Alces

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SIX YEAR (1986/87-1991/92) SUMMARY OF IN UTERO PRODUCTIVITY OF MOOSE IN MANITOBA, CANADA

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ABSTRACT: Information on in utero productivity of moose in Manitoba for the period 1986/87 - 1991/92 is discussed. Age specific pregnancy rates are reported. The twinning rate was 15.6%. The sex ratio of foetuses significantly favoured females in one game hunting area (GHA). The average conception date was September 29 with 92.6% of the cows being bred by October 12. The median breeding date was September 26. There was a significant difference in the sex of fetuses produced before and after the average breeding date with more females produced earlier in the breeding season. The overall ovulation rate was 1.12 corpora lutea/female and 1.03 fetuses/female. A total of 173 corpora lutea were found and 160 calves suggesting a 7.7% loss of ova through early embryonic mortality or fertilization failure.

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Crichton (1992a) listed 12 parameters which can be used for monitoring the welfare of moose herds. He suggested that individual parameters used exclusively of others are of little value but when used in combination may give an indication of trends and/or health of specific populations and facilitate management decisions. Those parameters related to productivity are mean age of adults, percentage of adult males and females in the population, ratio of calves/100 females and bulls/100 females, sex of calves in the population, productivity of females 2½ years of age and older and the percentage of 1½ year old animals breeding.

Significant contributions toward understanding in utero productivity of moose and sex variation of fetuses have been made by Edwards and Ritcey (1958), Pimlott (1959), Peek (1962), Simkin (1965), Markgren (1969), and Crichton (1988). Edwards and Ritcey (1958) found that a minimum of 76% of the reproductive tracts examined (in which the cows exceeded 1½ years of age) were pregnant. This is a minimum as some cows were collected in September at which time pregnancies are difficult to determine or breeding may not have occurred. If yearlings (1.5 years old) are included in the sample a minimum of 61% were pregnant. They discovered that 85% of the females are bred in a 10 day period in late September and suggested that a few are bred in an earlier estrous while some are bred in two subsequent estrous periods with an interval of about 30 days between each. Peek (1962) concluded that corpora lutea were secondary if they were less than half as large as those designated as primary corpora lutea. None of the ovaries he examined contained more than one primary corpus luteum indicating an ovulation rate of one ovum per estrous which coincided with the low numbers of twins observed in the field. The lowest ovulation rate found by Pimlott (1959) in Newfoundland was 1.1 with 3% of the cows having twins in utero. Pimlott (op cit) and Rausch (1959 vide Peek 1962) concluded that yearling females exhibited a lower pregnancy rate than adults in Newfoundland and Alaska respectively. Rausch (op cit) stated that the number of corpora lutea of pregnancy occurring in ovaries of Alaska moose usually corresponded to the number of fetuses present. Simkin (1965) stated that an excellent key to the reproductive rate of a species is the ovulation rate. This may be determined by counting the number of primary corpora lutea observed shortly after the major peak in ovulation has occurred. He found that 35% of the yearlings and 86% of the adults had ovulated. In the adult cohort, the ovulation rate was 127 primary corpora lutea/100 females. Within the adults, a good index to productivity is the proportion of females which have multiple ovulations ie. ovulating more than one ovum at a time. The multiple ovulation rate of animals over 2 years old was 35%. The fertilization rate for yearlings was 45% and 89% for adults. The reproductive rates were 17 calves/100 cows for yearlings and 113 calves/100 cows for adults.

Haagenrud and Lordahl (1979) reported 58% males in the Norwegian calf harvest, (1971-74) and concluded that variations in the calf sex ratio contributes to self regulation of a population and suggested that more female births would result in a more rapidly expanding population. Franzmann (vide Verme and Ozoga 1981) found 66% of the newborn calves were male in areas of Alaska where bulls are heavily harvested. He suggested that this skewed sex ratio resulted from cows being bred late in estrous due to a scarcity of bulls. Créte (1982) on the other hand believed heavy hunting mortality at rut peak could have limited most breeding to early in the rut resulting in more female calves.

The issue of unbalanced sex ratios in the adult cohorts has been discussed at length by Peterson (1977), Bailey (1978), Sylven et al (1979), Bannikov (1970 vide Nygren 1984), Créte et al (1981), Van Ballenberghe (1983), Mytton and Keith (1981) and Hauge and Keith (1981). Ballard et al (1991) identified five issues related to skewed sex ratios namely: (1) concern over insufficient females being bred due to low bull densities (Peterson 1955); (2) an extended parturition period leading to late born, less viable calves (Bubenik and Timmermann 1982); (3) conception extending over two or three estrous cycles, producing calves of various sizes (Bishop and Rausch 1974); (4) sociological implications (Bubenik 1972); and, (5) potential physical deterioration caused by continual breeding by younger, small bodied, genetically inferior bulls (Harmel 1982).

This paper summarizes data for the period 1986/87 to 1991/92 from an ongoing study of moose productivity in Manitoba. The 1986/87 data were previously reported by Crichton (1988). The objectives of this study are to determine if all potentially productive cows are being bred, the pregnancy rate of different age cohorts within populations, the ovulation and fetal rates, to describe the observed productivity indices in relation to adult sex ratios, to determine the sex ratio of fetuses and the breeding period for moose.

METHODS

Specimens were largely collected from game hunting areas (GHA) 13, 18, 21A, 23, 23A and smaller numbers from GHA's 5, 7, 8, 9, 12, 15, 19, 26, 29, 35, 35A, 36, and Hecla Island. The majority are from that ecozone of Manitoba described as the midboreal transition and low boreal ecoregions.

Ageing was done using incisor teeth and employing the techniques described by Sergeant and Pimlott (1959). Age classes were pooled as yearlings (1½ years), teens (2½ years), primes (3½-9½ years) and seniors (10½+ years). These age categories were selected based on what is believed to be differing fecundity rates for Manitoba moose.

Each hunter obtaining a license via the draw system for "any moose" was sent an instruction letter and diagram to assist in collection of the reproductive tract from female moose. In addition, they were asked to submit the anterior 15.0 cm of the lower mandible for ageing purposes. Submission of samples was voluntary. All hunters submitting specimens were rewarded with a specially designed belt buckle and crest as a token of appreciation. Samples from non-draw areas were collected by department staff from animals taken illegally or by Treaty Indians. All samples were frozen prior to examination.

Crichton (1988) identified problems inherent in asking hunters to collect specimens and not knowing if only the uteri from pregnant cows were being submitted. In addition to the 210 specimens submitted an additional two were not the requested material and 37 (18%) were from non-pregnant animals and calves. It is believed that the instructions sent to hunters combined with their knowledge ensured that the sample was not biased toward pregnant animals.

Pregnancy could be ascertained in most cases by the enlarged size of the uterus. In those few cases in which fertilization had only recently occurred and in which the uterus had only begun to enlarge, the uterus was carefully cut open and searched for developing fetal tissues. Pregnancy was confirmed by the finding of a fetus in the uterus. In a few instances where the fetus had been lost by the hunter, pregnancy was confirmed by the large size of the uterus, the presence of enlarged cotyledons and other tissues associated with the presence of a developing embryo. Non-pregnant adult cows which had not bred previously were determined by the size of the uterus which was only slightly larger than that seen in calves and did not display evidence of stretching. Those bred previously but not pregnant when killed had a uterus which was enlarged and more flaccid than that of non-breeders. The number of fetuses represent only those known to be alive at the time of death of the cow. Females lacking fetuses as of December 1 were regarded as current breeding failures.

Each fetus was weighed to the nearest gram and the crown-rump length measured to the nearest millimetre. Fetal age was determined following the technique of Markgren (1969). The time of day that animals are killed varies considerably thus, for consistency the day prior to the kill date was taken as the first day when computing conception date. The average breeding date was determined using the Julian calendar. Fetal sex was determined by looking for external genitalia. In extremely small specimens (up to 2 cm) it was impossible to confirm the sex thus it was documented as unknown.

The fetal sex data were pooled by year for all samples and by GHA. Tests were conducted using a G-test for goodness of fit (Sokal and Rohlf 1981, p.692) with a Williams correction factor applied to determine if the sex ratio of the fetuses was significantly different from unity.

The ovaries were removed and sectioned lengthwise once at the thickest portion and examined macroscopically. They were not fixed prior to sectioning. The number of corpora lutea was recorded for each ovary as well as the length and width (in millimetres) of each. Corpora lutea 7mm or less in diameter were considered as small (secondary) whereas those 11mm or greater were classed as large (primary) as suggested by Peek (1962). Some samples in the early collection period were not measured but only the relative size noted (small or large).

RESULTS

A total of 210 reproductive tracts were submitted and 173 fetuses collected. Some cows could not be aged as jaws were not submitted. 155 reproductive tracts, in which one or both ovaries were present, were examined from cows at least 1½ years of age and older. Of these, 118 had a single calf, 22 had twins and 19 were not pregnant.

Age Specific Pregnancy Rates

Table 1 summarizes the age (when available) specific pregnancy rates and twinning data. 13½ year old animals were not found and are omitted from all relevant tables.

Twinning

Table 2 gives the data on sex of twins for each collection period. The overall twinning rate was 15.6% for the six year period.

Table 1. Pregnancy rates of moose in Manitoba by age from 1986/87 - 1991/92.

Age Class	Sample size	Pregnant No.	Pregnant %	Twins No.	Twins %
1½	22	8	36	0	0.0
2½	18	12	67	2	16.7
3½	24	23	96	4	17.3
4½	11	10	91	0	0.0
5½	16	16	100	7	43.8
6½	12	12	100	1	8.3
7½	8	8	100	2	25.0
8½	11	8	73	0	0.0
9½	10	10	100	3	30.0
10½	5	5	100	1	20.0
11½	7	6	86	1	16.7
12½	7	7	100	0	0.0
14½	2	1	50	0	0.0
15½	2	1	50	0	0.0
16½	2	1	50	0	0.0
18½	1	0	0	0	0.0

Note: % pregnant with twins is based on number pregnant not sample size

Table 2. In utero twinning in Manitoba moose from 1986/87-1991/92.

Year	Sets of twins	Same sex	Different sex
1986/87	10	7	3
1987/88	6	4	2
1988/89	4	2	2
1989/90	0	0	0
1990/91	2	0	2
1991/92	5	2	3
Total	27	15	12

Fetal Sex

Table 3 depicts the sex of fetuses and the fetal bull/cow ratio. The trend appears to be toward more cows than bulls with only two of the six collecting periods showing more bulls than cows.

Table 4 gives the breakdown of fetus sex for GHA's 13, 18, 21A, and 23/23A. The sex ratio of the fetuses was significantly different from unity (G value = 13.712 $P<0.001$, d.f.=1) for GHA's 23/23A while that for GHA's 21A, 13 and 18 was not.

Respecting fetus sex by age class the 1½ year old animals produced 2 females and 3 males, the 2½ year old animals 9 females and 2 males, the 3½ to 9½ year old animals 56 females and 38 males while the 10½+ age category produced 9 females and 10 males.

A comparison was done to ascertain if there was a trend to produce more calves of one sex prior to the mean breeding data as

Table 3. Fetal sex data collected from cow moose in Manitoba from 1986/87 to 1991/92.

Year	No. of males (%)	No. of females (%)	Bulls/cow
1986/87	16(30)	38(70)	0.42
1987/88	16(55)	13(45)	1.23
1988/89	8(28)	21(72)	0.38
1989/90	5(42)	7(58)	0.71
1990/91	10(67)	5(33)	2.00
1991/92	16(47)	18(53)	0.89
Total	71(41)	102(59)	0.70

compared to later. A total of 98 fetuses from conceptions prior to the mean breeding date revealed 33.7% to be males and 66.3% females. Only 12 were from conceptions on the mean breeding date with 5 being males and 7 females - this sample size is too small to draw any conclusions. Of the 45 samples from conceptions following the mean breeding date 55.6% were males and 44.4% females. Tests for association between time of conception and sex ratio were made. The association was significant (G Williams = 5.991, d.f. = 1 and $P<0.025$).

Breeding Period

Table 4. Fetal sex data from game hunting areas 23/23A, 21A, 13 and 18 plus population status.

GHA	Population status	Females (%)	Males (%)	Total
23/23A	↑	43(72.0)	17(28.0)	60
21A	↑	20(62.5)	12(37.5)	32
13/18	<-->	10(40.0)	15(60.0)	25
Others		29(52.0)	27(48.0)	56

↑increasing; <--> stationary
Others: GHA's 5,7,8,9,12,15,19,26,29,35,35A,36 and Hecla Island

Table 5 summarizes conception data by age category.

Figure 1 summarizes the conception data by 3 day increments. One day was added on each side of the mean and 3 day increments determined from this starting period. The mean was September 29 with a range of September 13 to November 3. Two outliers of August 21 and November 22 were excluded from calculations of mean conception date. The median in terms of breeding date was September 26 and 92.6% of the females were bred by October 12. This time period represents approximately the first three weeks of the fall hunting period and in this period 89% of the harvest occurs.

Ovulation/Fetal Rate

Table 6 presents number of fetuses, number of corpora lutea, ovulation rate and fetal rate. The assumption was made in cases of single fetuses and when no ovaries were present or, only one (the non active one) that there had been a minimum of one primary corpus luteum present. With those cows containing twins, only those in which both ovaries were present were considered in the calculations. No assumptions were made respecting corpora lutea because of the variations observed in those where both ovaries were present. A total of 173 corpora lutea were found with all but 12 being primary and a total of 160 calves. In no cases were any fetuses found in the process of being resorbed.

Table 5. Average conception data for female moose in Manitoba from 1986/87-1991/92.

Age	Sample size	Conception date
1½	5	September 30*
2½	10	September 29
3½-9½	99	September 27
10½+	22	October 2
Average		September 29

*The outlines of August 21 and November 22 are excluded.

Of the 118 cows with single fetuses, 120 primary and 7 secondary corpora lutea were found. Two of these cows had 2 primary corpora lutea each suggesting that one ovum was not fertilized or, there had been early embryonic mortality. 7 cows had a single primary corpus luteum along with a secondary one suggesting that they had ovulated earlier but had not conceived.

Of the 22 cows carrying twins, 37 primary and 4 secondary corpora lutea were

Table 6. Corpora lutea (CL) and fetuses for aged female moose from Manitoba, 1986/87 - 1991/92.

Female	Sample	Fetuses			Copora lutea					CL/	Fetuses/
age	size	NP	S	T	Nil	L	2L	1L,1S	1S	female	female
1 1/2	14	8	6	0	0	5	0	1	0	0.50	0.43
2 1/2	14	3	9	2	1	9	2	2	0	1.21	0.93
3 1/2	20	0	17	3	0	17	3	1	0	1.25	1.15
4 1/2	12	1	9	2	1	10	0	1	0	1.00	1.08
5 1/2	13	0	8	5	0	7	5	1	0	1.46	1.38
6 1/2	13	0	11	2	0	13	0	0	0	1.00	1.15
7 1/2	6	0	5	1	0	4	1	1	0	1.33	1.17
8 1/2	7	2	7	0	0	8	1	0	0	1.43	1.00
9 1/2	8	0	7	2	0	6	2	1	0	1.38	1.38
10 1/2	7	1	4	2	1	5	0	1	0	1.00	1.14
11 1/2	7	1	6	0	0	6	1	0	0	1.14	0.86
12 1/2	8	0	8	0	0	8	0	0	0	1.00	1.00
14 1/2	3	1	2	0	1	2	0	0	0	0.67	0.67
15 1/2	1	0	1	0	0	0	0	1	0	2.00	1.00
18 1/2	1	1	0	0	0	1	0	0	0	1.00	0.00
?	21	1	18	2	0	19	0	1	1	1.05	1.05
TOTALS	155	19	118	21	4	120	15	11	1	1.12	1.03

NP - not pregnant; S - one fetus; T - twins; L - llmm; S - 7mm
Numbers under fetuses and corpora lutea refer to number of cows.

found. In 3 cases, only a single primary corpus luteum was found and in each there was one fetus of each sex. Four cows had a single primary and one secondary corpus luteum. In three of these cases all fetuses were females while in the other there was a male and female.

Of those cows which were not pregnant and in which both ovaries were present there were 8-1½ year olds which were not pregnant and had no corpora lutea. 7 cows had not been bred previously: 2-2½ year olds with one primary corpus luteum each, a single 2½ year old with no corpora lutea and 2-8½ year olds with one primary corpus luteum each, a 14½ year old with no corpora lutea and one cow of unknown age with a single secondary corpus luteum. Four cows had bred previously but

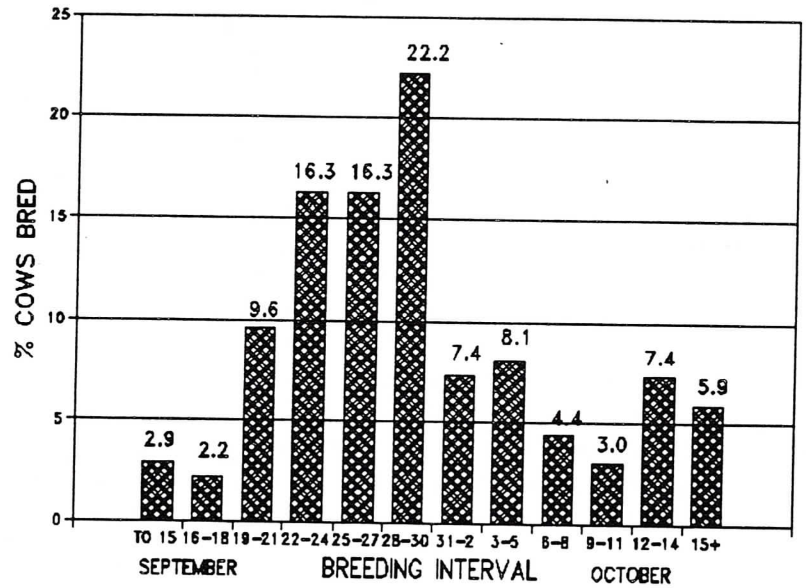

Fig. 1. Percentage of cow moose bred in 3 day intervals during September and October.

Table 7. Fetus per cow by age class in Manitoba from 1986/87-1991/92.*

Age class	Fetus /cow
1½	0.36
2½	0.78
3½-9½	1.13
10½+	0.92

* Includes all specimens in which age could be determined and for which the fetuses were present. Ovaries not present in all cases.

were not pregnant when killed: a 4½ and 10½ year old with no corpora lutea and an 11½ and 18½ year old each with one primary corpus luteum.

Table 6 also presents the number of corpora lutea and fetuses/cow. Table 7 presents the fetus/cow rate for all samples (including those in which ovaries were absent) in which the age could be determined and the fetuses were present.

DISCUSSION

Knowledge of the sex ratio of fetuses and reproductive performance by age class is required to calculate the rate of increase of populations and gross productivity of female ungulates. This productivity is governed by the complex interplay of various physiological, environmental and sociological factors. The results in this study demonstrate initial breeding age and reproductive performance of different age cohorts as well as sex of fetuses in different GHA's in Manitoba.

It is suggested that the significant differences in sex ratios in utero may be in response to population densities and herd welfare. If declines in numbers of bulls were to continue it is postulated that the scenario depicted by Franzmann (vide Verme and Ozoga 1981) would occur. Eason (1986) suggested that a high proportion of male calves may indicate a high density moose population or one with heavy selective pressure on bulls which is what is believed to be occurring in GHA's 13 and 18. He further postulated that a high female ratio may indicate a heavily hunted low density population.

The majority (92.6%) of female moose in

Manitoba are bred by October 12. Peek (1962) suggested that the main breeding season is in late September and early October. Edwards and Ritcey (1958) reported that 5% of the embryos which they found were from early September conceptions while 89% were conceived in a late September-early October period. Simkin (1965) suggests that since a high proportion of both Ontario and Swedish (Backstrom 1952 vide Simkin 1965)) exhibited a silent heat period and it has been shown that a small percentage of the moose in British Columbia (Edwards and Ritcey 1958) do breed in the same period (early September) that a higher proportion of these moose may have had an early September estrous cycle and that in only a small percentage were conditions favourable for fertilization. Simkin (1965) suggested that the presence of degenerating corpora lutea in many animals was evidence of an earlier estrous.

The greater number of corpora lutea found compared to calves suggests that fertilization does not occur in all cases or, that there is early embryonic mortality.

Notable are the three cases where there appeared to be a single large corpus luteum and the sex of the fetuses was different in two of these situations. If this was a case of identical as compared to fraternal twins, they should be of the same sex. One possible explanation is that a single follicle produced two ova. Brambell (1948 vide Robinette and Gashwiler 1955) reported that more than one egg can be shed from a single follicle. Alternatively, two follicles may have formed close together and the corpora lutea may appear to have been fused but in fact were two distinct entities. The macroscopic examination done could have resulted in this oversight. Child (pers comm) indicated that on gross examination it is frequently difficult to distinguish between two corpora lutea and that microscopic examination is required.

The finding of corpora lutea in non pregnant cows which have not previously been bred indicates there are some cows which annually ovulate but are not successful breeders. Further, the presence of a corpus luteum in a 8½ year old cow which had been bred previously suggests that there are a small number of breeding cows which annually ovulate but do not become pregnant. It is not unexpected that some animals do not breed annually for various reasons and these data corroborate this aspect.

The presence of more corpora lutea than fetuses suggests that using only these structures to evaluate productivity can result in an overestimation. Simkin (1965) suggested that the secondary corpora lutea seen are the result of an early estrous. It would appear in the present study that there has been about a 7.7% loss of ova through fertilization failure or early embryonic mortality when compared to the number of fetuses alive when the cows were killed in December and January. Markgren (1969) found a 10-15% in utero loss of embryos in Sweden. Although the author has observed dead fetuses in the uteri of elk and deer, they were not found in any of the moose examined. This phenomenon ie.

Table 8. Reproductive performance of moose in Manitoba by age from 1986/87-1991/92.

Age			Fetus/Cow	
Class	Present	Sample size	Crichton (1988)	Sample size
1½	0.36	22	0.63	8
2½-4½	0.96	69	1.17	13
5½-9½	1.17	41	1.33	18
10½+	0.88	26	0.70	10

dead fetuses, has also been observed by other investigators.

Markgren (1969), Franzmann (1981), Saether and Haagenrud (1983) suggested that maximum female reproductive potential is considered to be realized from age 4 to 12. The data presented here and that of Crichton (1988) suggest that for most of the populations examined in Manitoba maximum reproduction is being attained in the 5½-9½ age category followed closely by the 2½-4½ age category.

The age categories used in this paper differ slightly from those used by Crichton (1988). Table 8 compares productivity of the present data with those of Crichton (1988) using age classes of the latter. The differences as listed are not significant. These productivity data are similar to that reported from Hecla Island (Crichton 1988) except for the older aged females which in the latter case had 1.50 fetuses/female in utero with all of the pregnant cows having twins except one and only one was not pregnant.

The fact that a high percentage (92.6%) of cows are bred in about a three week period suggests that populations generally, in spite of bull only seasons, are still socially well balanced. It is suggested that the harvest of about 1100 moose (about 95% of which are bulls) annually by licensed hunters is not negatively impacting the herds. On the other hand, the uncontrolled harvest does have the potential to impact herds. There are some hunting areas which have low bull/cow ratios which deserve close monitoring to ensure that reproduction is not impacted.

Manitoba's moose population declined through the 70's and into the 80's (Crichton 1988). In the late 80's signs of a reversal in this downward trend were beginning to show. During the present collecting period, populations in GHA's 21A and 23/23A were increasing whereas those in GHA's 13 and 18 were thought to be relatively stable.

Manitoba has had a tradition over the last 20 years of having bull only seasons in the fall with openings varying from about September 18 to 25. In the 70's, it was common to have any moose winter seasons in many areas with licenses allocated on a quota basis in a few GHA's. The 80's brought a change with the recognition that populations were decreasing resulting in many winter seasons being changed to bull only. In those GHA's with draws the number of any moose permits available were reduced and in many cases eliminated. These changes were intended to protect the female cohort and reverse the population decline. In those GHA's where concern existed for the decreasing numbers of bulls, the opening of the fall season was delayed to exclude all or a significant portion of the rutting period. Should the trend in the numbers of bulls continue there may eventually be insufficient numbers to service all cows in a single estrous period with the attendant consequences (Bubenik and Timmermann 1982, Child and Aitken 1989).

GHA 23/23A (Riding Mountain National Park) has had an increasing population over the last 6 years. This is not surprising in light of the fact that 72% of the fetuses produced were females. The density was about 0.5 moose per km² when the increase started. The moose harvested in GHA's 23/23A are in fact part of the Riding Mountain National Park herd which is hunted in the aforementioned GHA's which surround the Park.

Crichton (1988) reported that GHA 21A was experiencing a sharp increase and it is believed that this population has continued to increase. A large burn occurred in this GHA in 1976 and it is speculated that the rate of increase in recent years is probably not as great as it was in the first 10 years after the burn. The estimated density in 1986 was about 0.47 moose per km² and immediately prior (1976) to the burn about half of this. It is speculated that the density today is about 0.6 moose per km². Funding restraints prohibit confirmation of population densities.

The situation in GHA's 13 and 18 is somewhat different with the populations suspected of being relatively stable. The estimated densities in 1985 were 0.27 and 0.5 moose per km² respectively where as today they are about 0.27 and 0.84 respectively.

The highest moose densities in Manitoba are found in moose management zone C (Crichton 1992b) where GHA's 23/23A, 13 and 18 are located and zone E where GHA 21A is located (0.4 and 0.13 per km² respectively). Although they are the highest densities observed in this study, they are still considered to be low density populations.

In moose management unit C (Crichton 1992b) the bull/100 cow ratio has declined over the last 15 years from about 60 to approximately 30. In unit E the decline has been from about 58 to approximately 42. Concern has been expressed for the bull component in these herds. With this in mind, the opening date for the fall season in GHA's 13 and 18 was delayed to near the end of the rut period. Speculation was that the bull component was being harvested (by licensed and unlicensed hunters) at a high level even though licenses were issued via a draw. The age structure showed a declining trend and hunters were expressing concern about the lack of bulls.

The high preponderance of female fetuses in GHA 23/23A may suggest that the moose population was below its potential carrying capacity. An examination of the fetal data for GHA's 13 and 18 revealed that 60% were male but the difference is based on a small sample size and not significant.

Larger sample sizes in GHA's 13 and 18 may reveal that sex ratio is significantly different and favours bulls. This could be interpreted as compensatory productivity to offset the high harvest of bulls. Mech (1975) has reported similar data for wolves. This long term decline points to potential problems and that if more males are being produced than females it may be in response to the long term decline of males. Every effort should be made to increase the sample size to ascertain if there is any variation from unity in the sex of the fetuses produced. Until this can be confirmed management decisions are warranted to ensure the bull component does not decline further.

This study suggests that productivity of moose populations can vary and that efforts should be made to gather such data for discrete populations. The strategy of managing moose populations on a GHA basis which in fact are politically expedient boundaries of convenience is fraught with problems. Many of these populations are closely associated and may not be geographically distinct.

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