SELECTIVE HARVESTS, HUNTERS, AND MOOSE IN CENTRAL BRITISH COLUMBIA

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ABSTRACT: Moose populations in the central interior of British Columbia are managed by a combination of selective harvest strategies, limited entry hunting (LEH), and temporal regulations. Since 1981, harvest structures, hunter performance, temporal adjustments in rutting activities, and conception dates of cows have been monitored. Annual harvests averaged 967 moose since inception of these regulations. Harvest ratios for all hunters averaged 53.5% males, 14.7% females, 31.8% calves. Harvest ratios for LEH-hunters averaged 40.1% males, 52.7 females, 7.3% calves; whereas, non-LEH hunters harvested 35.6% males and 64.4% calves. Success and effort for all groups of hunters when combined were similar to hunter performance prior to 1981 when traditional bulls only regulations were in effect. In spite of educational efforts, hunters continue to select adult animals in preference to younger animals. Mean dates of kill for bulls and mean dates of conception for cows suggest a synchronous rut. No significant relationship was found between duration of the rut and harvests of prime bulls. Harvest options are presented. Management implications and suggestions for strategy adjustment are discussed.

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Sport hunting of moose is generally governed by traditional bulls-only regulations and temporal restrictions on use of the antlerless component (Timmermann 1987). When challenged by A. Bubenik during his visit to British Columbia in 1979, a mix of selective harvest strategies and temporal regulations was developed to govern moose hunting in the central interior of British Columbia (Macgregor and Child 1981). A combination of selective harvest strategies and temporal regulations has been in effect since 1981. The selective harvest strategy is designed to exert high hunting pressures on calves, moderate pressure on bulls, and light pressure on adult females (Bubenik 1971, Child 1983). Temporal regulations on the other hand encourage hunters to harvest either a calf, a spike-fork bull or a mature bull at post rut. A summary of hunting regulations, season dates and hunter options for various age and sex classes of moose as practiced in the central interior is presented in Table 1.

Annual allowable harvests of cows and bulls were based on population estimates and hunter success rates. Harvests of cows and bulls were governed by quota allocations to non- residents and by lottery draw to residents. Unlimited hunting (non-LEH) was permitted for spike-fork bulls (≤2 points on one antler) and calves by a combination of regulations and general open seasons. Harvests of non spike-fork males (≥3 points on one antler) were controlled by selective limited entry hunting (LEH) prior to and during the rut. Since 1986, a post-rut male season, without antler point restriction, was open to all hunters each year (Table 1).

A late season antlerless hunt was advertised each year. Hunter participation was determined by lottery draw. Successful hunters were required to collect and submit the complete reproductive tract for examination (Child 1983).

These regulations and hunting seasons were designed to (a) govern the level and structure of the annual harvest, (b) meet program and recreation objectives, and (c) facilitate improvements in herd productivity.

This paper examines results of this program. We offer some recommendations that may assist others contemplating similar strategies.

Table 1. Summary of moose hunting regulations in Management Units 7-10, 7-12, 7-13 and 7-15, from 1975 to 1988.

Hunt Type	Year	Permit Required	Season Dates
Any Bull	1975-79	No	Sept. 15 - Nov. 15
	1980	Yes	Sept. 15 - Oct. 10
	1980	No	Oct. 11 - Nov. 15
	1986-88	No	Oct. 20 - Nov. 5
Mature Bull	1981-85	Yes	Sept. 15 - Nov. 15
	1986-88	Yes	Sept. 10 - Oct. 19
Spike-Fork	1981-85	No	Sept. 15 - Nov. 15
Bull	1986-88	No	Sept. 10 - Nov. 5
Cow or	1980	Yes	Oct. 11 - Nov. 9
Calf*	1981-82	Yes	Oct. 10 - Oct. 23
	1983	Yes	Oct. 8 - Oct. 23
	1984	Yes	Oct. 6 - Oct. 21
	1985	Yes	Oct. 5 - Oct. 20
	1986	Yes	Oct. 4 - Oct. 19
	1987	Yes	Oct. 4 - Oct. 22
	1988	Yes	Oct. 7 - Oct. 23
Calf*	1980	Yes	Oct. 1 - Oct. 21
	1981	No	Oct. 10 - Oct. 21
	1982	No	Oct. 10 - Oct. 23
	1983	No	Oct. 8 - Oct. 30
	1984	No	Oct. 6 - Oct. 21
	1985-86	No	Oct. 5 - Oct. 20
	1987	No	Oct. 4 - Oct. 22
	1988	No	Oct. 4 - Oct. 26
Late Antlerless	1978-88	Yes	Last weekend in November; first weekend in December

* Dates for cow or calf and calf seasons were adjusted each year to open and close on weekends.

METHODS

Harvest composition and magnitude plus hunter success and effort were determined annually by post-season mail survey of resident hunters only. Harvest data collected for the 1980 and 1981 hunting seasons were not included in the analyses because regulations advertised in 1980 differed substantially from preceeding and subsequent years (Table 1) and because no distinction was made in the post season harvest statistics in 1981 to differentiate between LEH and non-LEH harvests. Non-resident harvest statistics provided by Guide declarations were not included in the analyses since non-residents represented only 2 percent of the 1980-88 hunters and they harvested only 5 percent of the moose for this period.

Estimates of LEH hunter numbers, harvests and hunter days were corrected by the ratio of reported LEH cow harvest to the estimated total cow harvest since cow harvests are by LEH hunters only. Hunter numbers, harvests and hunter days for non-LEH hunters are therefore represented by the difference between estimated total statistics and these corrected LEH statistics. Percent suc-

cess and days per kill were subsequently calculated for LEH and non-LEH hunters from the corrected statistics.

Changes in total hunter numbers, success and effort, harvest levels and structures were compared between three regulation periods 1976 to 1979, 1982 to 1985, and 1986 to 1988 in order to examine effects of the transition from traditional males only regulations in the late 70's to selective harvests in the early 80's and introduction of a post-rut bull season in 1986. Changes in these statistics were analyzed by one-way ANOVA across the three regulation periods and differences in means were compared by Duncan's Multiple Range test. Changes in LEH harvest statistics were compared across the last two regulation periods by t-test. Similarly, changes in non-LEH harvest statistics were compared across the same periods by t-test. Comparison of both hunter groups and their respective harvests were made within each of the last two regulation periods and over the seven years from 1982 to 1988. Analyses of changes in percent hunter success and percent harvest compositions were performed after arcsin transformations (Zar 1974).

Ages of harvested animals were determined by counting annuli (Sergeant and Pimlott 1959) in incisor teeth. Mean ages of male harvests by all hunters were compared across the three regulation periods by one-way Anova and Duncan's Multiple Range test. Mean ages of bull harvests by LEH hunters were compared by t-test for the last two regulation periods. Similar comparisons were made for male harvests by non-LEH hunters. Mean age of annual harvests of bulls by LEH and non-LEH hunters were compared by t-test within each of the last two regulation periods and over the last seven years. Mean age of females harvest of were also compared by t-test across the last two regulation periods. Coefficients of variation about the mean ages of males and females were compared as described above for the mean ages.

Harvests of bulls and females were grouped by social- maturity classes (Bubenik 1971). Changes in proportions of primes (≥5.5 years) and teens (1.5 to 4.5 years) in the annual harvests by all hunters were compared across the three regulation periods by one-way Anova. Changes in proportions of these social classes in the harvests by LEH and non-LEH hunters were compared by t-test across the last two regulation periods. Analysis of changes in proportions were performed after arcsin transformations.

Annual mean age and coefficient of variation for each social-class of both sexes were compared across the regulation periods as described previously for population age structures.

Kill dates for males were converted to Julian days. Analysis of kill dates considered only harvest data collected between September 15 and October 31 each year to reduce variation in the harvest statistics that may be attributed to changes in opening and closing dates of the hunting seasons. Mean dates of kill and coefficients of variation for the total bull harvests were compared by one- way ANOVA to determine whether changes in the timing of male harvests had occurred from year to year.

Hunters participating in the late antlerless seasons were required to collect the complete reproductive tract from cow moose harvested. Pregnancy was determined by inspection of the uterus for a fetus or embryonic tissues (Markgren 1969). Date of conception was determined by subtracting estimated age of the fetus from the date of kill (Cheatum and Morton 1946, Armstrong 1950, Morrison *et al.* 1959). Age of the fetus was determined by comparing crown-rump length to age-length criteria for fetal development of moose within 90 days of conception (Markgren 1969). Conception dates were converted to Julian dates. Differences in mean dates of conception and coefficients of variation were tested for significance by one-way ANOVA and Duncan's Multiple Range

test across the three regulation periods to determine whether or not a time shift had occurred in breeding schedules from year to year.

Ninety-five percent confidence intervals were calculated for the means of each statistic within each period. Subsequently, 95% confidence intervals were calculated for overall means when no differences were found in the statistics between the regulation periods.

RESULTS

Hunter Participation, Success and Effort

Numbers of hunters (Table 2) did not change significantly (F=0.8207, df=2,8, P=0.474) over the three regulation periods averaging 4,372 hunters (95% CI = 4,063-4,682). Numbers of LEH hunters were also not significantly different (t=-1.60, df=5,P=0.171) between the latter two regulation periods when selective harvesting strategies were practiced averaging 788 hunters (95% CI = 723-853). Similarly, numbers of non-LEH hunters have not changed significantly (t=-2.09,df=5,P=0.091) over the latter seven years in spite of regulation changes, averaging 3,487 hunters (95% CI = 3,341-3,633).

Table 2. Estimated number of moose hunters in Management Units 7-10, 7-12, 7-13 and 7-15.

Regulation Period(Yr)	Total no. Hunters	No. LEH Hunters	No. nonLEH Hunters
1976	3666		
1977	4596	n.a.	n.a.
1978	4454		
1979	5461		
$\bar{x}$	4544	n.a.	n.a.
95% CI)	(4003-5085)		
1982	4277	760	3517
1983	4248	700	3548
1984	4042	816	3226
1985	3980	737	3243
$\bar{x}$	4137	753	3384
(95% CI)	(3596-4678)	(667-839)	(3191-3577)
1986	4264	745	3519
1987	4455	840	3615
1988	4653	920	3733
$\bar{x}$	4457	835	3622
(95% CI)	(3832-5082)	(736-934)	(3399-3845)

n.a. - not applicable in this study

Success of all hunters (Table 3) was not significantly different (F=4.4116 ,df=2,8, P=0.0511) across the three regulation periods, averaging 21.2% (95% CI = 19.4-23.1). Similarly, effort did not change significantly (F=2.6008,df=2,8,P=0.1348) between the three periods averaging 31.9 days/kill (95% CI = 28.8-35.1).

Success of LEH hunters increased significantly (t=-3.79,df=5,P=0.013) from 38.1% (95% CI = 33.9-42.4) to 47.9% (95% CI = 42.9-54.8) over the last two regulation periods. Effort, on the other hand, decreased significantly (t=3.08,df=5,P=0.028) from 16.3 days/kill (95% CI = 13.8- 18.8) to 11.7 days/kill (95% CI = 8.8-14.6).

Success of non-LEH hunters did not change significantly (t=-1.08,df=5,P=0.330) over the last two regulation periods, averaging 17.6% (95% CI = 15.3-20.1). Effort also did not change significantly (t=1.55, df=5,P=0.181) for these hunters over the history of the regulation changes and harvesting program, averaging 42.5 days/kill (95% CI = 36.7-48.3).

Annual Harvests

Average total harvests of moose (Table 4) differed significantly (F=5.4836, df=2, 8,P=0.0316) between the three regulation periods, being larger in the 1986-88 period ($\bar{x}$=1,075, 95% CI = 951-1,199) than harvests reported in the previous two periods (1976-79, $\bar{x}$=877, 95% CI = 770-965; 1982-85, $\bar{x}$=858,95% CI = 710-984). The total harvests of both bulls (F=31.306,df=2,8,P=0.0002) and cows (F=59.7399,df=2,8,P<0.0001) differed significantly between each of the three

Table 3. Comparison of success and effort of hunter groups in Management Units 7-10, 7-12, 7-13 and 7-15.

Year	All Hunters		LEH Hunters		non-LEH Hunters	
	Success %	Effort days/ kill	Success %	Effort days/ kill	Success %	Effort days/ kill
1976	19.8	27.8	n.a.	n.a.	n.a.	n.a.
1977	21.7	26.7				
1978	18.7	32.1				
1979	17.4	37.5				
$\bar{x}$	19.4	31.0				
(95% CI)	(17.1-21.8)	(26.3-35.7)				
1982	17.0	41.4	36.4	18.4	12.8	55.6
1983	21.8	32.5	35.3	17.1	19.2	38.1
1984	21.9	34.9	38.5	15.3	17.7	45.6
1985	22.4	32.7	42.3	14.3	17.9	42.7
$\bar{x}$	20.8	35.8	38.1	16.3	16.9	45.5
(95% CI)	(18.4-23.2)	(31.1-40.5)	(33.9-42.4)	(13.8-18.8)	(13.7-19.9)	(36.0-55.0)
1986	25.8	27.1	51.9	9.5	20.2	36.7
1987	24.2	28.1	47.0	12.1	18.9	37.3
1988	22.5	30.5	44.6	13.6	17.1	41.3
$\bar{x}$	24.2	28.6	47.8	11.7	18.7	38.4
(95% CI)	(21.3-27.2)	(23.2-34.0)	(42.9-54.7)	(8.8-14.6)	(15.1-22.6)	(23.6-53.2)

regulation periods. Average harvests of bulls for the 1976-79 period was 777 (95% CI = 670-884), 258 (95% CI = 151-365) for 1982-85, and 469 (95% CI = 345-593) for the 1986-88 period. The average harvests of cows changed from 53 (95% CI = 31-75) in 1976-79 to 154 (95% CI = 132-176) in 1982-85 and to 206 (95% CI = 181-231) in the third regulation period. Calf harvests changed significantly ($F=25.1635, df=2,8, P=0.0004$) also but only between the first and last two regulation periods. Calf harvests increased from 48 (95% CI = 0-147) in 1976-79 to 446 (95% CI = 347-545) in 1982-85 and to 400 (95% CI = 286-514) in 1986-88.

Table 4. Estimated annual harvests of moose in Management Units 7-10, 7-12, 7-13 and 7-15.

Regulation Period(Yr)	Total Harvest	No. Bulls	No. Cows	No. Calves
1976	727	637	40	50
1977	999	917	67	15
1978	833	750	36	47
1979	949	803	68	78
$\bar{x}$	877	777	53	48
(95% CI)	(770-984)	(670-884)	(31-75)	(0-147)
1982	727	205	162	360
1983	927	261	129	537
1984	885	283	172	430
1985	891	282	153	456
$\bar{x}$	858	258	154	446
(95% CI)	(751-965)	(151-365)	(132-176)	(347-545)
1986	1099	346	189	564
1987	1078	565	198	315
1988	1048	496	232	320
$\bar{x}$	1075	469	206	400
(95% CI)	(951-1199)	(345-593)	(181-231)	(286-514)

Total harvests of moose by LEH hunters (Table 5) increased significantly ($t=-5.58, df=5, P=0.003$) from 288 (95% CI = 255-321) to 397 moose (95% CI = 359-435) over the last two regulation periods. The average total harvests of bulls by LEH hunters also increased significantly ($t=-3.58$, $df=5$, $P=0.016$) between the two regulation periods from 114 bulls (95% CI = 92-136) in 1982-85 to an average harvest of 161 bulls (95% CI = 135-187) in the 1986-88 period. Average total female harvest similarly increased significantly ($t=-3.39, df=5$, $P=0.019$) from an average of 154 cows (95%

Table 5. Comparison of estimated annual harvests of moose by LEH and non-LEH hunters in Management Units 7-10, 7-12, 7-13 and 7-15.

Period Year	LEH Harvests Total	Bull	Cow	Calf	non-LEH Harvests Total	Bull	Calf
1982	277	94	162	21	450	111	339
1983	247	101	129	17	680	160	520
1984	314	124	172	18	571	159	412
1985	312	136	153	23	579	146	433
$\bar{x}$	288	114	154	20	570	144	426
(95% CI)	(255-321)	(92-136)	(128-180)	(6-34)	(448-692)	(58-230)	(267-585)
1986	387	153	189	45	712	193	519
1987	395	176	198	21	683	389	294
1988	410	154	232	24	638	342	296
$\bar{x}$	397	161	206	30	678	308	370
(95% CI)	(359-435)	(135-187)	(176-236)	(9-51)	(488-868)	(208-408)	(121-619)

CI = 128-180) during 1982-85 to an average harvest of 206 cows (95% CI = 176-236) in 1986-88. Calf harvests did not change significantly (t=-1.57,df=5,*P*=0.177) however, averaging 24 calves (95% CI = 16-30).

The total harvest of moose by non-LEH hunters on the other hand, did not change significantly (t=-1.84,df=5,*P*=0.125) over the last two regulation periods averaging 616 animals (95% CI = 542-690). The average harvests of bulls increased significantly (t=-3.20,df=5,*P*=0.024) from 144 males (95% CI = 58-230) during the second regulation period to 308 males (95% CI = 208-408) in the third regulation period while harvests of calves did not change significantly (t=0.74,df=5,*P*=0.494) averaging 402 (95% CI = 305-499) over the three periods.

Harvest Structures

(a) Males, Females and Calves

Proportions of males, females and calves in the annual harvest changed across the three regulation periods from an average of 88.5% bulls: 5.9% cows: 5.6% calves under traditional hunting regulations to an average of 31.6% bulls: 18.7% cows: 49.8% calves in 1982-85 and changed again to average 44.6% bulls: 19.5% cows: 35.9% calves in the third regulation period, 1986-88.

Composition of moose harvests by LEH hunters changed very little over the last two regulation periods. Harvests for 1982-88 averaged 39.5% bulls: 53.6% cows: 6.9% calves whereas harvests for 1986-88 averaged 40.6% bulls: 51.8% cows: 7.6% calves.

In contrast, harvests by non-LEH hunters changed considerably from 25.3% bulls: 74.7% calves in the 1982-85 period to 45.9% bulls: 54.1% calves in the third regulation period from 1986 to 1988.

(b) Age Composition

The mean ages of bull moose harvested by all hunters did not differ significantly (F=0.3580,df=2,8,*P*=0.7098) between the three regulation periods (Table 6), averaging 3.2 years (95% CI = 3.0-3.5). Similarly, the coefficients of variation about the mean ages did not change significantly (F=3.3993, df=2, 8,*P*=0.0854), averaging 0.774 (95% CI = 0.721- 0.827).

Mean ages of bulls harvested by LEH hunters (Table 7) during 1982-85 were not significantly different (t=0.60, df=5, *P*=0.575) from mean ages of bulls harvested in the 1986-88 period, averaging 3.6 years (95% CI = 3.1-4.1) over the seven years. The coefficients of variation about these mean ages also did not differ significantly (t=0.61,df=5,*P*=0.566), averaging 0.640 (95% CI=0.561-0.719).

Table 6. Comparison of mean ages of bull and cow moose harvests from Management Units 7-10, 7-12, 7-13 and 7-15.

Year	Male Harvests			Female Harvests		
	$\bar{x}$ Age	CV	*n*	$\bar{x}$ Age	CV	*n*
1976	2.8	0.893	74	n.a.	n.a.	
1977	3.5	0.714	77	7.8	0.557	21
1978	3.5	0.857	68	5.6	0.639	35
1979	3.5	0.829	65	6.5	0.625	32
$\bar{x}$ (95% CI)	3.3 (2.8-3.8)	0.816 (0.741-0.891)		6.6 (5.7-7.5)	0.607 (0.485-0.729)	
1982	2.9	0.714	91	5.3	0.673	117
1983	3.3	0.774	118	5.2	0.673	118
1984	2.8	0.885	193	5.5	0.745	171
1985	3.9	0.800	204	5.7	0.754	162
$\bar{x}$ (95% CI)	3.2 (2.7-3.7)	0.793 (0.718-0.868)		5.4 (4.7-6.1)	0.711 (0.513-0.909)	
1986	3.4	0.706	262	5.0	0.765	209
1987	2.9	0.714	239	5.3	0.830	192
1988	2.9	0.657	182	5.6	0.676	199
$\bar{x}$ (95% CI)	3.1 (2.6-3.6)	0.692 (0.606-0.778)		5.0 (4.1-5.9)	0.762 (0.640-0.884)	

Similarly, the mean ages of the bulls harvested by non- LEH hunters (Table 7) did not change significantly (t=-1.95, df=5, P=0.109) between the 1982-85 and 1986-88 periods, averaging 2.6 years (95% CI = 2.2-3.0). The coefficients of variation for the mean ages of male harvests also did not differ significantly (t=-1.51,df=5,P=0.191) for these two regulation periods, averaging 0.574 (95% CI = 0.350-0.798).

But mean age of bulls harvested by LEH hunters when compared to mean age of bulls harvested by non-LEH hunters were significantly different (t=4.54,df=6,P=0.004). The coefficients of variation about the mean age of bulls harvested by LEH hunters were not significantly different (t=0.61, df=6, P=0.653) from the coefficients of variation for males harvested by non-LEH hunters over the seven years.

The mean age of males harvested by LEH and non-LEH hunters during the 1982-85 regulation period (Table 7) were significantly different (t=6.33,df=3,P=0.008). However, coefficients of variation did not differ significantly (t=1.18,df=3,P=0.322). During the 1986-88 regulation period, when the post-rut bull season was advertised, mean age of males harvested by both groups of hunters did not differ significantly (t=2.63, df=2, P=0.119) but coefficients of variation did differ significantly (t=-24.78,df=2,P=0.002).

Mean age of females harvested (Table 6) differed significantly (F=5.4544, df=2,7, P=0.0373) between the three regulation periods. The mean age of females harvested during the 1976-79 period ($\bar{x}$=6.6 years, 95% CI = 5.7-7.5) was significantly different from the mean ages of females harvested in 1982-1985 ($\bar{x}$=5.4 years, 95% CI = 4.7-6.1) and in 1986-88 ($\bar{x}$=5.0 years, 95% CI = 4.1-5.9). Similarly, coefficients of variation about the mean ages of the females harvested did differ significantly (F=6.7327,df=2,7,P=0.0234) between the three regulation periods. The coefficients of variation for the 1976-79 period averaged 0.607 (95% CI = 0.485-0.729) and differed significantly from coefficients of variation for 1982-1985 which averaged 0.711 (95% CI = 0.513-0.909) and for 1986-88 which averaged 0.762 (95% CI = 0.640-0.884).

Table 7. Comparison of age structures of bull harvests by LEH and non-LEH hunters in Management Units 7-10, 7-12, 7-13 and 7-15.

Year	LEH Harvests			non-LEH Harvests		
	$\bar{x}$ Age	CV	*n*	$\bar{x}$ Age	CV	*n*
1982	3.4	0.558	59	2.5	0.800	17
1983	3.4	0.711	105	2.2	0.591	10
1984	3.4	0.763	116	1.6	0.314	50
1985	4.7	0.595	137	2.9	0.135	44
$\bar{x}$ (95% CI)	3.7 (3.0-4.4)	0.657 (0.553-0.761)		2.3 (1.8-2.8)	0.460 (0.164-0.756)	
1986	3.9	0.590	169	3.0	0.699	72
1987	3.1	0.677	160	2.9	0.792	47
1988	3.4	0.589	125	2.9	0.689	33
$\bar{x}$ (95% CI)	3.4 (2.6-4.2)	0.619 (0.499-0.739)		2.9 (2.3-3.5)	0.727 (0.385-1.069)	

(c) Social-Maturity Class Composition

Table 8. Comparison of harvest structures for bulls and cows harvested in Management Units 7-10, 7-11, 7-12 and 7-13 by LEH and non-LEH hunters.

	Bull Harvests by						Cow Harvests	
	All Hunters		LEH Hunters		non-LEH Hunter			
Year	%Teens	%Prms.	%Teens	%Prms.	%Teen	%Prms.	%Teens	%Primes
1976	82.0	18.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1977	79.2	20.8					47.6	52.4
1978	81.8	18.2					48.6	51.4
1979	78.5	21.5					46.9	53.1
$\bar{x}$	80.4	19.6					47.7	52.3
(95%CI)	(75.5-	(15.1-					(45.1-	(49.7-
	84.9)	24.6)					50.4	54.9
1982	82.5	17.5	80.4	19.6	87.5	12.5	50.9	49.1
1983	83.3	16.7	83.2	16.8	90.0	10.0	48.6	51.4
1984	86.2	13.8	82.4	17.6	100.0	0.0	51.6	48.4
1985	72.2	27.8	66.4	33.6	86.0	14.0	51.7	48.3
$\bar{x}$	81.3	18.7	79.8	21.6	93.0	7.0	50.7	49.3
(95%CI)	(76.5-	(14.3-	(73.3-	(13.8-	(80.5-	(6.0-	(48.4-	(47.0-
	85.1)	23.5)	85.6)	30.5)	99.4)	19.0)	53.0)	51.6)
1986	79.4	20.6	76.5	23.5	85.9	14.1	58.2	41.8
1987	84.7	15.3	84.8	15.2	89.1	10.9	53.4	46.6
1988	82.9	17.1	83.2	16.8	81.8	18.2	58.9	41.1
$\bar{x}$	82.4	17.6	81.6	18.4	85.7	14.3	56.8	43.2
(95%CI)	(76.9-	(13.4-	(71.8-	(10.3-	(67.4-	(12.8-	(54.2-	(40.6-
	87.3)	22.2)	89.7)	29.0)	97.2)	32.6)	57.7)	45.8)

The proportion of teen bulls (Table 8) in the harvests by all hunters did not change significantly (F=0.2114,df=2,8,*P*=0.8138) over the three regulation periods averaging 81.3% teens (95% CI = 78.8-83.7). Similarly, the proportion of prime bulls in the annual harvests did not change significantly (F=0.2114,df=2,8,*P*=0.8264) over the three periods averaging 18.7% primes (95% CI = 16.3-21.3).

The proportion of teen bulls in the harvests by LEH hunters did not change significantly (t=-0.66,df=5,*P*=0.537) over the last two regulation periods averaging 79.8% teens (95% CI = 73.3-85.6). The proportions of prime bulls in these LEH harvests also did not change significantly (t=0.66, df=5, *P*=0.537) over the last two periods averaging 20.2% primes (95% CI = 14.4-26.7).

For the non-LEH harvests, the proportions of teen bulls did not change significantly (t=1.11,df=5,*P*=0.319) over the last two regulation periods averaging 90.2% (95% CI = 80.1- 97.0). The proportions of primes in these harvests also did not change significantly (t=-1.11,df=5,*P*=0.319) between the two periods and averaged 9.8% primes (95% CI = 3.0-19.9).

The proportion of the male harvests by LEH and non-LEH hunters that were of the teen social-classes differed significantly (t=-2.66,df=6,*P*=0.037) over the seven years from 1982-88. Similarly, the percent harvest of prime bulls by LEH and non-LEH hunters differed significantly (t=2.66,df=6,*P*=0.037) over these seven years.

In the female harvests, the proportion of teens did change significantly (F=17.8121, df=2,7,*P*=0.0018) over the three regulation periods. The proportions of teen females averaged 56.8% (95% CI = 54.2-57.7) in the 1986-88 harvests and differed significantly from the proportions of teens in the female harvests for 1976-79 (47.7%, 95% CI = 45.1-50.4) and for 1982-85 (50.7%, 95% CI = 48.4-53.0). Also, the proportion of primes in the female harvests changed significantly over the three periods (F=17.8121, df=2,7, *P*=0.0018). The proportions of prime females averaged 43.2% (95% CI = 40.6-45.8) in the 1986-88 harvests and differed significantly from the proportions of primes in the female

Table 9. Comparison of mean ages and coefficients of variation of teen bull harvests over the regulation periods, 1976 to 1988.

Period Year	Characteristics of male harvests: Combined Harvests			Limited Entry			non-Limited Entry: Spike/fork			Post-Rut Bull		
	$\bar{x}$	CV	*n*	$\bar{x}$	CV	*n*	$\bar{x}$	CV	*n*	$\bar{x}$	CV	*n*
1976	2.4	0.603	30									
1977	2.4	0.437	33									
1978	2.4	0.272	32									
1979	2.3	0.406	25									
$\bar{x}$	2.4	0.430										
(95%CI)	(2.2-2.6)	(0.329-0.531)										
1982	2.5	0.397	59	2.6	0.410	45	1.9	0.040	14			
1983	2.4	0.445	93	2.4	0.442	84	1.8	0.386	9			
1984	2.2	0.464	141	2.5	0.431	89	1.6	0.400	48			
1985	2.8	0.363	126	3.1	0.305	89	2.1	0.406	37			
$\bar{x}$	2.5	0.417			2.7	0.397	1.9	0.398				
(95%CI)	(2.3-2.7)	(0.316-0.518)			(2.3-3.4)	(0.334-0.460)	(1.6-2.2)	(0.272-0.524)				
1986	2.7	0.402	188	2.8	0.373	127	2.3	0.437	50	2.4	0.471	11
1987	2.3	0.399	175	2.3	0.377	134	1.9	0.491	24	2.6	0.402	17
1988	2.5	0.403	131	2.6	0.385	104	1.6	0.201	18	3.4	0.296	13
$\bar{x}$	2.5	0.401		2.6	0.378		1.9	0.376		2.8	0.390	
(95%CI)	(2.4-2.6)	(0.284-0.518)		(2.2-3.0)	(0.305-0.451)		(1.5-2.3)	(0.231-0.521)		(1.5-4.1)	(0.171-0.609)	

harvests for 1976-79 (52.3%, 95% CI = 49.7-54.9) and for 1982-85 (49.3%, 95% CI = 47.0-51.6).

(d) Mean Ages of Social-Maturity Classes

Mean ages of teen bulls (Table 9) did not differ significantly (F=0.3318, df=2,8, *P*=0.7271) over the three regulation periods, averaging 2.4 years (95% CI = 2.3-2.6). Coefficients of variation about the mean age also did not differ significantly (F=0.0880, df=2,8, *P*=0.9166) over the three periods, averaging 0.417 (95% CI = 0.364-0.471). Mean ages of teen bulls harvested by LEH hunters did not differ significantly (t=0.040,df=5,*P*=0.707) over the last two regulation periods, averaging 2.6 years (95% CI = 2.3-2.9). Similarly, the coefficients of variation for the mean age of these harvests did not differ significantly (t=0.050, df=5,*P*=0.638), averaging 0.389 (95% CI = 0.341- 0.437).

Mean age of teen bulls harvested under spike-fork regulations did not differ significantly (t=-0.31,df=5,*P*=0.766) between the 1982-85 and 1986-88 regulation periods, averaging 1.9 years (95% CI = 1.6-2.2). The coefficents of variation about these mean ages did not differ significantly (t=0.29,df=5,*P*=0.783), averaging 0.389 (95% CI = 0.294-0.484). The mean age of teen bulls harvested during the post-rut male season averaged 2.8 years (95% CI = 1.5-4.1) and coefficients of variation averaged 0.390

Table 10. Comparison of mean ages and coefficients of variation of prime bull harvests over the regulation periods 1976 to 1988.

Period	Characteristics of male harvests: Combined Harvests			Limited Entry			non-Limited Entry: Spike/fork			non-Limited Entry: Post-Rut Bull		
Year	$\bar{x}$	CV	*n*	$\bar{x}$	CV	*n*	$\bar{x}$	CV	*n*	$\bar{x}$	CV	
1976	7.4	0.398	11									
1977	7.6	0.274	16									
1978	9.2	0.299	12									
1979	8.0	0.418	14									
$\bar{x}$	8.1	0.347										
(95% CI)	(7.4-8.8)	(0.274-0.420)										
1982	6.6	0.219	13	6.5	0.218	11	7.0	0.214	2			
1983	7.9	0.217	18	8.0	0.387	17	5.5	0.000	1			
1984	7.6	0.363	19	7.6	0.363	19	---	-----	0			
1985	7.8	0.212	51	7.8	0.429	45	7.7	0.407	6			
$\bar{x}$	7.5	0.253		7.5	0.349		6.7	0.207				
(95% CI)	(6.8-8.2)	(0.180-0.326)		(6.8-8.2)	(0.257-0.441)		(5.4-8.0)	(0.000-0.439)				
1986	6.9	0.275	49	7.5	0.257	39	7.9	0.230	5	6.7	0.125	5
1987	7.5	0.267	29	7.3	0.265	24	7.5	0.211	4	11.5	0.000	1
1988	6.8	0.257	27	6.9	0.264	21	7.5	0.189	3	5.5	0.000	3
$\bar{x}$	7.1	0.266		7.3	0.262		7.6	0.210		7.9	0.042	
(95% CI)	(6.3-7.9)	(0.182-0.350)		(6.5-8.1)	(0.156-0.368)		(6.3-8.9)	(0.000-0.442)		(0.0-15.8)	(0.0-0.221)	

(95% CI = 0.171-0.609).

Mean ages of prime bulls (Table 10) were not significantly different ($F=2.1218$, df=2,8, $P=0.1823$) over the three periods, averaging 7.6 years (95% CI = 7.1-8.0). The coefficients of variation for these mean age also did not differ significantly ($F=2.5682$, df=2,8, $P=0.1376$), averaging 0.291 (95% CI = 0.242-0.339). The mean age of prime bulls harvested by LEH hunters were not significantly different ($t=0.52$,df=5,$P=0.624$) over the last two regulation periods, averaging 7.4 years (95% CI = 6.8-8.0). And the coefficients of variation for these mean ages did not differ significantly ($t=1.61$,df=5,$P=0.169$), averaging 0.312 (95% CI = 0.243-0.381). Mean ages of prime bulls harvested by hunters under the spike-fork regulation did not differ significantly ($t=-1.39$,df=4,$P=0.237$) over the last two regulation periods, averaging 7.2 years (95% CI = 6.3-8.1). Similarly, coefficients of variation of prime bulls harvested under the spike-fork regulation did not change significantly ($t=-0.03$,df=4,$P=0.981$) between the two periods, averaging 0.209 (95% CI = 0.045-0.375). The mean age of prime bulls harvested during the post-rut male season averaged 7.9 years (95% CI=0.0-15.8) and coefficients of variation averaged 0.042 (95% CI=0.0-0.221).

Mean age of teen bulls harvested by LEH hunters were significantly different ($t=8.61$,df=6,$P<0.001$) from mean ages of teen bulls harvested during the spike-fork season. On the other hand, coefficients of variation were not significantly different

(t=0.01,df=6,*P*=0.994).

Mean age of prime bulls harvested by LEH hunters were not significantly different (t=0.36,df=5,*P*=0.732) from the mean ages of prime bulls harvested under spike-fork regulations. Similarly, coefficients of variation did not differ significantly (t=1.60, df=5, *P*=0.171).

Mean age of teen bulls harvested during the LEH season were not significantly different (t=-0.67,df=2,*P*=0.574) from mean ages of teens harvested during the post-rut season. Coefficients of variation similarly were not significantl different (t=-0.21, df=2, *P*=0.854). Mean ages of prime bulls harvested during the LEH and post-rut seasons were not significantly different (t=-0.36, df=2, *P*=0.752). Coefficients of variation differed significantly (t=4.99,df=2,*P*=0.038) however.

Mean age of teen female harvests (Table 11) did not differ significantly (F=1.4083, df=2,7,*P*=0.3062) over the three regulation periods, averaging 3.0 years (95% CI = 2.7-3.4). Similarly, the coefficients of variation of the mean age of these females harvested did not differ significantly (*P*=0.0565, df=2,7, *P*=0.9455), averaging 0.378 (95% CI = 0.344-0.412). Mean age of prime females were not found to differ significantly (F=0.3980,df=2,7,*P*=0.6860), averaging 9.3 years (95% CI = 8.7-9.9). Similarly, coefficients of variation about the mean age for prime females did not differ significantly (F=1.0013,df=2,7,*P*=0.4145), averaging 0.317 (95% CI = 0.285- 0.348).

Comparisons of mean age of teen males (Table 9) and females (Table 11) harvested

Table 11. Comparison of mean age and coefficients of variation of teen and prime cows harvested for the three regulation periods.

Period	Characteristics of cow moose harvests					
Year	Teens (1.5-4.5 yrs.)			Primes (5.5 +)		
	$\bar{x}$	CV	*n*	$\bar{x}$	CV	*n*
1977	4.3	0.306	10	11.1	0.322	11
1978	2.9	0.404	17	8.1	0.398	18
1979	3.0	0.443	15	9.6	0.310	17
$\bar{x}$	3.4	0.384		9.6	0.343	
(95% CI)	(2.8-4.0)	(0.310-0.485)		(8.4-10.8)	(0.283-0.403)	
1982	3.2	0.328	49	8.7	0.299	50
1983	2.6	0.429	51	8.4	0.235	51
1984	2.9	0.394	78	9.5	0.297	69
1985	3.1	0.333	72	9.5	0.352	67
$\bar{x}$	2.9	0.371		9.0	0.296	
(95% CI)	(2.4-3.4)	(0.304-0.435)		(8.0-10.0)	(0.244-0.348)	
1986	2.9	0.336	97	9.3	0.305	75
1987	2.6	0.404	86	9.5	0.355	76
1988	2.8	0.399	89	9.5	0.293	62
$\bar{x}$	2.8	0.380		9.4	0.318	
(95% CI)	(2.2-3.4)	(0.306-0.454)		(8.2-10.6)	(0.258-0.378)	

over the three regulation periods show a significant difference (t=-3.88,df=9,*P*=0.004). The overall mean age of teen female harvests was 3.0 years (95% CI = 2.7-3.4) whereas the mean age of teen male harvests was 2.4 years (95% CI = 2.3-2.6). By contrast, coefficients of variation about these mean ages were not significantly different (t=0.93, df=9, *P*=0.376).

Mean age of prime male (Table 10) and female (Table 11) harvests were also significantly different (t=-4.36,df=9,*P*=0.002) over the three regulation periods. The overall mean age of prime female harvests averaged 9.3 years (95% CI = 8.7-9.9) whereas the overall mean age of prime male harvests was 7.6 years (95% CI = 7.1-8.0). Coefficients of variation were not significantly different (t=-1.53,df=9,*P*=0.160) between the harvests of prime males and females.

Mean age of teen bulls harvested during the LEH season were significantly different (t=-3.50,df=6,*P*=0.013) from the mean age of teen females over the last two regulation periods. The mean age of teen bull harvests was 2.6 years (95% CI = 2.3-2.9) whereas the mean age of teen female harvests was 2.9 years (95% CI = 2.7- 3.1). Coefficients of variation were not significantly different (t=0.93,df=6,*P*=0.388) over these periods. Furthermore, mean ages of prime bulls harvests during the LEH season were significantly different (t=-6.94, df=6, *P*<0.001) from the mean age of prime females. The mean age of the prime bull harvested was 7.4 years (95% CI = 6.8-8.0) whereas the mean age of prime female harvested was 9.2 years (95% CI = 8.8-9.6). Coefficients of variation did not differ significantly (t=0.19,df=6,*P*=0.853) over these periods.

Rut Synchronicity and Conception Timing

Mean kill dates of bull moose (Table 12) did not change significantly (F=2.1609, df=2, 8,*P*=0.177) over the three regulation periods with an overall mean date of October 7 (95% CI = Oct.4-Oct.9). However, the coefficients of variation decreased significantly (F=26.227,df=2,8,*P*=0.0003) between the first and subsequent regulation periods, from 0.181 (95% CI = 0.165-0.197) for 1976-79, 0.125 (95% CI = 0.109-0.141) for 1982-85 and 0.117 (95% CI = 0.098-0.136) for 1986-88.

Table 12. Mean kill dates of bull moose harvested from September 15 to October 30 in Management Units 7-10, 7-12, 7-13 and 7-15.

Year	$\bar{x}$ Kill Date	CV	*n*
1976	Oct. 10	0.194	143
1977	Oct. 5	0.168	194
1978	Oct. 6	0.182	164
1979	Oct. 6	0.179	173
$\bar{x}$ Date	Oct. 7	0.181	
(95% CI)	(Oct.3-Oct.11)	(0.165-0.197)	
1982	Oct. 9	0.146	68
1983	Oct. 1	0.123	95
1984	Oct. 5	0.126	153
1985	Oct. 2	0.105	158
$\bar{x}$ Date	Oct. 4	0.125	
(95% CI)	(Sept.30-Oct.8)	(0.109-0.141)	
1986	Oct. 9	0.127	204
1987	Oct. 7	0.113	198
1988	Oct. 11	0.111	87
$\bar{x}$ Date	Oct. 9	0.117	
(95% CI)	(Oct.4-Oct.14)	(0.098-0.136)	

Mean dates of conception (Table 13) did not change significantly (F=2.8797, df=2,7, *P*=0.1223) over the three regulation periods with an overall mean date of October 9 (95% CI = Oct.4-Oct.14). The coefficients of variation did not change significantly (F=3.2134,df=2,7,*P*=0.1023) between the three periods, averaging 0.0250 (95% CI = 0.0202- 0.0298).

DISCUSSION

Hunter Participation, Success and Effort

Although hunter number did not change significantly, a slight increase in the numbers of both LEH and non-LEH hunters was noted after introduction of the post-rut bull season in 1986. This change in hunting interest occurred in spite of a constant number of limited entry hunting licenses and no adjustment in either the calf or spike-fork bull seasons. Hunters were quick to respond to increased

Table 13. Mean dates of conception of cow moose harvested by LEH-hunters in Management Units 7-10, 7-12, 7-13 and 7-15.

n	Year	$\bar{x}$ Date of Conception	(95% CI for $\bar{x}$ Dates)	CV	(95% CI)
11	1977	Oct. 23		0.026	
22	1978	Oct. 10		0.014	
25	1979	Oct. 13		0.017	
	$\bar{x}$ Date	Oct. 15	(Oct.7 - Oct.23)	0.019	(0.012-0.026)
36	1982	Oct. 16		0.033	
24	1983	Oct. 3		0.026	
43	1984	Oct. 5		0.021	
40	1985	Oct. 3		0.022	
	$\bar{x}$ Date	Oct. 6	(Sept.29-Oct.13)	0.026	(0.020-0.032)
50	1986	Oct. 6		0.025	
54	1987	Oct. 4		0.032	
44	1988	Oct. 4		0.034	
	$\bar{x}$ Date	Oct. 5	(Sept.27-Oct.13)	0.303	(0.027-0.037)

hunting opportunities available for bulls during the post-rut season.

Hunters generally enjoy comparable success and effort as experienced in pre-program years in spite of license controls, lottery draws and antler restrictions on male harvests. Indices of success (22.5%) and effort (32.2 days/kill) for all hunters in these Management Units with selective harvesting are similar to indices of hunter performance (19.4% and 31.0 days/kill) prior to regulation and strategy changes announced in 1981.

LEH hunters generally enjoy higher success and exercise less effort in their hunts because (a) they hunt during the rut when adults are more vulnerable, and (b) they enjoy unrestricted hunting for bull moose and may take any male regardless of antler architecture. Non-LEH hunters, on the other hand, are restricted to hunt only calves, spike-fork bulls and any bull during the post-rut male season. Consequently, success and effort for these hunters is consistently lower than for LEH hunters because of the restricted nature of their targets and lower vulnerability of the particular age and sex classes of moose that they may only hunt during the open season. Success and effort of LEH hunters were better after 1981 because of possible improvements in population numbers and lower competition amongst hunters. Performance of non-LEH hunters was slightly poorer than performance of all moose hunters before 1981 because of the restriction to harvest either spike-fork bulls or calves.

Nevertheless, in spite of seemingly complex regulations and administrative needs, program goals and objectives for hunter benefits and moose harvests are being met. Despite hunter arguments to the contrary, selective age and sex regulations when combined with temporal seasons on males at post-rut have maintained hunter success at levels comparable to those reported before selective harvesting was introduced.

Annual Harvests

Following the introduction of selective harvesting in 1982, the average annual harvests of moose did not change significantly from the 1976-79 harvests, that is before limited entry hunting strategies were practiced. However, a significant increase in the annual harvest of moose was reported for the third period when hunters could harvest any bull during the post-rut male season. Between the last two regulation periods, total LEH and non-LEH harvests increased on average 109 and 108 animals respectively (Table 4).

With inception of selective harvesting, male harvests changed. Initially average harvests of bulls dropped from 777 during 1976-79, to 258 in 1982-85 and then increased to 469 bulls after introduction of the post-rut

season in 1986.

The harvests of bulls by LEH hunters increased 41.2% (114 to 161) with no change in the number of licenses. These changes in the male harvests argue for improvements in the annual recruitment and an increased availability of males as a result of the cumulative effects of several years of reduced harvests of bulls.

Average harvests of bulls by non-LEH hunters more than doubled (144 vs. 308) between the last two regulation periods. A portion of the additional harvest of 164 bulls by non-LEH hunters was the result of an average harvest of 95 bulls, including 9 spike-fork males, during the post- rut season. The remaining 69 bulls were taken during the regular spike-fork season. The harvests of spike-fork bulls changed over the two regulation periods, from an average harvest of 144 in 1982-85 to 222 in 1986-88. In the three latter years, harvests of spike-fork bulls changed from 109 in 1986 to 311 in 1987 and to 245 in 1988. During the post- rut seasons in 1986, 1987 and 1988, harvests of spike-fork bulls totalled 8, 8, and 10 bulls respectively. These observed changes in the harvests of spike-fork bulls again suggest that recruitment was improving.

Cow and calf harvests also increased after introduction of the selective harvesting program when hunting opportunities for antlerless animals were once again offered to the public. Cow harvests continued to increase over the last two regulation periods when license numbers were held constant suggesting increased availability. By contrast, average calf harvests remained relatively stable over the same two periods.

Calf harvests did change substantially after 1986 however when the post-rut bull season was introduced. Harvests of calves seemingly decreased as bull harvests continued to increase each year.

Harvest Structures

(a) Male, Female and Calf Harvests

In the first period (1982-85) of the selective program, harvest structures reflected regulations directing hunters to harvest calves in contrast to harvest structures under traditional regulations prior to 1980. However, with introduction of the post-rut bull season in 1986 the structure of the annual harvests began to favour males in preference to calves. This selection against calves has not differed from traditional hunting practices (Macgregor and Child 1981). Regardless of regulations or strategy, hunters generally prefer to take adults whenever given the opportunity to do so. The desire to harvest adult moose in preference to juveniles seems a reasonable explanation for the shift in harvest structures witnessed during the third regulation period.

Hunters are conditioned by tradition to harvest adult moose. Educational programs must teach and convince them that juvenile harvesting is biologically and demographically sound. In spite of ongoing educational programs, hunters still wish to maximize benefits for effort expended and will usually take the largest animal when presented a choice. This desire takes precedence over a conscious decision for the resource. Consequently, a mixture of regulations that blend age and sex selection with traditional temporal seasons may be more practical if selective harvesting is being practiced and a desired harvest composition is to be achieved. Otherwise, hunter attitudes may continue to compromise management goals and prevent realization of harvest objectives.

(b) Age and Social-Class Compositions of Annual Harvests

Comparison of age structures of harvests permits analysis of harvest trends, population dynamics, and may at the sametime give one an insight into the social status of a population. Trends in mean ages are difficult to interpret. They may reflect real population responses or may be just constructs of regulation changes. Caughley (1977) further sug-

gested that changes in age distributions are possibly functions of survival and/or fecundity and are therefore difficult to interpret.

Mean ages of male harvests did not change over the three periods of different regulations and harvest strategies. Mean ages of female harvests were also stable. Male harvests when compared to female harvests by mean ages and coefficients of variation (Table 7) were generally "younger" and representative of fewer age-classes. These differentials may reflect population structures that have been generated and maintained by hunting strategies that encouraged male-only harvests for 6 years prior to implementation of selective harvesting.

LEH hunters in comparison to non-LEH hunters generally harvest older aged bulls. Since LEH hunters can hunt for any bull during the rut, they will likely harvest the most vulnerable males which are usually of the prime age classes. In contrast, since antler restrictions direct non-LEH hunters to harvest bulls of specific antler architectures during the rut, the mean age of these harvests were "younger" since spike-fork bulls are primarily of the yearling and teen male classes (in prep).

The composition of male harvests by social-classes did not change over the three regulation periods, averaging 81.3% teens and 18.7% primes. Compositions of female harvests by social-class changed over the three periods however to slightly favour the teen social classes (56.8% teens and 43.2% primes in 1986-88). This difference in the proportions of primes in both the male and female harvests may be reflective of an imbalance in the social structure (social disorder) of the population. This imbalance may influence the duration of the rut and possibly impact productivity (in prep).

The social-class composition of female harvests has changed from approximately 49.2% teens: 50.8% primes prior to 1985 to 56.8% teens: 43.2% primes subsequent to 1985. This change in the harvest composition suggests an increased availability of younger-aged cows, indicating that current harvests are likely below recruitment. Consequently, current harvests of females may be too conservative at 2% of the estimated population especially in view of the suggested improvements in recruitment to the male segment indicated by increasing harvests of spike-fork and teen bulls.

(c) Mean Age of Social-Maturity Classes

Mean age of teen bull harvests did not change significantly over the three regulation periods despite variations in harvest levels. Since mean ages of these male harvests have remained relatively stable, it suggests that current harvest levels are sustainable under current regulations; that is, off-take is below annual recruitment. And, since mean age of teen females harvested did not change significantly over the three periods, it suggests that current harvests of teen females are also at sustainable levels. Similarly, since mean ages of harvests of prime males and of prime females have remained relatively stable, it suggests that harvests of primes of both sexes are sustainable at current levels also.

However, the mean ages of both teen and prime female harvests were "older" than mean ages of teen and prime male harvests. Since regulations traditionally emphasized male harvests, the female harvests would likely be "older" as a consequence of lower harvest rates. These differences in mean ages are observed when male and female harvests by LEH hunters are compared and do not reflect the harvesting of young-aged bulls under the spike-fork regulation. The differentials in the mean ages of these social-maturity classes argue that male harvests need to be further regulated if the age structure of the male segment is to be comparable to the age structure of the females. This may mean fewer males available for harvest.

The spike-fork regulation has been somewhat successful in directing harvests towards the yearling class although some bulls har-

vested under this regulation have come from older teens and prime age-classes. The spike-fork bulls taken from prime age-classes were technically legal as defined by antler architecture (deformity and occasional breakage). Moreover, even though harvests of these bulls have increased over the last two years, the harvests of spike-fork yearlings are believed sustainable under current regulations because recruitment has not yet been impacted as determined by aerial census.

Rut Synchronicity and Conception Timing

Based on analyses of conceptions and kill dates of bulls, the rut seemingly did not change, remaining relatively synchronous over the years. However, the reduction in coefficients of variation about the mean kill dates of bulls and about the mean dates of conception may indicate a reduction in the duration of the rut. As further evidenced, the proportions of cows bred in the second and subsequent estrous did continue to decline over the three regulation periods from 17.5% in 1977-79, 14.0% in 1982-85 to 7.7% in 1986-88 (unpub. data). Breeding may be occurring over a relatively shorter period of time. As suggested by Bubenik (1982) and Lincoln (1971), the onset of the annual rut is likely related to the maturity of the male segment. Although there was no relationship found between the age structure of male harvests and mean dates of conception, the reduction in male harvests after introduction of selective harvesting in 1981 may have permitted recruitment of bulls into the prime social-classes resulting in an earlier onset of breeding and as a result, an abbreviated rut. Despite increased male harvests after 1986, harvests of bulls did not seem excessive since there was no observed increase in the frequency of conceptions after the first estrous. In fact, the shift in the mean dates of conception since 1982 (10 days earlier) in concert with the reduction in the proportions of cows being bred after the first estrous argue that an increased number of bulls, possibly more primes, may be present on the rutting arenas. These observations would suggest that harvests of bulls are below threshold as cautioned by Lent (1973).

The temporal changes in conception are biologically significant. For example, survival advantages may be offered to calves that are born in an early synchronous birthing period by offsetting predator mortalities due to the neonatal swamping effect, and by providing a longer summer growth period which may enhance winter survival due to larger body size. Higher annual yields and greater biomass of calves may be realized as a result. Hunters might expect more benefits such as larger harvests, better success and realize larger carcass weights of calves for their efforts. Survival advantages of an early rut extend to adult moose as well because they may replenish fat reserves earlier and move to traditional winter ranges in better condition.

MANAGEMENT IMPLICATIONS

In spite of efforts to blend traditional regulations with age and sex selective harvesting strategies, hunter responses subsequent to 1986 suggest the need for more refinement. Following relaxation of temporal regulations in 1986, hunters quickly sought bulls in preference to calves. Educational programs that encourage hunters to select younger-aged moose (calves and spike-fork bulls) are important and therefore should compliment management efforts.

Rut synchronicity is possibly a function of the breeding sex ratio and its duration related to the presence and non- parental value of prime males on the rutting arena (Bubenik, 1987). We believe that moose harvests, especially of prime males, can exceed a threshold. Control of these harvests is therefore of management concern (Page 1983). A spike-fork bull regulation could be introduced to direct male harvesting and permit recreation. Hunting during the rut can still occur but limiting hunter participation by license control is important. Harvests of

prime bulls need to be closely monitored and held below threshold. Harvest levels should be based on population estimates and license issue adjusted by hunter success at the rut. If a post-rut open male season is to be advertised the manager should consider further reducing the number of licenses available to hunters during the rut in order to compensate for the expected harvest of prime bulls taken after the rut.

The following regulation changes will be considered:

(1) no rut closure to be announced as this regulation denies recreation,
(2) the post-rut male season may be shortened slightly since harvests are not excessive,
(3) the number of LEH licenses for bulls may be adjusted,
(4) the number of LEH licenses for antlerless moose may be increased, and
(5) the open seasons for calves and spike-fork bulls may be expanded.

We plan to continue our investigations of the reproductive performance of females in order to study the relationship of male harvests to female breeding success and timing of the rut.

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