ABUNDANCE AND POPULATION COMPOSITION OF MOOSE ALONG THE MACKENZIE RIVER, NOVEMBER 1984

KENT JINGFORS

ROY BULLION

AND

RAY CASE

DEPARTMENT OF RENEWABLE RESOURCES

GOVERNMENT OF THE NORTHWEST TERRITORIES

INUVIK, NWT

1987

Northwest Territories Renewable Resources

File Report No. 70

ABSTRACT

To document the population composition and abundance of moose (Alces alces andersoni) along the Mackenzie River, a stratified block survey was flown in two areas near Norman Wells and Fort Good Hope between 13 and 23 November, 1984. Moose density in the Norman Wells survey area was 0.15 moose/km^2 (465 $\pm$ 90 moose; 90% C.I.), with 44 calves/100 cows and an adult sex ratio of 76 bulls/100 cows. In the Fort Good Hope area, moose density was 0.13 moose/km^2 (281 $\pm$ 52 moose; 90% C.I.) with 61 calves/100 cows and an adult sex ratio of 79 bulls/100 cows. While calf:cow ratios and the proportion of cows with twin calves was higher in the Fort Good Hope area, difference in moose population parameters between survey areas were not significant. The sex and age distribution varied considerably between strata in both survey areas. Local concentrations of moose were found in riparian habitat along drainages and on the islands and willow flats of the Mackenzie River. Harvest data from the Norman Wells area suggest that about 11% of the moose population there is harvested annually. No changes are recommended to current moose hunting regulations.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Moose are one of the principal species of wildlife in the Northwest Territories. They are of particular value to residents of the Mackenzie Valley. The potential economic value of moose has been estimated at from $2.4 million to $6.2 million annually (NWT, Science Advisory Board 1980). Despite their economic and cultural importance, less than $10,000/year was spent on moose management programs in the NWT up to 1984 (Treseder and Graf 1985). As a result, our understanding of moose population status, demography, and distribution is limited.

With few exceptions, previous surveys along the Mackenzie Valley corridor have been restricted to fixed-wing, unsystematic flights to document moose distribution in relation to proposed industrial development (Prescott et al. 1973, Walton-Rankin 1977, Geddes and Duncan 1982). Industrial activities culminated in May 1985 when the construction of an oil pipeline was completed between Norman Wells and Zama, Alberta. During the construction phase, local concerns were expressed over increased hunting activity and its effect on local moose populations. At that time, virtually no information was available on population demography or status, and harvest data were incomplete.

In the fall of 1984, we attempted moose surveys in two areas along the Mackenzie River. Our objectives were three-fold:

1. To determine and compare the early winter distribution

and abundance of moose in areas traditionally used by native hunters and in areas exposed in industrial development.

2. To determine and compare population composition and calf survival in the two areas.
3. To evaluate the feasibility of a stratified block sampling technique for surveying moose in the NWT.

STUDY AREA

Two survey areas, near Norman Wells and Fort Good Hope, were chosen to determine moose distribution and abundance along the Mackenzie River. These areas are considered good to fair moose habitat (Class 1 and 2; Prescott et al. 1973) and we expected to find relatively high densities of moose there. The Norman Wells survey area (3200 km^2) included a continuous block of land between the Mackenzie River and the Mackenzie Mountains (Fig. 1). The second survey area "Fort Good Hope" included major river drainages emptying into the Mackenzie River between Fort Good Hope and Norman Wells, as well as some of the larger islands in the Mackenzie River (Fig. 1).

The description below is based on Prescott et al. 1973). The survey areas lie within the Boreal Forest zone and are characterized by discontinuous permafrost and a subarctic climate. The mean annual temperature is approximately +8^{o}C, ranging from -34^{o}C to +22^{o}C. Annual precipitation averages 330 mm with 200 mm of rain and 1200 mm of snow. Topography varies from the flat Ramparts River lowlands southwest of Fort Good Hope to the undulating (<300 m a.s.l.) Mackenzie Plain physiographic division that includes most of the Norman Wells survey block. The poorly drained areas are dominated by black spruce (Picea mariana) forest of varying density, interspersed with numerous bogs and small lakes. In more well-drained areas, stands of white spruce (P. glauca) dominate, often in association with

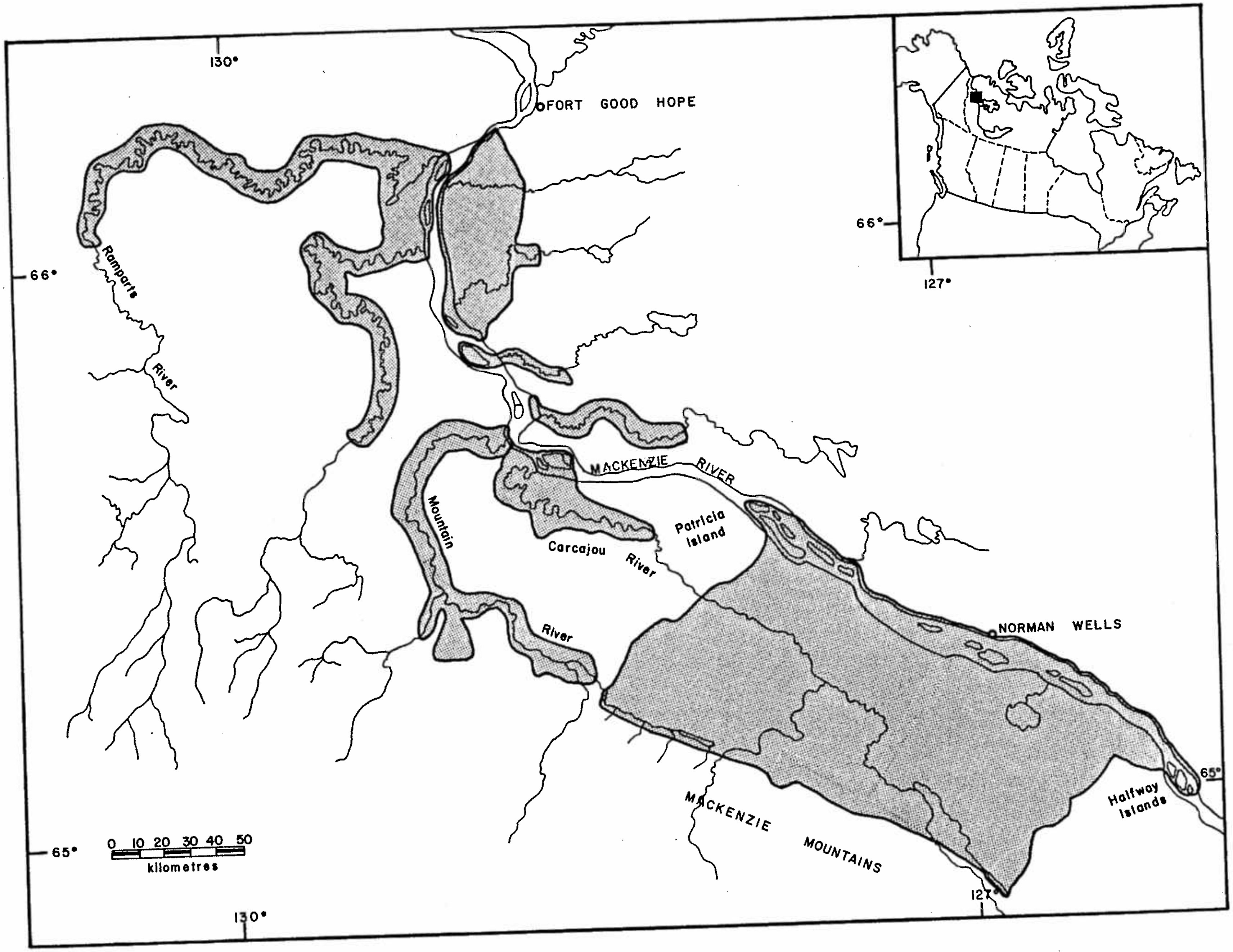

Figure 1. Moose survey areas along the Mackenzie River, 1984.

balsam poplar (Populus balsamifera), aspen (P. tremuloides) and white birch (Betula papyrifera) on upland sites.

Most of the area has been subjected to forest fires resulting in deciduous regeneration at different stages of succession. Many of the burned areas (e.g., Hoosier Ridge and Ramparts River lowlands) have grown out of the favorable early successional stages and most of the available browse occurs as shrub understory. Similar to fire, ice and flood action during spring break-up along the more fast-flowing drainages (i.e., Mackenzie, Mountain and Carcajou rivers) have kept much of the vegetation in an early successional stage. The islands in the Mackenzie River, for example, provide many food species important to moose including willow (Salix spp.), alder (Alnus spp.), balsam poplar, and red osier dogwood (Cornus stoloifera).

The Norman Wells survey area is also characterized by considerable oil exploration and development activities, including a maze of seismic lines, winter access roads and numerous exploratory well sites. A below-ground pipeline along the east side of Mackenzie River, across from the survey area, was put into operation in April 1985. The pipeline transports oil from producing wells on Bear and Goose islands, artificial islands in the Mackenzie River, and the mainland of Norman Wells. In contrast, the survey areas south of Fort Good Hope have received much less industrial development and have traditionally been used by people from Fort Good Hope both for trapping and for hunting big game, primarily moose.

METHODS

We used a stratified block sampling technique developed by Gasaway et al. (1981) to estimate moose abundance and composition in the Norman Wells and Fort Good Hope areas. Briefly, the technique involves the stratification of blocks, or sample units, based on moose densities observed during an initial reconnaissance survey. The stratification is followed by a census, or intensive search, of randomly selected sample units in each density stratum.

Each of the two survey areas was divided into sample units using natural terrain features, that were identifiable from the air, as boundaries. The sample units were drawn on 1:50,000 scale topographical maps prior to the survey and each was given a unique identification number. We tried to keep the size of the sample units consistent to improve precision of the population estimates (Gasaway et al. 1981). Areas were measured using a polar planimeter.

Stratification

Sample units were stratified from two fixed-wing aircraft (Cessna 185 in Norman Wells and Helio Courier in Fort Good Hope). Each aircraft included one pilot/observer, one navigator/observer, and two rear seat observers. The reconnaissance surveys were flown at 90-100 m agl at approximately 160 kph. Flight lines included two passes over each sample unit during which observations of moose or moose tracks were recorded directly on the survey maps.

We identified three density strata (high, medium, and low) based on the number of moose, or different sets of moose tracks, actually observed during the reconnaissance flights. We used similar criteria in both survey areas and considered the high density stratum to include all sample units in which at least 10 moose or sets of tracks were observed. The medium density stratum included sample units containing fewer than 10 but more than 2 moose observations, while the low density included all sample units with 2, or fewer, observations.

Census

Census flights were flown immediately after the completion of stratification with a crew arrangement similar to that of the reconnaissance flights. A Bell-206 helicopter was used in Norman Wells while the Helio Courier was retained for the census of the Fort Good Hope survey area. Census surveys were flown between 50-150 m agl at 50-130 kph depending on terrain and tree cover. To achieve total coverage, overlapping transects about 0.5 km apart were flown in each sample unit selected. Once moose were spotted, the animals were circled to obtain age and sex information and to search for additional moose nearby.

Moose were sexed by the presence or absence of antlers and vulva patch (Mitchell 1970). Males were further classified into small bulls (yearlings) or large bulls (adults) based on antler morphology (Oswald 1982). Yearling cows (18 months old) could not reliably be identified in the field but were assumed to occur in the population in the same proportion as yearling bulls.

Sampling effort varied between strata and was based on the expected correlation between animal density and sample variance (Norton-Griffiths 1975). Most sample units in the high density stratum were censused to reduce sampling variance in that stratum. Sample units in the medium and low density strata were randomly selected and censused until an acceptable level of precision was obtained. We considered a 90% confidence interval (C.I.) that fell within 20% of the overall population estimate to be an acceptable level of precision. The precision of the estimate was calculated daily and used to determine the number of units that needed to be surveyed in each stratum. The population estimate and associated variance was determined for each stratum within the survey area using a ratio estimator (Gasaway et al. 1981). The overall population estimate, as well as composition, was then obtained by adding stratum estimates and their variances together.

We did not feel it was economically feasible to determine a sightability correction factor (SCF) in our survey areas.

RESULTS

Survey Characteristics

Surveys of both the Norman Wells and Fort Good Hope areas were flown between 13-23 November, 1984. A total of 143 sample units, averaging 22.5 ± 3.2 km^2 in size, was delineated for the Norman Wells area (3190 km^2) while the Fort Good Hope survey area (2180 km^2) was subdivided into 107 sample units, averaging 20.4 ± 1.1 km^2 (Table 1). The initial stratification required 12 and 8 hours, respectively, of fixed-wing flying, including ferrying time. The overall sampling intensity during the census was slightly higher in the Fort Good Hope area (29% versus 25%, Table 1), in which a larger proportion of sample units in the medium density stratum were sampled. Similarly, overall search intensity (excluding ferrying time) was higher in the Fort Good Hope area (2.0 versus 1.6 min/km^2, Table 1) where a Helio Courier was used in place of a Bell 206 helicopter. Search intensity generally increased from the low to the high density strata (Table 1) as we spent more time circling and classifying individual moose. The census portion of the survey required total of 28 hours for Norman Wells and 40 hours for Fort Good Hope of flying, including ferrying time.

Snow cover was complete during the survey and the mean snow depth in Norman Wells during October was 290 mm (Environment Canada, Norman Wells). Temperatures ranged between -15^{o} and -32^{o} C under mostly calm conditions during the survey period. Visibility varied from good to excellent

Table 1. Sampling effort and search intensity in two moose survey areas along the Mackenzie River, November, 1984.

Survey area	Stratum High	Stratum Medium	Stratum Low	Total
Norman Wells ($3190\ km^2$)				
No. of sample units (S.U.)	8	43	92	143
No. of S.U. sampled	6	11	18	35
% of S.U. sampled	75	26	20	25
Search intensity (min/km^2) Mean ± SD	1.5±0.2	1.8±0.4	1.4±0.3	1.6±0.3
Fort Good Hope ($2180\ km^2$)				
No. of S.U.	4	18	85	107
No. of S.U. sampled	4	11	16	31
% of S.U. sampled	100	61	19	29
Search intensity (min/km^2) Mean ± SD	2.4±0.2	2.0±0.2	1.9±0.3	2.0±0.3

with mostly scattered or clear sky conditions. during the initial reconnaissance, the snow cover was 1-2 weeks old. On 18 November, we had fresh snow and tracking conditions were excellent throughout most of the census.

Population Characteristics and Distribution

Norman Wells Area

The estimated moose population in the Norman Wells area at the time of the survey was 465±90 using a 90% confidence interval (Table 2, Appendix A). The overall density was 0.15 moose/km^2 and ranged from 0.42 to 0.08 moose/km^2 in the high and low density strata, respectively.

The composition of this population varied between strata (Table 2). The largest proportion of bulls (including yearlings) was found in the high density stratum (53%), while cows were more commonly found in the low (50%) and medium (46%) density strata. Calves were most common in the medium density stratum (26%). Overall, a calf/cow ratio of 44 calves/100 cows in the medium and low density strata, respectively (Table 2). The differences were significant ($p<0.05$; $x^2=22.4$, 4 df.), as were differences in the age/sex distribution between any pair of density strata. The overall proportion of yearlings to adult cows was much less, only 6 yearlings/100 cows. The overall sex ratio was 76 bulls/100 cows but varied considerably between strata. A higher bull to cow ratio was recorded in the high density stratum (160 bulls/100 cows) compared to either the medium or low strata (Table 2). The twinning rate, calculated as

Table 2. Moose population density and composition in the Norman Wells survey area, November, 1984.

Parameter	Stratum High	Stratum Medium	Stratum Low	Total (±90%C.I.)
Population estimate	83	218	164	465±90
Coeff. of variation (C.V.)	9%	17%	23%	11%
Density (moose/km^2)	0.42	0.22	0.08	0.15
Bulls	44	60	57	161±42
(proportion by stratum)	(53%)	(28%)	35%)	
Cows	28	101	82	211±53
(proportion by stratum)	(34%)	(46%)	(50%)	
Calves	11	57	25	93±34
(proportion by stratum)	(13%)	(26%)	(15%)	
	83	218	164	465±90
	(100%)	(100%)	(100%)	
Calves/100 cows	40	56	31	44±14
Bulls/100 cows	160	59	69	76±24

the number of cows with twins as a proportion of all cows with calves, was 10% (3/31).

An estimated mean group size of 1.8±0.1 (S.E.) was recorded. We found significant differences between strata (p,0.05; f=3.75, 2 and 83 df.) with larger groups in the high density stratum (x=2.0) and smaller in the low density areas (x=1.4). Ninety-six percent of the calves were in solitary cow/calf groups while 17% of all single cows were associated with bulls during the survey. The largest group observed together was four moose.

Concentrations of moose, or recent moose signs, were found in riparian habitat along the Carcajou River and along smaller creek drainages scattered throughout the survey area (Fig. 2). Localized high density areas also included Mirror Lake, the Hoosier Ridge area and some of the islands in the Mackenzie River. Fourteen moose were observed in the high density stratum (19 km^2) that included Ogilvie Island and the adjacent willow flat extending down from Hoosier Ridge. Moose were also found throughout burned areas west and south of Three Day Lake.

One case of adult mortality was observed while surveying a low density area south of the Carcajou River. A bull moose appeared weak and unable to stand up and, when checked the next day (23 Nov.), was found dead. Subsequent examination of tissue samples submitted to the Western College of Veterinary Medicine suggested chronic arthritis and emaciation as the probable causes of death. The bull was 14 years old as determined from counting cementum annuli

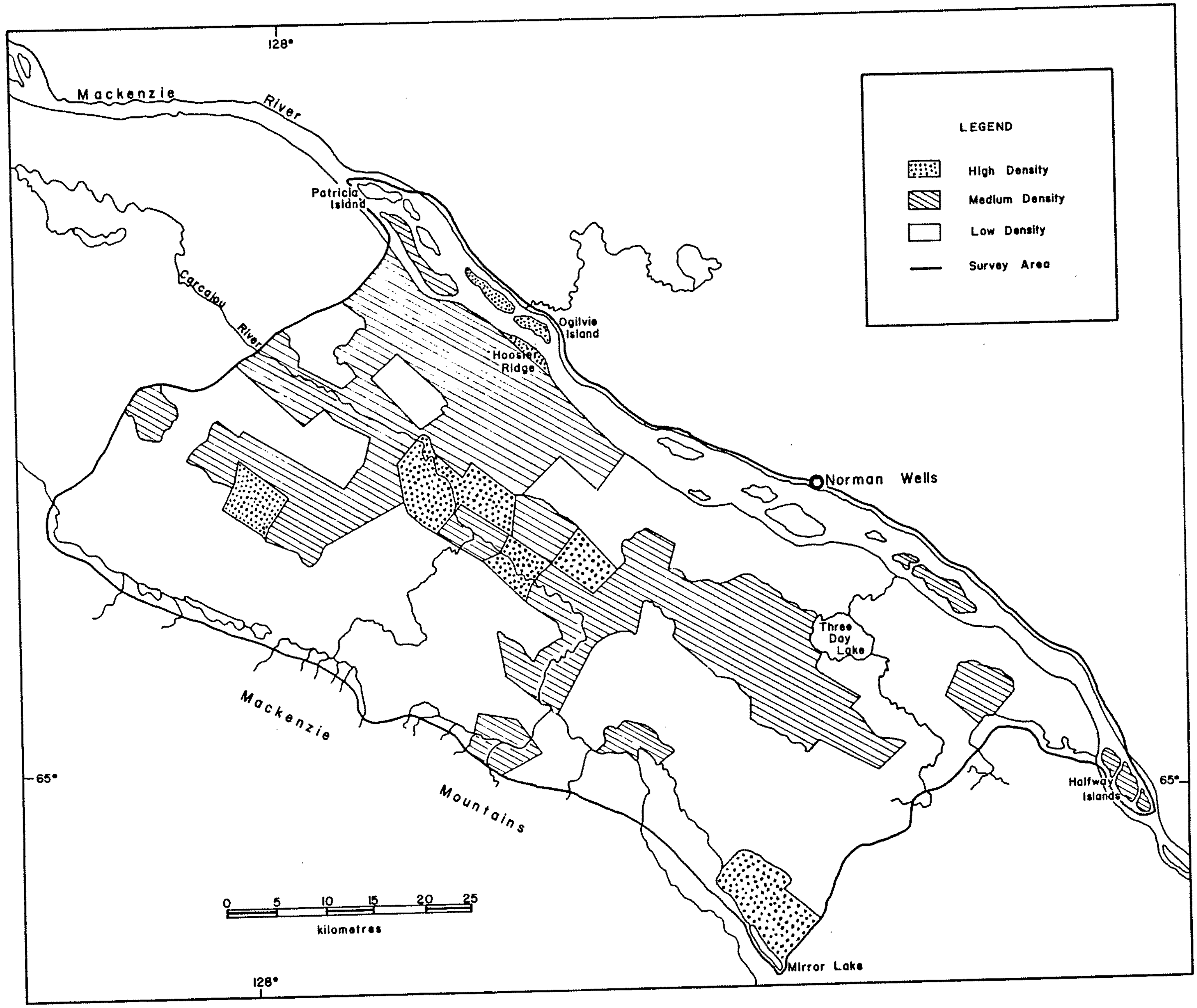

Figure 2. Moose densities in the Norman Wells survey area, 1984.

in the first incisor.

Fort Good Hope Area

The estimate for the number of moose present in the Fort Good Hope survey area was 281 ± 52 (Table 3). The overall density was 0.13 moose/km^2 and ranged from 0.20 to 0.08 moose/km^2 in the high and low density strata, respectively. Surveyed were portions of the Hume, Ramparts, Mountain, and Carcajou rivers on the west side of Mackenzie River, and the Hanna, Donnelly, Snafu, and Tsintu rivers on the east side of the Mackenzie.

As with the Norman Wells area, moose composition varied significantly (p,0.05; x^2=23.6, 4 df.) between strata (Table 3, Appendix B). However, most of the bulls were observed in the medium, rather than the high, density stratum (50%), while cows were more commonly found in the high (51%) and low (44%) density strata. Calves were most common in the low density stratum (34%). Overall, a calf/cow ratio of 61 calves/100 cows was recorded with a range of 75 to 37 calves/100 cows in the low and high density strata, respectively (Table 3). The overall proportion of yearlings to adult cows observed was 12 yearlings/100 cows. The observed twinning rate was 18% (4/22). An overall sex ratio of 79 bulls/100 cows was recorded but, again, this varied considerably between strata (Table 3).

Mean group size was 1.9 ± 0.1 (S.E.) and similar to that found near Norman Wells. However, we found no

Table 3. Moose population density and composition in the Fort Good Hope survey area, November, 1984.

Parameter	Stratum High	Stratum Medium	Stratum Low	Total (±90%C.I.)
Population estimate	37	101	143	281±52
Coeff. of variation (C.V.)	0%	10%	20%	10%
Density (moose/km2)	0.50	0.28	0.08	0.13
Bulls	11	50	32	93±35
(proportion by stratum)	(30%)	(50%)	(22%)	
Cows	19	35	63	117±30
(proportion by stratum)	(51%)	(34%)	(44%)	
Calves	7	16	48	71±23
(proportion by stratum)	(19%)	(16%)	(34%)	
	37	101	143	281±52
	(100%)	(100%)	(100%)	
Calves/100 cows	37	48	75	61±11
Bulls/100 cows	58	143	50	79±41

significant differences in group size between strata. Other group characteristics were also comparable between survey areas, i.e., the proportion of calves in solitary cow/calf groups (96%) and the largest group size observed (6 moose). A slightly higher proportion (12% versus 17%) of all single cows in the Fort Good Hope area was associated with bulls during the survey.

Localized concentrations of moose were found along several of the river drainages surveyed (Fig. 3). In the flat lowlands of the Ramparts and Hume rivers, concentrated areas of heavy moose use were evident particularly in areas of dense willow growth. Wolf tracks were observed near a recent moose carcass along the Hume River and four wolves were spotted in a bend of the Ramparts River. Most moose along the Mountain River drainage were observed in the flatter areas near the Mackenzie River and there were few moose signs up river, towards the Mackenzie Mountains. Cutlines near both the Mountain and Carcajou rivers frequently had moose tracks along them. We observed 6 moose on Axel Island in the Mackenzie River, opposite the mouth of the Carcajou River. With the exception of the Hanna River, moose densities were much lower on the east side of the Mackenzie River (Fig. 3). Few moose were found in the large survey block near Snafu Creek, south of Fort Good Hope. This area of numerous lakes and mixed coniferous/deciduous stands is part of the large 1969 burn that extends across the Mackenzie River to the mouth of the Ramparts River. Similarly, we observed few moose in that area of the

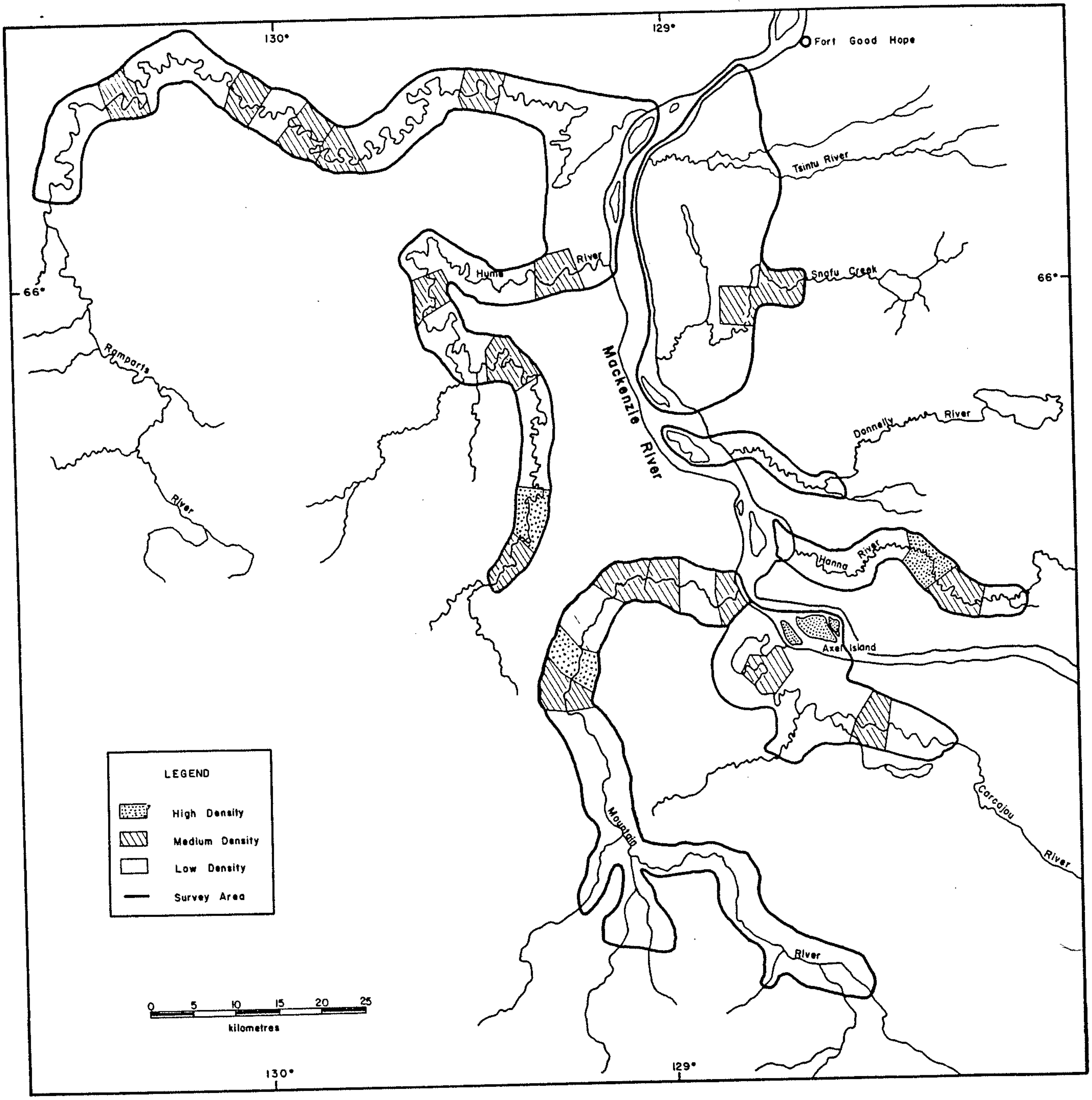

Figure 3. Moose densities in the Fort Good Hope survey area, 1984.

Ramparts (Fig. 3). In contrast, we found localized concentrations of moose in upland areas along the Hanna River. In two sample units, we observed 20 moose. We also saw a pack of 6 wolves at the mouth of the Hanna River.

DISCUSSION

Survey Conditions

Generally, we found the stratified block sampling technique worked well for surveying moose along the Mackenzie River valley. The patchy habitat types, ranging from large burns to open canopy coniferous stands, precluded the use of standard transect surveys by fixed-wing aircraft. We selected early winter (November) as moose tend to aggregate in mixed groups in more open habitats during the post-rut period when the snow is still relatively shallow and is no hindrance to movements (Peek et al. 1974, Lynch 1975, Gasaway et al. 1981). Snow conditions during the survey were good for spotting moose according to the criteria developed by Gasaway et al. (1981). The snow cover was complete with fresh or moderately fresh snow (<2 weeks old) throughout the survey. Mostly clear and calm conditions also enhanced the sightability of moose.

Search effort has also been shown to have a significant influence on sightability of moose. Gasaway et al. (1981) found an overall observer efficiency of 88% in all habitat types during early winter surveys using fixed-wing aircraft and search intensities of 1.5 to 1.9 min/km^2. The same observer efficiency (88%) was also reported from moose surveys with a helicopter in forested habitat in Alberta (Mytton and Keith 1981). These estimates were based on the proportion of radio-collared moose observed in the survey area. In the Yukon, where helicopters are used during the census, search efforts have ranged between 1.4 and 2.0 min/km^2 (Larsen 1982, Johnston et al. 1984). Our average search times were similar to other areas and were higher for the fixed-wing (2.0 min/km^2) than for the helicopter (1.6 min/km^2). Given the superior visibility provided from a helicopter, we felt that a higher search effort by the Helio Courier would reduce possible biases resulting from using two different aircraft types.

During the composition counts, we used the presence or absence of antlers to sex adults assuming bulls still had antlers at the time of the survey. This appeared to be a reasonable assumption as we observed the first antler drop (one side only) during the last day of surveying each area (21 Nov. for Fort Good Hope and 22 Nov. for Norman Wells).

Population Characteristics

Population parameters in our two survey areas were sufficiently similar (Table 4) to conclude there were no apparent differences in moose abundance and composition between areas traditionally used by native hunters and areas exposed to industrial development. While we observed a higher calf:cow ratio in the Fort Good Hope area, differences between the two survey areas were not significant ($p>0.05$; $T = 1.56$, 19 d.f.).

During an unstratified drainage survey ("total count") along the Mackenzie River and adjacent tributaries in 1980, Brackett et al. (1985) observed an overall density of 0.10 moose/km^2. Since their survey was done in February

Table 4. Comparison of moose population characteristics in the Northwest Territories adjacent areas. (Data from stratified block surveys.)

Area	Time of survey (year)	Density ($moose/km^2$)	Bulls/ 100 cows	Calves/ 100 cows	Twinning rate[a]	Source
Northwest Territories						
- Norman Wells	Nov(84)	0.15	76	44	10%	This study
- Fort Good Hope	Nov(84)	0.13	79	61	18%	This study
- Liard Valley	Feb(79)	0.13	?	31	?	Donaldson and Fleck 1980
- Liard Valley	Nov(85)	0.12	100	81	40%	Case et al. (in prep.)
- Slave River Lowlands	Dec(81)[b]	0.05	120	64	?	Hawley and Antoniak 1983
Alberta						
- Northeast	Jan-Feb(78)	0.18	43	60-72[c]	10-29%	Hauge and Keith 1981
- Central[d]	Dec-Feb (75-77)	0.64	33	85	52%	Mytton and Keith 1981
Yukon						
- Southwest	Oct-Dec(81)	0.17	49	22[c]	?	Larsen 1982
- Southwest	Oct-Dec (81-82)[e]	0.21	41	17[c]	?	Johnston et al. 1984
Alaska						
- Tanana Flats	Nov-Dec(78)	0.18	?	61[c]	14%	Casaway et al. 1981
- Tanana Flats	Nov (83)	0.48	36	40[c]	?	Jennings 1985
- Kenai Peninsula	Nov (83)	?	14	47	12%	Spraker 1985

a The proportion of cows with twins to total cows with calves.
b Based on a total sample of 70 moose.
c Based on cows $\geq$ 30 months old and, thus, excludes yearling cows.
d Data collected in small (290 km^2), unhunted area essentially without predation.
e Data represent cumulative totals from 8 surveys of 6 different areas.

composition data were limited to calf percentages. They observed 11% calves (62/562) which is considerably fewer than the 25% and 20% we estimated for the Fort Good Hope and Norman Wells Areas, respectively (Tables 2 and 3). Brackett et al. (1985) felt that a large, but unknown, proportion of moose were missed during their survey and suggested that densities twice as high as they observed were more probable. Information on moose population dynamics from other parts of the Northwest Territories is limited partly due to the reliance on strip transect surveys in the past (see Treseder and Graf 1985). When compared with other areas, moose densities in the NWT are low while the proportion of calves in early winter is as high, or higher, than reported from the Yukon, Alberta or Alaska (Table 4). The low calf survival in southwestern Yukon, where at least 70% of the calves were dying during the first 6 months of life, has been attributed to excessive predation by grizzly bears and wolves (Yukon, Dept. of Renewable Resources 1984). Given the relatively high calf/cow ratios (44-61 calves/100 cows) and the apparent scarcity of wolves during our 1984 surveys, (grizzly bears are virtually absent along the river valley), we do not believe that predators influenced calf production and survival that year. This is further supported by the sample of 21 cows we radio-collared in the Norman Wells area in November 1985 (Jingfors and Bullion in prep.). four of the cows were yearlings and of the remaining 17 cows, 13 (76%) (76%) had calves. Pregnancy was confirmed in 18 out of 20 cows (90%) tested.

It has been suggested that the severe climate of the NWT may affect winter survival and act as a constraint on recruitment and abundance of moose (Dickinson and Herman 1979, Treseder and Graf 1985). Our survey observations suggest that calf production and survival, at least to early winter, is good. The low yearling counts in both areas may, in part, be due to our inexperience in classifying yearling bulls (18 months old). In addition to spike or forked antlers, some individuals in this cohort may carry small palmated antlers and could be mistaken for older moose from the air (Van Ballenberghe 1979, Oswald 1982). Of the radio-collared cows, one was killed by wolves in December while the remaining cows, and at least 67% (8/12) of the calves (11-12 months old), were alive in late May 1986. Continued monitoring of these cows should allow us to evaluate what mortality factors, including hunting, may be important in maintaining the population as most moose are able to use the prime areas that may be available.

Distribution

In November 1984, we found localized concentrations of moose in low-lying riparian habitats including the islands and willow flats of the Mackenzie River. Similar observations were made during fixed-wing surveys along the Mackenzie River in November and March 1973-74 (Walton-Rankin 1977) and in February 1980 (Brackett et al. 1985). Moose in the area were thought to use tributary river valleys as movement corridors between the Mackenzie Valley and surrounding uplands, making heavy use of river islands and sand bars between November and March (Walton-Rankin 1977).

To evaluate late winter use of the islands in the Mackenzie River, one of us (RB) did a total search from Halfway Island to Axel Island using a Bell 206 helicopter on 30 March 1984. A total of 26 moose was observed including 12 on the spit below Hoosier Ridge and on the adjacent Ogilvie Island. This small area contained 14 moose during the preceding November survey (see Results); by 14 May 1984, there were no moose observed in the area (Roy Bullion, pers. obs.) suggesting a spring movement inland, away from flooded areas. The localized concentration of moose in the Hoosier Ridge area was also observed by Walton-Rankin (1977) and is somewhat surprising given that the area is receiving substantial human activity during the winter season. Part of the spit has been used as a staging site for drill rigs moving to test sites further inland (Petro Canada and AT&S Exploration Ltd; N85T414). A winter road from Norman Wells was used to haul equipment and fuel to the site and was also used by hunters. During the 1985/86 winter, 11 moose were harvested in this general area.

Our survey observations suggest that moose were using islands in the Mackenzie River both in early (Nov.) and late (Mar.) winter. We suspect some moose may spend the entire year on some of the larger islands, such as Axel Island. Preliminary movement data based on the radio-collared cows show intensive use of small areas near the original capture site. One of the cows moved out to Bear Island, opposite

Norman Wells, in January and return inland in May. Local hunters in Fort Good Hope believe that most moose move out to the islands after the first heavy snowfall (usually December) and, while some cows may remain and calve on islands not exposed to flooding, most leave as water starts accumulating on the river in late April (T'Seleie 1985).

Use and Management

Current regulations allow a resident hunter to take one moose, any age/sex, between 1 September - 31 January. An exception to this are all islands in the Mackenzie River where moose can only be hunted from 1 September - 30 November. A holder of the General Hunting Licence (GHL) can harvest any number of moose at any time of the year.

In Norman Wells, the number of resident hunters almost doubled between 1982 and 1984 (from 52 to 91), largely due to the construction of the Norman Wells pipeline. The proportion of GHL holders has always been relatively small compared with other communities in the NWT; however the influx of workers to Norman Wells also included GHL holders. Accordingly, the annual moose harvest was 44 moose (Table 5). Construction of the pipeline was completed in 1985 and the population of Norman Wells has again stabilized at a lower level.

The reported Norman Wells moose harvest represents a minimum estimate and the harvest largely occurs from within our survey area (Fig. 2). The 1985 harvest refers exclusively to moose taken within this area by hunters from

Table 5. Characteristics of the reported moose harvest for Norman Wells and Fort Good Hope, 1981-85.

Community	Year	Moose Harvest			Sex ratio(n) (Bulls:Cows)	Age of harvest (x±SD; n)
		GHL	Resident	Total		
Norman Wells	1981	12	7	19	-	-
	1982	10	9	19	-	-
	1983	22	7	29	50:50(4)	6.5±3.7(4)
	1984	26	18	44	56:44(16)	5.2±2.3(16)
	1985	35[a]	11	46	83:17(12)	5.2±3.2(13)
Fort Good Hope	1981	128	-	128	-	-
	1982	160	-	160	-	-
	1983	?	-	?	-	-
	1984[b]	70	-	70	77:23	-
	1985	127	-	127	73:27	-

a Includes 14 moose harvested within the survey are (Fig. 2) by GHL holders from Fort Norman.

b No data collected between April-May; likely an underestimate.

both Norman Wells and Fort Norman. If we assume an average harvest of 50 moose, hunters remove about 11% (50/465) of the moose in the area annually. Due to the access facilitated by winter haul roads and seismic lines, most of the harvest is localized along these developments and not spread evenly over the study area. Hunters appeared to select bulls in slightly higher proportion than their availability in the population (Table 5, Table 2) possibly as a result of their higher vulnerability during, and after, the rut (Crete et al. 1981). The age distribution of the harvest (Table 5) was similar to that of the radio-collared cows (6.4 ± 3.3; n = 20) with the exception of yearling that were not represented in the harvest.

During the height of oil development in Norman Wells, concerns were expressed by local Hunters and Trappers Associations (HTAs) over the increasing number of hunters and facilitated access for moose hunting in localized areas. Recommendations by the HTAs included a shortened season, to 1 December, would effectively reduce access along winter haul roads, a bulls-only season will not likely result in increased calf production or moose abundance. In our areas, where moose densities are low and harem-like groups are not formed during the rut, the proportion of bulls must be kept high for cows to be bred. In southwestern Quebec, where moose density was similarly low, Crete et al. (1981) recommended retaining at least 40% bulls among the adults (67 bulls:100 cows) to maintain breeding effectiveness.

In Fort Good Hope, moose are harvested exclusively by

GHL holders and the number of active hunters is more stable than in Norman Wells. The average annual harvest is reported to be between 125 and 160 moose (Table 5). Local reports suggest that more moose are available in the Fort Good Hope area than ever before (T'Seleie 1985) and it is likely that the harvest will remain at the upper level. In 1985, 51 hunters were successful in harvesting moose; of these, 6 hunters accounted for 39% of the harvest (49/127). Most of the moose were harvested during the rut (Sept./Oct.) and in 1985, almost half of the reported harvest (47%) took place along the river drainages that we surveyed, particularly the Hume and Rampart rivers (Fig. 3). Since moose are harvested throughout most of the year and we have only information on moose abundance and distribution in early winter (Nov. '84), any comparison of harvest rate to "population" size must be interpreted with caution. It appears, however, that in 1985 hunters removed about 21% (60/281) of the moose we observed during the previous fall. Again, the harvest was concentrated along some drainages while others were not hunted at all. Since there are no indications that hunting success has declined in recent years, we cannot conclude that overharvesting is occurring. Moose are seldom extirpated even from heavily hunted areas as it takes a great deal of additional hunting to further reduce a moose population that is already at a low density (Crete et al. 1981).

We have no information on the age distribution of the harvest from previous years but have recently started a collection of jaws in the community. The sex ratio of the harvest was strongly skewed in favour of bulls, more so than found in Norman Wells (Table 5).

RECOMMENDATIONS

1. No changes are recommended to current moose hunting regulations. Data on the age and sex distribution of the harvest should continue to be collected in Norman Wells and expanded to include Fort Good Hope and Fort Norman.

2. More information on yearling recruitment and adult survival rates is needed to determine factors that maintain moose population in the NWT at apparent low densities. A population ecology study including 20 radio-collared cows in the Norman Wells area has been initiated to address this need.

3. The Norman Wells area should be resurveyed in November 1987. A sightability correction factor should be obtained during the survey using the radio-collared moose in the area.

4. The stratified block survey technique should be used in early winter (November) in other potential moose habitat along the Mackenzie River and Delta, including areas hunted by residents of Fort McPherson and Inuvik. Additional effort is required to ensure that yearling bulls are accurately identified during aerial surveys and classification counts.

ACKNOWLEDGEMENTS

We would like to thank Renewable Resource Officers Keith Hickling (Fort Norman) and Walter Bayha (Fort Franklin) for taking an active and enthusiastic part in the surveys. Jim Pierrot from Fort Good Hope also helped out on the aerial survey, while Michel Lafferty collected moose harvest figures from the same community. To our pilots, Perry Linton and Warren Wright (Nahanni Air), and Murray Addison (Okanagan Helicopters) we extend our appreciation for a job well done. William Gasaway (ADF&G, Fairbanks) supplied programs for the data analysis and Gavin Johnston (Northern Biomes, Whitehorse) advised on survey techniques. Les Kutny and Francis Jackson (Wildlife Technicians) prepared the figures and assisted in data analysis, while Joyce Mitchell, and Roberta Souriol typed the manuscript.

LITERATURE CITED

Brackett, D., W. Spencer, G. Baird, J.A. Snowshoe, E. Krutko, L. Males and P. Latour. 1985. Moose surveys in the Mackenzie River Delta, valley and tributaries, 1980. NWT Wildl. Serv. File Rep. No. 48. 15 pp.

Case R., K. Dauidee, and G. Bohnet (in prep.). Abundance and distribution of moose along the Liard River NWT, November 1985 - November 1986. NWT Dept. of Renewable Resources File Rep.

Crete, M.R.J. Taylor, and P.A. Jordon. 1981. Optimization of moose harvest in southwestern Quebec. J. Wildl. Manage. 45(3):598-611.

Dickinson, D.M. and T.B. Herman. 1979. Management of some terrestrial mammals in the Northwest Territories for sustained yields. Sci. Advisory Board of the NWT Rep. No. 4

Donaldson, J.L. and S. Fleck. 1980. An assessment of potential effects of the Liard Highway on moose and other wildlife populations in the lower Liard Valley. NWT Wildlife Serv. Contract Rep. No. 2. 36 pp.

Gasaway, W., S. DuBois, and S. Harbo. 1981. Estimating moose abundance and composition. Alaska Dept. Fish and Game, Fairbanks. 62 pp.

Geddes, F.E. and J.A. Duncan. 1982. Late winter moose surveys along the Mackenzie River and Norman Wells pipeline route. Prep. for Interprovincial Pipeline (N.W.) Ltd. by McCourt Management Ltd. 34 pp.

Hauge, T.M. and L.B. Keith. 1981. Dynamics of moose populations in northeastern Alberta. J. Wildl. Manage. 45(3):573-597.

Hawley, V. and R.S. Antoniak. 1983. Fort Smith region moose studies, 1979-1982. NWT Wildl. Serv. Prelim. Rep., Fort Smith, NWT. 95 pp.

Jennings, L.B. 1985. Moose survey-inventory progress reports Tanana Flats. Pages 83-85 in A. Seward (ed). Annual report of survey-inventory activities. Project W-22-3. Alaska Dept. Fish and Game, Juneau.

Jingfors, K. and R. Bullion. In prep. Moose immobilization in the Norman Wells area, Nov. 1985. NWT Dept. of Renewable Resources manuscript report.

Johnston, W.G., D.G. Larsen, H.A. McLeod, and C.A. McEwen. 1984. Moose population dynamics and habitat use, southern Yukon River basin. Prep. for Government of Yukon and Yukon River basin study by Northern Biomes Ltd. 60 pp.

Larsen, D.G. 1982. Moose inventory in the southwest Yukon. Proc. N. Am. Moose Conf. Workshop 18:142-167.

Lynch, G.M. 1975. Best timing of moose surveys in Alberta. Proc. Am. Moose Conf. Workshop 11:154-180.

Mitchell, H.B. 1970. Rapid aerial sexing and antlerless moose in British Columbia. J. Wildl. Manage. 34:645-646.

Mytton, W.R. and L.B. Keith, 1981. Dynamics of moose populations near Rochester, Alberta, 1975-78. Can. Field-Nat. 95:39-49.

NWT Science Advisory Board. 1980. Fish, fur and game in the Northwest Territories. Rep. no. 2 to the Legislative Assembly of the Northwest Territories. 39 pp.

Norton-Griffiths, M. 1975. Counting animals. Publication No. 1. Serenget. Ecol. Monitoring Programme, Nairobi, Kenya, African Wildlife Leadership Foundation. 110 pp.

Oswald, K. 1982. A manual for aerial observers of moose. Ministry of Natural Resources, Wava District, Ontario. 103 pp.

Peek, J.M., R.E. LeResche, and D.R. Stevens. 1974. Dynamics of moose aggregations in Alaska, Minnesota, and Montana. J. Mammal. 55:126-137.

Prescott, W.H., G.L. Erickson, L.e. Walton and D.G. Smith. 1973. Atlas of moose habitat maps: part of a wildlife habitat inventory of the Mackenzie Valley and northern Yukon. Can. Wildl. Serv., Environ. Soci. Progr., Northern Pipelines.

Spraker, T.H. 1985. Moose survey-inventory progress report: Kenai Peninsula. Pages 56-60 <u>in</u> A. Seward (ed.). Annual report of survey-inventory activities. Project W-22-3. Alaska Dept. Fish and Game, Juneau.

Treseder, L. and R. Graf. 1985. Moose in the Northwest Territories - a discussion paper. NWT Wildlife Serv. manuscript rep. 41 pp.

T'Seleie, B. 1985. Baseline data: Dene knowledge of behaviour patterns in moose, caribou and fish. Prel. rep. prep. by Fee-Yee Consulting Ltd., Fort Good Hope. 36 pp.

Van Ballenberghe, V. 1979. Productivity estimates of moose populations: a review and re-evaluation. Proc. N. Am. Moose Conf. Workshop 15:1-18.

Walton-Rankin, L. 1977. An inventory of moose habitat of the Mackenzie Valley and northern Yukon. Can. Wildl. Serv. Mackenzie Valley Pipeline Investigations. 39 pp.

Yukon, Dept. of Renewable Resources. 1984. Current management of ungulates and their predators in the Yukon Territory. Department of Renewabl Resource, Whitehorse. 31 pp.

Appendix A. Summary of moose census data for sample units (SUs) in Norman Wells area, November 1984.

SU No.	SU area (km2)	Search effort (min/km2)	No. Moose Observed	Bulls Adult	Bulls Ylg	Bulls Total	Cows	Calves
<u>High density stratum</u> (196 km^2)								
90	19.0	1.3	14	4	0	4	7	3
73	22.5	1.6	13	10	1	11	2	0
58	22.2	1.7	4	1	0	1	2	1
55	22.5	1.6	8	5	0	5	3	0
47	28.9	1.4	9	6	0	6	2	1
152	27.1	1.6	12	5	0	5	4	3
Totals	142.2		6	31	1	32	20	8
<u>Medium density stratum</u> (973 km^2)								
33	24.8	1.2	3	0	0	0	1	2
56	22.2	1.9	0	0	0	0	1	0
16	23.3	1.5	1	1	0	1	0	0
89	25.5	1.4	4	0	1	1	2	1
83	24.1	1.8	4	0	0	0	2	2
134	22.6	2.1	8	1	0	1	4	3
78	18.3	2.0	8	2	0	2	3	3
57	21.8	2.0	8	3	0	3	3	2
122	27.0	1.4	4	3	0	3	1	0
140	24.5	2.4	6	3	0	3	3	0
27	24.8	2.2	11	2	0	2	7	2
Totals	258.9		58	15	1	16	27	15
<u>Low density stratum</u> (2025 km^2)								
31	18.0	0.9	0	0	0	0	0	0
5	20.0	1.2	0	0	0	0	0	0
139	22.6	1.1	0	0	0	0	0	0
68	22.8	1.5	6	3	0	3	3	0
149	24.1	1.3	5	0	0	0	2	3
136	26.8	1.2	0	0	0	0	0	0
145	20.8	1.5	3	3	0	3	0	0
118	22.4	1.7	2	0	0	0	2	0
143	20.4	1.6	1	0	0	0	1	0
102	21.0	1.4	4	0	0	0	3	1
25	24.0	1.3	2	1	0	1	1	0
41	21.1	1.5	0	0	0	0	0	0
125	25.0	1.2	0	0	0	0	0	0
132	20.7	1.3	3	1	0	1	2	0

(Cont'd)

Appendix A (Cont'd)

SU No.	SU area (km2)	Search effort (min/km2)	No. Moose Observed	Bulls Adult	Bulls Ylg	Bulls Total	Cows	Calves
130	25.4	1.3	2	2	0	2	0	0
113	23.0	1.5	4	1	0	1	2	1
34	16.4	2.0	0	0	0	0	0	0
64	19.0	1.7	0	0	0	0	0	0
Totals	393.5		32	11	0	11	16	5
Survey Totals	794.6		150	57	2	59	63	28

Appendix B. Summary of moose census data for sample units (SUs) in the Fort Good Hope area, November 1984.

SU No.	SU area (km2)	effort (min/km2)	No. Moose Observed	Bulls Adult	Bulls Ylg	Bulls Total	Cows	Calves
High density stratum (74 km^2)								
79	19.6	2.3	13	1	0	1	10	2
25	19.0	2.6	7	3	0	3	4	0
4	19.1	2.4	11	2	1	3	4	4
7	16.4	2.1	6	4	0	4	1	1
Totals	74.1		37	10	1	11	19	7
Medium density stratum (366 km^2)								
54	21.0	2.1	10	3	0	3	6	1
55	19.4	2.3	9	1	0	1	3	5
80	20.3	2.3	3	2	0	2	1	0
5	19.4	2.2	9	2	1	3	3	3
102	20.0	2.1	5	2	0	2	3	0
17	19.5	1.8	0	0	0	0	0	0
23	20.4	1.8	7	4	1	5	2	0
22	20.0	1.8	5	3	0	3	1	1
73	19.2	1.9	5	5	0	5	0	0
69	20.3	1.9	2	2	0	2	0	0
76	21.3	2.0	6	4	0	4	2	0
Totals	220.8		61	28	2	30	21	10
Low density stratum (1742 km^2)								
31	21.5	1.5	2	0	0	0	1	1
10	21.8	1.7	2	0	0	0	1	1
81	19.8	2.1	3	0	0	0	2	1
94	20.6	2.0	2	0	0	0	1	1
44	21.2	2.0	0	0	0	0	0	0
105	22.2	2.1	0	0	0	0	0	0
84	21.0	2.0	0	0	0	0	0	0
107	19.6	2.4	3	0	0	0	2	1
14	20.3	2.3	1	1	0	1	0	0
70	20.8	1.6	4	4	0	4	0	0
51	21.2	1.8	0	0	0	0	0	0
47	20.8	1.8	3	0	0	0	2	1

(Cont'd)

APPENDIX B (Cont'd)

SU No.	SU area (km2)	effort (min/km2)	No. Moose Observed	Bulls Adult	Bulls Ylg	Bulls Total	Cows	Calves
41	20.4	1.5	2	0	0	0	1	1
40	17.0	1.3	1	1	0	1	0	0
97	20.2	1.5	4	0	0	0	2	2
86	21.3	2.0	0	0	0	0	0	0
Totals	329.7		27	6	0	6	12	9
Survey Totals	624.6		125	44	3	47	52	26