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ABSTRACT

In 36 inches or more of soft snow moose will concentrate in shelter-providing forest cover types, in much the same way that white-tailed deer will at depths from 12 to 20 inches. Winter feeding damage by ungulates to forest regeneration is liable to be most severe adjacent to shelter types and least severe in the midst of large out-overs. Cuttings to produce winter food should be adjacent to suitable shelter types.

Deer and moose were found to use different forest cover types in January. In March they were both in shelter-providing types, but not in the same places within the types. In June both species were using most habitat types and their association was about as would be expected by chance.

About 13 per cent of the moose trails observed in June were in areas used by deer for yarding in March. This suggests that one moose in eight was particularly liable to infection by the parasite *Pneumostrongylus tenuis*, the probable causitive agent of the "moose sickness".

INTRODUCTION

The ranges of moose (Alces alces) and white-tailed deer (Odocoileus virginianus) overlap in large areas of eastern Canada and a few adjoining border states. The relationship between these species in localities where they occur together is interesting from several points of view. The recent work of Anderson (1964) suggests the possibility of the transmission of the parasite Pneumostrongylus tenuis from deer to moose, with disastrous results to the moose. Both moose and deer can do serious damage to forests by heavy feeding on the regeneration of commercial tree species. This damage is most likely to occur in or near areas used for concentration during the winter. Therefore, winter distributions of these two browsing species are of practical importance to land managers. In recent years some progress has been made in habitat management to provide better winter range for deer and moose. Such programs can succeed only if based on detailed local knowledge of seasonal movements and habitat preferences. For the ecological theorist the exact definition of the ecological niche occupied by these related species of similar feeding habits would also be of considerable interest.

To gain some information on these problems, I studied deer and moose distribution and association during the winter and spring of 1967 at the Acadia Forest Experimental Station of the Canada Department of Forestry and Rural Development in central New Brunswick.

ACKNOWLEDGEMENTS

I wish to acknowledge the generous assistance of the staff of the Acadia Forest Experimental Station in keeping essential roads open, loaning aerial photographs and maps, and providing many other services. I also wish to acknowledge the assistance of technician John Maxwell and student assistant Wayne Bauman who collected much of the field data.

METHODS

The Study Area.

The Acadia Forest Experimental Station is a federally owned research forest of 22,488 acres, located near Fredericton, New Brunswick. The Station is part of the Burpee Game Refuge in which there is no open season. Over the last 20 years the Refuge has had a fairly high deer population and a rather stable moose population. Local residents recall that the area now forming the Station was famous for its high moose population about 50 to 60 years ago. At that time deer were reported to have been much less numerous than they later became.

Elevations on the Station range from about 75 feet to 375 feet above sea level. The topography is one of long gentle slopes and is quite flat in appearance. The whole area slopes generally to the south toward the St. John River Valley.

Association.

To get a quantitative measure of the association of moose and deer on the research area I used the method proposed by Dice (1945). This method provides mathematical expressions of the extent to which the two species occur together in a series of samples. Dice thoroughly discusses the necessary assumptions to be made and the limitations of his proposed method. Briefly, the main limitations are that the sample units must be:

(a) the same kind and size,

(b) of a size suitable for the species to be studied, and

(c) taken randomly.

The calculated measures are valid only for the time and place of the sampling.

In the present study, I used a line 20 chains ($\frac{1}{4}$ mile) long as the sample unit. A line of this length was chosen after careful consideration. I believed that shorter lines might result in underestimates of association between large mammals. Conversely, during the winter confinement period, deer and moose separated by much more than 20 chains might not be associated at all. One hundred and thirty-five lines were covered. Four to six lines were located within each of the 28 compartments of the Acadia Forest Experimental Station. The sample lines were located at random along painted access lines established to facilitate location of permanent forest inventory sample plots.

In the field, we counted all deer and moose paths and individual trails that crossed the sample lines. We measured snow depth and track depth at each trail with a snow rule.

The sample lines were examined in

(a) early winter (January),

(b) late winter and early spring (late March, early April), and

(c) late spring (early June).

In early April deer were beginning to move on the "sun crust" formed on the snow cover by daily thaws followed by freezing at night. Distribution and association of moose and deer at the height of the winter confinement period in mid-March were determined by examining old trails. This period is separated in Table 1 from "early April", which is the period when the sun crust permits some movement of deer from yards.

The "early winter" study coincided with the initial period of winter concentration for deer.

The presence of snow during the first two examinations of the sample lines made track location and identification easy. In June, however, track location was more difficult. Two men worked together at that time. One would follow the line while the second concentrated on the ground. I believe that some deer trails were inevitably missed in the June study. However, it is unlikely that all trails would be missed in an area receiving any appreciable amount of deer use.

At the same time that the sample lines were studied, we noted deer and moose activity on our travel routes and along roads. This information was combined with the sample observations to produce the distribution maps (Figs. 3-6).

Dice (1945) proposed four measures of association. They are:

1. The coefficient of association, calculated by the following formula:

   $$\text{Coefficient of association} = \frac{h}{ab/n} = \frac{hn}{ab}$$

   a = number of samples in which species "A" occurs alone or with species "B".

b = number of samples in which species "B" occurs alone or with species "A".

h = number of samples in which both species occur.

n = total number of samples.

A coefficient of association of 1.0 indicates that the two species "A" and "B" are associating as one would expect from a chance arrangement. A coefficient of less than one suggests that the species are more separate than one would expect from chance. Also, a coefficient greater than one suggests more association between the species than one might expect on the basis of chance alone.

2. The coincidence index, calculated as follows:

$$\text{Coincidence index} = \frac{2h}{a+b}$$

This measure gives a value between those of the two association indices. It is not necessary to choose a "base species".

3. Association index (species B with species A): $\frac{B}{A} = \frac{h}{a}$

4. Association index (species A with species B): $\frac{A}{B} = \frac{h}{b}$

This index gives a measure of the extent that one species occurs in association with the other, which is called the "base species" (A in the first formula and B in the second).

The association indices and the coincidence index range in value from 1.0 to zero. A value of 1.0 means that each species occurs in all the samples in which the other occurs, thus indicating a high degree of association. Lower values, near zero, show that the species occurred together in few samples and were therefore not highly associated.

The association data were examined by a chi-square method outlined by Dice (1945) to determine if the departures of the observed distributions from a chance distribution were significant.

Forest Cover-Type Classification.

Forest cover at each ungulate trail was classified according to the following system:

	open softwood
	open mixedwood
Food types	open hardwood
	dense hardwood
	regeneration stands
Shelter types	dense softwood
	dense mixedwood

"Open" stands were those with scattered individual trees or patches of trees, and with much of the ground exposed to the sky. "Dense" stands were those of average or greater crown cover where the stand presented the appearance of a closed forest. Much of the Acadia Forest Experimental Station was burned in the half-century before the 1930's. Those burns and the many black spruce muskeg areas support understocked softwood stands that were classed as "open". They contain a fair supply of red maple (Acer rubrum) and wild raisin (Viburnum cassinoides) browse. These areas are classed as "food types" along with other open stands and the densely stocked hardwood stands. These hardwood stands support a considerable undergrowth of striped maple (Acer pensylvanicum), beaked hazel (Corylus cornuta), mountain maple (Acer spicatum), and sugar maple (Acer saccharum) reproduction.

The so-called "shelter types" are low in food but have a dense protective crown cover. Total basal areas per acre in these stands range between 85 and 180 square feet, averaging around 120 square feet.

In addition to measuring the extent of the association of deer and moose with each other, I compared their forest cover-type preferences at different seasons. I calculated the percentage of the total length of the sample lines falling in each of the cover-types previously mentioned by referring to field notes, forest cover-type maps, cut maps, and aerial photos. The percentage of deer and moose trails found in each cover type was compared with the percentage occurrence of that type to get a measure of habitat preference. During the early winter and again in June the deer were making individual tracks. In March, however, they were using beaten paths. To get an estimate of the number of individual tracks the count of paths was multiplied by five. I used the factor of five because I believed that, if a path existed, at least four or five separate trips must have been made over the same route. In some cases, many more trips had obviously been made, but the number could not be determined. Using the factor of five for paths, the total estimate of individual deer tracks found in March came to about five times the number of individual moose tracks, the same ratio as that observed in January. Moose did not make paths at any time.

RESULTS

Distribution Related to Forest Cover-Type.

The general trend of deer and moose habitat preferences is shown in

Figures 1 and 2, and in greater detail in Table 2. The early winter study period found the moose in the better food-producing types. The deer had already concentrated in the softwood and dense mixedwood. By late winter both moose and deer were restricted to shelter types and the edges of immediately adjoining food-type stands. In June both deer and moose were using food and shelter types about in the proportion that these types occurred on the strips. Deer were still showing slightly more preference for shelter types than were moose. However, the deer were using the dense mixedwood type rather than continuing to use the dense softwood areas where most of the late winter yards had been established.

Association.

The trend of the values for these measures is shown by Figure 11. The coefficient of association is high during late winter and early spring, but lower in early winter and late spring. The other measures are rather low until late spring when they rise sharply.

The actual areas used by deer and moose during the study periods are shown by the maps in Figures 3 to 6 and by Table 1 which is derived from these maps. The early winter figures show that deer were using about half of the Station area while moose were using only about a quarter. In mid-March deer were using only eight per cent of the Acadia Station's 22,488 acres. Moose ranged a little more widely, using about 15 per cent. It should be noted that at that time the two species overlapped on only one per cent of the area. During early April, when deer started to move on the sun crust, both deer and moose were using about

14 per cent of the Station. In June moose were found on only two-thirds of the area while deer were found on 85 per cent of it.

The association data suggests lack of association in early winter, association in early spring, and association at a rather low level in late winter and again in June. Chi-square analysis indicated that only the early winter lack of association was significant. ($p = 0.05$).

DISCUSSION

Distribution Related to Forest Cover-Type.

Since it is apparent from Figures 1 and 2 that deer preferred shelter types to food types all winter while moose exhibited the same preference in late winter, it appears probable that the habitat preferences of both species may have been determined by severe weather and deep snow.

The weather in the latter part of the winter of 1966-67 was severe in central New Brunswick (Canada Department of Transport, 1967). Mean minimum temperatures for February and March at the Fredericton Airport, about 10 miles from the study area, were more than 10 degrees below the 1931-67 average (Fig. 8). Both April and May mean minimum temperatures were several degrees below normal. Total snowfall and snow cover depths at the Fredericton Airport weather station greatly exceeded the average (Figs. 9 and 10) in February, March, and April. A snow cover depth expectancy diagram for the Fredericton Airport Station (Potter, 1965:68) shows that depth as great as those at the ends of the months of February and March 1967, occurred in less than 10 per cent of the years for which records are available. Our 1967 late winter and early spring studies therefore provide observations of moose and deer distributions under unusually severe climatic conditions.

During most of the early winter study period snow depths were under one foot in the dense softwoods, but about 1.5 feet in the "food" types. The snow cover on the study area built up steadily from late January to mid-March (Fig. 7) when there was an average depth of 36 inches even in shelter types, and some 45 inches in the food types. Studies of the snow-cover condition in mid-March disclosed a crust, dating from a wet storm in late January, that provided a bearing surface about 14 to 24 inches beneath the surface in the shelter types. The same crust was present in the food types but was too thin to provide a reliable bearing surface and was more deeply buried. In mid-March moose were sinking to an average depth of 37 inches in the open softwood type and 33 inches in the open mixedwood.

Ritcey (1976) mentions that settled snow deeper than 26 inches impedes moose, and depths over 36 inches seriously hinders them.

During the late winter study we found that deer were closely confined in parts of the shelter types, where they were sinking about 13 to 18 inches. Deer venturing into parts of food-type stands were sinking about 23 inches on the average.

Hosley (1956:223) states that loose snow over 20 inches deep makes travel difficult for deer. Hepburn (1959:13) found that in Ontario deer activity was severely restricted as snow depths increased from 10 to 16 inches. The influence of the snow cover alone might be sufficient to create the forest cover-type preferences demonstrated by moose and deer during this study period, although other meteorological factors and perhaps behavioural adaptations may have been involved. Hepburn (1959:24) pointed out that deer in his Ontario study area continued to use stands of cover types providing a considerable amount of food throughout the winter of his study. Those areas used had a medium snow depth. Hepburn states (p. 26) that these deer appeared to select the most favourable combination of shallow snow cover and abundant food. In the present study, however, we found deer active mainly in the shelter types. This difference can probably be attributed to the fact that the snow cover at Acadia in 1967 was about a foot greater than the depths found by Hepburn in comparable timber types.

Locations chosen by deer for yard nuclei during later winter were on the middle and lower portions of southerly and westerly slopes. The Acadia Station is so flat, however, that it was often difficult to determine the topographic relationships of certain areas on the ground without recourse to contour maps. Moose made more use of northern and eastern exposures, but most of their late winter range was also on south and west exposures.

Figures 1 and 2 show that moose were less tied to the shelter types than deer, but deer were more numerous on the Acadia Station and were using most of the stands providing acceptable shelter at the time.

Measures of Association.

The coefficient of association for the first study period in early winter is rather low (Fig. 11). By late winter the coefficient had increased, indicating a very high interspecific association. However, the coincidence index suggests that the animals were not actually together. I assumed that this high coefficient of association was due to the concentration of both species in a similar habitat, leaving many sample units unused by either species. This assumption was also supported by the figures presented in Table 1 for proportion of the station area used by both species in late winter. The area of overlapping range was only one-eighth of the total deer range and one-fifteenth of the total moose range at that time.

The early spring coefficient of association is slightly less than in late winter as both species began to move out of winter habitat. Because both species began to pass through the same cover types during this increase in movement, the coincidence index increased to 0.28.

By late spring the coefficient of association had dropped to about the value to be expected by chance as both moose and deer moved freely over the study area. This extensive movement raised the coincidence index to a high of 0.74.

The association indices show that deer tended to be associated with moose less strongly than moose were with deer. McMillan (1953) studied the association of moose with elk (Cervus canadensis) during two sumers in part of Yellowstone National Park. He found elk to be much more strongly associated with moose than moose were with elk. That phenomenon he attributed in part to the tendency of elk to feed in bands while moose lived as isolated individuals. The finding of the present study that many deer were not in association with moose probably results from the fact that there are only about one fifth as many moose as deer on the

Acadia Forest Experimental Station. There may not be enough moose to occupy the available habitat.

Parker (1966:57 et seq.) suggests that moose may acquire the nematode parasite *Pneumostrongylus tenuis*, the causitive factor in the so-called "moose sickness" (Anderson, 1964), by spring feeding on areas where deer had been concentrated in early spring. These areas would hold concentrations of infected deer feces from which the local gastropod fauna could become infected. Moose and other deer could then pick up the parasite by swallowing infected gastropods while feeding. Other studies in Nova Scotia (Telfer, 1967) support the hypothesis that infection of moose by *P. tenuis* is in some way related to the late winter and spring association of this species with deer. To check the extent that moose in June were using areas where deer yarded in early spring I calculated a coefficient of association between sample lines having deer during the March - April study and evidence of moose on the same sample lines in June. The coefficient was 1.08, showing that moose were using the yarding areas to about the same extent that one would expect by a chance distribution. Thirteen per cent of the moose trails recorded in June were on sample lines where deer had been recorded in early spring. One moose in eight on the Acadia Station may have had a higher than average chance of infection by *P. tenuis* in the spring of 1967.

In summary, this study suggests that:

1. During a winter with deep, relatively uncrusted snow, moose and deer had the same high preference for shelter-providing cover types. Snow depths of 36 inches and over caused moose to concentrate to the extent that deer did at depths of 12 to 20 inches.

2. Although both moose and deer chose shelter cover-types during winters of deep snow, their populations remained largely separate.

3. In late spring both species used all of the cover-types and were associated to an extent that would be expected by chance.

4. The total percentage of this fairly large unit of range (36 square miles) actually used by either moose or deer under deep snow conditions was quite small (Figs. 3 and 4).

The results of this study are interesting from at least two points of view.

1. The study provides information on the ecological niche diversification of these two related species of similar food habits. The severe snow conditions of 1967 led to the use of the same forest cover-types for winter habitat. However, within those types there was surprisingly little overlapping of range that would have led to feeding in the same areas during the late winter stress period. Even where ranges did overlap it is possible that serious food competition between these ungulates may not have resulted because of preferences for different plants or because feeding is done at different levels in the vegetation. Further work is planned to determine the exact types of the vegetation taken by both species.

2. The study results have implications for forest management. They suggest that during winters of heavy snow in Central New Brunswick winter browsing damage to forest regeneration should be at a

minimum in large clear-cut or heavily cut areas. Serious damage could occur, however, on regenerating areas adjacent to fairly heavy softwood shelter-type stands. These effects would no doubt be less pronounced during winters with less severe snow conditions. The study also points up some important facts that should be considered in formulating a multiple-use forest management plan providing for ungulate habitat management. Under deep snow conditions moose as well as deer need shelter-type stands. To be effective, timber stand management to produce deer and moose foods would have to be carried out immediately adjacent to suitable shelter stands.

LITERATURE CITED

Anderson, R.C. 1964. Motor ataxia and paralysis in moose calves infected experimentally with Pneumostrongylus tenuis (Nematoda: Metastrongyloidea). Proc. Northeast Wildl. Conf., Hartford, Connecticut. 7 pp. Mimeo.

Benson, D.A. 1958. Moose "sickness" in Nova Scotia - 1. Canadian J. Comp. Med. and Vet. Sci. 22(7):244-248.

Canada, Department of Transport. 1967. A record of observations taken at the Fredericton Airport, N.B. Monthly meteorological summaries, Dec., Jan., Feb., March, April, and May, 1967. Meteorological Division, Can. Dept. of Transport.

Dice, L.R. 1945. Measures of the amount of ecological association between species. Ecol. 26(3):297-302.

Hepburn, R.L. 1959. Effects of snow cover on mobility and local distribution of deer in Algonquin Park. Unpub. M.Sc. thesis. Univ. of Toronto. pp. 1-55.

Hosley, N.W. 1956. Management of the white-tailed deer in its environment, pp. 187-259. In W. P. Taylor (Editor). The deer of North America: Their history and management. Stackpole Co., Harrisburg, Pennsylvania, and the Wildl. Mgmt. Inst. Washington, D.C. 668 pp.

McMillan, J.F. 1953. Measures of association between moose and elk on feeding grounds. J. Wildl. Mgmt. 17(2):162-166.

Parker, G.R. 1966. Moose disease in Nova Scotia; gastropod - nematode relationship. Unpub. M.Sc. thesis. Acadia Univ. 126 pp.

Potter, J.G. 1965. Snow cover. Meteorological branch, Canada Dept. of Transport. Climatological studies No. 3. 69 pp.

Ritcey, R.W. 1967. Ecology of moose winter range in Wells Gray Park, British Columbia. Fourth workshop on moose research and management, Edmonton, Alta., March 17 and 18, 1967. 15 pp. mimeo.

Telfer, E.S. 1967. Comparison of moose and deer winter range in Nova Scotia. J. Wildl. Mgmt. 31(3):418-425.

Table 1. Per cent of total area of the Acadia Forest Experiment Station occupied by moose and deer at different seasons.

	Deer Only	Moose Only	No Ungulates	Moose and Deer	Total Deer Range	Total Moose Range
January 1967	46	14	31	9	55	23
Mid-March 1967	7	14	78	1	8	15
Early April 1967	11	10	76	3	14	13
June 1967	30	30	7	55	85	63

Table 2. Distribution by per cent of deer and moose trails among forest cover types - Acadia F.E.S., winter 1967.

Forest cover type	Per cent of sample in type	Early winter (concentration)		Late winter (confinement)		Late Spring	
		Deer	Moose	Deer	Moose	Deer	Moose
Open Hardwood	1.2	0.8	4.0			8.2	5.2
Dense Hardwood	14.2	1.5	21.8			16.0	5.2
Open Mixedwood	2.0	2.7	4.0	1.6	8.8	18.3	17.5
Dense Mixedwood	23.0	14.7	12.8	6.5	9.9	32.3	15.1
Open Softwood	38.8	7.1	26.6	3.1	9.9	10.8	43.1
Dense Softwood	12.1	62.1	9.9	68.9	68.1	12.6	12.2
Regeneration	8.7	11.1	10.9	19.9	3.3	1.8	1.7

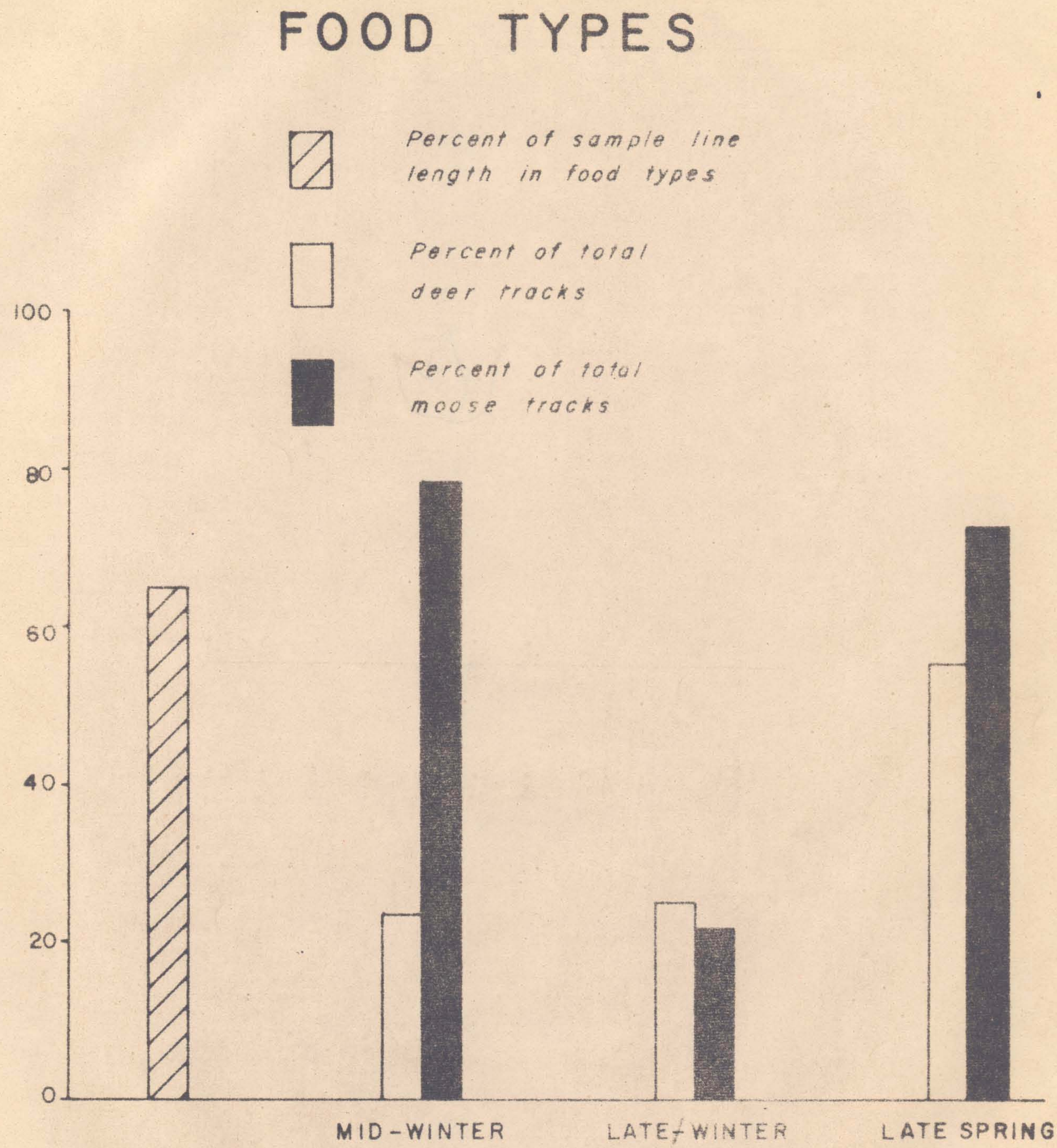


Fig. 1. Distribution of deer and moose in food-supplying forest cover types. Acadia Forest Experiment Station, 1967.

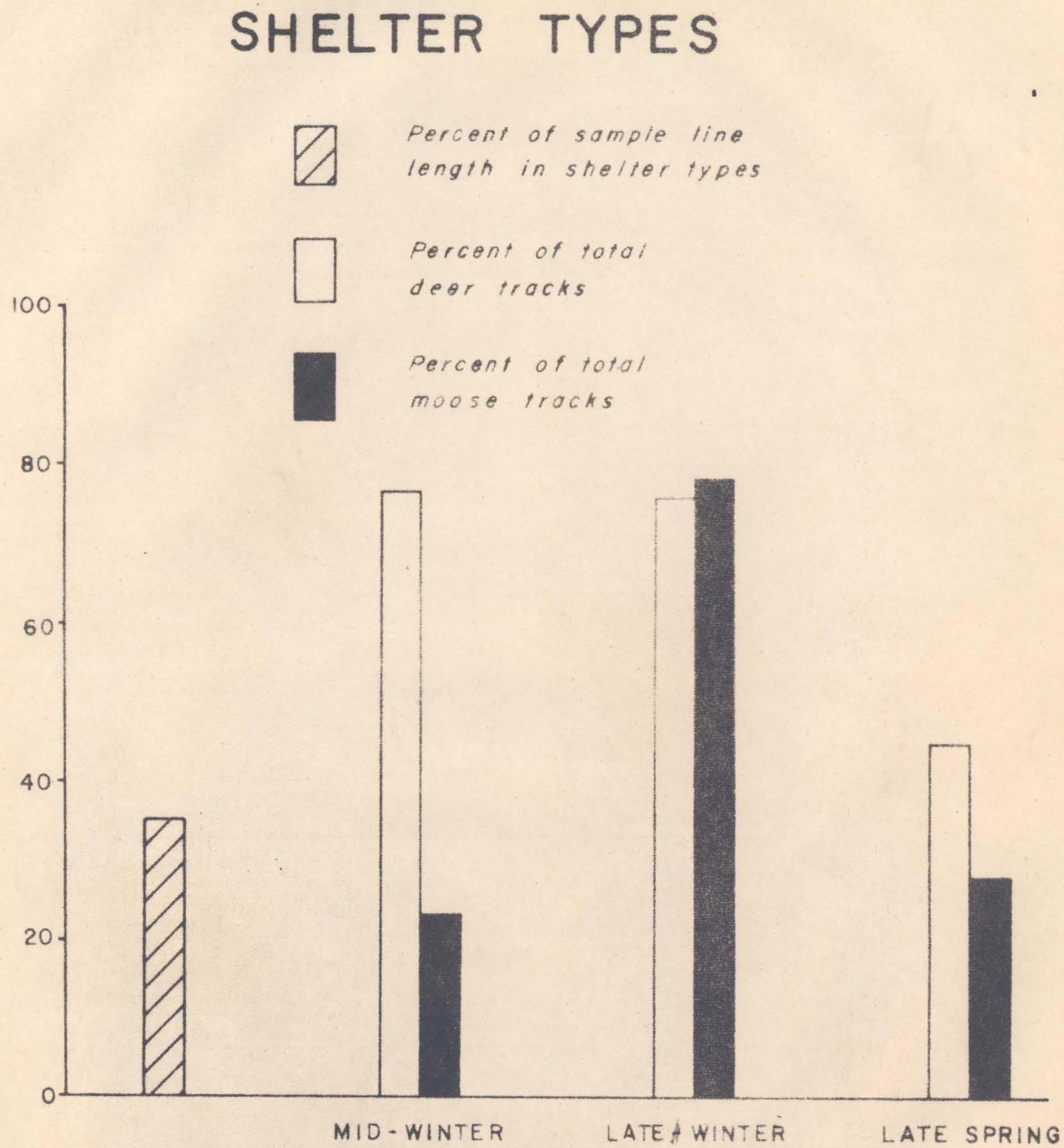


Fig. 2. Distribution of deer and moose in shelter-supplying forest cover types. Acadia Forest Experiment Station, 1967.

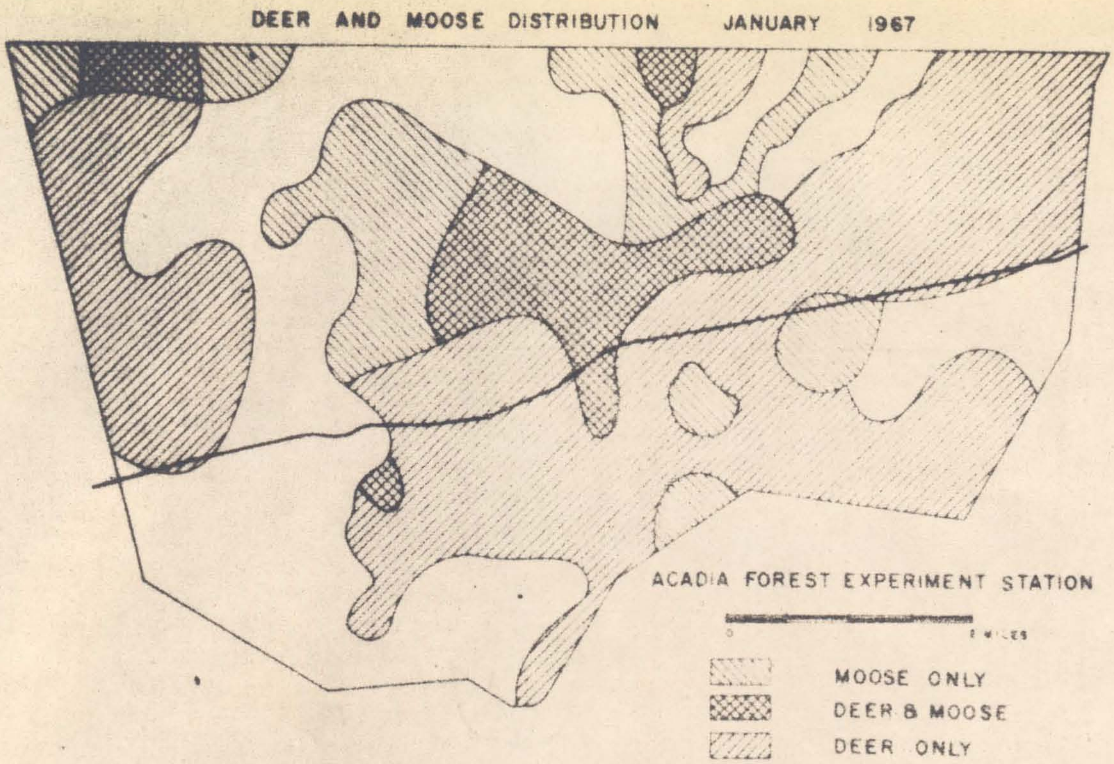


Fig. 3. Map of distribution of moose and deer on the Acadia Forest Experiment Station. January 1967.

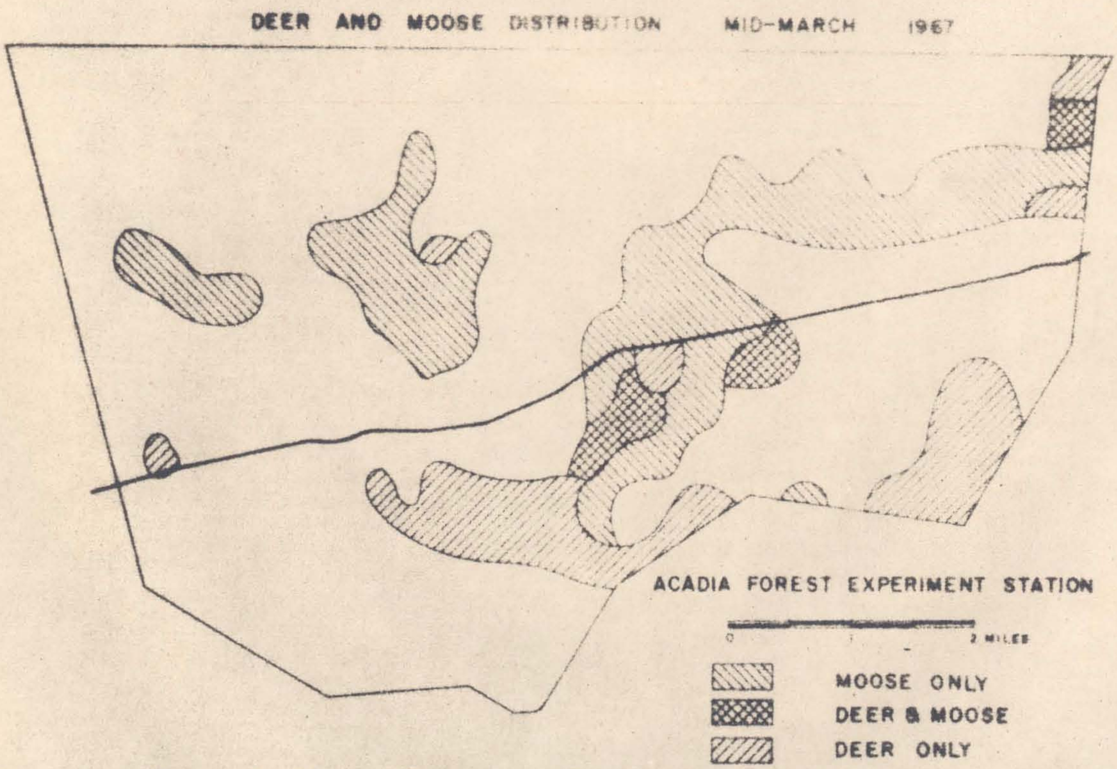


Fig. 4. Map of distribution of moose and deer on the Acadia Forest Experiment Station. Mid-March 1967.

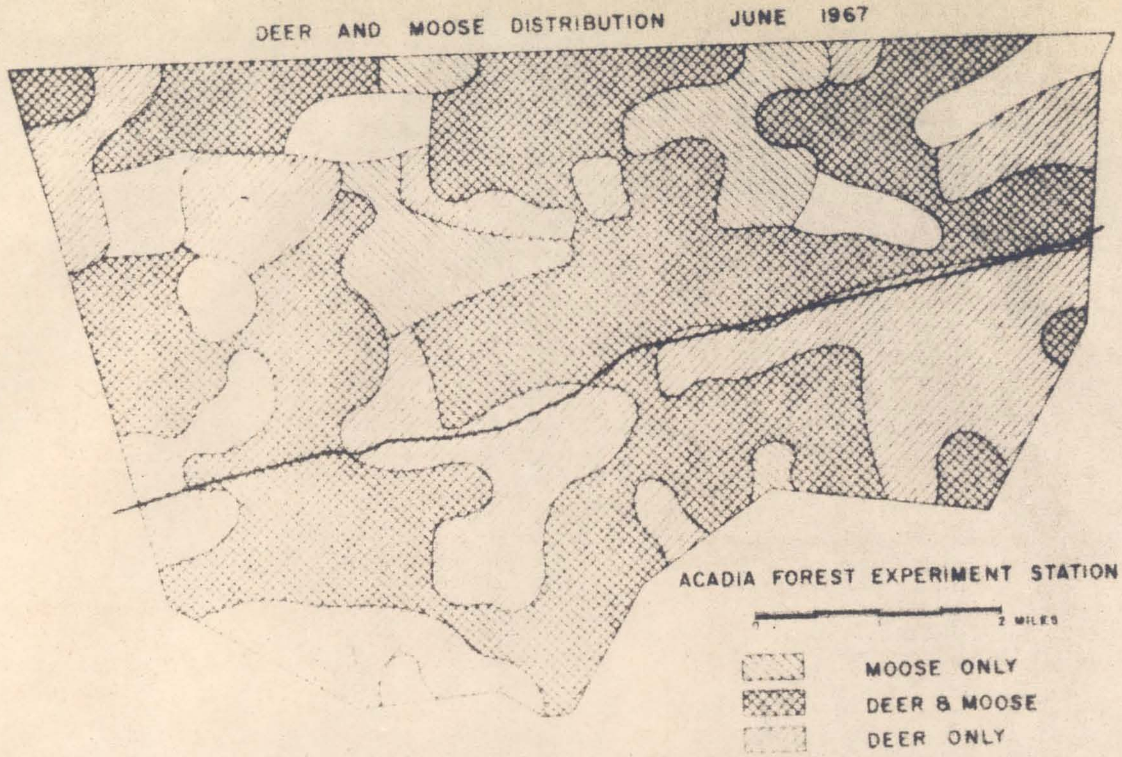


Fig. 6. Map of moose and deer distribution on the Acadia Forest Experiment Station. June 1967.

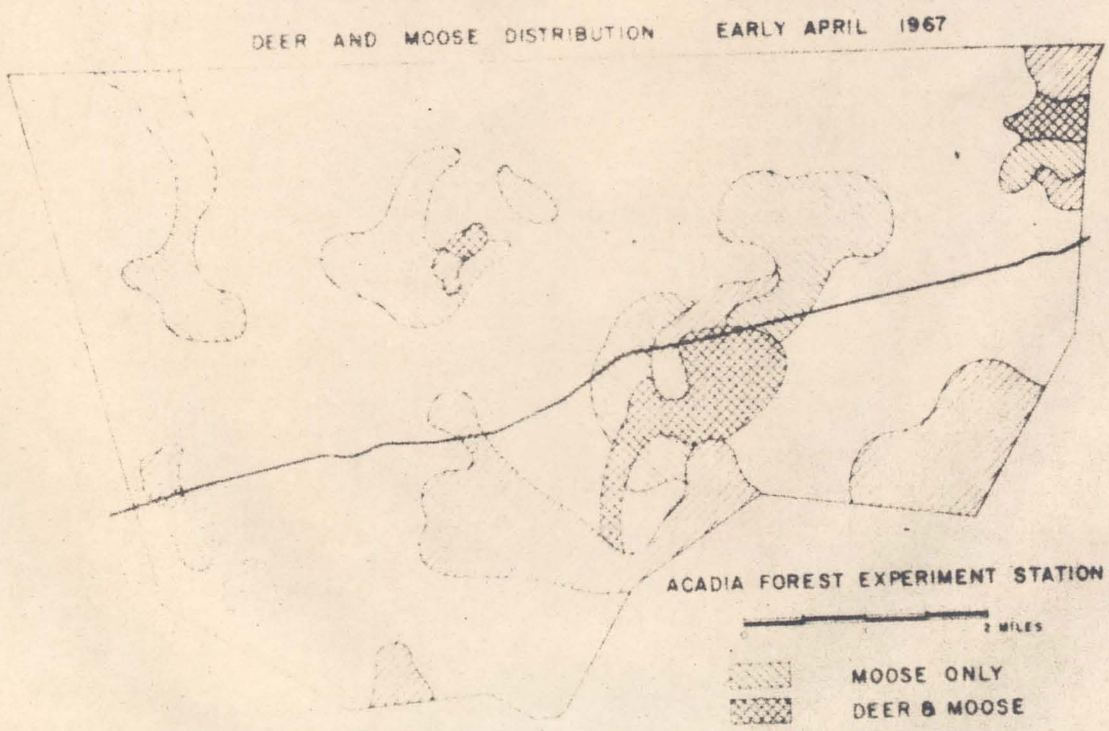


Fig. 5. Map of moose and deer distribution on the Acadia Forest Experiment Station. EarlyyApril 1967.

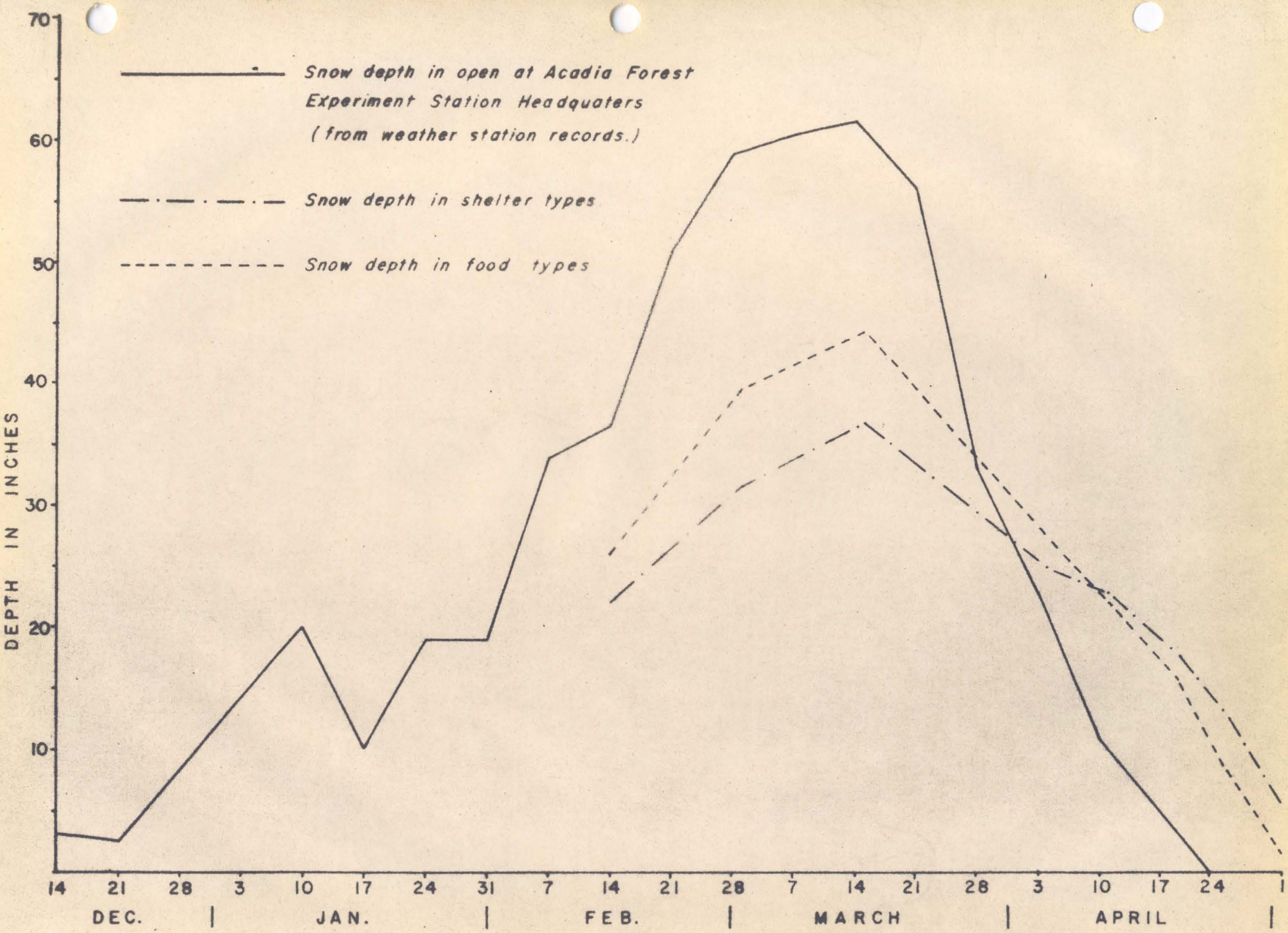


Fig. 7. Snow depths in "food" and "shelter" types. Deer confinement period 1967.

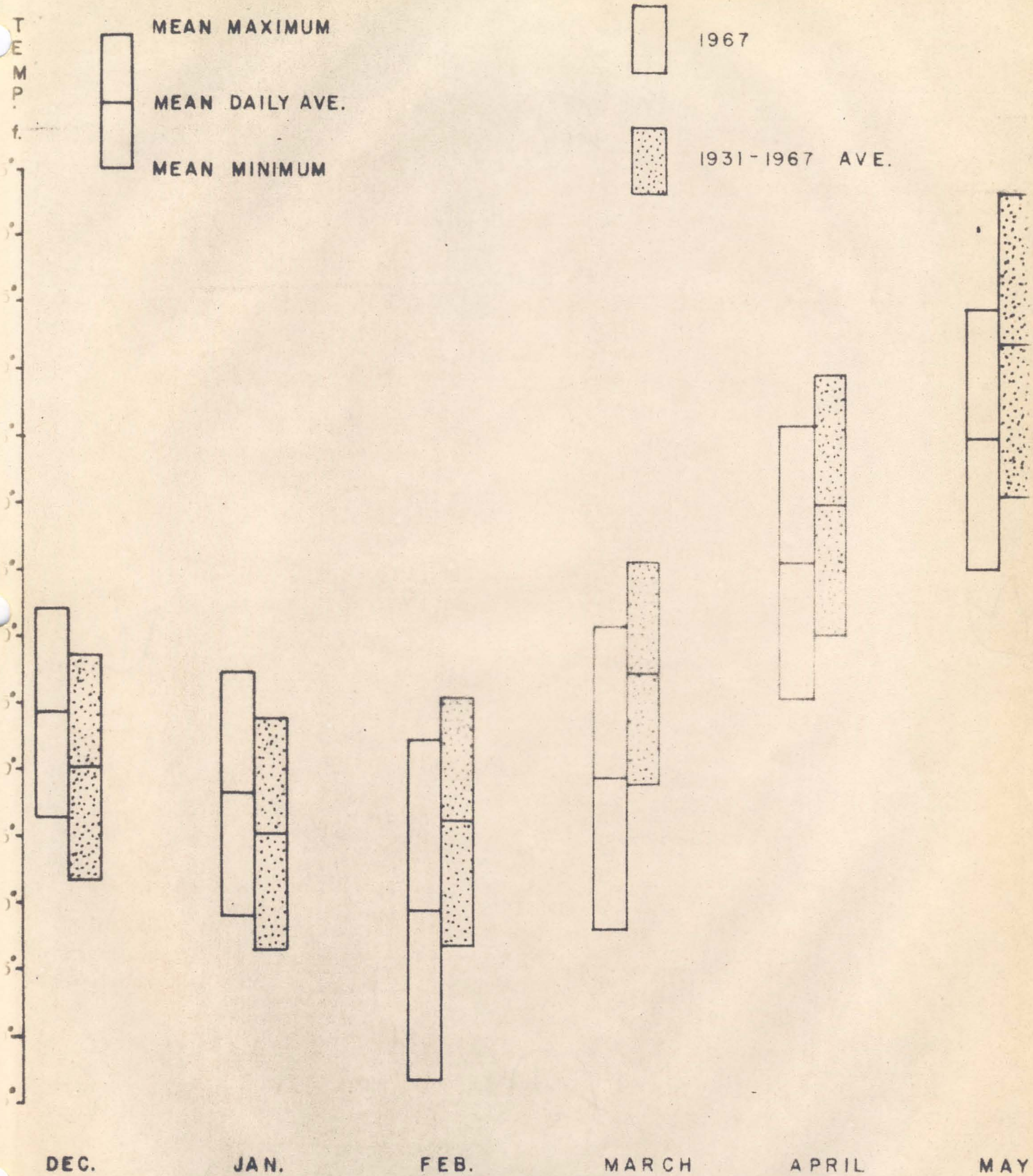


Fig. 8. Temperature data for 1967 compared with 1931-67 averages. Fredericton Airport Weather Station.

Fig. 9. Snowfall data for 1967 compared with 1931 - 67 average. Fredericton Airport weather Station.

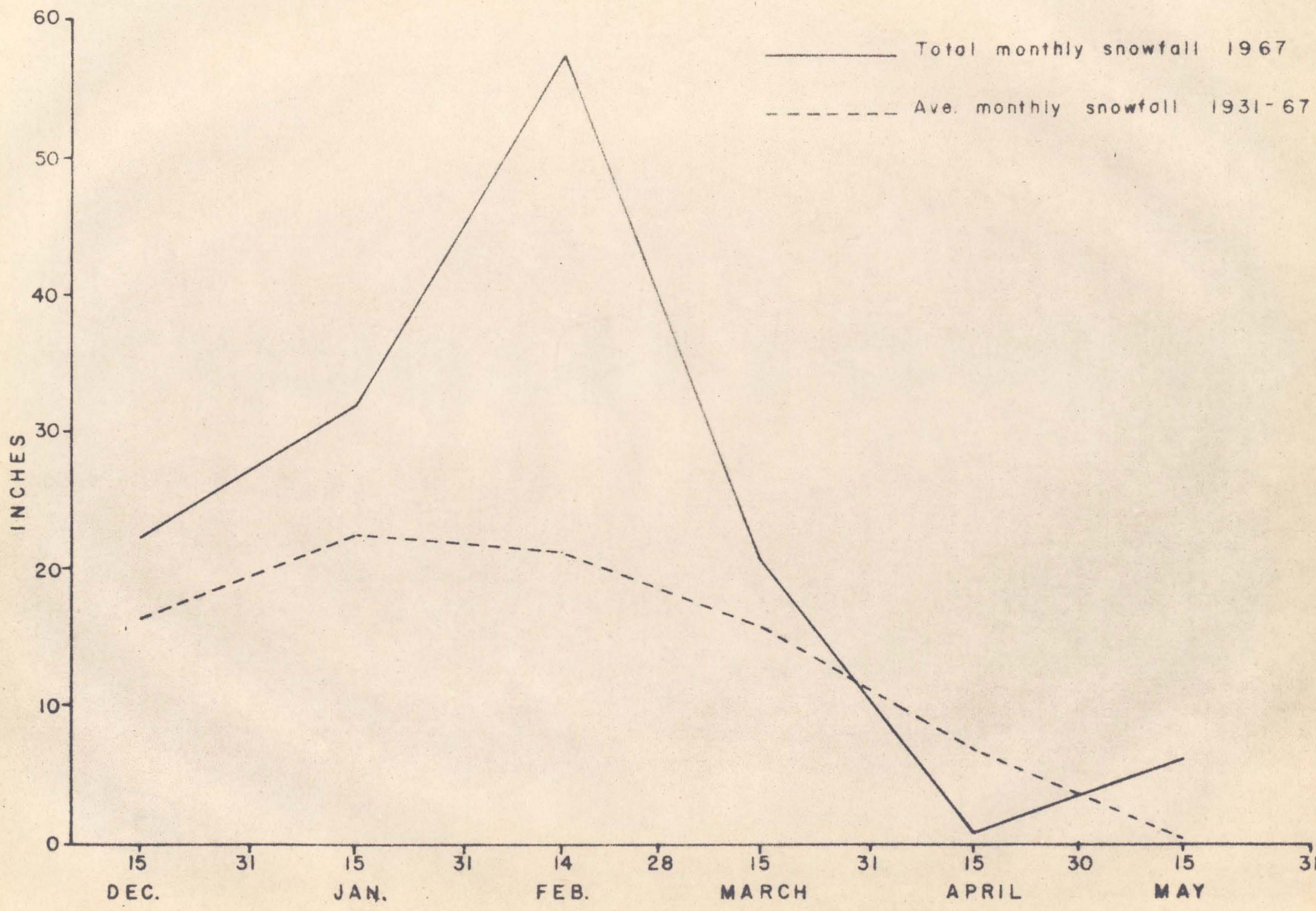
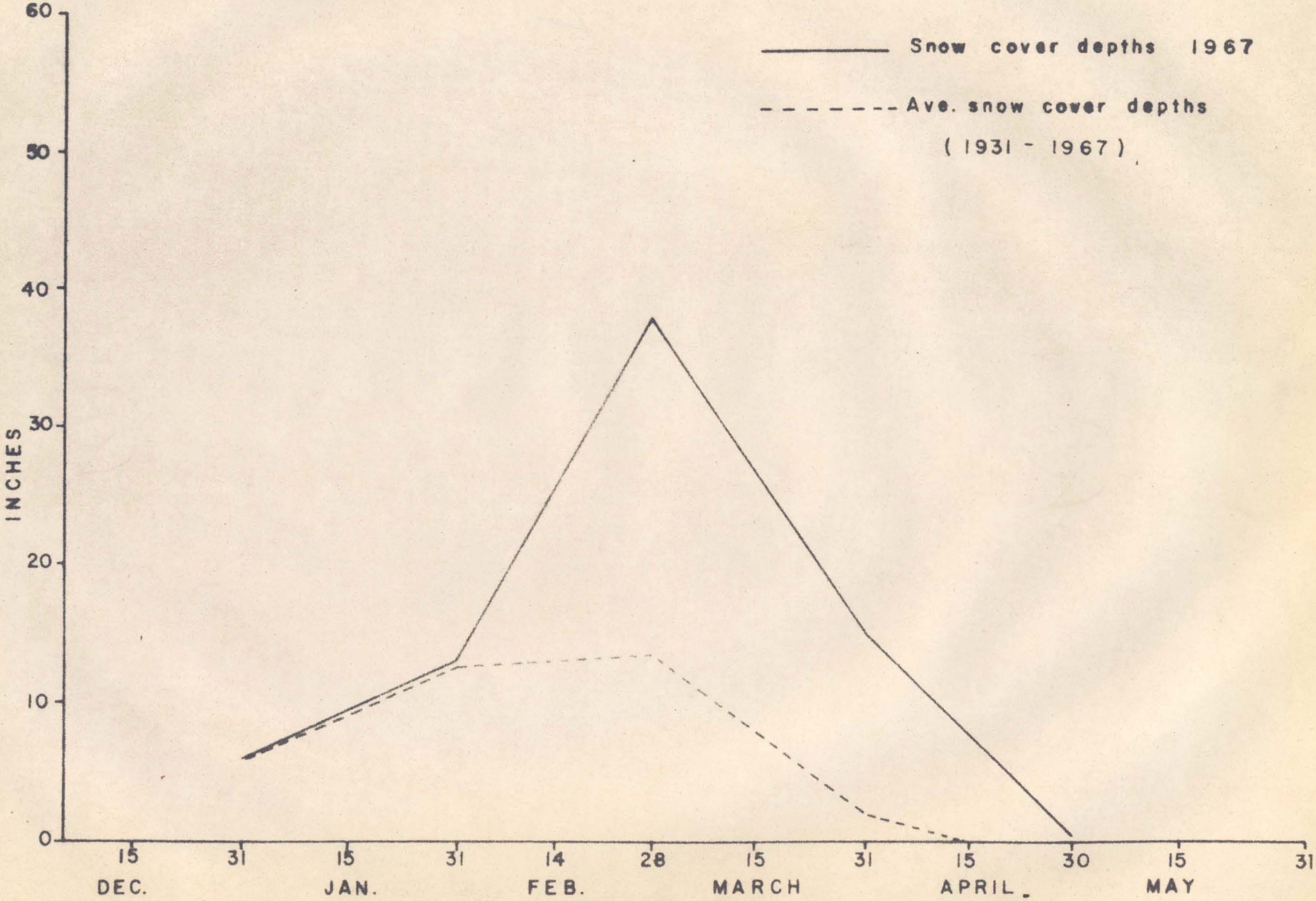


Fig. 10. Snow cover depth data for 1967 compared with 1931 - 67 average. Fredericton Airport weather station.



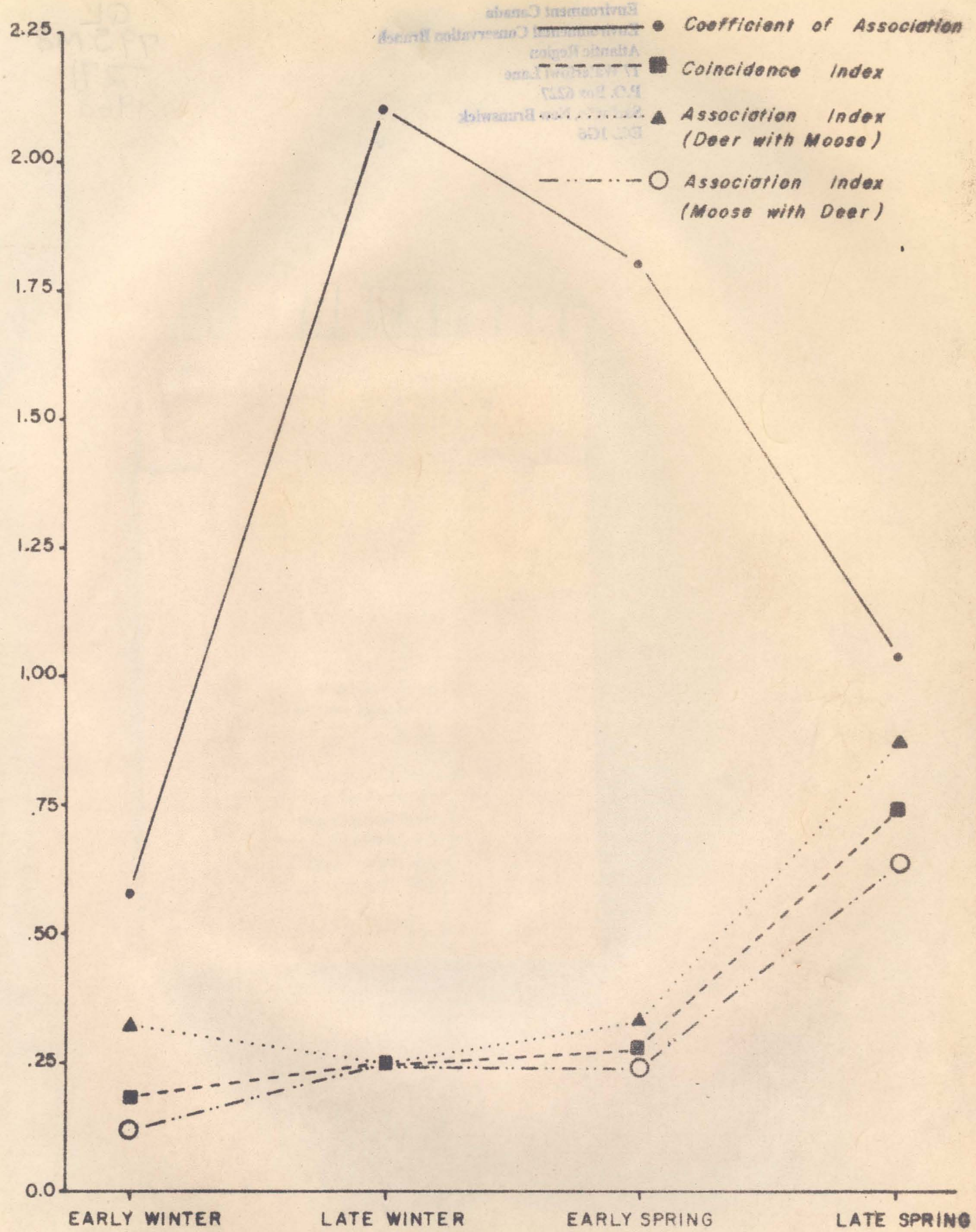


Fig. 11. Values for measures of moose-deer association. Acadia Forest Experiment Station. Winter and spring, 1967.