THE MIGRATIONS OF A MOOSE HERD

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This paper was derived from study, for six years, of moose (*Alces alces) in Wells Gray Park. British Columbia.* Part of this work involved study of the migrations of these animals between lowland burns with deciduous vegetation and coniferous forests with few burns among them at higher elevations.

A number of mammals are known to be migratory, Hamilton (1939) notes that whales and seals of several species, some bats, caribou, bison, elk, mule deer, mountain sheep and porcupine undertake migrations. The last four move mainly in relation to altitude. Hatter (1946) has noted that moose are migratory in parts of British Columbia, while Hosley (1949) quotes Palmer's reports, on moose in Alaska, which describe seasonal movements similar in many respects to those in Wells Gray Park.

Moose ascend the Clearwater Valley in spring when snow is still present on the valley floor. Data on spring migration is obtained from counting moose tracks crossing a snowshoe trail. Tracks are counted daily, are recorded as to direction, then are marked to avoid inclusion in subsequent counts. This technique has been used in California and Oregon for deer (Interstate Deer Herd Committee, 1954). The fall migration is not so easily observed. Its progress on the valley floor is more leisurely, with movement continuing downward throughout the winter. Some information concerning this movement is available from hunting statistics gathered in autumn, while track counts and general observations provide further data.

The main objective of these track counts in spring is a partial census of the herd. The first movement north, up the valley, is rather sudden and involves over a thousand animals. Since this first movement is quite variable as to calendar date, means of predicting the time of migration are necessary for efficient operations of the track counting project. This paper is a result of studying migration patterns, and seeking environmental conditions that control them. Casual observation indicated that weather was probably the major influence. Close study has confirmed this hypothesis.

The vegetation and topography of this park has been described briefly in a previous paper (Edwards, 1954). Part of the park is within a region of relatively heavy precipitation known generally throughout the province as the Interior Wet Belt, where lowland coniferous forests have striking similarities with some forests on the humid Pacific Coast. Summer rainfall is frequent, and winter snow depths are deep, with much variation to elevation, aspect, slope, and vegetation. Over six feet of snow may accumulate at sub-alpine elevations. The moose migrate away from this high ground in winter toward lower, warmer, drier winter range.

Most of this spring fieldwork necessitated long hours on snowshoes in wet snow, and was done by J.Norman, C. Gaglardi and R. Miller, all with the B.C. Forest Service.

Migration,--The movements undertaken by moose are true migrations, comparable in all respects to the altitude migrations of mule deer and elk on mountainous range. We consider migrations to be spatial oscillations, repeated at seasonal intervals, undertaken by animals to utilize different environments in such a way that detrimental conditions experienced are reduced to a minimum. Thus migration has survival value.

Altitudinal migrations are ecologically similar to the more latitudinal migrations. They differ only in the distance involved. The migration of some Wells Gray Park moose from timberline to conditions approaching Douglas fir parkland, and involving map distances of about 40 miles, is ecologically similar to their moving some 350 miles from tree line in Canada's Northwest Territories to the fringes of the taiga in central Saskatchewan.

Annual pattern of distribution. –In general the annual distribution of the Wells Gray moose herd shifts from summer range in sub-alpine forests of alpine fir (*Abies lasiocarpa*) and Engelman spruce *(Picea engelmanni)* at roughly 5000 to 7000 feet, which are rich in deciduous browse species. Part of this migration takes place down the gentle slope of the valley floor. While some moose find these seasonal ranges only a few miles apart and migrate up and down the steep sides of the valley, the majority follow more gradual slopes. For some animals the distance between winter and summer range is over 40 miles.

The segregation of winter and summer range is not complete. A few moose summer in ranges heavily populated in winter, while some survive in winter in forests supporting substantial summer populations.

Moose rarely inhabit extensive alpine meadows. The bulk of the herd summers in sub-alpine forest up to timberline. Preferred areas are wet from seepage with meadows among trees or above high burns. Moose summering in those deciduous burns used more heavily in early winter also favour poorly drained areas about meadows.

In the autumn there is movement to lower elevations. In warm weather there may be little movement until after October. Even casual observations reveal variations in this downward movement, and that cold weather with snow has some connection with migration. A wintery autumn will bring moose into low elevations is early October.

December usually finds them still on the highest of the lowland burns (3000 to 4000 feet above sea level) on the valley floor. The rest of the winter is a period of gradual descent down the gradient of the broad valley. In general this movement is slow, with occasional periods when it temporarily ceases altogether. All of this winter migration is through open, deciduous growth, rich in browse.

The return migration to higher elevations begins in April. The change in direction of migration may be abrupt, the slow drift downward changing overnight to rapid movement up the valley. Some moose may still be drifting downward while this first movement upward is in progress.

While movement up the valley begins with a rush, its pace slows later and becomes more leisurely – a slow infiltration of summer range as spring ascends the mountain slopes. Perhaps the autumn migration is similar, the slow movement noted on the valley floor being preceded by a more rapid initial phase as yet unobserved.

This outline of moose migration is general. The essential elements are present every year, but each year appears to have its peculiarities in timing and rapidity of movement. Data from track counts in the spring illustrates this variability.

Insert graph

Fig 1.- Net figures from daily counts of tracks in the spring of two years, 1952 (open dots) and 1954 (solid dots) Values above zero indicate most movement was upward; values below indicate movement was downward. Zero values indicate either no movement, or equal movement up and down

Spring migration.—Spring track counts were undertaken for four years, 1952 to 1955 inclusive. The Clearwater River runs from north to south, so that movement northward is movement to higher elevations, but of course has little significance with respect to latitude. In every year termination of the count has coincided with lack of sufficient snow to record tracks.

Figure 1 illustrated the variability found in these migrations. Data for two years, 1952 and 1954, are presented. Net movement only is shown. Equal numbers of moose going north and south result in no net movement for the period involved. This figure illustrates the variations observed in dates of migration and duration of movement. In 1952 most migration took place in a few days and was nearly over by mid-April. In 1954 most migration was still in progress in early May. In this year there were two peaks of northward movement with a lull between. This pattern, with two distinct periods of movement, was noted in 1953 and 1955 as well. In the lull between peaks in 1954, there was one 24 hour period when net movement reversed. It was south for this brief period.

The difference in pattern of migration in the two years discussed may be due in part to 1952 figures being obtained about four miles down the valley from, and 500 feet lower than, where figures for 1954 were gathered.

Figures indicating net movement are insufficient for a full understanding of the migration. Gross figures are better. Those for 1954 are shown in Figure 2. In that year there was a period from the start of counting to April 6 in which movement up and down the valley was recorded, but there was little difference between the magnitudes of north and south counts. There followed nine days with virtually no movement of any kind. Northward migration probably began on April 16 and climaxed April 23. A lull in northward movement followed which was accompanied by maximum southward movement. Another peak in movement to higher ground followed, climaxing May 2. With increased movement northward, there was evidence of increased numbers of southbound tracks throughout. Much of this increase was due to wandering, accompanying feeding activity, by moose numbers that had been increasing in the vicinity of the line by northward migration.

Gross figures for 1953 and 1955 exhibit some important differences from 1954 data. In 1953 northward movement began April 2. From March 10 to 31 there was a drift southward which then changed abruptly to northward migration. In both 1953 and 1955 there were two peak periods of northward movement just as in 1954. In 1953, the lull between was still a period of considerable northward migration, so it is a lull only in the relative sense. In 1955 part of the lull contained a brief period when almost no tracks were recorded.

There are no gross figures available for 1952, apparently the only year in which northward movement was not interrupted.

Generalizing then, the slow downward drift of moose throughout the winter may continue to within a few days of migration upward. The upward movement comes to a rapid peak which may be interrupted with a second peak following. Not all movement is upward, even when movement is maximum. In one year the direction of migration reversed for a brief period between upward maxima.

INSERT FIGURE 2

Fig 2.—Gross figures from daily counts of tracks in the spring of 1954. The curve for 1954 in figure 1 is derived from these gross curves. Temperature data indicate similar periods of maximum and minimum Fahrenheit readings and the figures shown are averages of maxima and minima in the periods concerned (see text).

Figure 2 shows maximum and minimum temperatures (Fahrenheit) for the track counting period in 1954. Figures shown are average for periods selected as having more or less similar readings. Maximum and minimum temperatures are only roughly indicative of temperature conditions generally, but are the best figures available for the study.

Study of Figure 2 reveals that the interruption of migration upward in 1954 was accompanied by a period of cold weather. Movement slowed with a drop of maximum temperatures into the forties and, later, a series of cold nights in the tens. With the return of warmer weather migration resumed. Similar weather changes accompanied the lulls in migration in 1953 and 1955. In both years, dropping temperatures to maxima in the forties and minima in the tens were associated with a slowing of upward movement, and in both years a return of warmer weather with maxima in the sixties and minima in the high twenties accompanied a second peak of upward movements.

Since cold weather stopped migration in three successive years, and the return of warm weather appeared to start it again, it is logical to suspect that warm weather initiated these migrations in the first place. It is evident from Figure 2 that migration began in 1954 during a period of maximum temperatures in the fifties . Three warm nights with temperatures well above freezing preceded by almost a week the appearance of large numbers of moose crossing the count line. The counting line was about five miles above the range supporting the most moose when upward movement began, and this may account for the lag between rapid thaw and first recorded migration in numbers. Intervening weather of cooler nature may have contributed to this lag also. In 1953 an extended warm period culminated in a 24-hour thaw on March 30. Large numbers of moose crossed the counting liner five days later in spite of somewhat cooler weather. In 1952 the counting line was four miles south of the line used subsequently. A thaw April 11-14, with rapidly melting snows, resulted in over 200 moose crossing the line in the 24-hour period prior to the morning of April 14. In 1951 general field observations indicated that moose began moving upward on April 3 and were moving “in a steady stream” on April 4. There had been a marked thaw March 29-31.

In one respect this agreement between temperature and migration data does not hold for 1955. The first half of April was warm with maximum temperatures in high fifties, minima in the high twenties. There was no upward migration in this period. The weather became colder April 17 and thereafter warmed gradually to minima in the thirties by April 21. The first migration in numbers was recorded April 21. Related to this behaviour is a condition evident in all years. In all winters there are periods of relatively warm temperatures with melting snows that result in no upward migrations. It must be concluded that temperature is not the only factor controlling migration.

Snow depth appears to be a factor associated with temperature in this respect. There follows semi-monthly snow depth readings on moose winter range, 1951-2. Descending moose reach this elevation in number in February.

On December 1 snow depth was 0 inches; on December 15, 8 inches; January 1, 17 inches; March 1, 25 inches; March 15, 20 inches; April 1, 16 inches; and April 15, 0 inches. Other records confirm that this data is typical in its trends for the winters of concern in this study. An initial rapid increase of snow depths in early winter is followed by a more gradual increase until March, with a rapid decrease thereafter.

On the track counting line, mean snow depths were about 20 inches or more at the beginning of the count each year. In all years mean snow depths decreased throughout the counting period. Migration upward (for the four years 1952-1955 inclusive) was always associated with snow depths of a foot to a foot and a half and decreasing rapidly. First large movements were in mean snow depths of 18, 18, 12 and 16 inches respectively. Also, in 1955, four miles down the valley from the counting line, first evidence of movement upward was noted in about 16 inches of snow, and first migration involving large numbers of moose took place in 12 inches of snow.

Snow is a major environmental variable affecting the survival, and hence the survival behavior, of many animals. Moose require large quantities of food for survival, and deep snow increases the energy output necessary to obtain adequate nourishment. Snow appears to be a major factor in moose migration, and may be a factor preventing movement to higher elevations during warm periods in winter. Thus in 1955, in spite of warm temperatures through the first half of April, there was no migration because snow depths were too deep. In 1954 (Fig. 2) the warm period April 4 to 9 occurred when snow was about 20 inches deep, and there was no migration upward.

The slow drift of moose down the valley throughout the winter coincides with a period of increasing snow depths. Rapidly melting snow in spring coincides with rapid migration upward.

Temperature is the basic factor involved. It acts partly through its influence upon snow conditions. Temperature alone may be important, however, since cold weather slowed migration upward in three successive years.

Fall and winter migration.—Data from hunter success during the period September to December, both months partly inclusive, provide general information on moose migration in fall and early winter. In addition, a short track counting line has been maintained from early January to mid-April in 1954 and 1955.

Hunter success data are available for three years. Figures for 1952 and 1954 are remarkably similar. In these years moose became increasingly numerous in the higher burns on the valley floor throughout the hunting period. For example, in 1953, from September 20 to December 14 in four successive twenty day periods and a final seven day period, the numbers-of-days-hunting required to bag a moose were, successively, 31,23,17,10 and 7. In 1954 by contrast, an average of 25 days was required to bag a moose up to December with little variation through this period. In December only nine days were required.

Table 1. –*Total moose track counts, along a short snowshoe trail, in half month totals, 1954*

Period	Tracks down	Tracks up
Jan. 1-15	16	3
16-31	14	4
Feb . 1-15	51	1
16-28	2	3
Mar. 1-15	20	9
16-31	0	0
Apr. 1-15	0	1
16-20*	0	28

*No snow after this date

The difference in hunter success between the two years is a reflection of fewer moose upon the ranges used in early winter. These are the most heavily hunted areas. Fewer moose in 1954 coincides with shallower snow depths. Snow depths on these ranges averaged over a foot at the close of hunting in 1953, but averaged only two inches the following year.

Track counts in winter indicate irregular movement downward until spring, with heaviest movement in February at the elevation of the counting line. The month of the heaviest movement would vary, of course, with the elevations at which the data was collected. Table 1 presents these track counts in 1954, and illustrates the irregular nature of this downward drift. Movement downward is indicated until mid-March. In 1955, downward movement continued until April.

The critical snow depth beyond which moose find survival difficult appears to differ from depths associated with upward movements in spring. Comparisons of snow depths and moose abundance on higher ranges indicate that few moose inhabit these areas once snow depths reach 30 inches.

Peterson (1955: 111) notes, however, that well over 30 inches of snow is necessary to restrict their movement in some types of snow.

From all these data there emerges a picture of winter range as a dynamic thing. The centre of distribution of moose moves downward through the winter. With snow depths increasing throughout the winter, and being greater at higher elevations, moose appear to be pushed downward by increasing snow depths. While other factors are involved, snow depths are one major factor inducing these migrations. The condition of snow, such as its density, may be important too, but this factor has not been adequately studied.

SUMMARY

Moose in the area studied undertake annual migrations between winter and summer ranges. The distance moved is 40 miles or more for some animals, while some may not migrate at all.

Spring migration upward begins suddenly and movement is at first rapid, then slows. The start of this movement is associated with thaws and decreasing snow depths. Arrival of cold weather may slow the migration until warm weather returns.

Movement downward appears to be more leisurely, and continues through the winter as snow depths increase. This slow drift downward may continue until spring migration begins.

Winter range is a dynamic thing under these conditions, the centre of moose abundance moving downward slowly as snow accumulates throughout the winter.

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