

CHANGE IN HUNTING ACTIVITY AND HUNTERS' PERCEPTIONS FOLLOWING THE INTRODUCTION OF SELECTIVE HARVEST IN QUÉBEC

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ABSTRACT: Between 1994 and 1997, we surveyed moose hunters in Québec to assess the social impacts of the 1994-1998 moose management plan. The number of hunters that stopped hunting and the number of hunting days practiced were estimated as indices of hunting activity changes, while hunters' opinions about population abundance and the number of moose seen and killed per 100 hunting days were monitored as indices of population change as perceived by hunters. The number of moose found dead per 100 hunting days was used to assess the proportion of animals accidentally or illegally killed. Knowledge and perception of the regulation were measured to evaluate the acceptance of the selective harvest program by hunters. Between 3,500 and 7,000 questionnaires were sent each year to hunters randomly chosen in 5 hunting zones where different harvesting scenarios were applied (limited number of cow permits, no cow harvest for 5 years, cows allowed every 2 years, no cows for 2 years and limited number of cow permits thereafter, and non-selective harvest) to determine their relative efficiency. Over 13% of the hunters quit hunting each year but were replaced by a similar number that started or resumed hunting. The number of hunting days per hunter did not vary significantly between 1994 and 1997, but 22 - 38% of the hunters indicated they hunted for a longer period in 1994 than in 1993 to increase opportunities to harvest a moose under the selective harvest program. An increasing number of hunters thought that moose populations were growing. The number of moose seen per 100 hunting days and the hunting success increased in some hunting zones. In zones where no cow harvest was allowed, hunters indicated that a large number of dead moose were left in the forest; this figure is likely voluntarily overestimated by hunters considering their proportion in relation to the legal harvest, the absence of a difference between the sexes of moose that were presumably found dead, and the low illegal harvest reported by wildlife officers. Hunters correctly understood the regulation of their hunting zone, approved its objectives, and still considered that the regulation allowed for an enjoyable hunting experience. Overall, hunters seemed satisfied with the 1994-1998 management plan despite the considerable changes brought about by the selective harvest program. This emphasizes the need for their participation in elaborating hunting strategies. Among the different hunting scenarios, the harvest of cows every 2 years seemed the most acceptable to hunters because it is easy to manage (no computer draw) and understand, is fair for all hunters, and permits a moderate population increase.

Keywords: harvest, hunters' perceptions, hunting success, license, mail survey, population changes, selective harvest, sex ratio

RÉSUMÉ: Entre 1994 et 1997, nous avons effectué des enquêtes postales auprès des chasseurs d'orignaux du Québec pour vérifier l'atteinte des objectifs du plan de gestion de l'orignal 1994-1998, particulièrement sur le plan des impacts sociaux. Le taux d'abandon et le nombre de jours de chasse pratiqués ont été retenus comme indices de l'activité des chasseurs. Leur opinion sur l'évolution des populations et le nombre d'orignaux tués et vus par 100 jours de chasse ont été utilisés pour déterminer si les chasseurs percevaient des changements d'abondance suite à l'introduction de la



chasse sélective. Le nombre d'originaux trouvés morts en forêt a été retenu pour estimer l'importance des originaux tués accidentellement ou illégalement. La connaissance de la réglementation et la perception des chasseurs face à celle-ci ont été mesurées pour évaluer l'acceptation du plan de gestion par les chasseurs. Entre 3,500 et 7,000 questionnaires ont été envoyés annuellement à des chasseurs choisis aléatoirement dans cinq zones de chasse représentatives des différents scénarios d'exploitation appliqués dans le plan de gestion (nombre limité de permis de femelle, aucune chasse à la femelle durant les cinq années du plan, femelles permises à tous les deux ans, aucune femelle les deux premières années et ensuite nombre limité de permis, chasse non sélective) afin de déterminer leur efficacité relative. Plus de 13% des chasseurs ont cessé leurs activités à chaque année, cependant ils ont été remplacés par une proportion équivalente qui commençaient ou reprenaient leurs activités de chasse. Le nombre de jours de chasse par chasseur n'a pas varié de façon importante entre 1994 et 1997. Cependant, 22 à 38% des chasseurs disent avoir chassé plus longtemps en 1994 qu'en 1993 pour accroître leurs chances de succès pendant le programme de chasse sélective. Un nombre croissant de chasseurs pensent que les populations d'originaux sont en augmentation. Un accroissement du succès de chasse et du nombre d'originaux vus par 100 jours de chasse ont aussi été observés dans certaines zones. Cependant, les chasseurs estiment qu'un nombre important d'originaux morts sont laissés en forêt dans les zones où la chasse des femelles est interdite. Ces estimations semblent toutefois surévaluées si l'on considère leur importance par rapport à la récolte légale, l'absence de différence significative entre les sexes chez les animaux trouvés morts et le nombre restreint de prélèvements illégaux rapportés par les agents de conservation de la faune. Les chasseurs ont bien compris la nouvelle réglementation de leur zone de chasse; ils étaient d'accord avec ses objectifs et considéraient que la réglementation permettait une chasse agréable. Globalement, les chasseurs ont paru satisfaits du plan de gestion 1994-1998 malgré les importants changements apportés par la chasse sélective. Ceci met en évidence la nécessité de les impliquer dans l'élaboration des stratégies de chasse. Parmi les différents scénarios étudiés, la chasse aux femelles à tous les deux ans semble le plus intéressant pour les chasseurs car ce scénario est facile à gérer (pas de tirage au sort) et à comprendre, il est juste pour tous et il permet un accroissement modéré de la population.

Mots-clés: chasse sélective, chasseurs, enquête postale, perception, permis, population, rapport des sexes, récolte, succès de chasse

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In Québec, hunting constitutes the main cause of moose (*Alces alces*) mortality. Before 1994, harvest rates frequently exceeded 20% and reached more than 50% for bulls in some hunting zones (MLCP 1993). Consequently, densities were low (Courtois 1991) and generally far below the maximum sustainable yield, which is reached when the density is about 50 - 60% of the carrying capacity of the habitat (Crête 1987, Courtois and Jolicoeur 1993).

This situation led the Ministère de l'Environnement et de la Faune (MEF) to explore ways to improve moose populations and hunting conditions. For the last 10

years or so, the MEF has worked closely with hunters and their representatives for the management of moose populations. Because hunters take part in the management decisions, this may lead to a better understanding and acceptance of regulations. Moreover, hunters can often bring relevant arguments for choosing between apparently equivalent scenarios. Public hearings and discussions with hunters' representatives resulted in the adoption of a management plan (MLCP 1993) which was aimed at increasing moose populations, maintaining recreational opportunities (number of hunting days, accessibility), and

improving the quality of the hunting experience (hunters' satisfaction, number of moose seen, hunting success). To do so, the management plan focused on the protection of cows. Five hunting scenarios were established, ranging from the complete prohibition of the cow harvest, to the harvesting of all age and sex classes in zones where populations were in better condition (i.e., bow hunting only) or where hunting pressure was low (northern zones).

As the introduction of selective harvests was one of the most restrictive regulation measures implemented in the last 30 years, the Ministry implemented a research program to verify if the objectives of the plan were achieved and to evaluate the biological and social impacts of this new regulation (Courtois *et al.* 1993). The introduction of selective harvests could theoretically incite a proportion of hunters to stop hunting, leading to a lowering of the economic impact. While the majority of hunters approved the plan, their support may have changed during the execution of the plan due to unexpected problems in practicing selective harvests. Moreover, many hunters have expressed concerns, thinking that an important number of females might be shot accidentally and left in the forest, thereby reducing the effectiveness of the management plan. Courtois and Lamontagne (1999) evaluated the impact of selective harvests on license sales, moose harvest, and moose populations while Laurian *et al.* (1996) studied the impact on the reproduction of moose. The objectives of this study were: (1) to evaluate the impact of regulation modifications on hunter activities, habits, and perceptions (acceptance of the regulation modifications, major irritants, long-term support for the management plan); (2) to assess if hunters perceived a change in density resulting from the selective harvest program; and (3) to estimate the proportion of cows shot acci-

dentally.

METHODS

Québec is subdivided into 25 hunting zones which may each contain up to 4 types of hunting areas: wildlife reserves, ZECs (controlled harvesting zones), outfitters' areas, and general areas. The basic regulation can differ among hunting zones but is the same for all areas within the same hunting zone. Any hunter who purchases a general moose license has free access to general areas. The number of hunters is not limited in ZECs but hunters must pay a nominal access fee. Outfitters determine the fee and other conditions to gain access to their area. Hunting in wildlife reserves is somewhat different because the number of hunters is restricted by a limited entry draw and hunting seasons last longer than in other areas. Most hunters use a firearm to hunt moose, and seasons generally last from 10 - 21 days, beginning around 10 October. A 7 - 14-day bow season is offered in mid- or late- September in all hunting zones, prior to the firearm season. Courtois and Lamontagne (1997) provide a more exhaustive description of moose hunting organization in Québec. In our survey, we were particularly interested in hunters that hunted outside reserves because they were more numerous (around 98% ; Lamontagne and Gignac 1996) and because hunting pressure was higher outside reserves.

Methods used were similar to those described by Nedelca (1991) and Daigle *et al.* (1995). We chose 5 hunting zones or groups of zones that we judged to be representative of the 5 harvest scenarios adopted in the management plan (Table 1). In each of these sampling units, we used mail questionnaires to survey moose hunters. Hunters were randomly chosen from the previous year's moose hunting license holder database. It was not possible to survey hunters from the current license year be-

cause it takes about 6 months to collect and compile the information from around 2,000 sales points. This 6-month delay would have led to a bias caused by lower response rates and reduction in the reliability of the results, since hunters would have difficulty accurately remembering their hunting season after such a lengthy period (Gollat and Timmermann 1987, Courtois 1989). Moreover, surveying hunters of the previous year gave us the opportunity, through questions on their hunting status and territory, to estimate the proportion of hunters that stopped hunting (desertion rate) or that changed to a new zone where the regulation differs.

A preliminary questionnaire was prepared in the spring of 1994 and was improved following comments of wildlife managers from all the administrative regions of the province. The revised questionnaire was tested with the help of 29 randomly selected moose hunters. A final version was then prepared in collaboration with specialists on polls and communications

within the MEF. The final version included 19 questions dealing with: (1) number of hunting days practiced; (2) hunting success; (3) number of moose seen and killed; (4) quality of the hunting season; (5) knowledge of the regulation; (6) ability to distinguish cows and calves; and (7) perception of the selective harvest system and activity changes due to the selective harvest program. The same questionnaire was used for both 1994 (Daigle *et al.* 1995) and 1997, with the only exception being that 1 question was added in 1997 to evaluate changes in the hunting zone frequented. This last question was also added to the 1995 and 1996 questionnaires (Sigouin *et al.* 1997) but, for these years, all questions concerning hunters' opinions and knowledge of the regulation were removed.

Only Québec residents (99% of hunters) were surveyed, and hunters with an incomplete address, as well as duplicates, were rejected. In 1994, 500 questionnaires were sent per hunting scenario for a total

Table 1. Cow harvest scenarios applied during the 1994-1998 moose management plan, hunting zones where they were applied, and hunting zone(s) retained for the mail survey (from Courtois *et al.* 1993).

Cow harvest scenarios	Abbreviation	Hunting Zones	Sampled zones
1- Limited number of cow licenses (10% harvest rate) ¹	10% cows	1, 2, 8, 9, 10, 11, 18 East, 18 West	18 West ²
2- Cows prohibited during all the management plan	No cows	3, 4, 5, 6	3, 4 ³
3- Cows allowed every 2 years beginning in 1995	No cows -alternate yr	12, 13, 16, 17	13
4- Cows prohibited in 1994 and 1995; scenario 1 thereafter	No cows/2yrs- 10% cows/3yrs	14, 15	14
5- Non-selective harvest	Non-selective	7, 19, 20, 22	19

¹15% in Hunting Zone 18 East

²All hunters from Zone 18 were sampled because it was impossible to determine *a priori* which part of the zone was frequented; only hunters who declared that they hunted in Zone 18 West were retained

³Data from these 2 small contiguous zones were pooled and weighted according to the number of hunters

sample of 3,500. Two small hunting zones (3 and 4) were sampled for the scenario requiring the protection of all cows. In Hunting Zone 18, because a slightly different regulation was applied in the eastern part of the zone, only the western part was sampled to estimate the impact of the limited cow harvest scenario (Table 1). Consequently, 1,000 hunters were sampled in this zone because it was impossible to determine *a priori* if a hunter used the western or the eastern part of the zone. In 1995 and 1996, a total of 5,600 questionnaires were sent yearly according to the same distribution proportion (800 per zone and 1,600 in Zone 18). In 1997, due to a defect in the optical reader, the zones frequented by hunters were partly misclassified during processing. As a result, 7,000 hunters were sampled (1,000 and 2,000 per scenario) to maximize the number of questionnaires returned per hunting scenario. Two reminders (after 3 and 6 weeks) were sent each year to improve the response rate (Gollat and Timmermann 1987).

Each year, close to 75% of the valid questionnaires were returned within 4 weeks after the initial mailing. This proportion reached 99% after 10 weeks. Despite the length of the questionnaire, the overall response rate varied from 67 - 70%, which is comparable to similar surveys (IQOP 1985, Gollat and Timmermann 1987, Rollins and Romano 1989, Nedelca 1991). Taking each scenario independently, the response rate varied from 43 - 60%. These lower values in comparison to the overall response rate were due to the large number of hunters that did not hunt (18 - 20% per year) or that hunted in a different zone which was not part of the present study (7 - 10%).

The normality of the data was assessed by analyzing the skewness and kurtosis of distribution and by performing a Kolmogorov-Smirnov test for normality using the Lilliefors option (Zar 1984, Wilkinson

1990). Attempts were made to normalize the data, but as they were not successful, we used non-parametric tests. To limit Type I error, only differences with $P < 0.01$ were considered, and we used only *a priori* comparisons. Temporal changes within a scenario were determined by comparing the 1994 results with those of 1997. The log-likelihood ratio (*G* test) was used for nominal variables or hunters' opinions and the Mann-Whitney U test was used for continuous variables. Differences among scenarios were evaluated only for 1997, using the Kruskal-Wallis non-parametric test. Non-parametric multiple comparisons were conducted according to the method suggested by Zar (1984).

RESULTS

Hunting Activity

Between 1994 and 1997, the number of licenses sold was relatively stable in most of the hunting zones surveyed (no cows: 8,457 licenses sold in 1994 vs. 8,853 in 1997; no cows-alternate yr: 12,873 vs. 12,694; no cows/2yrs-10% cows/3yrs: 11,362 vs. 11,739; 10% cows: 27,634 vs. 25,018; non-selective: 5,853 vs. 5,143). Among hunters that bought a moose hunting license the previous year, between 7.3 and 16.8% did not hunt during the year of the survey (Table 2). For all scenarios, this figure tended to decrease during the study. However, more than 98% of hunters that bought a license for the current year actually hunted. In 3 of the 5 scenarios, only 4-5% of the hunters changed their hunting zone. The no-cows/2yrs-10% cows/3yrs and the non-selective scenarios had higher desertion rates (Table 2). Except for the no-cows scenario, hunters generally switch to a neighboring hunting zone rather than to another zone characterized by a less restrictive regulation.

Firearms were used by more than 90% of hunters every year. The only exception

Table 2. Percentage of hunters that stopped hunting (desertion rate) and who changed hunting zones between 1995 and 1997.

	Cow harvest scenarios				
	No cows	No cows -alternate yr	No cows/2yrs- 10% cows/3yrs	10% cows	Non- selective
1995					
Desertion rate	13.6	8.6	11.0	11.7	16.7
Change of hunting zone ¹	5.0	3.5	9.7	4.9	8.4
To a less restrictive zone	78	0 ²	76	67	0
To a contiguous zone	68	83	62	82	51
1996					
Desertion rate	13.7	14.8	8.7	11.6	16.8
Change of hunting zone	5.0	3.6	8.3	4.9	10.8
To a less restrictive zone	84	61	0 ³	41	0
To a contiguous zone	70	83	65	81	48
1997					
Desertion rate	11.7	7.3	10.5	8.8	12.8
Change of hunting zone	4.1	3.0	8.7	5.3	7.6
To a less restrictive zone	97	0 ²	50 ³	45	0
To a contiguous zone	42	75	67	63	50

¹Hunters that changed hunting zones could change for a less restrictive zone, which can also be a neighboring zone, therefore, percentages might frequently exceed 100%

²Male, female and calf harvest allowed during these years

³Limited number of cow licenses issued during these years

was the hunting zone sampled in the no-cows scenario, where more than 40% of all hunters used a bow (7.8% bow only, 34.3% both firearm and bow). No matter the hunting zone, the majority of hunters (75.8-98.9%) practiced their activity in general areas (outside reserves, ZECs, and outfitters' areas). Wildlife reserves were used by less than 1% of the respondents at the provincial level. Because the regulation differs and moose density is higher in these sites (Courtois and Lamontagne 1997, Sigouin *et al.* 1997), wildlife reserves were excluded from further analysis to eliminate any potential bias.

The mean number of hunting days per hunter varied from 6.4 - 10.9, across sce-

narios and years (Fig. 1). In 1997, the mean number of hunting days per hunter was significantly lower in the no-cows scenario and higher in the 10% cows and the non-selective scenarios ($P < 0.01$). The weapon used also impacted on the number of hunting days. Hunters using both a firearm and a bow hunted longer than others ($P < 0.01$).

Hunting Success and Population Trends According to Hunters

In the no-cows scenario, hunting success was higher in 1997 than in 1994 ($P < 0.01$; Fig. 2). A marked increase is also noted in the no-cows-alternate yr scenario but no statistical tests were conducted because 1994 and 1997 were years with dif-

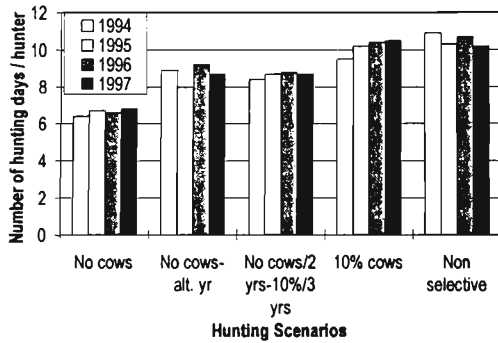


Fig. 1. Mean number of hunting-days per hunter between 1994 and 1997 for each cow harvest scenario.

ferent regulations. Hunting success differed among scenarios ($P < 0.01$), but *a posteriori* tests were unable to identify these differences. However, in 1997, the highest success rates were observed in the non-selective harvest (16.4%), the no-cows (15.7%), and the no-cows-alternate yr scenarios (13.0%).

A higher number of moose were seen per 100 hunting days in the no-cows scenario than in all others ($P < 0.01$; Fig. 3). In this same scenario and in all age and sex classes, the number of moose seen per 100 hunting days increased from 1994 - 1997 ($P < 0.01$; Table 3). In other scenarios, no particular trend was observed. In the no-cows scenario, where both firearms and bows were common, bull and overall hunt-

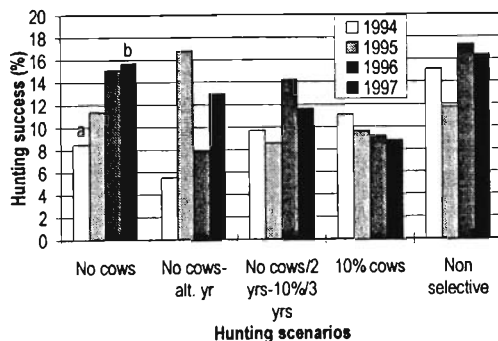


Fig. 2. Hunting success between 1994 and 1997 in hunting zones sampled for each cow harvest scenario. Different letters indicate significant differences ($P \leq 0.01$) between 1994 and 1997.

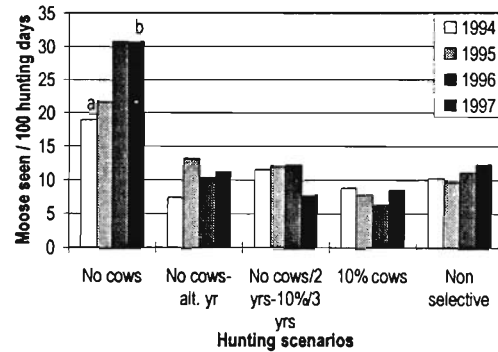


Fig. 3. Number of moose seen per 100 hunting days between 1994 and 1997 in hunting zones sampled for each cow harvest scenario. Different letters indicate significant differences ($P < 0.01$) between 1994 and 1997.

ing success were much higher for bow hunters than for firearm hunters (Table 3; $P < 0.01$). The same pattern was noted for the number of moose seen in all moose categories ($P < 0.01$).

A significantly increasing number of hunters subject to the no-cows and the no-cows/2 yrs-10% cows/3 yrs selective harvest scenarios were under the impression that moose populations have been growing since 1994 ($P < 0.01$; Fig. 4). In 1997, 11 - 15% of the hunters thought that moose populations were increasing in their hunting zone as compared to 3 - 11% in 1994 (Fig. 4). In 1994, the highest proportion of hunters observing an increase in populations was found in the non-selective scenario, while in 1997 maximum values were observed in the no-cows scenario.

Moose Found Dead

When consulted, hunters expressed the fear that populations would not increase because a large number of cows would be mistakenly killed and abandoned in the forest. Excluding the no-cows scenario, few moose were found dead by hunters and mean numbers were less than 0.13 per 100 hunting days (Table 4). Values were at least 4 times higher in the no-cows scenario

Table 3. Hunting success and number of moose seen per 100 hunting-days for each weapon used in the no-cows scenario from 1994 - 1997. *P* values represent inter-annual comparisons within each type of weapon used and different letters indicate significant differences between specific years.

Weapon	<i>n</i>	Year	Hunting success rate (%)				Number of moose seen per 100 hunting days			
			Bull	Cow	Calf	Total	Bull	Cow	Calf	Total
Firearm	302	1994	3.3	-	1.7	5.0	3.8	7.0a	2.8	14.2a
	486	1995	4.7	-	1.9	6.8	3.5	7.0a	2.1	13.2a
	476	1996	6.9	-	4.2	11.3	7.0	12.8b	5.5	26.6b
	401	1997	5.7	-	4.2	10.0	5.7	11.5ab	6.8	25.0b
<i>P</i>			0.15	-	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Bow & Firearm	141	1994	8.5	-	2.1	10.6	9.5	8.0a	3.4	21.7
	287	1995	9.1	-	4.2	13.2	9.7	9.6ab	5.1	24.7
	286	1996	8.0	-	5.9	14.0	8.8	9.8ab	5.6	24.8
	298	1997	8.7	-	5.4	14.4	9.8	11.8b	7.0	29.8
<i>P</i>			0.98	-	0.32	0.73	0.50	0.04	0.01	0.10
Bow	25	1994	32.0	-	8.0	40.0	34.1	15.6	8.9	58.7
	69	1995	31.9	-	4.3	36.2	27.4	21.9	13.7	68.7
	73	1996	37.0	-	5.5	43.8	42.2	24.2	14.0	81.4
	71	1997	50.7	-	2.8	53.5	37.5	15.4	10.1	67.0
<i>P</i>			0.10	-	0.73	0.22	0.12	0.76	0.59	0.27

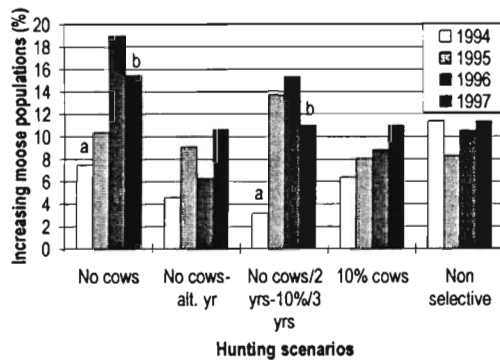


Fig. 4. Hunters' perception of moose population trends between 1994 and 1997. Different letters indicate significant differences ($P < 0.01$) between 1994 and 1997.

than in others. No inter-annual differences within scenarios occurred between 1994 and 1997.

Hunters' Knowledge and Perception of the Regulation

Hunters had a good understanding of the regulation as it applied in their hunting zone. In 1994, more than 88% of the respondents answered correctly to the 4 questions related to the regulation. This value was 83% in 1997 but did not differ from the 1994 value and no significant differences were found among scenarios in 1997. Overall, hunters had a good understanding of the regulation's objectives and their effects on the population, in both 1994 and 1997. With the exception of the non-

selective scenario, a majority of hunters agreed that the regulation of their hunting zone was needed to stop the decline in moose populations (> 67%) and to allow a population increase (> 76%).

The number of hunters that found it easy to distinguish a cow from a calf (Fig. 5) has increased since 1994 in 3 scenarios (no-cows, no-cows/2yrs-10% cows/3yrs, 10% cows; $P < 0.01$). The non-selective scenario differed from the others in that a higher number of hunters in 1994 than in 1997 said that they were able to easily distinguish a cow from a calf.

Hunters' opinions about the regulation seemed to be rather positive (Table 5). A large majority of hunters agreed that the regulation of their hunting zone allowed a reduction in the cow harvest with the obvi-

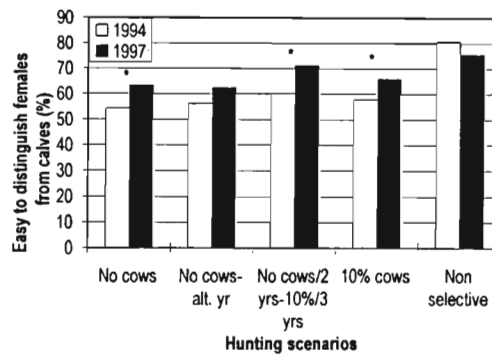


Fig. 5. Hunters' opinions about their capacity to distinguish between cows and calves in a hunting situation. An asterisk indicates significant differences ($P \leq 0.01$) between 1994 and 1997.

Table 4. Number of dead moose [mean (standard error)] found per 100 hunting days from 1994 - 1997.

Cow harvest scenarios	Mean number of moose found dead per 100 hunting-days			
	Male	Female	Calf	Total
No cows	0.25(0.05)	0.43(0.07)	0.10(0.05)	0.79(0.12)
No cows-alternate yr	0.04(0.03)	0.04(0.02)	0.01(0.01)	0.09(0.03)
No cows/2yrs-10% cows/3yrs	0.05(0.03)	0.08(0.04)	0.01(0.01)	0.13(0.07)
10% cows	0.04(0.02)	0.06(0.03)	0.01(0.01)	0.10(0.04)
Non-selective	0.06(0.03)	0.00(0.00)	0.00(0.00)	0.06(0.03)

Table 5. Hunters' opinions about the selective harvest scenario applied in their hunting zone in 1994 and 1997.

Statement	% of hunters in agreement with the statement									
	No cows		No cows- alternate yr		No cows/2yrs -10% cows/3yrs		10% cows		Non-selective	
	1994	1997	1994	1997	1994	1997	1994	1997	1994	1997
Regulation has made it possible to reduce the cow harvest ($P < 0.01$; $P < 0.01$) ¹	83.4**	78.5	88.4**	59.9	85.8	80.6	75.3	76.3	31.6	25.8
Cow harvest did not decrease: cows killed were left in the forest ($P < 0.01$; $P < 0.01$)	34.7	39.4	28.4	26.2	33.2	27.6	28.1	34.6	26.4	27.5
Cow harvest did not decrease: cows killed were registered by hunters that had a license, even from another hunting party ($P < 0.01$; $P < 0.01$)	14.5	16.9	9.1	11.3	11.7**	22.1	37.1	37.3	28.8	26.6
Cow harvest did not decrease: cows killed were registered in a hunting zone where cow harvest is allowed ($P < 0.01$; $P = 0.03$)	13.1	14.9	7.7*	15.0	12.7	17.7	17.0	17.6	22.8	23.6
Regulation should be abolished: it is too hard to correctly identify cows and calves ($P < 0.01$; $P < 0.01$)	39.4	35.8	31.1	24.6	38.9**	29.3	28.5	31.3	20.4	20.9
It would be better to allow bull-only hunting with the general licence ($P < 0.01$; $P < 0.01$)	66.1**	58.3	57.8**	28.9	66.2**	43.4	45.7**	34.1	33.9*	23.7
Regulation of my hunting zone made an enjoyable hunting experience possible ($P < 0.01$; $P < 0.01$)	54.7**	60.1	68.5*	77.1	65.6	75.2	63.0*	55.9	91.2	91.8

¹P among scenarios in 1994 and 1997

* and ** significant differences between 1994 and 1997 at $P < 0.05$ and $P < 0.01$, respectively

ous exception of the non-selective scenario. Nevertheless, agreement with this statement declined significantly in 1997 for the no-cows and no-cows-alternate yr scenarios ($P < 0.01$). Generally, less than 35% of hunters agreed with the 3 statements saying that the cow harvest did not decrease. However, about 30% of hunters thought that dead cows were left in the forest. Moreover, 37% of hunters of the 10% cows scenario thought that cows accidentally or intentionally killed were registered by other hunters who had a cow permit. In 1997, more hunters of the no-cows-alternate yr scenario agreed with the fact that cows were registered in another hunting zone ($P = 0.02$). Between 20 and 39% of the hunters thought that the selective harvest program should be abolished because it is too hard to correctly identify cows and calves. However this proportion declined between 1994 and 1997 in all hunting scenarios. Moreover, in all scenarios, there was a significant reduction in the proportion of hunters who think that it would be preferable to allow only bull hunting with the regular license, but bull-only hunting is still popular where the cow harvest was severely reduced (no-cows and no-cows/2yrs-10% cows/3yrs scenarios). Finally, more hunters seemed to enjoy their hunting experience in 1997 than in 1994, with the non-selective harvest hunting zone having the highest satisfaction rate (~91%).

Only a small proportion (<10%) of hunters stopped hunting, hunted outside Québec, used another hunting zone, changed their hunting party, started or stopped bow hunting, hunted other big game species, or formed a new hunting party (Table 6). However, between 16 and 37% of hunters hunted longer or changed their hunting techniques under the selective harvest regulation. These figures were less than 12% in the hunting zone where the non-selective harvest scenario was in effect. Moreover, bow

hunting increased between 1994 and 1997 in the no-cows and the no-cows-alternate yr scenarios ($P < 0.01$). In 1997, as well as in 1994, there were more hunters who "intended to" change their hunting habits than there were who "really" did (Tables 6-7). Overall, the hunters' intention about their hunting habits did not change in 1997 as compared to 1994. The principal differences were in the no-cows scenario, where fewer hunters intended to stop hunting, to change hunting zones, to change their hunting techniques, or to form a new hunting party.

DISCUSSION

Hunting Activity

The introduction of selective harvest was accompanied by a 9% decline in license sales (Courtois and Lamontagne 1999) indicating that some moose hunters were negatively affected by the new regulation. However, license sales declined 1.5-2% per year between 1991 and 1993, prior to the 1994-1998 management plan. This change, probably due to insufficient moose hunter recruitment, might indicate that the introduction of selective harvests led to a 7% decrease in the number of hunters. This evaluation was confirmed by a direct estimate made in the first mail survey (Daigle *et al.* 1995). The decline in moose hunters in 1994 was not accompanied by an increase in interest for other big game species as license sales for other species did not rise between 1993 and 1994 [white-tailed deer (*Odocoileus virginianus*): 116,095 vs. 116,036; caribou (*Rangifer tarandus*): 9,764 vs. 10,144; black bear (*Ursus americanus*): 19,813 vs. 18,894].

Between 13.6 and 18.6% of the respondents did not hunt depending on the year and the hunting scenario. As the total number of hunters tended to stabilize at around 130,000 in 1994 and thereafter (Lamontagne and Gignac 1996), it seems

Table 6. Hunters' opinions about the impact of selective harvests on their hunting habits in 1994 and 1997.

Statement	% of hunters in agreement with the statement									
	No cows		No cows- alternate yr		No cows/2yrs -10%		10% cows		Non-selective	
	1994	1997	1994	1997	1994	1997	1994	1997	1994	1997
Because of the new regulation:										
I stopped hunting moose in Québec ($P = 0.92$; $P = 0.28$) ¹	2.2	2.4	1.7	1.0	1.4	1.3	1.4	1.2	1.5	1.2
I hunted moose elsewhere than in Québec ($P = 0.64$; $P = 0.04$)	1.1	1.3	0.4	0.2	0.5	0.4	0.6	0.6	1.5	2.0
I changed my hunting zone for one having a less restrictive regulation ($P < 0.01$; $P < 0.01$)	1.8	2.3	0.4	0.8	2.3	2.9	1.7	2.1	7.8*	14.6
I changed my hunting party to admit a hunter with a cow license ($P < 0.01$; $P < 0.01$)	1.3	1.6	0.9	0.6	2.3*	6.7	6.9	8.6	1.0	0.9
I hunted longer to increase my harvest opportunities ($P < 0.01$; $P < 0.01$)	33.1	36.6	21.9	23.5	23.3**	37.3	24.9**	37.7	9.3	11.8
I changed my hunting techniques ($P < 0.01$; $P < 0.01$)	29.0	26.3	16.4	19.8	18.8	20.1	22.6	27.3	5.9	8.3
I began bow hunting ($P < 0.01$; $P < 0.01$)	10.2**	20.2	2.5**	7.9	5.5	3.4	2.6	4.3	2.0	2.3
I stopped bow hunting ($P = 0.29$; $P = 0.025$)	3.1	4.2	1.8	2.9	1.1**	5.2	2.7	3.3	1.0	2.1
I hunted other big game species (white-tailed deer, caribou, black bear, etc.) ($P = 0.07$; $P < 0.01$)	9.6*	13.4	5.6	6.7	9.3	8.3	9.0	8.1	4.4	8.0
I formed a new hunting party ($P = 0.55$; $P = 0.07$)	6.2	4.9	5.2	5.5	4.3*	9.3	6.1	7.4	3.5	4.9

¹P among scenarios in 1994 and 1997

* and ** significant differences between 1994 and 1997 at $P < 0.05$ and $P < 0.01$, respectively

Table 7. Hunters opinions about future probable impact of the regulation on their hunting habits in 1994 and 1997.

Statement	% of hunters in agreement with the statement for 1994 and 1997									
	No cows		No cows- alternate yr		No cows/2yrs -10%		10% cows		Non-selective	
	1994	1997	1994	1997	1994	1997	1994	1997	1994	1997
Because of the new regulation:										
I intend to stop moose hunting in Québec ($P < 0.01$; $P < 0.01$) ¹	22.9**	17.1	6.0*	10.4	11.2	10.7	12.9	15.6	8.1	9.6
I will have to hunt moose elsewhere than in Québec ($P < 0.01$; $P < 0.01$)	13.1	10.7	2.1	3.5	7.9	8.8	7.5	8.2	3.4	8.7
I intend to change hunting zones ($P < 0.01$; $P < 0.01$)	20.0**	14.0	5.1	6.5	12.4	16.0	10.6	13.4	7.2	10.4
I intend to change my hunting party to admit a hunter with a cow permit ($P < 0.01$; $P < 0.01$)	8.8	9.9	3.8	4.9	9.3	14.1	18.1	18.5	2.9	4.6
I will have to hunt longer to have a better chance of harvesting a moose ($P < 0.01$; $P < 0.01$)	52.5	48.1	37.4	39.5	38.7*	49.2	43.8	45.6	17.4	22.7
I will have to change my hunting techniques ($P < 0.01$; $P < 0.01$)	35.5**	27.3	25.4	25.0	24.1	25.3	29.6	29.7	9.6	9.7
I will have to start bow hunting ($P < 0.01$; $P < 0.01$)	21.2	22.4	10.7	12.8	11.2	8.8	7.9	9.6	2.9	5.7
I will have to stop bow hunting ($P = 0.09$; $P = 0.02$)	6.1	7.7	3.6	3.5	3.7	5.6	4.7	4.3	1.6*	4.9
I intend to hunt other big game species (white-tail deer, caribou, black bear, etc.) ($P < 0.01$; $P < 0.01$)	23.6	23.9	11.5	14.6	16.8	18.0	18.6	16.1	11.8	16.3
I will have to form a new hunting party ($P < 0.01$; $P < 0.01$)	9.0**	4.7	3.0	4.6	4.2**	10.1	12.4	11.6	5.9	5.4

¹*P* among scenarios in 1994 and 1997* and ** significant differences between 1994 and 1997 at $P < 0.05$ and $P < 0.01$, respectively

that on an annual basis, new hunters and hunters that resume their hunting activities represent about 20,000 individuals in Québec.

However, the introduction of the selective harvest influenced the desertion rate, as it increased in the no-cows-alternate yr scenario in 1996 when the cow harvest was prohibited. Nevertheless, a detailed examination of each hunting scenario indicates that the more liberal non-selective harvest scenario also has the highest desertion rate (Table 2). This suggests that the regulation may not be the only factor influencing the desertion rate in a specific zone. Low moose density, poor hunting conditions, no signs of improvement, high hunting pressure, etc. may have induced some hunters to temporarily or permanently stop hunting. For example, the hunting zones for the no-cows and the non-selective scenarios have low moose densities (0.4 moose / 10 km²; Courtois 1991) and, in the last zone, hunting conditions were considered poor by a large proportion of hunters (35 - 40%). It is also in this zone that we found the highest proportion of hunters who considered the moose population was stable. This perception may indicate that hunters considered that hunting conditions will remain as they are in this scenario. Overall, the moose population of this hunting zone is not heavily exploited because some parts are not accessible. However, the harvest rate is near 20% in harvested parts of the zone (Gingras *et al.* 1989) which is sufficient to limit moose in this northern zone. A closer examination of the status of this population would be beneficial.

Hunters remained loyal to their hunting zone. Due to the complex organization required to hunt moose (form a group, find and prepare a suitable hunting territory, build a camp, etc.), hunters prefer to stop hunting rather than change their hunting zone. A similar situation was noted in

Alaska (Schwartz *et al.* 1992). Except in the no-cows/2yrs-10% cows/3yrs and the non-selective harvest scenarios, the proportion of hunters that changed their hunting zone was less than 5%. Non-loyal hunters generally chose a neighboring zone except where and when the regulation was the most restrictive. This indicates that anticipated success, including cow harvest, had a certain influence on moose hunters.

Since the establishment of the selective harvest program, the number of hunting days practiced by hunters increased slightly, at least in some hunting scenarios. Between 22 and 38% of the hunters indicated that they hunt longer to increase their chances of harvesting a moose. Comparisons among scenarios suggest that this is probably the most important and the most generalized impact of the prohibition of cow harvests (Table 6).

Abundance Changes According to Hunters

It seemed important to measure hunter perception about the abundance of moose because hunter support is an important part of management planning. As in the assessment made in the management plan (MLCP 1993), a majority of hunters (>75%) thought that moose populations were stable or declining in the 5 years prior to the introduction of selective harvests. However, since 1994, an increasing number of hunters (7.1, 9.7, 12.3, and 12.6% from 1994 - 1997 respectively) considered that moose populations were growing, suggesting that hunters perceived some beneficial effects of the cow protection.

Nevertheless, this tendency did not translate into a marked increase in hunting success for many scenarios. However, hunting success as well as the number of moose seen per 100 hunting days has increased steadily in the no-cows scenario since 1994. It seems that hunters perceived a popula-

tion increase, a tendency which has been confirmed by aerial surveys (Courtois and Lamontagne 1999). As expected, the no-cows-alternate yr and the no-cows/2yrs-10% cows/3yrs scenarios had a higher hunting success when the cow harvest was allowed, but no trend was found for the other scenarios.

Hunting success and moose seen per 100 hunting days are 1.5 - 7 times higher with bows than with firearms. The principal factor that might explain this situation is that the bow hunting season occurs before the firearm season, therefore overlapping with the rutting period of moose (Sigouin *et al.* 1995). Several studies have demonstrated the higher vulnerability and the particular behaviour of moose in this critical period, especially for bulls (Ritcey 1974, Crête *et al.* 1981, Dussault and Huot 1986, Sigouin *et al.* 1995). It is also important to point out that bow hunters are less numerous, reducing competition during bow hunting and, therefore, increasing harvest opportunities (Daigle *et al.* 1995).

Moose Found Dead

In selective harvest, hunters must be able to identify all moose categories. However, 19 - 45% of hunters found it difficult to distinguish calves from cows. In such circumstances, it is important to determine if a high number of cows could be killed accidentally. In all hunting zones, there were more cows seen than bulls. However, the only significant difference found between bulls and cows that were found dead was in the no-cows scenario in 1994. Therefore, we cannot firmly conclude from our results that more cows than bulls were accidentally or illegally killed. According to hunters, more moose were found dead under the no-cows scenario. However, as observed by Daigle *et al.* (1995), this estimate seems very high. In the Kenai Peninsula, Schwartz *et al.* (1992) reported that

the illegal take of cows during bull-only hunting seasons represented about 5% of the known legal harvest of bulls. In a complex selective harvest system in which only young (spike and fork) and large bulls (antlers > 50 inch or 3 tines) were legal, illegal harvest of cows diminished and that of mistakenly identified bulls represented only 7% of the legal harvest. Using the hunting success estimated in our survey, 389 moose would be harvested in Hunting Zone 3 (no-cows scenario) in 1995, but only 241 were registered in the official database. Data declared by hunters suggest that 157 moose were killed and left in the forest in this hunting zone, which would represent 40% of the estimated harvest and 65% of the registered harvest. In fact, wildlife officers reported 9 cows accidentally or illegally harvested in 1995 and 1996. Therefore, even if we consider that poaching may be underestimated, it is highly likely that hunters tend to voluntarily overestimate the number of moose found dead. Such an attitude might be due to their concern about the status of the moose population and to a certain mistrust regarding the fairness of other hunters.

The extent of the illegal harvest is not known. Based on the radio-telemetry of 239 individuals followed for 2 - 3 years each, Courtois *et al.* (1994) demonstrated that moose mortality rates resulting from illegal harvesting were less than 2%. In sharp contrast and based on the opinions of managers of 16 North American jurisdictions, Wolfe (1987) reported that illegal kill could represent 30% of the total harvest in North America. The no-cows-alternate yr and no-cows/2yrs-10% cows/3yrs scenarios did not have as high a percentage of illegal moose deaths as in the no-cows scenario, even in those years when they were as restrictive as the no-cows scenario. While we cannot rule out the possibility that the illegal harvest could be greater in the no-

cows scenario, the real amount is probably much less than that reported by hunters.

Hunters' Knowledge and Perception of the Regulation

Although no improvements occurred from 1994 - 1997, overall knowledge of the regulation seems quite satisfactory, as about 90% of the hunters answered correctly those questions related to the hunting regulation of their hunting zone. Moreover, hunters understood the objectives of the regulation and its effect, on both the moose population and hunting activities. It is also interesting to note that a higher proportion of hunters indicated that they could easily distinguish cows from calves in 1997 as compared to 1994.

Hunters' opinions about the regulation varied from one scenario to the other, and temporal changes were also noted in some cases. Marked differences were frequently detected between selective harvest scenarios and the non-selective scenario (Table 5). The greatest differences concern the proportion of hunters who considered that the cow harvest was reduced, the bulls-only law was useful, and their hunting experience was satisfactory. The proportion of hunters who considered that the new regulation made a reduction in the cow harvest significantly declined between 1994 and 1997 in the no-cows-alternate yr scenario. Hunters might have realized that being allowed to harvest cows without restriction every 2 years was not as efficient as they initially thought. In all scenarios in 1997, significantly fewer hunters thought that the regular license should allow bull hunting only. Hunters probably realized that calves helped to increase their harvest opportunities. In spite of a good acceptance of the selective harvest program, the non-selective scenario still seems to produce the most enjoyable experience. This might be explained by the less restrictive policy, but

also by the rather good hunting success and its stable value over the years.

Changing hunting techniques and hunting for a longer period were the most considerable changes in hunters' habits since the establishment of the selective harvest program (Table 6). However, the increase in the number of hunting days per hunter was not significant in all hunting zones. This suggests that hunters hunted longer in 1994 than in 1993 and they continued at the same rate for the rest of the management plan. Also, many hunters may have hunted more hours per day, but not necessarily more days during their hunting season. The fact that significantly fewer people intended to stop hunting, change hunting zones, change their hunting techniques, or form a new hunting party in the no-cows scenario may indicate that, even though this scenario is the most restrictive, hunters may have been able to understand and accept its efficiency in increasing moose populations.

A large proportion of hunters did not change their hunting habits. However, in 1997 as well as in 1994, a larger proportion of them intended to do so (Table 7). We may conclude that many hunters are more inclined to complain than to actually act.

MANAGEMENT IMPLICATIONS

The management plan generally seemed to achieve its intended results. The hunters' perceptions were generally positive, a higher proportion of them considered that populations were increasing, and moose seen and killed suggest that moose populations may be growing at least in some hunting zones, a trend similar to that observed in aerial surveys (Courtois and Lamontagne 1999). However, all hunting scenarios were not equal. Based on moose seen and killed per 100 hunting days, the no-cows scenario seems to be more appropriate and effective in increasing moose densities in a short period of time. However,

hunters' responses suggest that this scenario may lead to a higher number of animals accidentally or illegally killed. This concern could be overestimated because no statistical difference was found between bulls and cows found dead in spite of the preponderance of cows in the population. The no-cows scenario might also lead to a more unbalanced sex ratio resulting in potential reproduction problems (Ballard *et al.* 1991, Crichton 1992). However, it would appear that most cows are breeding because both the harvest and the hunting success are increasing even with the restriction on the cow harvest, and hunters are not more negative toward the regulation than in other hunting scenarios. In a study block, Laurian *et al.* (1996) confirmed that all cows followed by telemetry met a potential mate during the rutting period and most of them gave birth to calves the following spring.

The alternating scenario (no-cows-alternate yr) also seems interesting. First, it is easier and less expensive to manage than the draw for special cow permits used in the 10% cows and the no-cows/2yrs-10% cows/3yrs scenarios. It is less restrictive for hunters and it maintains their interest for hunting because they know they will be allowed to hunt cows every 2 years. Their number increases when cow hunting is allowed indicating that this measure stimulates hunters' interest in moose hunting. Moreover, this strategy has the advantage of favoring a more balanced sex ratio. Finally, hunters do not have to change their hunting party to include someone having a cow permit. Such a scenario could be interesting where managers and hunters want a slow population increase with minimal administrative and social investments.

The quota strategy (no-cows/2yrs-10% cows/3yrs and 10% cows scenarios) did not appear to work very well. First, it was difficult to limit the harvest at the predeter-

mined level (Courtois *et al.* 1996). Secondly, no evident increase in the population was detected from the mail survey indicators. Finally, this technique is more expensive for hunters who may pay to participate in the draw.

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