SELECTIVE MOOSE HARVEST IN NORTH CENTRAL ONTARIO - A PROGRESS REPORT

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Abstract: Ontario introduced a province-wide sex and age selective harvest strategy for moose in 1983. The program was designed to double the provincial moose population by the year 2000 by controlling the annual hunter harvest of bulls and cows in 65 Wildlife Management Units. In North Central Ontario the harvest sex/age ratio has averaged 54% bulls, 31% cows and 15% calves after three years. The step-wise increase in the calf kill is encouraging, however, there appears to be a trend towards a higher proportion of breeders and a lower proportion of yearlings and teens in both the 'adult' cow and bull harvest. Hunter success has increased and hunters report seeing more moose. Aerial inventories since 1983 however, have generally been insensitive in measuring population change with confidence intervals still overlapping those previously calculated. The overall public attitude toward selective harvest appears positive although some aspects of the program are still poorly understood.

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Ontario has employed three distinct moose (*Alces alces*) harvest strategies over the past three decades in an effort to balance harvests with herd recruitment. Liberal, unlimited entry, either sex seasons were used from the mid 1950's to 1979 (Timmermann and Gollat 1982). Passive harvest control measures in the form of curtailed seasons and licence fee increases were introduced during the latter part of this time period in an effort to stabilize suspected population declines (Gollat and Timmermann 1983a, Timmermann In Press). A harvest system introduced in 1980 required two hunters to share one moose (Timmermann and Gollat 1984). Decreased economic benefits, enforcement problems and area specific overharvests lead to its replacement by a selective harvest system in 1983 (Euler 1983a).

The primary objective of the selective harvest program was to double the Ontario moose population by the year 2000. Population and harvest targets were assigned to each of 65 Provincial Wildlife Management Units (WMU). Harvest strategies were designed to protect breeding cows and focus hunting pressure on bulls and calves. The biological basis of selective harvest assumes hunting mortality of calves to be partially compensatory (Euler 1983a) and a polygamous breeding capacity of bulls.

The harvest quota is based on the most recent reliable population estimate. Harvest quotas were initially formulated using methods described by Gollat and Timmermann (1983b). A standard approach (Greenwood et al. 1984) was adopted in 1985. Each WMU harvest quota is apportioned into a specific number of bulls, cows and calves. The applied 1983 ratio of 50:20:30 was refined to a baseline 60:20:20 in 1984 based on computer simulation (OMNR 1984, Gollat et al. 1985).

The selective harvest program introduced major changes in regulations and required hunters for the first time to identify and select the animal they were licenced to hunt. Qualifying residents wishing to hunt could purchase a basic moose licence and harvest a calf in any WMU during the open season. Those wishing to also hunt 'adult' animals ($\geq$ 1.5 yr.) had the option of applying for a bull or cow tag. Bull tag holders were entitled to take either a bull or a calf. Those receiving a cow tag were restricted to a cow or calf. If a moose was shot and the sealing coupon affixed, that hunter was no longer eligible to continue hunting moose in the years 1983-85. This regulation was originally introduced in 1980 to eliminate previously legalized party killing.

Adult tags are limited in number for each WMU (Gollat and Timmermann 1983a) and are distributed by computer draw where the number of applicants exceeds the quota. A limited number of adult tags are also available through licenced tourist outfitters for their resident and non-resident guests (Bisset and Timmermann 1983). Purchase of a licence prior to draw entry was a requirement introduced in 1984 to minimize the number of successful applicants who failed to hunt, as occurred in 1983 when licence purchase was not required. In addition, preference pooling was added to give those unsuccessful in the previous year's draw a greater chance of being selected.

Changes in regulations were communicated to hunters and management staff by a variety of traditional and innovative means. Initally a pamphlet with a nine question and answer format was mailed to all 1982 licence holders. This was followed in 1984 by a 22 page booklet (OMNR 1984) covering 19 specific items. More recently a moose hunter fact

sheet has been employed. Considerable emphasis was placed on communicating sex/age identification features and selective harvest philosophy. Informational articles were published in trade magazines (Euler 1983b, Timmermann 1983). A moose identification quiz consisting of 62 colour slides and score sheet was prepared and distributed to field offices. In addition a 21 minute film entitled 'Of Moose and Man' was produced in both 16 mm and video formats. Field offices conducted community workshops/seminars and special information meetings during the first two years. Local interviews on radio and T.V. as well as feature newspaper articles continue to play a significant ongoing role in communicating the program.

This paper examines the impact of selective harvest in North Central Ontario and where possible compares hunting and harvest statistics with those of two previously used harvest strategies. The influence of non-hunting mortality, moose population response, and implications of enforcement and harvest control measures are also discussed.

METHODS

Hunter perception and acceptance of selective harvest was evaluated by a cooperatively designed mail survey questionnaire conducted by Lakehead University Outdoor Recreation Department, Thunder Bay. Survey design was modelled after methods described by Dillman (1978) using a 10% sample of licence holders in two WMU's with one follow up reminder.

The impact of selective harvest was measured by comparing harvest data derived from voluntarily submitted jaw samples obtained from 14 WMU's in the North Central Region between 1977 and 1985. Sex and age composition was examined for each of the three distinct harvest

strategies employed during the nine hunting seasons involved. These include season manipulation 1977-79, the party harvest system 1980-82, and selective harvest 1983-85. Data were pooled and mean values for each strategy tested for statistical significance (generally at $P<0.05$) using a 2x2 contingency table analysis. Five arbitrary age classes described by Timmermann and Gollat (1984) and modified from Bubenik and Timmermann (1982) were used for harvest social structure analysis. Trends in hunter numbers, total harvests, hunter days, moose sighted by hunters and hunter effort obtained from an annual centrally conducted provincial mail survey were tested using basic t-test analysis. Hunter success rates were determined from district conducted post-hunt mail surveys.

The impact of black bear (*Ursus americanus*) predation and winter severity on population and harvest trends was examined during the study period. Black bear harvest data were obtained from both big game harvest cards and export permits (Bisset 1982).

Winter severity was projected on the basis of total annual snowfall records provided by the federal weather office in Thunder Bay and compared to snow depth records from standard OMNR snow stations within the region.

Population trend data derived from standard aerial inventories (OMNR 1981) were examined to determine population response to changes in harvest strategy and compared to program targets (OMNR 1982).

Enforcement statistics taken from Offence, Seizure and Prosecution records for five North Central Region districts 1983-85 were summarized and compared with similar records collected during the periods 1977-79 and 1980-82.

RESULTS AND DISCUSSION

Hunter Perception and Acceptance

A majority of hunters support the selective harvest system according to two independent surveys conducted in 1985 and 1986 (Borovsky and Rollins 1985; Vanden Brand 1986). The standard deviation for both surveys, however, was high indicating considerable variation in response to the series of over 70 questions posed. Results indicated a high level of knowledge of harvest regulations but a lower level concerning moose management and biology. Respondents believe that they themselves comply more to the regulations than either their hunting companions or other hunters in general. The majority agreed that selective harvest makes hunters more knowledgeable about moose management and that it will provide continued opportunities for hunting. However, they also felt that it leads to increased poaching and waste. Both surveys concluded that an expanded hunter education effort is needed to strengthen hunter understanding of moose biology and management.

Hunt Statistics

Hunter numbers declined in 1984 but increased to near late-1970 levels during the third year of selective harvest (Fig. 1). Regulation changes including purchase of a licence as a prerequisite to enter the adult draw are believed responsible for the initial decline. Total annual harvests have stabilized and approximate those experienced prior to the inception of the party harvest system. Recreational opportunities expressed in total hunter days have increased ($P<0.001$) over the party harvest system and in 1985 exceeded those experienced during the pre-1980

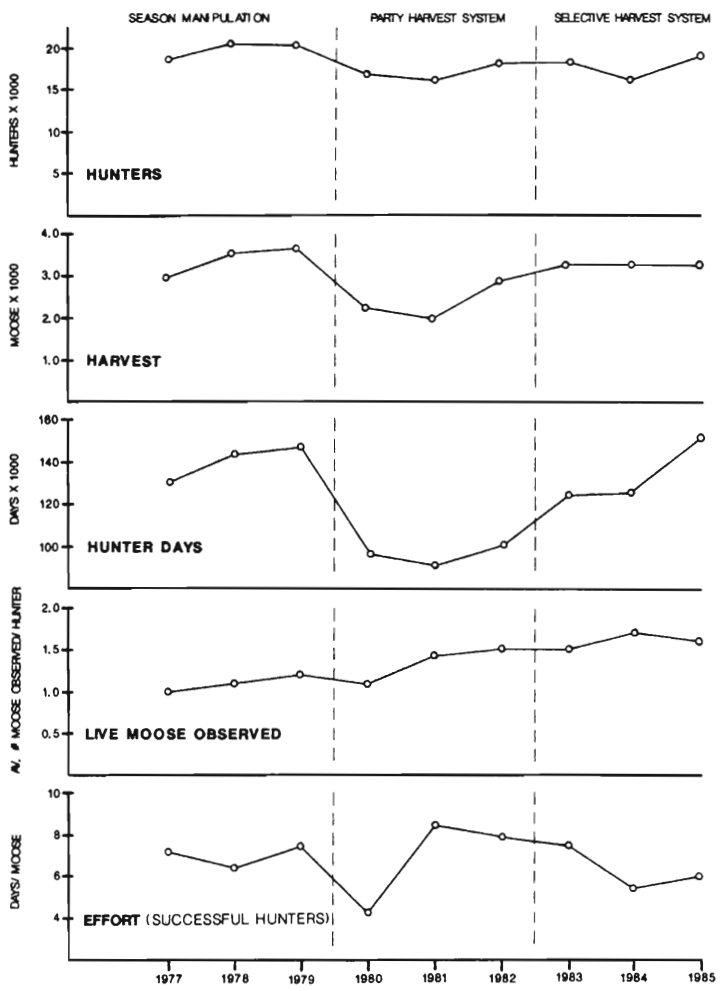

Figure 1. Provincial hunter mail survey statistics for 14 WMU's - North Central Region, 1977-84.

period (Fig. 1). Longer seasons and removal of the regulation to share one moose between two hunters have contributed to the change. Significantly more ($P<0.05$) moose have been sighted by hunters since 1983 compared to the period 1977-79 (Fig. 1). Finally, although not significant ($P>0.05$), a general downward trend in effort required by successful hunters to harvest a moose has been noted since 1981.

Harvest Composition

The composition of the 1983-85 harvest has changed ($\chi^2=35.74$, d.f.=4, $P<0.001$) from that of the previous two harvest strategies (Table 1). Under selective harvest, bulls, cows and calves averaged 54, 31 and 15 percent of the reported harvest over three years. This compares to 50/38/12 for the party harvest system and 48/38/14 for pre-1980 season manipulation. During selective harvest, the proportion of harvested bulls was higher than recorded for either season manipulation ($\chi^2=17.42$, d.f.=1, $P<0.001$) or the party harvest strategy ($\chi^2=6.39$, d.f.=1, $P<0.05$). Conversely, the cow harvest was lower than realized during either the party harvest system ($\chi^2=22.25$, d.f.=1, $P<0.001$) or season manipulation ($\chi^2=23.07$, d.f.=1, $P<0.001$). This change is believed to have resulted from a direct manipulation of adult tag quotas to achieve the targeted adult harvest ratio. To date we have been unsuccessful in our efforts to increase the overall mean calf harvest to 20-30% as targeted, primarily due to the surplus of adult tags in most WMU's and suspected party killing of adults. The step wise increase in calf harvests (11.9/14.3/18.3) over the last three years however, suggests populations and/or hunters are in part responding to selective harvest strategies.

Table 1. Sex and age composition of hunter harvested moose for three distinct harvest management strategy periods, North Central Region of Ontario 1977-85: A) unlimited, non selective, B) party harvest system, C) selective harvest.

		Percent Total				Percent Bulls			Percent Cows	
Strategy	Year	N	Bulls	Cows	Calves	N	Teen*	Prime**	N	Yearlings	Breeders***
A	1977	2,067	47.1	39.2	13.7	856	78.6	18.5	701	44.9	55.1
	1978	2,122	50.2	35.7	14.1	899	76.8	19.4	648	31.9	68.1
	1979	2,409	45.8	39.4	14.7	949	80.8	16.9	800	28.6	71.4
	X_3		**47.7**	**38.1**	**14.2**		**78.7**	**18.3**		**35.1**	**64.9**
B	1980	1,295	49.8	38.0	12.2	549	82.3	13.5	429	38.9	61.1
	1981	1,680	52.0	37.7	10.2	769	82.7	14.3	551	34.5	65.5
	1982	2,284	48.4	39.6	12.0	941	84.4	13.7	764	36.0	64.0
	X_3		**50.1**	**38.4**	**11.5**		**83.1**	**13.8**		**36.5**	**63.5**
C	1983	1,996	56.8	31.3	11.9	972	79.0	17.4	546	34.1	65.9
	1984	1,942	54.9	30.8	14.3	899	81.3	16.1	497	31.4	68.6
	1985	2,068	50.3	31.3	18.3	846	77.2	20.1	523	31.5	68.5
	X_3		**54.0**[1]	**31.1**[2]	**14.8**		**79.2**[3]	**17.9**[4]		**32.3**[5]	**67.7**[6]

* Teen = (1.5-4.5 yr.) ** Prime = (5.5-10.5 yr.) *** Breeders = ($\geq$ 2.5 yr.)

[1] C>A ($P<0.001$)/C>B ($P<0.05$); [2] C<A,B ($P<0.001$); [3] C<B ($P<0.05$); [4] C>B ($P<0.05$); [5] A=B=C ($P>0.05$); [6] A=B=C ($P>0.05$)

Selective harvest has affected an increase (χ^2=4.89, d.f.=1, $P<0.05$) in the proportion and number of prime bulls in the kill, while a corresponding decrease in teen bulls has occurred (Table 1). Although not significant (χ^2=1.88, d.f.=1, $P>0.05$), similar trends were also recorded for breeding and yearling cows, respectively. Earlier season opening dates, a weekend season opener since 1983 and a suspected higher proportion of breeding cows and prime bulls in the population resulting from reduced harvests 1980-82 are believed responsible.

Non-Hunting Mortality

Winter weather and predation may impact moose populations especially the survival of calves. Prolonged deep snow winters reduce moose mobility thereby increasing the incidence of malnutrition and vulnerability to wolf predation (Peterson and Allen 1974). In addition, those moose born after severe winters may show increased vulnerability throughout their life (R. Peterson, pers. comm. 1986). A cursory examination of total seasonal snowfall since 1968 reveals 10 of 18 winters fell below the 30 year mean (1950-80) of 212 cm in the Thunder Bay area (Fig. 2). Six of these have occurred since 1979-80, coincidental with added party and selective harvest restrictions. Snow depth records from standard snow stations (Passmore 1953) scattered across the North Central Region also verify reduced snow depths during the first half of this decade.

Black bear, a known predator of newborn calves (Stewart et al. 1985) are common throughout the region. The spring bear harvest which represents 80% of the annual take has doubled from approximately 400 to 800 since 1982. Reduced harvest opportunities in adjacent U.S.

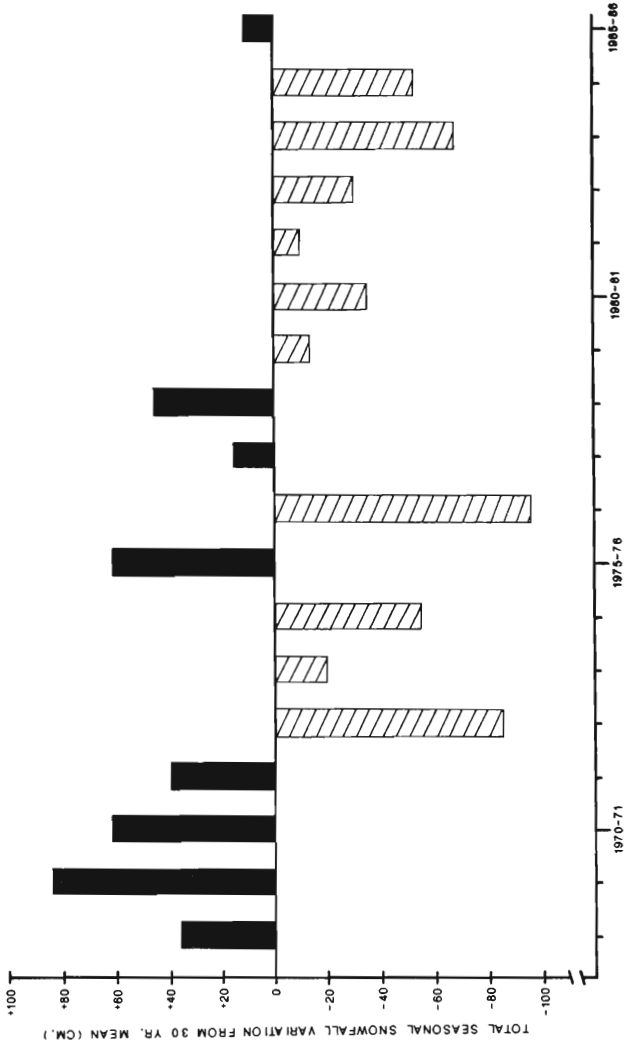

Figure 2. Total season snowfall variation above and below the 30 year mean for Thunder Bay 1967-68 through 1985-86.

lake states coupled with extremely liberal bear harvest regulations in Ontario are believed largely responsible. It is unclear whether more bear are being taken from a relatively static or decreasing population or from one that is increasing. Preliminary data from a heavily hunted portion of the region which shows a decrease in the proportion of subadult males and an increasing proportion of adult females in the harvests may reflect a population decline (Kolenosky In Press).

Population Changes

Hunter success is generally regarded as a measure of hunting quality and related in part to population levels. Success rates for cow hunters under selective harvest are generally higher than for bull hunters (Table 2). Cow hunter success rates in 1985 were higher in all six WMU's than those observed in 1983. Bull hunter success rates, however, show a clear increase in only half of the WMU's. Factors responsible include: initially fewer cow tags available (i.e., 1 cow:2 bull tags on average), suspected greater illegal party killing for cows, more dramatic reduction in cow tag quotas 1983-85, and a probable increase in the cow population in some WMU's as a result of decreased harvests.

Population estimates derived from aerial inventories conducted in eight of 14 WMU's before and after initiation of selective harvest fail to show a consistent trend (Table 3). Mean population estimates for four WMU's are higher while an equal number are lower. Confidence intervals for all however, overlap those previously calculated. Failure to demonstrate a real ($P<0.05$) change could involve a number of factors including: survey confidence intervals that rarely fall below ±20%

Table 2. Estimated hunter success rates for six WMU's, North Central Region 1983-85.

	Bull tag holder % success			Cow tag holder % success		
WMU #	1983	1984	1985	1983	1984	1985
12B	23	20	21	30	29	36
13	17	18	19	19	23	30
14	23	17	22	24	17	38
15B	11	18	15	11	19	25
19	12	11	15	14	10	28
21B	10	13	15	16	12	18

of the mean at the 90 percent confidence level and an insufficient time period for populations to respond. In addition, harvests exceeding set quotas in several WMU's may have limited population response.

Table 3. Population estimates for eight WMU's before and after initiation of selective harvest, North Central Region.

WMU	Pre-selective[1] Harvest	(year)	Post-selective[1] Harvest	(year)	Year 2000 Population Target
11A	424 ± 178	(83-84)	562 ± 288	(85-86)	1,000
11B	349 ± 115	(83-84)	443 ± 124	(85-86)	600
12B	1,368 ± 416	(83-84)	1,435 ± 318	(85-86)	2,100
13	2,622 ± 694	(82-83)	2,277 ± 606	(84-85)	4,400
15B	2,528 ± 844	(81-82)	2,872 ± 709	(84-85)	5,850
18A	917 ± 195	(82-83)	754 ± 177	(84-85)	2,550
21A	3,389 ± 1,115	(82-83)	2,871 ± 653	(85-86)	5,350
21B	2,860 ± 847	(80-81)	2,257 ± 616	(84-85)	5,000

[1] uncorrected for observer sightability bias

Enforcement Implications

Ontario moose regulations became more complex beginning in 1980. Major changes associated with the party harvest system required hunters to adjust to shorter seasons and new rules associated with sharing a moose. The selective harvest which followed, introduced a whole new set of regulations further restricting hunters to shooting only animals of a particular sex or age. Many hunters found it difficult to distinguish bulls from cows and adults from calves. Termination of legal party killing in 1980 was extremely difficult to enforce, especially when several members of a party are hunting in close proximity, each possessing either a bull or cow tag. It is not surprising, therefore, that enforcement related charges specific to moose increased as regulations became more complex and seasons lengthened. Combined charges accrued for each of three year periods are as follows: 300 during 1977-79; 358 for 1980-82; and 511 during the first three years of selective harvest (1983-85). General charges which included loaded firearms in a vehicle, unencased firearms after dark, and hunting without a licence nearly doubled from 1980-82 to 1983-85. In addition, nearly 10% of charges during the latter period were directly related to selective harvest regulations.

Harvest Control

Harvest estimates exceeded desired quotas by >10% in five of six WMU's in 1983 for which reliable data is available (Fig. 3, Table 4). During the subsequent two years, they were similarly >10% in three and eight of 14 WMU's respectively. The total kill exceeded prescribed quotas by 76 (3.4%) in 1984 and 334 (14.6%) in 1985 (Table 4).

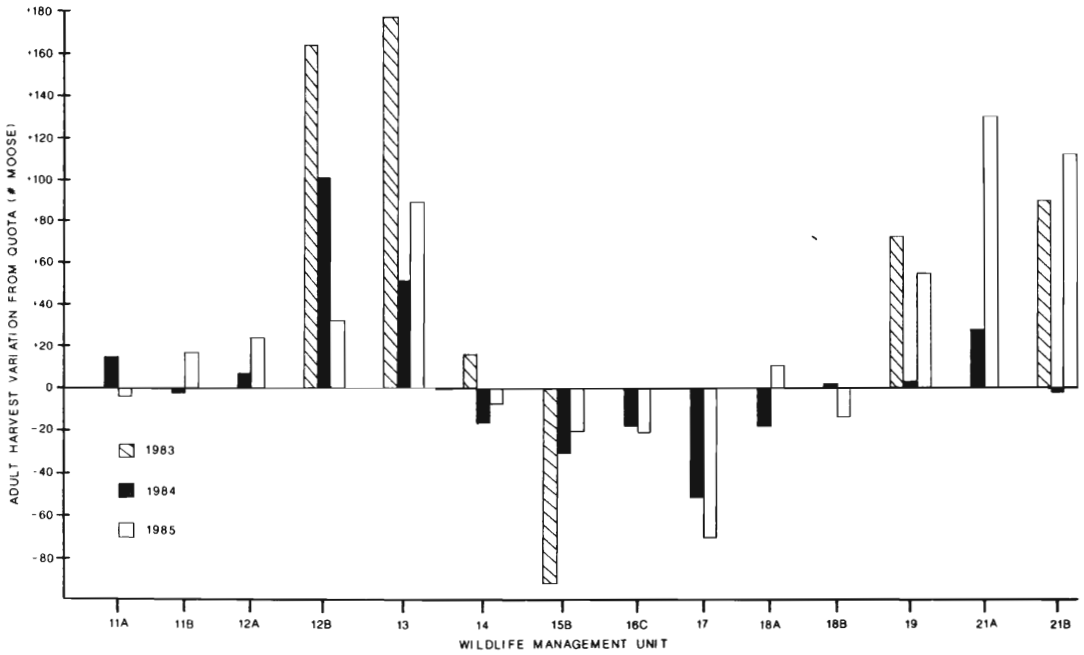

Figure 3. Adult moose harvest variation from quota 1983-85. (Note: Data based on district post-hunt questionnaire survey. Only six WMU's completed in 1983.)

Table 4. Adult moose harvest quotas and estimated harvests for the resident draw in 14 WMU's, North Central Region 1983-85.

	1983		1984		1985		
WMU #	Quota	Harvest	Quota	Harvest	Quota	Harvest	Year 2000 Target**
11A	23		23	40	42	39	175
11B	50		50	47	43	60	100
12A	93		93	101	99	122	235
12B	158	* 322	158	260	196	228	365
13	397	* 575	397	450	407	497	765
14	62	* 80	62	46	65	57	80
15B	436	* 346	436	406	458	438	1,020
16C	53		53	35	71	51	190
17	77		77	29	93	23	315
18A	62		62	43	38	48	385
18B	7		7	9	33	19	205
19	128	* 201	128	131	105	159	700
21A	345		345	372	313	444	930
21B	325	* 413	325	323	317	429	875
Total	**2,216**	*	**2,216**	**2,292**	**2,280**	**2,614**	**6,340**
	1,378	**1,937**					
Over +/Under Harvest	+559*		+76		+334		

* Harvests based on district post hunt questionnaires - only six WMU's completed in 1983.

** Includes adult and calf harvest target plus an additional ±8% Tourist Industry component.

Contributing factors included computer program problems which over-allocated tags in nearly all WMU's in 1983 and two that were oversubscribed in 1984 (Table 5). In addition, success rates in most WMU's were higher than anticipated and some recommended tag quotas were arbitrarily inflated for socio-economic reasons. The reluctance of hunters to change their choice of hunting WMU contributed to a 4,054 and 2,462 tag undersubscription in twelve and eight WMU's respectively in 1984 and 1985 (Table 5).

Although harvest quotas were increased slightly during the three year period (Table 4), the number of available adult tags has actually been reduced in response to increased success rates. In future, unless populations show a significant increase or hunter efficiency is reduced, success rates will continue to limit hunting opportunities for adult animals.

CONCLUSIONS

The majority of hunters appear to support the selective harvest program and are generally knowledgeable with its regulations. Understanding of moose management and biology however, requires strengthening through increased efforts in hunter education according to two recent surveys (Borovsky and Rollins 1985, Vanden Brand 1986).

Redistribution of hunting effort remains a slow process as hunters appear reluctant to readily change their choices of WMU.

Harvest statistics to date indicate a higher quality of hunt reflected by increases in success, hunter days of recreation and number of moose observed. A trend towards increased calf harvests and a lower harvest of cows suggests some progress in the direction intended.

Table 5. Number of adult bull and cow tags (quota vs. actually issued) in the resident draw for 14 WMU's, North Central Region of Ontario 1983-85.

WMU #	1983		1984		1985	
	Tag Quota	Issued	Tag Quota	Issued	Tag Quota	Issued
11A	155	203	155	151	160	160
11B	337	341	350	255	300	269
12A	628	663	650	419	510	505
12B	1,024	1,133	1,050	1,130	940	940
13	2,682	3,307	2,580	2,332	2,250	2,250
14	261	346	275	268	260	216
15B	3,137	3,152	3,400	2,230	3,320	2,327
16C	339	417	350	220	365	274
17	621	407	650	259	820	217
18A	689	547	700	358	430	371
18B	76	83	100	74	260	72
19	1,224	1,581	1,100	1,200	865	865
21A	3,502	3,540	3,550	2,446	2,800	2,507
21B	3,299	3,353	3,070	2,584	2,675	2,675
Total	**17,974**	**19,073**	**17,980**	**13,926**	**15,955**	**13,648**
Over +/Under - Quota		+1,099		-4,054		-2,462

An increase in the proportion of harvested prime bulls and breeding cows is however, of some concern and may be partially related to earlier seasons.

Moose populations are believed "stable" or increasing in the majority of North Central Ontario WMU's, however standard population inventories lack the sensitivity to identify significant changes to date.

Selective harvest strategies are believed to be partially responsible for population growth in some WMU's. Additional positive factors which may be contributing include an extended period of winters with below average snowfall, increased black bear harvests and significant reductions in harvests realized with the previous party harvest system (Timmermann and Gollat 1984).

Enforcement related charges specific to moose have increased as regulations have become more complex and numerous.

Fine tuning of adult tags to meet harvest quotas will remain a challenge due to shifting success rates. Initial quota restrictions implied a future increase in adult tags in response to anticipated population growth. In reality, this has not occurred and generally fewer tags are now available. Factors which impact the ability of managers to provide additional adult hunting opportunities include reintroduction of earlier seasons which overlap the rut and the reinstitution of legal party killing for calves beginning in 1986. Both factors, however will increase hunt quality as measured by success and increasing season length.

Management objectives are to expand populations and harvests to achieve year 2000 targets (OMNR 1982). It is believed that these targets

need re-examination to determine their continued relevance and achievability. In light of an increasing demand for more tags, it becomes more difficult for managers to continue reducing hunting opportunities. Crete et al. (1981) recently indicated that low moose density provides proportionately more recreation per kill than higher density. Lower densities (i.e., ½ K) also provide a greater sustained yield if hunting is assumed as being the major mortality factor. The question then arises whether it is really necessary to increase populations in all WMU's by actively restricting participation? Some options which could be considered include reducing hunter efficiency by introducing additional archery seasons, restricting ATV use while hunting, requiring firearms to be encased in vehicles and shifting seasons out of the rut period. In addition, managers might offer a mix of hunting quality - high but limited in some WMU's and lower and more liberal in others.

Finally, both managers and the various interest groups (hunter organizations and commercial outfitters) need to work more closely together in clarifying objectives and evaluating results. Each group has an important role to play to ensure moose populations remain viable and contribute to social and economic goals.

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