# TIMBER HARVEST AND CALVING SITE FIDELITY OF MOOSE IN NORTHWESTERN ONTARIO

**Ian D. Welch[1], Arthur R. Rodgers[2,3], and R. S. McKinley[1]**

[1] Waterloo Biotelemetry Institute and Department of Biology, University of Waterloo, Waterloo, ON, Canada N2L 3G1; [2] Centre for Northern Forest Ecosystem Research, Ontario Ministry of Natural Resources, 955 Oliver Road, Thunder Bay, ON, Canada P7B 5E1

ABSTRACT: Disturbance, whether natural or human, can limit the ability of individuals to maintain occupancy of preferred habitats over time. If suitable habitat provides for the successful rearing of offspring, then an individual may return to use the same area in subsequent years. Loss of that habitat may have important consequences. To evaluate the effects of timber harvest on moose (*Alces alces*) populations, 60 adult females have been repeatedly captured and fitted with GPS radio collars in northwestern Ontario annually since 1995. To determine if cow moose return to the same area in subsequent years to give birth, location data collected from the collared moose were used to delineate potential calving sites from 1995 - 98. Areas where distances between successive GPS locations (i.e., distances traveled) were less than 100m for a period of at least 3 consecutive days in May of each year were identified as potential calving areas. The UTM coordinates of the locations comprising each potential calving area were averaged to obtain a central point. Linear distances between these points from year to year were used as a measure of site fidelity for individual cow moose. Distances between consecutive calving sites differed between 2 timber harvesting systems that produce different habitat disturbance patterns in the study area. Cow moose that inhabited 2 areas harvested using small, dispersed patch cuts (80-130 ha) had average distances between annual sites of 2.82 $\pm$ 2.37 km ($n$ = 24) and 2.02 $\pm$ 1.68 km ($n$ = 11), whereas collared moose in an area that has been contiguously and progressively clear cut averaged 4.87 $\pm$ 3.62 km ($n$ = 12) in successive years. These differences are attributable to habitat heterogeneity in the size and distribution of cut and uncut patches within harvested areas and, possibly, differences in the density of suitable calving sites. Collared moose showed a lot of individual variability in distances between consecutive calving sites across both types of logged landscapes and among years. The minimum distance between consecutive sites was only 56 m, and the maximum distance was 12.32 km. Changes in distributions of logging activity, predators, conspecifics, and climate could all contribute to this variability. Regardless of timber harvesting effects, distances between successive calving sites of cows that successfully raised a calf (2.60 $\pm$ 2.29 km, $n$ = 30) were significantly less than distances of cows that were not observed with a calf following parturition (4.13 $\pm$ 3.04 km, $n$ = 17). Thus, it appears that calving site fidelity of cow moose could be related to past reproductive success. Identification of the specific characteristics that contribute to calving site fidelity, as well as an analysis of the distribution and abundance of potential sites in different landscapes, are needed if preferred calving habitat is to be protected in timber management plans.

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Individuals of most species show fidelity to at least some part of the area they occupy. Site fidelity may be inversely proportional to the degree of heterogeneity in the habitat occupied by an animal (Switzer 1993). It has also been correlated to past

[3] Corresponding author.

breeding success (Switzer 1997). The re-use of suitable habitat that results in successful breeding can reduce the costs of searching and relocation (Greenwood 1980). By using a familiar site, there is less risk than using an unknown site that may prove to be unfavorable. However, disturbance, whether natural or human, can restrict the ability of individuals to maintain occupancy of preferred habitats over time. The consequences may be particularly detrimental if specific sites are needed to meet important life history requisites. Therefore, preservation of habitat used for activities such as mating and parturition can have important conservation implications for the productivity of a species.

The first stage of an animal's life is often the most critical in terms of its survival and consequently the propagation of the species. In evolutionary terms, individuals that are slightly better at producing offspring than their rivals will be at a selective advantage, so behaviour that maximizes successful production of offspring should be favored by natural selection (Krebs and Davies 1993). Therefore, to ensure reproductive success, species should evolve strategies that minimize the risk of predation to their offspring during this first critical period of life.

Cow moose (*Alces alces*) constantly remain in close proximity to their newborn calves and will vigorously defend them (Peterson 1955, Stringham 1974). They also require secluded areas to give birth to their calves, and the selection of habitat characteristics that can reduce the risk of predation is believed to increase calf survival rates (Bailey and Bangs 1980, Addison *et al.* 1990, Langley and Pletscher 1994). If suitable habitat provides for the successful rearing of offspring, then an individual may return to use that same area in subsequent years.

This paper utilizes data from Global Positioning System (GPS) collared moose as a tool for determining potential calving sites, and to discern the degree of fidelity to these calving sites in consecutive years. Site fidelity of moose inhabiting an area that has been progressively clearcut is compared to moose inhabiting 2 areas harvested using small patch cuts. The relationship between reproductive success and calving site fidelity in cow moose is also examined.

## STUDY AREA

The study utilized location data from GPS-collared cow moose in northwestern Ontario, about 50 km southeast of Dryden and 100 km northeast of Fort Frances (Fig. 1). The area lies approximately within 48.68° N (southern limit) to 49.61° N (northern limit), and from 93.48° W (western limit) to 91.98° W (eastern limit). The entire study area consists of rolling topography, ranging in elevation from 300 to 550 m above sea level (Rodgers *et al.* 1995). The region is inundated by numerous bodies of water, including small streams and rivers less than 10m wide, as well as ponds and lakes ranging from 10 to 100 ha in size, producing a land to water ratio of 55: 45 (Rodgers *et al.* 1995).

The dominant forest types in the area are comprised of both pure and mixed-wood stands of jack pine (*Pinus banksiana*), black spruce (*Picea mariana*), white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and white birch (*Betula papyrifera*). The secondary tree species typical to the area include balsam fir (*Abies balsamea*), eastern white cedar (*Thuja occidentalis*), eastern larch (*Larix laricina*), red pine (*Pinus resinosa*), and eastern white pine (*Pinus strobus*). Depending on the species, the stands range in age from recent clearcuts to mature forests that may be 60 - 120 years old (Rodgers *et al.* 1995).

Two portions of the area in which moose are collared have been harvested using a 2-pass, dispersed block-cut harvesting system consisting of 80 - 130 ha ($\bar{x}$ = 121 ha) patch cuts, following the *Timber Management Guidelines for the Provision of Moose Habitat* (OMNR 1988; hereafter referred to as the "Moose Habitat Guidelines"). One of these modified clearcuts is in the Manitou Forest Management Area (FMA) and is approximately 15 x 40 km in size (Fig. 1). The other modified clearcut is in the Seine FMA and is approximately 15 x 30 km in size. The Manitou and Seine FMAs are about 50 km apart. The Manitou FMA is dominated by white and black spruce, while the Seine FMA has a larger jack pine component. Since 1981, when timber harvesting began, more logging activity has occurred in the Manitou FMA than the Seine FMA. Return cuts (i.e., the second pass through an area to remove timber from undisturbed patches not harvested on the first pass) have not yet occurred in either of these FMAs. A third portion of the study area, also containing collared moose, approximately 15 x 30 km in size, has been contiguously and progressively clear cut since 1978 (Rodgers *et al.* 1995) and lies within the Wabigoon FMA. The Wabigoon FMA is dominated by jack pine. The average patch size of the cuts in this part of the study area is 1,184 ha (Rempel *et al.* 1997).

## METHODS

To evaluate the effects of timber harvest on moose populations, 60 adult cow moose have been repeatedly captured and fitted with Global Positioning System (GPS) radio collars in the study area annually since 1995. The telemetry system (GPS_1000), developed by Lotek Engineering Inc. (Newmarket, ON) consists of remote units attached to the animals (i.e., collars) and a command unit, which is operated from an aircraft or ground vehicle using UHF radio modems as the means of communication (Rodgers *et al.* 1996). To determine if cow moose return to the same area in subsequent years to give birth, data collected from collared moose were used to delineate potential calving sites through examination

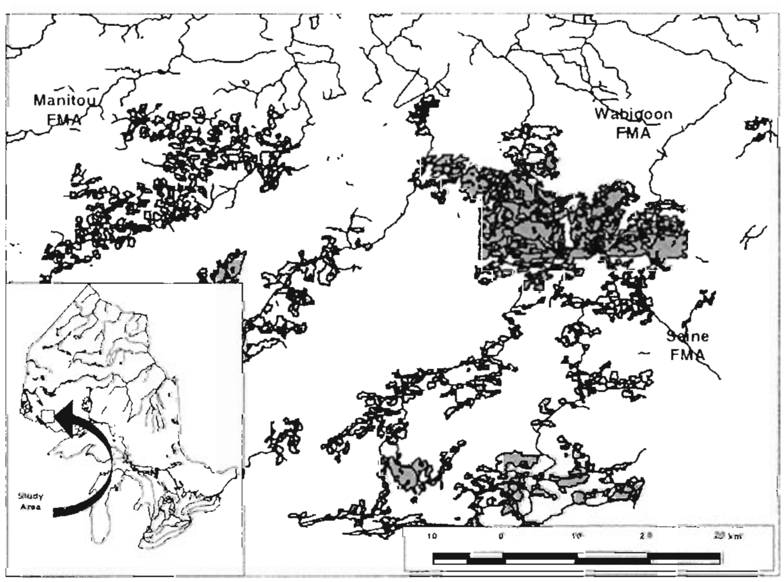


Fig. 1. Forest Management Areas (FMAs) in northwestern Ontario where cow moose have been GPS-collared since 1995. Shading indicates areas in each FMA where timber harvest has occurred.

of location patterns. Location data were downloaded from individual collars each June, from 1995 - 1998, and differentially corrected to improve the accuracy (3 - 7 m) of position estimates (Rempel and Rodgers 1997).

Moose give birth almost exclusively in May (Addison *et al.* 1993; Sigouin *et al.* 1997), so potential calving sites were pinpointed by viewing the corrected data for the month of May from 1995 - 1998, with ArcView® GIS Version 3.0a software (ESRI Inc., Redlands, CA). Since cow moose constantly remain in close proximity to newborn calves, their movements for the first few days after parturition may be restricted to a small area (Stringham 1974). Consequently, areas where distances between successive GPS locations (i.e., distances traveled) were less than 100m for a period of at least 3 consecutive days, were identified as "potential" calving sites (Stringham 1974, Langley and Pletscher 1994, Chekchak *et al.* 1998). A software extension for ArcView® (Rodgers and Carr 1998) was used to graphically display the locations of each moose, calculate interfix distances, and determine temporal movement patterns. In a few cases, areas were calculated even though 1 interfix distance was greater than 100m, but only if the temporal sequence of locations indicated that the moose moved to a single point then moved back toward the main cluster of points on the next move. The UTM coordinates of the locations comprising each potential calving site were averaged to obtain a central point. Linear distances between centres of potential calving sites from year to year were used as a measure of site fidelity for individual cow moose.

Each December, collared moose were located from an aircraft by homing in on the VHF transmitter in each of the collars. These flights served to locate the moose, observe calves, and determine any missing or dead animals prior to the captures and re-collaring each winter. The presence of a calf with a collared moose was also recorded during the period of re-capture and collaring that took place each February. Observations of calves with the collared cows were used to provide an indication of reproductive success.

Location data are not normally distributed because animals do not move randomly. Moose presumably have some choice in calving site selection and would be expected to show bias toward areas of preferred habitat. Furthermore, variances in data from the 2 areas examined were quite different, again violating an assumption of the *t*-test (Zar 1999). Therefore, the non-parametric Mann-Whitney *U* test (White and Garrott 1990, Zar 1999) was used to compare mean distances between centres of calving sites in the progressive clearcut and patch cut areas, and between moose observed with and without calves. A Kruskal-Wallis test (Zar 1999) was used to compare the 3 time intervals in the study (i.e., 1995-1996, 1996-1997, and 1997-1998). All statistics were calculated with SPSS version 7.5 statistical software (SPSS Inc., Chicago, IL), and tests were carried out using a maximum probability of a type 1 error at $\alpha = 0.05$.

## RESULTS

The average distance between calving sites in successive years for all cow moose in the study was 3.15 km ($\pm$2.77 km, $n = 47$). The minimum distance between subsequent sites was only 56 m, and the maximum distance was 12.32 km. Some moose exhibited strong site fidelity, where 12% of sites were less than 500m from the site used the previous year and 25% within 1 km. Others appeared to give birth some distance from the area used the previous year; 17% of all sites were greater than 6 km from the previous year's sites. There was also high variability between years in some moose. The largest variation by an individual was a moose in the Manitou FMA that had a calving site in 1996 that was 7.02 km from the one used in 1995. The site in 1997 however, was only 56m from that in 1996. In 1998, she calved 7.84 km from the site used in 1997. She was observed with a calf each winter.

Moose that inhabit each of the 3 forest management areas displayed different degrees of fidelity (Fig. 2). The mean distances between calving sites used in successive years were quite similar between the Manitou and Seine FMAs (2.82 km and 2.02 km, respectively) with slightly higher variability in moose inhabiting the Manitou FMA ($P$ = 0.390). Both of these FMAs have been harvested using small patch cuts (80 - 130 ha) following the Moose Habitat Guidelines (OMNR 1988).

Sample sizes for the Seine and Wabigoon FMAs were similar, and a comparison between these 2 provides some evidence of the effects of different timber harvesting methods. Moose in the Wabigoon FMA inhabit an area that has been progressively clear-cut, resulting in larger contiguous patches of disturbance. The mean distance between successive calving sites in the Wabigoon FMA was 4.87 $\pm$ 3.62 km ($n$ = 12) which is higher than the mean distances found in either the Manitou or Seine FMAs (Fig. 2). Distances between successive calving sites in the Seine and Wabigoon FMAs, were significantly different ($P$ = 0.016).

The general trends mentioned are also evidenced in the frequency distributions of distances between successive calving sites within each FMA (Fig. 3). Both the Manitou and Seine FMAs show a strong trend towards distances less than 3km, while the distribution from the Wabigoon FMA is slightly skewed towards greater distances. These frequency distributions also demonstrate the wide range of individual variability that was observed, regardless of the timber harvesting system applied in each FMA.

Differences in the degree of site fidelity over the time period of the study are illustrated in Fig. 4. The distances between sites used in 1996 and 1997 produced the smallest mean, but also had the highest variation. Interestingly, the minimum distance of 56 m and the maximum distance of 12.32 km were both recorded between 1996 and 1997. A Kruskal-Wallis test of the 3 time intervals revealed no significant difference ($\chi^2$ = 3.744, 2 df, $P$ = 0.154).

The degree of fidelity exhibited by moose that were observed with or without calves in the following winter is summarized in Fig.

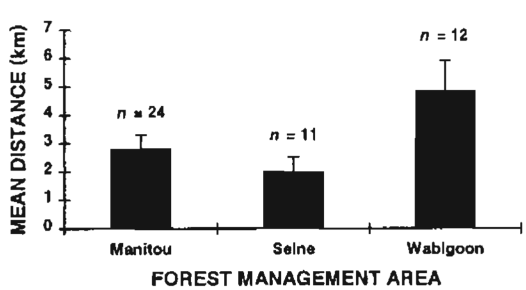


Fig. 2. Means and standard errors of distances between successive calving sites of GPS-collared cow moose in 3 Forest Management Areas of northwestern Ontario.

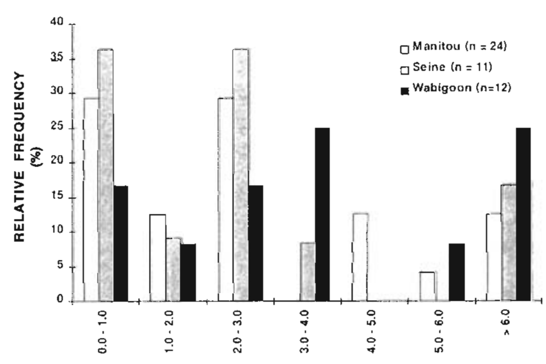


Fig. 3. Frequency distributions of distances between successive calving sites of GPS-collared cow moose in 3 Forest Management Areas of northwestern Ontario.

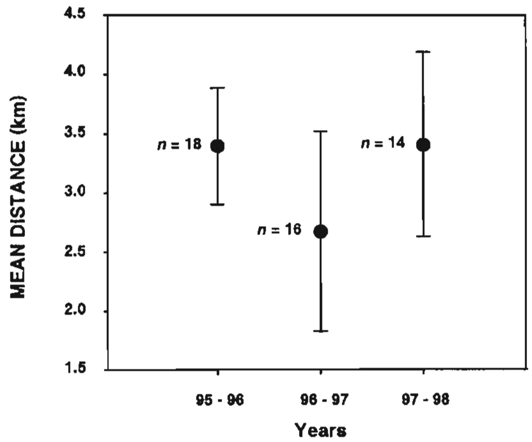


Fig. 4. Means and standard errors of distances between successive calving sites of GPS-collared cow moose in 2-year periods over the duration of the study.

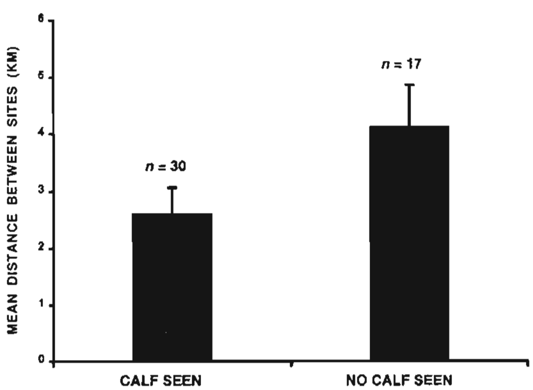


Fig. 5. Means and standard errors of distances between successive calving sites of GPS-collared cow moose that were seen with or without a calf following parturition.

5. The mean distance between sites used by moose seen with a calf was 2.60 km ($\pm$ 2.29 km; $n = 30$), while the mean for moose not seen with a calf was 4.13 km ($\pm$ 3.04 km; $n$=17). A Mann-Whitney $U$ test showed a significant difference between these 2 groups ($P = 0.024$).

## DISCUSSION

Our results demonstrate that calving site fidelity in cow moose differed between 2 timber harvesting systems (Fig. 2). Distances between successive calving sites were shorter for cows in the areas harvested using small patch cuts (Manitou and Seine FMAs) than in the area that was progressively clear cut (Wabigoon FMA). This finding may support theories that predict site fidelity is inversely proportional to habitat disturbance (Switzer 1993). The largest distance between successive calving sites (12.32 km) and the highest variability among cows were observed for moose in the progressively clear cut Wabigoon FMA (Fig. 3), in which cut patches averaged 1,184 ha (Rempel *et al.* 1997). On the other hand, the shortest distance between successive sites (56 m) was recorded for a cow moose in the Manitou FMA, and the Seine FMA had the lowest variability (Fig. 3). These 2 areas were harvested using small patch cuts, following Ontario's Moose Habitat Guidelines (OMNR 1988), that averaged 121 ha (Rempel *et al.* 1997). Thus it appears that small patch cuts, which produce smaller patches of disturbance than contiguous and progressive clear-cutting, result in stronger calving site fidelity.

The relationships between timber harvesting system and calving site fidelity that we observed in cow moose are not simply determined by differences in the relative sizes of disturbed patches, but are also determined by the distribution of the cuts in each area. Numerous small patch cuts leave numerous, small undisturbed patches. As a result, the percentage of total disturbance area within 100 m of undisturbed forest was higher in the areas harvested using patch cuts than in the area harvested by progressive clearcutting (Rempel *et al.* 1997), but site fidelity was also higher in the patch cut areas. At first this may appear contradictory because it implies that cow moose in the patch cut areas were likely to encounter disturbance more often, and they should exhibit less site fidelity, than cows in the progressive clearcut. However, for an early successional species such as moose, both natural and human disturbance can produce an increase in preferred forage. Consequently, the net effect of small patch cuts is to increase the forage supply within a short distance of cover, which may have contributed to the observed increase in calving site fidelity of cow moose in these areas.

Although the average cut size in the Wabigoon FMA was much larger than the patch cuts in the Manitou and Seine FMAs, many small patches of mature forest occurred throughout the area, as well as extensive shoreline reserves around lakes and rivers (Rempel *et al.* 1997). As a result, the interspersion of mature forest with disturbed areas was greater in the progressive clearcut (29.3%) than in the patch cuts (18.5%). At the same time, the mean distance between disturbed patches was less in the progressive clearcut (133 m) than in the patch cuts (178 m). Taken together, these characteristics suggest greater habitat heterogeneity in the progressive clearcut than the patch-cut areas, which may have contributed to the observed decrease in calving site fidelity of cow moose in the Wabigoon FMA.

In a park landscape in south central Quebec, Chekchak *et al.* (1998) reported a mean distance between successive calving sites of 3.29 ± 1.05 km. This value is intermediate between the mean distances we observed in the patch-cut areas (2.82 ± 2.37 km and 2.02 ± 1.68 km) and the progressive clearcut (4.87 ± 3.62 km). The fact that moose in a park area, not disturbed by logging, exhibited greater site fidelity than cows in the progressive clearcut of the present study may not be surprising since it is consistent with the theory that site fidelity is inversely proportional to habitat disturbance (Switzer 1993). But why should site fidelity be greater in the patch-cut areas than in an undisturbed landscape? Without the necessary landscape parameters for comparison, this question is difficult to answer. However, one explanation might involve the distribution and abundance of suitable calving sites relative to forage supply in the 2 situations. As noted above, the net effect of small patch cuts is to increase the forage supply within a short distance of cover, leading to an increase in calving site fidelity of cow moose in these areas. It is conceivable that the relationship between forage supply and distance to cover that may be used for calving was even more favourable in the patch-cut areas that we studied than in the undisturbed park landscape in Quebec.

To this point we have emphasized the relationship between calving site fidelity and the relative size and distribution of disturbed patches. However, there is an alternative explanation of our results which assumes that the cow moose do not show any fidelity to calving sites, as concluded by Chekchak *et al.* (1998) in south central Quebec. In this case, it is the size and distribution of undisturbed patches that determines the distance between successive calving sites. Moose inhabiting small patch cut areas would thus have smaller undisturbed patches in which to find a suitable calving site. Moose inhabiting the progressive clearcut, on the other hand, may have large undisturbed patches between cuts in which to select a calving site. Distances between successive calving sites might then be greater in the progressive clearcut than the patch-cut areas, as we observed. If this hypothesis is correct, then movement of individuals between undisturbed patches in the patch-cut areas must have been restricted; otherwise, distances between successive sites would have been more similar to those observed in the progressive clearcut. We do not believe this was the case because an objective of Ontario's Moose Habitat Guidelines (OMNR 1988) is to maintain connectivity between undisturbed patches of forest so that moose have access to the various habitat components they require. These guidelines were closely followed in the patch-cut areas of the present study (Rempel *et al.* 1997). In addition, preliminary analyses of location data from collared moose over longer time periods than considered in this study indicate that most cows used several undisturbed patches within their home ranges at different times of the year (A. Rodgers, *unpubl. data*). Since movements were not likely restricted, the only other possibility that is consistent with our observations is that the density of suitable calving sites in the patch-cut areas was higher than in the progressive clearcut area. This might have been the case if spruce is an important characteristic of preferred calving sites since the patch-cut areas had more black and white spruce than the progressive clearcut, which was dominated by jack pine. Testing this hypothesis will require detailed studies of the specific habitat characteristics at calving sites used by cow moose and analysis of the distribution and abundance of sites having these characteristics in each of the cutover areas.

Collared moose in our study showed a lot of individual variability in calving site fidelity across both types of logged landscapes (Fig. 3). Some moose tended to return to particular calving areas more faithfully than others regardless of which FMA they inhabited. The overall standard deviation of 2.77 km was nearly as large as the overall mean distance between successive calving sites (3.15 km), giving a coefficient of variation of 87.9%, and indicating the wide spread in fidelity we observed. Chekchak *et al.* (1998) similarly reported high variability in south central Quebec, with distances between successive calving sites ranging from 675 - 6,900 m for 8 moose between 1995 and 1996. Addison *et al.* (1993) also found variability in the fidelity of moose they monitored in south central Ontario. Some calving sites were used repeatedly, but by different moose in subsequent years (Addison *et al.* 1993). Since seclusion is a common characteristic associated with calving areas (Bailey and Bangs 1980, Addison *et al.* 1990), the presence of predators or other moose could alter subsequent use of an area. Individual responses to predators and conspecifics probably change with age and experience. These factors may account for some of the variability in calving site fidelity we observed.

Variability in distances between successive calving sites was also observed across the time period of the study (Fig. 4). Site fidelity appeared to be strongest in 1996 - 97 for moose throughout the study area. However, variability in this time period was also the highest and statistical differences from other years could not be detected. This makes it difficult to draw any strong conclusions about the apparent increase in fidelity between 1996 and 1997. Larger samples over a longer time period might illuminate temporal patterns that may occur, which could then be compared to changes in the distributions of other moose and predators, logging activities, and climatic factors over the same time frame.

Regardless of timber harvesting effects, our results also indicate that calving site fidelity of cow moose differed according to past reproductive success (Fig. 5). Distances between successive calving sites of cows that successfully raised at least 1 calf to at least 6 months of age were found to be significantly less than distances of cows that were not observed with a calf. However, given the magnitude of the mean distance between sites used by cow moose seen with a calf (2.60 km), is it reasonable to conclude that successful cow moose showed fidelity to calving sites? Certainly, for smaller species such as tree-nesting birds, we would not likely conclude that a distance of 2 km between successive nest sites showed any evidence of fidelity because we would expect much less distance between suitable sites that could have been used. For a large species such as a moose, however, distances between potential calving sites could be quite large and require cows to search over a wide area to find suitable sites. Further studies of the scale at which cow moose perceive their surroundings are required to confirm the relationship between calving site fidelity and reproductive success that we observed.

An alternative explanation for the relationship between calving site fidelity and reproductive success that we observed might be that our methodology for identifying potential calving sites was in error. We used the calf observation data from location flights in December and capture flights in February as an indicator of reproductive success. At those times, we noted which cows were successful in rearing at least 1 calf to at least 6 months of age. However, for an individual cow moose there was no way of knowing the initial number of calves that were born and survived until the time of the flights, or if a calf was present but not observed from the air. Consequently, it might be argued that we mistakenly ascribed a calving site to some cows in a given year when in fact they did not give birth that year. We do not believe that was the case because blood progesterone levels, which were also measured at the time of capture in February each year, indicate pregnancy rates of collared moose consistently exceeded 90% (A. Rodgers, *unpubl. data*). In addition, the criteria we used (i.e., a series of locations within 100 m for at least 3 consecutive days) are consistent with findings in other studies where cows with newborn calves were directly observed. Stringham (1974) reported that none of the captive moose observed in that study were seen to have moved more than 5 m from where they were first spotted for the first few days postpartum. As well, Langley and Pletscher (1994) reported calving cows remained on the site an average of 6.2 days. Chekchak *et al.* (1998) observed an average stay at calving sites of 4.4 days. Thus, we believe the evidence from the GPS location patterns strongly suggests the majority of collared cows did give birth and the absence of a calf the following winter indicates the calf, or calves, did not survive. The resulting increase in distance between successive calving sites by moose not observed with a calf is likely a response to the loss of at least 1 calf to predation, poor nutrition, or hunting.

Features of moose calving areas can play an important role in moose population dynamics because of the vulnerability of calves to predation (Bailey and Bangs 1980). In a moose calf mortality study in Alaska, 94% of the natural mortality of radio-collared calves occurred before July 19 of each year studied, and predation was found to be the greatest cause, accounting for 86% of calf deaths (Ballard *et al.* 1981). Black bear predation in Alaska is a significant cause of mortality of young calves, but nearly ceases when the calves reach 1 -2 months of age (Franzmann *et al.* 1980). Because of this heavy predation on newborn and young individuals, strategies that reduce the chances of encounters between neonates and predators would confer a considerable selective advantage on these individuals (Langley and Pletscher 1994). Selecting a new, unfamiliar location may result in an increased risk of predation (Greenwood 1980). As well as past reproductive success, returning to the same area may be beneficial to the animal due to familiarity with cover and forage, reducing costs associated with re-locating, and searching for new suitable habitat (Greenwood 1980, Cooch *et al.* 1993). It would seem logical then, that if a cow moose found suitable habitat to reduce the risk of predation and successfully reared her offspring, she would return to that site the following year if possible. Habituation of predators to calving sites, however, may limit the degree of fidelity exhibited by individual cow moose.

## MANAGEMENT IMPLICATIONS

Our results indicate that application of Ontario's Moose Habitat Guidelines (OMNR 1988) may reduce the distance between successive calving sites used by cow moose. However, we cannot conclude that these guidelines promote fidelity because the average distance between successive calving sites used by cows was more than 2 km in areas where the guidelines were applied. Examination of the scale at which cow moose perceive their surroundings and detailed studies of the specific characteristics of suitable moose calving sites, as well as an analysis of the distribution and abundance of potential sites in different landscapes, are needed to determine whether or not the Moose Habitat Guidelines contribute to calving site fidelity. We also need to know more about the effects of other factors such as predators and climate, on calving site selection. Ideally, if moose were found to prefer certain habitats for parturition sites, the Moose Habitat Guidelines could be modified to protect tracts of preferred calving habitat.

Regardless of whether or not cow moose show any fidelity to calving sites, we need to determine if application of the Moose Habitat Guidelines (OMNR 1988) can increase the productivity of moose populations. Based on aerial survey data, Rempel *et al.* (1997) found that during a 16-year period (1977 - 92) preceding our study, the moose population in the progressively clearcut Wabigoon FMA increased but the population in the patch cut Manitou FMA remained stable. By 1992, application of the Moose Habitat Guidelines in the Manitou FMA had failed to produce a higher moose density than progressive clear cutting in the Wabigoon FMA. These results were attributed primarily to a combination of road access and hunting pressure. A consequence of applying the Moose Habitat Guidelines in the Manitou FMA was higher road density which allowed greater hunter access, while road density was lower in the Wabigoon FMA and hunting closures were in place until 1989. Rempel *et al.* (1997) also suggested that the higher interspersion of cover with forage in the Wabigoon FMA contributed to a higher population growth rate than in the Manitou FMA. However, they did not compare productivity of the moose populations in the 2 landscapes. Since their study was completed, 2 more aerial surveys have been conducted in the study area. These additional data need to be analyzed to determine whether or not moose densities have continued to remain stable under both timber harvesting systems, and the entire data set should be examined for possible differences in productivity of populations inhabiting different landscapes.

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