MOOSE MIGRATION: NORTHEASTERN ALASKA TO NORTHWESTERN YUKON TERRITORY, CANADA

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ABSTRACT: A study of moose (*Alces alces gigas*) movements and population identity in the southeastern Brooks Range, Alaska, was initiated in March 1995. Fifty-seven moose (43 females and 14 males) were captured and equipped with radio transmitters in 4 major drainages where moose are known to congregate during winter. Relocations indicated that 88% of the collared animals migrated seasonally. A majority of migrants (86%) moved to Old Crow Flats, in the Yukon Territory, where they remained for the summer. The mean maximum distance between summer and winter ranges was 123 km (range: 18-196, SD 37.2). Movements to summer range were underway in late March when moose were captured. Moose began moving to winter ranges in late August, and the migration was complete by the rut in early October.

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Migration between seasonal ranges is a common characteristic of many moose populations in both North America and Eurasia (LeResche 1974, Pulliainen 1974). Annual migration patterns of moose are maintained from mother to offspring (Sweanor and Sandegren 1988), with a high degree of fidelity to traditional routes and seasonal ranges (Le Resche 1974, Andersen 1991). In mountainous regions, a common migration pattern for moose is from summer ranges located in higher elevations to lower winter ranges, usually in response to varying levels of snow accumulation (Van Ballenberghe 1977, Sandegren *et al.* 1985, Ballard *et al.* 1991). A few studies have documented the opposite pattern in which moose move from low summer ranges to winter ranges located at higher elevations (Gasaway *et al.* 1983, Andersen 1991).

A study was undertaken in 1995 to determine moose movement patterns and population identity in the southeastern Brooks Range of Alaska. Moose concentrate during the fall and winter in southeastern Brooks Range valleys, however, few moose are observed there during the summer (Mauer and Akaran 1991). Moose are abundant during summer in the western Old Crow Flats, but are scarce in winter (Ruttan 1974). In this paper I present preliminary results which identify a migratory population of moose which move from elevated winter ranges in the southeastern Brooks Range of northeast Alaska to low summer ranges located in Old Crow Flats in northwestern Yukon Territory, Canada.

STUDY AREA

The study area includes a portion of the southeastern Brooks Range located within the Arctic National Wildlife Refuge, Alaska, and the western half of Old Crow Flats located in the Vuntut and Ivvavik National Parks, and Old Crow Settlement Lands in Canada (Fig. 1).

In Alaska, the study area includes the upper portions of the Sheenjek and Coleen Rivers which contribute to the Porcupine/ Yukon watershed, and the upper Kongakut

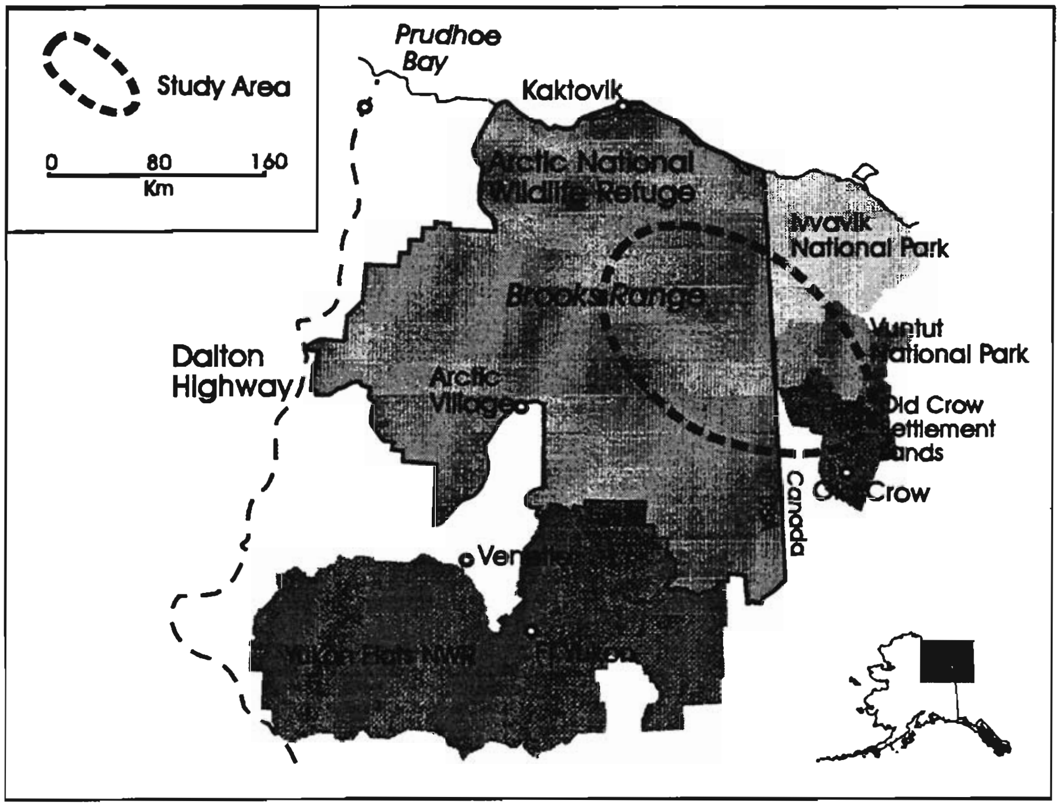

Fig. 1. Location of the study area.

and Firth Rivers which flow north to the Arctic Ocean. Vegetation, topography, and climate are described for the Sheenjek area in Kessel and Schaller (1960), and the Firth area in Drew and Shanks (1965). Briefly, the Sheenjek and Kongakut drainages are glacier-carved valleys bordered by steep mountains. The Firth and Coleen valleys show little or no evidence of glaciation, and are primarily bordered by moderate slopes. The transition from boreal forest to tundra occurs in the Sheenjek, Coleen and Firth valleys. Open spruce (*Picea glauca*) forests line the sides of these valleys in the lower reaches, and give way to alpine tundra at the headwaters. Feltleaf willow (*Salix alaxensis*) is the predominate shrub of gravel bars and low terraces of the active floodplains. The Kongakut River is beyond the limit of spruce forest. Its floodplain supports feltleaf willow communities, and isolated stands of balsalm poplar (*Populus balsamifera*). Small lakes and ponds are common throughout the lower part of the Sheenjek River valley. The Kongakut, Coleen, and Firth River valleys of the study area are nearly devoid of lakes and ponds.

The Old Crow Flats in Canada are an extensive complex of shallow lakes, ponds and wetlands covering a former glacial lake bed surrounded by unglaciated uplands and hills (Ovenden and Brassard 1989, Wilken *et al.* 1981). The Old Crow River meanders east and south through the flats, and joins the Porcupine River near the community of Old Crow. The vegetation is characterized as a transitional forest-tundra wetland. White spruce and tall willow communities line major drainages. Extensive upland shrub communities and wet meadows are common. The numerous shallow lakes and ponds have abundant aquatic vegetation.

Partially drained lake basins support dense thickets of blue green willow (*Salix glauca*) (J. Hawkings, Can. Wildl. Serv., *pers. comm.*).

The climate in both the Brooks Range and Old Crow Flats is characterized as continental subarctic. Mean July and January temperatures recorded at the community of Old Crow during 1951 - 1980 were 14.2 and -33.1° C, respectively, mean annual temperature was -10.1° C, and mean annual precipitation is 215 mm (Environment Canada 1982).

METHODS

During 30 March to 4 April, 1995, 57 moose (43 females and 14 males) were captured in 4 moose concentration areas of the southeastern Brooks Range, and marked with VHF radio-collars. Moose were immobilized with carfentanil hydrochloride delivered by dart gun from a helicopter. Fifteen moose were captured in each of the Sheenjek, Coleen, and Firth River drainages, and 12 moose were captured in the Kongakut drainage.

Marked moose were relocated using a Cessna 185 aircraft. Latitude and longitude were measured using a Global Positioning System on the aircraft. Data regarding group size, composition, and land cover type were recorded. Ten relocation surveys (4 in April-June, 2 in July-August, and 4 in September-November) were conducted in 1995, and 9 relocation surveys (5 in March-June, 2 in July-August, and 2 in September) were conducted in 1996.

Location data, movements and distances were plotted, measured, and analyzed using a geographic information system (ArcInfo V. 7.04 ESRI, Redlands, Ca). Maximum migration distance was determined by measuring straight line distances between the farthest summer and winter relocation points for each moose.

RESULTS

All collared moose were relocated within 30 days after capture, and no immediate study related mortalities were found. Fifty-one individuals were relocated 511 times in 1995 ($\bar{x}$ = 10 relocations/individual), and 42 individuals were relocated 349 times in 1996 ($\bar{x}$ = 8 relocations/individual). Data for these individuals were used to determine seasonal movement patterns and for distance measurements. Mortality and infrequent relocation precluded analysis of data for 6 moose in 1995 and 9 moose in 1996.

Moose exhibited either migratory behavior (88%) or were residents with overlapping winter and summer ranges (12%). Most of the migrants (91%) moved to summer ranges outside the drainage in which they were marked. Most moose migrated from wintering ranges in the Firth (96%), Kongakut (86%), and Coleen (75%) drainages to summer range on Old Crow Flats (Fig. 2). Only 43% of the moose collared in the Sheenjek drainage migrated to Old Crow Flats.

The mean maximum distance between summer and winter locations (1995 and 1996) for migratory moose was 123 km (range: 18-196 km, SD 37.2). The mean maximum distance between relocations for residents was 39 km (range: 16-59, SD 14.1). Elevations for summer ranges on Old Crow Flats ranged from 295 to 325 meters above sea level (asl). Winter ranges used by migratory moose varied from 610 to 1050 meters asl.

Long distance migrations were apparently underway when moose were captured in late March and early April, 1995. This was mainly evident in the Firth River area where 12 of the moose captured there returned to other winter ranges in the Kongakut (n = 8), Coleen (n = 3), and Sheenjek (n = 1) drainages. Three moose captured on the Kongakut area returned to winter ranges in the Sheenjek drainage, and

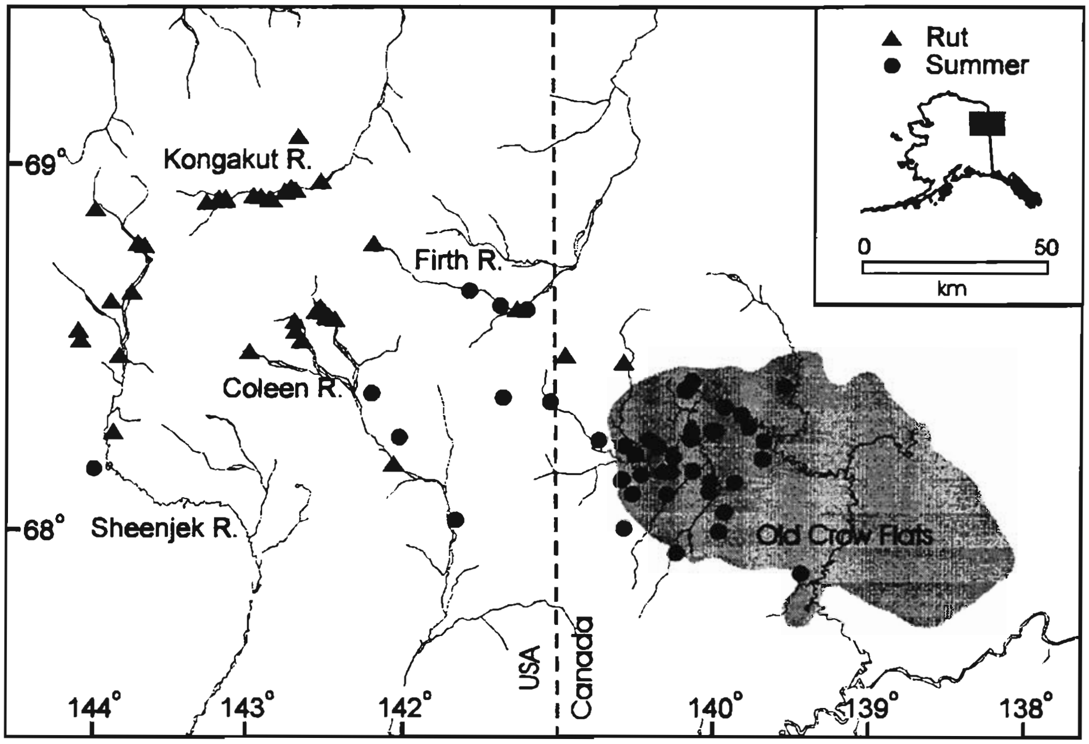

Fig.2. Locations of migratory radio-collared moose during summer and during the rut, 1995

2 moose captured on the Coleen area returned to winter in the Sheenjek drainage. Spring movements were not detected in 1996 until 2 May. In both years, spring migration was initiated before snow had begun to melt. The fall migration began in late August during both years, prior to the beginning of winter snow accumulation. Fall migration ceased by the peak of mating (28 September to 6 October). Relocation data as well as observations of tracks in the snow during spring enabled identification of several migration routes. Moose generally followed drainages, but also moved over mountain divides, usually through low passes.

DISCUSSION

Distances between seasonal ranges of migratory moose in this study are at the extreme of measurements that have been documented in Alaska and northwest Canada (Table 1). This is likely a function of the distribution of two major landscape features: Old Crow Flats and Brooks Range valleys. Migratory moose moved from summer ranges at low elevations to higher winter ranges. This is counter to the results of most moose migration studies, but similar to those reported by Gasaway *et al.* (1983) and Andersen (1991). In the Gausdal Vestjell area of central Norway, Andersen (1991) describes snow conditions on the winter range as deep (exceeding 70 cm), and loose with low density due to the continental climate. The Tanana Basin in Alaska, where some moose move to higher winter ranges, also has a continental climate which generally results in loosely packed snow < 80 cm deep (Gasaway *et al.* 1983). An unusually early accumulation of deep snow in 1970, however, resulted in moose moving from hills in the Tanana Basin to lower elevations Coady 1974). Ruttan (1974) reported that during winter, snow drifted into willow thickets of the Old Crow Flats to depths ranging from 122-152 cm, and suggested that moose

Table 1. Comparison of distances (km) between seasonal ranges of migratory moose reported during recent telemetry studies in Alaska and northwest Canada.

Study area	Period	Maximum distance	Mean distance (range)	n	Reference
Lower Koyukuk (Alaska)	1984-1991	68	42 (10-68)	19	Osborne and Spindler 1993
Upper Susitna (Alaska)	1976-1984	93	48 (16-93)	69	Ballard *et al.* 1991
White Mtns. (Alaska)	1985-1988	102	65 (40-102)	14	Hobgood and Durtsche 1990
Nelchina Basin (Alaska)	1974-1976	110	35 (21-52)	7-17	Van Ballenberghe 1977
North Slope (Yukon Terr.)	1987-1990	138	97 (60-138)	6	Smits 1991
Tanana Flats (Alaska)	1973-1981	140	60 (28-140)	45	Gasaway *et al.* 1983
SE Brooks Range (Alaska-Yukon Terr.)	1995-1996	196	123 (18-196)	45	This study

would have difficulty moving to forage sites and avoiding wolves if they remained there in winter. During capture operations and winter relocation surveys associated with this study, I observed that snow was loose, not drifted, and generally shallow (40 - 50 cm) where migratory moose were wintering in the southeast Brooks Range valleys.

In this study, most moose began fall migration during August and early September before snow accumulated on the summer range, and initiated spring movements in late March and April, before snow began to melt on the winter range. In Sweden, Sandegren *et al.* (1985) reported that initiation of fall moose migration ranged between 23 November and 25 January when accumulated snow on summer range reached a depth of about 40 cm. Van Ballenberghe (1977) found similar relationships in south central Alaska. Spring migration of moose in Sweden (Sandegren *et al.* 1985) and south central Alaska (Van Ballenberghe 1977) began after significant snow melt on winter ranges. In interior Alaska, Gasaway *et al.* (1983) reported fall migration starting in August (before snow fall) and spring migration began in February (before snow melt). Results of this study parallel Gasaway *et al.* (1983) in that migration is not in response to snow depths in either fall or spring. Instead, fall migration occurs during most of the rut period prior to breeding, and rut areas are generally a subset of the larger winter range.

Some spring migration was already underway when moose were captured, however, the amount of bias that may have resulted in determining the regional proportion of migrants and residents is not believed to be significant. During capture operations moose were found in typical habitats (riparian and open forest cover types), and migrants were inter-mingled with residents. There was no migratory behavior observed at the time of capture (such as groups of moose moving across open areas) that would have predisposed migrants for capture. Few moose are observed in the Kongakut, Coleen, and Firth winter areas during the summer, suggesting a predominantly migratory population. The relative proportion of moose from the Firth winter range that migrate to Old Crow Flats may be under-represented by results of this study due to the large infiltration of other migrants in that area at the time of capture, and also possible movement of Firth migrants out of the area prior to capture.

A total of 720 moose were observed during aerial surveys in the study area in 1991 (Mauer and Akaran 1991), suggesting a significant population of moose are shared between the U.S. and Canada. Most of the habitat used by these moose is currently in protected status (Fig 1). In the U.S. nearly all of the area used by migrants is designated as Wilderness and is within the Arctic National Wildlife Refuge. In Canada, most of the range is in Vuntut National Park, Ivvavik National Park, and Old Crow Settlement Lands, which are a special category of protected lands (Department of Indian and Northern Affairs 1993). Recent studies of moose migrations suggest that movement patterns are traditional (LeResche 1974), may be maintained over long periods (Andersen 1991), and individuals are philopatric to seasonal ranges (Sweanor and Sandegren 1989). These characteristics together with the sparse forest cover and open tundra of the southeastern Brooks Range may render migratory moose vulnerable to harvest. Management of these migratory moose will require close monitoring and coordination between regulatory agencies in both countries.

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