* that were in breeding condition. (Proportion of sub-adults and adults in breeding condition on each grid are indicated.)

Age Class	Grid	2 July		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.	
		Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N
Adults	Aspen	-	0	0.50	2	0.67	3	-	0	0.50	2	1.00	2	0.67	3	-	0	-	0	-	0
	Jack pine	0.50	2	0.33	3	0.80	5	1.00	2	1.00	3	0.50	2	0.00	1	-	0	-	0	0.00	1
	Willow	0.57	7	0.89	9	0.86	7	0.71	7	0.75	8	1.00	4	0.00	4	0.00	2	0.25	4	0.00	3
	Balsam poplar	0.67	3	1.00	2	1.00	2	1.00	2	0.33	3	0.50	2	0.00	1	0.00	1	0.00	1	-	0
	Poplar Creek					0.85	13	0.83	18	0.67	24	0.39	33	0.18	33	0.00	26	0.00	24	0.00	33
	Black spruce	1.00	3	0.67	6	0.56	9	0.64	11	0.91	11	0.67	9	0.33	12	0.33	3	0.00	1	0.00	1
	Thickwoods	0.67	3	0.79	14	0.81	16	0.95	20	0.83	18	0.59	17	0.41	17	0.14	14	0.00	7	0.00	7
	Tamarack	0.75	4	0.44	9	0.89	9	0.75	16	0.36	22	0.42	12	0.23	13	0.00	14	0.00	11	0.08	12
	$\bar{x}$	0.68	22	0.68	45	0.80	64	0.79	76	0.66	91	0.52	81	0.40	84	0.05	60	0.02	48	0.02	57
Sub-adults	Aspen	-	0	-	0	-	0	-	0	0.00	2	-	0	-	0	-	-	-	0	0.00	2
	Jack pine	-	0	-	0	-	0	0.00	1	-	0	0.00	2	0.00	1	0.00	1	0.00	1	-	0
	Willow	0.00	1	-	0	0.00	3	0.00	3	0.00	12	0.00	10	0.00	21	0.00	10	0.00	11	0.00	10
	Balsam poplar	-	0	-	0	-	0	-	0	0.00	1	-	0	-	0	-	0	0.00	3	0.00	2
	Poplar Creek					0.20	5	0.00	10	0.00	6	0.00	12	0.00	5	0.00	8	0.00	9	0.00	5
	Black spruce	-	0	-	0	0.00	1	-	0	0.00	8	0.00	6	0.00	6	0.00	4	0.00	6	0.00	4
	Thickwoods	-	0	-	0	0.00	1	-	0	0.00	6	0.00	6	0.00	4	0.00	7	0.00	9	0.00	5
	Tamarack	-	0	0.00	1	0.00	1	0.00	7	0.00	15	0.00	16	0.00	10	0.00	10	0.00	8	0.00	8
	$\bar{x}$	0.00	1	0.00	1	0.09	11	0.00	20	0.00	50	0.00	52	0.00	47	0.00	40	0.00	47	0.00	36

Appendix 14. Proportion of male *P. maniculatus* that were in breeding condition. (Proportion of sub-adults and adults in breeding condition on each grid are indicated.)

Age Class	Grid	2 July		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.	
		Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N
Adults	Aspen	-	0	-	0	-	0	-	0	0.50	2	0.00	2	0.00	2	0.00	2	0.00	3	0.00	2
	Jack pine	-	0	-	0	-	0	0.00	1	0.00	2	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1
	Willow	No *P. maniculatus*																			
	Balsam poplar	1.00	3	0.67	3	0.50	2	0.00	2	0.00	2	0.00	2	0.00	1	0.00	4	0.00	2	0.00	3
	Poplar Creek					1.00	1	-	0	-	0	0.00	1	0.00	4	0.00	4	0.00	5		
	Black spruce	-	0	-	0	-	0	-	0	0.00	1	0.00	1	0.00	1	0.00	1		0		
	Thickwoods	1.00	3	1.00	2	0.33	3	0.00	2	0.00	2	0.00	4	0.17	6	0.00	5	0.00	3	-	0
	Tamarack	No *P. maniculatus*																			
	Weighted $\bar{x}$	1.00	6	0.80	5	0.50	6	0.00	5	0.11	9	0.00	11	0.07	15	0.00	17	0.00	14	0.00	6
Sub-adults	Aspen	-	0	0.00	2	1.00	1	0.00	4	0.00	5	0.00	5	0.00	5	0.00	5	0.00	3	0.00	3
	Jack pine	-	0	0.00	1	1.00	1	-	0	-	0	-	0	-	0	-	0	-	0	0.00	1
	Willow	No *P. maniculatus*																			
	Balsam poplar	0.00	7	0.17	6	0.13	8	0.00	10	0.00	10	0.00	12	0.00	7	0.00	3	0.00	3	-	0
	Poplar Creek					0.00	3	0.00	6	0.00	7	0.00	9	0.00	7	0.00	5	0.00	8		
	Black spruce	-	0	-	0	0.50	2	0.00	4	0.00	1	0.00	2	0.00	2	-	0				
	Thickwoods	0.00	1	0.25	8	0.00	12	0.07	14	0.00	13	0.00	11	0.00	8	0.00	12	0.00	11	0.00	3
	Tamarack	No *P. maniculatus*																			
	Weighted $\bar{x}$	0.00	8	0.18	17	0.15	27	0.03	38	0.00	36	0.00	39	0.00	29	0.00	25	0.00	25	0.00	7

Appendix 15. Proportion of female *P. maniculatus* that were in breeding condition. (Proportion of sub-adults and adults in breeding condition on each grid are indicated.)

Age Class	Grid	2 July		20 July		2 Aug.		16 Aug.		28 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.	
		Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N	Prop.	N
Adults	Aspen	-	0	-	0	-	0	1.00	1	-	0	-	0	-	0	-	0	-	0	-	0
	Jack pine	-	0	-	0	-	0	0.00	1	0.00	1	-	0	-	0	-	0	-	0	-	0
	Willow	No *P. maniculatus*																			
	Balsam poplar	0.50	4	0.50	4	1.00	1	0.00	2	0.50	2	0.00	1	1.00	1	-	0	-	0	-	0
	Poplar Creek					-	0	-	0	-	0	-	0	-	0	-	0	-	0		
	Black spruce	-	0	-	0	-	0	-	-	-	0	-	0	-	0	-	0				
	Thickwoods	0.33	3	1.00	3	1.00	4	0.50	4	0.00	3	1.00	1	0.00	3	0.00	1	0.00	1	-	0
	Tamarack	No *P. maniculatus*																			
		0.43	7	0.71	7	1.00	5	0.38	8	0.17	6	0.50	2	0.25	4	0.00	1	0.00	1	-	0
Sub-adults	Aspen	0.00	1	0.00	5	0.50	2	0.00	4	0.11	9	0.00	3	0.00	4	-	0	0.00	4	0.00	2
	Jack pine	0.00	1	0.00	2	0.20	5	0.00	1	0.00	4	0.00	2	0.00	1	0.00	2	1.00	2	0.00	2
	Willow	No *P. maniculatus*																			
	Balsam poplar	0.10	10	0.08	13	0.00	12	0.00	10	0.00	11	0.00	8	0.00	9	0.00	5	0.00	9	0.00	1
	Poplar Creek					0.00	3	-	0	0.00	1	0.00	1	0.00	3	0.00	6	0.00	5		
	Black spruce	-	0	-	0	-	0	-	0	0.00	1	0.00	2	0.00	2	0.00	1				
	Thickwoods	0.00	1	0.00	3	0.14	7	0.00	6	0.00	5	0.00	10	0.00	7	0.07	14	0.00	13	0.00	2
	Tamarack	No *P. maniculatus*																			
		0.07	14	0.04	23	0.10	29	0.00	21	0.03	31	0.00	26	0.00	30	0.04	28	0.06	33	0.00	7

Appendix 16. Bi-weekly estimates of minimum survival rates (S) and recruitment rates (R) for males and females combined.

Grid	Species	20 July		2 Aug.		16 Aug.		29 Aug.		16 Sept.		26 Sept.		16 Oct.		27 Oct.		9 Nov.	
		S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
Aspen	*C. gapperi*	0.62	0.69	0.56	0.27	0.92	0.50	0.89	0.44	0.50	0.71	0.86	0.48	0.72	0.14	0.89	0.11	0.86	0.06
	M. pennsylvanicus	0.50	0.86	0.57	0.20	1.00	0.75	1.00	0.40	0.58	0.00	0.86	0.50	0.70	0.00	0.57	0.00	0.75	0.33
	P. maniculatus	0.00	1.00	0.75	0.22	1.00	0.42	0.88	0.42	0.77	0.17	0.95	0.13	0.80	0.14	0.88	0.00	0.67	0.00
Jack pine	*C. gapperi*	0.75	0.33	0.67	0.60	0.92	0.00	0.82	0.60	0.79	0.41	0.89	0.38	0.75	0.26	0.88	0.20	0.81	0.25
	M. pennsylvanicus	0.43	0.70	0.70	0.50	0.69	0.25	0.45	0.71	0.71	0.25	0.56	0.31	0.62	0.00	1.00	0.00	0.86	0.00
	P. maniculatus	1.00	1.00	1.00	0.33	1.00	0.00	0.86	0.43	0.56	0.00	1.00	0.00	1.00	0.00	0.75	0.00	1.00	0.25
Willow	*C. gapperi*	1.00	0.80	0.60	0.50	0.80	0.66	0.70	0.50	0.67	0.59	0.94	0.27	0.78	0.36	1.00	0.32	0.85	0.06
	M. pennsylvanicus	0.44	0.61	0.66	0.76	0.61	0.40	0.85	0.46	0.83	0.26	0.95	0.10	0.81	0.07	0.94	0.19	0.72	0.12
Balsam poplar	*C. gapperi*	0.89	0.42	0.85	0.36	0.80	0.41	0.73	0.34	0.68	0.34	0.91	0.21	0.76	0.13	0.91	0.11	0.73	0.20
	M. pennsylvanicus	0.29	0.86	0.50	0.33	1.00	0.25	0.67	0.33	0.67	0.57	0.29	0.50	1.00	0.50	1.00	0.75	0.71	1.00
	P. maniculatus	0.77	0.41	0.84	0.26	1.00	0.19	0.85	0.07	0.86	0.13	0.85	0.10	0.73	0.00	0.73	0.00	0.25	0.00
Poplar Creek cutline	*C. gapperi*					0.68	0.76	0.71	0.37	0.61	0.42	0.71	0.09	0.85	0.06	0.83	0.12	0.58	0.05
	M. pennsylvanicus					0.49	0.64	0.78	0.57	0.78	0.41	0.75	0.37	0.80	0.27	0.81	0.19	0.65	0.35
	P. maniculatus					0.75	0.71	0.91	0.38	0.85	0.36	0.87	0.21	0.88	0.27	0.72	0.28	0.06	0.00
Black spruce	*C. gapperi*	0.69	0.50	0.81	0.56	0.88	0.45	0.97	0.40	0.80	0.24	0.85	0.29	0.68	0.15	0.89	0.22	0.79	0.09
	M. pennsylvanicus	0.00	0.58	0.86	0.57	0.75	0.64	0.89	0.31	0.66	0.18	0.91	0.09	0.63	0.16	0.77	0.00	0.58	0.21
	P. maniculatus	0.00	0.00	0.00	1.0	1.00	0.50	0.75	0.00	0.00	0.33	1.00	0.20	1.00	0.00	0.50	1.00	0.00	0.00
Thickwoods cutline	*C. gapperi*	1.00	1.00	0.63	0.80	0.69	0.76	0.48	0.46	0.61	0.47	0.75	0.18	0.88	0.39	0.86	0.33	0.40	0.23
	M. pennsylvanicus	0.71	0.79	0.88	0.30	0.82	0.46	0.90	0.41	0.78	0.42	0.74	0.16	0.73	0.14	0.80	0.05	0.74	0.06
	P. maniculatus	1.00	0.48	0.91	0.53	0.84	0.04	0.91	0.16	0.88	0.08	0.94	0.00	0.97	0.16	0.91	0.00	0.17	0.00
Tamarack	*C. gapperi*	0.75	0.70	1.00	0.60	0.75	0.64	1.00	0.55	0.76	0.37	0.94	0.40	0.87	0.14	0.78	0.13	0.83	0.11
	M. pennsylvanicus	0.80	0.71	0.70	0.55	0.78	0.58	0.82	0.45	0.60	0.37	0.75	0.13	0.80	0.14	0.78	0.11	0.67	0.03