DETERMINING QUOTAS FOR A MOOSE SELECTIVE HARVEST IN NORTH CENTRAL ONTARIO

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Abstract : A 1983 moose harvest quota of 3,477 was established for 14 Wildlife Management Units (149,811 km.^{2}) in the North Central Region of Ontario. Quotas were based on the best estimate of the 1982 mid-winter population (27,750). A subjective methodology applying quantitative data including hunter numbers, harvests, individual hunter success rates and standardized aerial survey results was used to generate harvest quotas on a WMU basis. Harvest rates fell between 7.0 and 19.8% depending on population status. The harvest quota for each WMU was divided between the tourist industry and non-tourist industry on a Provincial ratio of 10:90, tempered with mean harvests experienced between 1975 and 1979. A ratio of 50% bulls, 20% cows and 30% calves was used to distribute the harvest quota among the three target age/sex categories. Modified 1975-79 mail survey projected hunter success rates formed the basis upon which licence quotas were determined. A total of 19,194 adult moose licences (13,398 bull and 5,796 cow) were generated.

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Moose populations in Ontario were considered to be declining between 1968 and 1975 according to Bisset (1978), Chamberlin et al. (1978), Morrison (1978) and Thompson (1978). Excessive hunting pressure was regarded to be a principle factor contributing to the decline. Efforts to reduce the annual harvest of moose by hunters included shorter and later opening seasons, increased licence fees and a provision introduced in 1980 requiring hunters to share a moose during

the early season. While partially successful in reducing the overall harvest, this latter strategy failed to provide predictable, area specific harvest control (Timmermann and Gollat, 1982).

A Provincial Moose Management Policy (OMNR 1980) aimed at doubling the population to 160,000 and tripling the harvest by the year 2000 to 25,000, was formally approved in December 1980. Harvest control options included both a limited entry, nonselective hunt as well as a selective hunt specifying the age and sex of the animal that could be legally taken. After considerable debate, the latter option which guaranteed hunting opportunity universality was approved and announced for implementation in 1983 (Euler, 1983).

Under the selective harvest system, all Ontario residents qualifying as hunters may purchase a basic moose licence. This basic unvalidated licence permits the holder to hunt and shoot a calf of either sex in any Wildlife Management Unit (WMU) offering an open season. No provision has been made to directly control the calf harvest. A limited quota of bull and cow validation tags are available for each WMU through a centrally controlled computer random draw. Those drawn have the option of hunting and shooting either a calf in any WMU or the specified adult (bull or cow) in a specific WMU. Hunters are legally entitled to shoot only one animal and party killing is not permitted. The licence becomes invalidated when the seal which is issued with the licence is used to tag a moose.

Provincial policy dictates that 90% of the planned Ontario bull and cow harvest be allocated through a computer draw to the non-tourist industry (NTI) while the remaining 10% is assigned to the commercial tourist industry (TI) (Bisset and Timmermann, 1983).

Harvest quota's had to be further broken down into bull, cow and calf components within both the NTI and TI sectors. A standard methodology was developed to determine licence quotas that would meet harvest targets for all WMU's within the Region.

METHODS

A. Harvest Quota Guidelines

The first approximation of a harvest quota was based on a nonselective any age/sex harvest strategy with limited hunter participation. Broad upper and lower harvest quota limits were established for each WMU based on population estimates and desired harvest-rates as follows:

(a) Lower Quota Limit

A 10% harvest rate was applied to a conservative 1982 mid-winter population estimate. The estimate was based on animals observed during the most recent aerial plot survey plus 25% to account for moose believed present but not observed on the survey.

(b) Upper Quota Limit

A 13% harvest rate was applied to a more liberal 1982 mid-winter population estimate. The estimate was based on observed animals and track aggregations of moose not observed. The track aggregations were converted to "missed moose" after the method described by Bergerud and Manuel (1969) and added to the observed animals to arrive at the final estimate.

(c) Modified Quota Limit

The lower and upper quota limits were further modified subjectively by considering the following:

1) Whether populations were increasing, decreasing or stable as determined from aerial census trend data.

2) The composition and magnitude of the kill as indicated by jaws submitted voluntarily by hunters.

3) Trends in annual harvests, hunter numbers and success rates obtained from a mail questionnaire for the period 1975-1979.

4) The most reliable recent mid-winter density estimate compared to the targeted year 2000 Strategic Land Use Plan (OMNR 1982) target density. A simple "compound interest" theoretical harvest calculation as described by Eberhardt (1969) was used to generate a harvest level designed to meet the year 2000 target density.

The final modified quota for each WMU based on a nonselective harvest was adjusted to a selective harvest by arbitrarily inflating quotas by 15%. Justification for this increase was based on a desire to increase the targeted calf harvest from approximately 15 to 30% of the

total quota. Likewise the cow harvest was set at 20%, down from the traditional 35-40% nonselective kill, while the bull harvest was pegged at 50%.

Historical mail questionnaire data was used to apportion WMU harvest quotas between the TI and NTI. Both groups were further broken down into bull:cow:calf components by applying the targeted harvest ratio of 50:20:30% respectively.

B. Licence Quota Calculations

Bull and cow harvest quotas were translated into adult validation tags (AVT) for each WMU using historical harvest data. Past success and harvest structure data formed the basis of predicting the proportionate 1983 harvest. Even though calves were targeted at 30% of the harvest, an unlimited number of unvalidated licences were made available thus fulfilling the universality of hunting objective.

RESULTS

The process of developing a selective harvest quota for a WMU is detailed in Table 1. Table 2 illustrates the final harvest quotas and AVT's for 14 WMU's managed by the NCR. The harvest quota distribution between the NTI and TI was 3,159 and 318 respectively. Targeted harvest rates varied between 7.0% and 19.2% with an overall mean of 13.1%.

Table 1. Quota development process (Example WMU 13)

(A)	(B)	(C)	(D)	(E)
LOWER QUOTA LIMIT	UPPER QUOTA LIMIT	MODIFIED QUOTA LIMIT	QUOTA (575) SUBDIVISION	LICENCE (AVT) QUOTA CALCULATION
330	455	(1) Mean harvest 1975-79 (mail questionnaire) = 550	(1) NTI harvest quota $\frac{(.984^2 \times 575)}{= 566}$	(1) NTI AVT quota Bull $\frac{(6.62^4 \times 284)}{= 1881}$ Cow $\frac{(7.09^5 \times 113)}{= 801}$
(.10 x 3300)	(.13 x 3500)	(2) Mean jaw collection 1975-79 = 338	(2) TI harvest quota $\frac{(.016^3 \times 575)}{= 9}$	(2) TI AVT quota Bull $\frac{(5.25^6 \times 4)}{= 21}$ Cow $\frac{(5.5^7 \times 2)}{= 11}$
		(3) Harvest/hunter no. trends 1975-79 no obvious overharvest	(3) NTI quota division Bull $(.50 \times 566) = 284$ Cow $(.20 \times 566) = 113$ Calf $(.30 \times 566) = 169$	
		(4) Hunter no./success rate trends 1975-79 at maximum level	(4) TI quota division Bull $(.50 \times 9) = 4$ Cow $(.20 \times 9) = 2$ Calf $(.30 \times 9) = 2$	
		(5) 1982 density estimate vs. SLUP target (/km²) = .26 vs .33		
		(6) Formula quota calculation = 494		
		(7) Non-selective quota chosen 500		
		(8) Adjustment to a selective harvest $\frac{(.15 \times 500)+(500)}{= 575}$[1]		

[1] final harvest quota selected
[2] historical NTI harvest share = 98.4%
[3] historical TI harvest share = 1.6%
[4] projected NTI bull hunter success = 15.1% or 6.62 AVT's/bull
[5] projected NTI cow hunter success = 14.1% or 7.09 AVT's/cow
[6] projected TI bull hunter success = 18.9% or 5.25 AVT's/bull
[7] projected TI cow hunter success = 17.6% or 5.50 AVT's/cow

Table 2. 1983 Moose harvest and AVT quotas for 14 WMU's North Central Region

WMU Number	Area (km.²)	Est. 1982 Density /km.²	Est. 1982 Pop.	Harvest Quota Non-Selective	Harvest Quota Selective	NON-TOURIST INDUSTRY Selective Harvest Components Bull:Cow:Calf	NON-TOURIST INDUSTRY AVT #s Bull:Cow	TOURIST INDUSTRY Selective Harvest Components Bull:Cow:Calf	TOURIST INDUSTRY AVT #s Bull:Cow	Calculated Average Harvest Rate (%)
11A	3,225	.15	200	30	35	17: 6: 9	111: 44	1: 1: 1	5: 5	17.5
11B	1,750	.15	550	70	81	36: 14: 21	235: 102	5: 2: 3	24: 11	14.7
12A	4,200	.23	1000	137	158	66: 27: 39	431: 197	13: 5: 8	52: 21	15.8
12B	6,550	.23	1500	213	245	113: 45: 67	739: 285	10: 4: 6	40: 17	16.3
13	13,325	.26	3500	500	575	284:113:169	1881: 801	4: 2: 3	21: 11	16.4
14	1,186	.51	600	100	115	44: 18: 26	180: 81	14: 5: 8	40: 16	19.2
15B	17,675	.25	5000	560	644	311:125:187	2190: 947	11: 4: 6	65: 26	12.9
16C	11,700	.07	850	110	127	38: 15: 21	220: 119	26:11:16	163: 96	14.9
17	29,900	.06	1950	150	173	55: 22: 32	413: 208	32:13:19	142: 73	8.9
18A	8,500	.08	1400	88	102	45: 17: 27	479: 210	6: 3: 4	48: 28	7.3
18B	11,100	.08	200	12	14	6: 1: 3	64: 12	2: 1: 1	16: 9	7.0
19	11,500	.15	1700	165	190	91: 37: 54	850: 374	4: 1: 3	28: 8	11.2
21A	15,700	.32	4800	459	528	247: 98:149	2470: 1032	17: 7:10	97: 42	11.0
21B	13,500	.32	4500	426	490	232: 93:139	2320: 979	13: 5: 8	74: 42	10.9
TOTAL	149,811	.18	27750	3020	3477	1585:631:943 3159	12583: 5391 17974	158:64:96 318	815:405 1220	13.1

An age/sex specific harvest of 1,585 bulls, 631 cows and 943 calves was targeted for the NTI while the TI received 158 bulls, 64 cows and 96 calves. Individual WMU harvest quotas ranged from a low of 35 moose in WMU 11A to a high of 644 in WMU 15B.

Translation of adult harvest quotas into AVT's resulted in a total of 19,194 (13,398 bull and 5,796 cow) hunting opportunities. Their distribution among the NTI and TI component is detailed in Table 2.

DISCUSSION

Data fundamental to the formulation of biologically sound harvest and licence quotas include a reliable estimate of population size, mortality from all sources, productivity, recruitment and hunter harvest success. Unfortunately this data is rarely available for all areas and thus assumptions frequently have to be made.

Recruitment, Mortality, Harvest Rate

Generally, only limited recruitment and non-hunting mortality data is availalbe for the 14 WMU's administered by the NCR. Normally in population modelling, this data is used in combination with a population estimate to generate an allowable harvest rate.

Using combined long-term Northern Ontario moose data, it was

determined by the ONE POP (Gross et al. 1973) computer simulation model, that a mid-winter population harvest rate of 13% would maintain populations at constant levels. Based on these results, the calculated 13% and an arbitrary 10% were used to establish the initial upper and lower harvest quota limits respectively.

Sustained yield harvest rates ranging from 10 to 25% as reported by Simkin (1974) for various parts of North America and 11 to 14% for the Kirkland Lake District of Ontario (Fraser 1976), generally support the conservative harvest rates used in the foregoing calculations.

Sex and Age Harvest Ratios

Traditional NCR harvest ratios tend to be more heavily weighted towards the bull (45-50%) and cow (35-40%) components and less so towards the non-productive calf component (10-15%). In comparison, Saskatchewan (Stewart 1978) and Swedish (Thelander 1979) selective harvest strategies centre around targeted calf harvest rates of 30-35 and 40% respectively. The underlying theory behind this harvest strategy is to selectively direct the hunting pressure to those population components which least influence herd growth, thus increasing the number of animals of fertile age.

The question of compensatory vs additive mortality as it applies to the determination of optimum harvest ratios for an Ontario selective harvest strategy, has been reviewed in detail by Euler (1983). He

concluded that increased hunting pressure on calves could be justified by the fact that compensatory mortality, if present in moose, is most likely present in the calf component.

With regard to the adult harvest ratio, Crête et al. (1981) and Baker (1975) felt that moose could be safely managed if the bull population was not permitted to decline to less than 40 to 50% of the mid-winter adult population. Sylvén et al. (1979) also reported on the advantages of a slight distortion in the sex ratio in favour of females.

Success Rates

Assuming similar hunter numbers, moose population levels, season dates and full hunting regulation compliance by hunters; 1983 age/sex specific individual hunter success rates are expected to be approximated by the 1975-79 averages. Under the same conditions and 100% party killing in 1983, individual hunter success rates for each of the bull and cow components should not exceed the 1975-79 average nonselective individual hunter success rate. In actual fact, 1983 success rates by age and sex are expected to lie somewhere between the two extremes. For lack of a more concrete data base, a median value was used.

CONCLUSION

The basic objective of the 1983 Ontario Selective Harvest Strategy is

to selectively remove specific age and sex classes of animals at a rate which will provide maximum population growth while still ensuring hunting opportunity universality. Once this mandate has been established, it then becomes a question of which sex/age classes should be harvested at what rate. In the NCR, it is believed desirable to apply a standard methodology to harvest and licence quota formulation. With this approach, less discrepency between WMU quotas will result. Consequently, calculations can be more easily explained and more readily defended. The resulting applied format provides a structured framework which makes best use of all sources of available quantifiable data while still allowing for subjective input.

In view of the fact that the selective harvest strategy is a completely new and radical departure from the traditional Ontario program, we recognize the potential weaknesses in a number of our key assumptions and corresponding projections. With time and experience, we expect to be able to more effectively adjust harvest and licence quotas. Most importantly, the 1983 hunting season will provide us with more concrete sex-specific hunter success rates to use in future licence quota calculations.

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