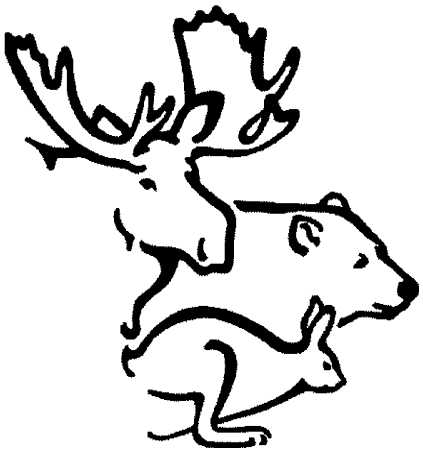

Moose Population Aerial Inventory Plan for Ontario: 1999-2002

NWST Information Report IR-004

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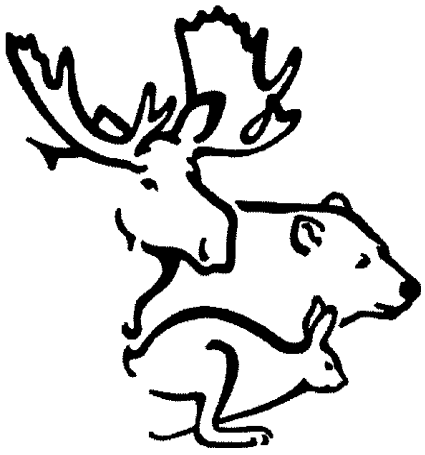
Ontario



Moose Population Aerial Inventory Plan for Ontario: 1999-2002

NWST Information Report IR-004
April 1999

by

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EXECUTIVE SUMMARY

The moose population of Ontario is a valuable asset to the economic, social and environmental well-being of the province. In 1996, moose hunting generated about $4.1 million in license revenues to the government. A 1993 study indicated that moose hunting created $57.2 million in direct expenditures. Indirect and induced impacts equal about $77.5 million for a total of $134.7 million. This generated 1690 person-years of employment, $60.7 million in labour income and $32 million in tax revenues. The provincial moose population is currently estimated at about 120,000 animals and has not changed substantially since 1985. There is good evidence that this population level is well below habitat limited population potential.

Resources can be effectively managed only with an inventory of stock and an assessment of stock use. For moose, the inventory normally consists of mid-winter, aerial, population surveys, which are the subject of this plan. Information on use of the stock comes from a number of sources including surveys of hunters, reports of non-hunting mortality, etc. Needs for this type of information are dealt with elsewhere.

Two types of moose population information are required. Adequate trend information on population levels for management purposes can normally be obtained through fixed-wing aerial surveys. However, control of moose harvest through the Selective Harvest Program places greater emphasis on the harvest of bulls and calves than cows. If not implemented in a manner which is consistent with local herd dynamics, the age-sex ratio of the population may become distorted. A second type of survey, with helicopters, is used to estimate the age-sex structure of the herd where there is evidence that this is warranted.

In developing this plan, two different purposes for surveys were recognized. The first purpose is the management of moose and moose hunting. The second purpose is to meet the general responsibility of the Ministry to ensure that populations of all wildlife species are healthy and the specific legal requirement under the Terms and Conditions of the *Class Environmental Assessment for Timber Management on Crown Lands in Ontario* (Timber EA) to monitor population levels of representative forest vertebrates. Funding for moose population inventories comes from the Provincial Wildlife Trend Inventory project and is linked to revenues from moose hunting licenses.

This plan is a continuation of one written in 1995 (Bisset and McLaren). A number of changes have been made in the aircraft recommended in an attempt to better match inventory requirements with the MNR fleet configuration, to provide more equality among districts and to match the skills available within the reorganized Ministry. Survey times have been adjusted to reflect survey characteristics for fixed and rotary wing surveys observed over the past three years. Changes have been made in the survey cycle to assist districts in delivering the program.

The major change has been a significant increase in aircraft, and therefore program costs. We estimate that population surveys adequate for both harvest management and population monitoring can be done for approximately $630,000 in each year of the plan. This amount might be reduced to approximately $550,000 by using only MNR fixed wing aircraft, but this may compromise the ability to effectively manage the age/sex structure of the herd which may

compromise the opportunity for population growth to meet both social and biological objectives for the herd. Reduced funding will also increase the risk of accident by using aircraft which were not designed for low level, low speed surveys, especially in rugged terrain.

ACKNOWLEDGEMENTS

Numerous people contributed to the development of the original document and therefore to this plan. Howard Smith, Chris Davies, Art Rodgers, Craig Greenwood, Tim Timmermann and Ken Morrison all contributed ideas towards the development of minimum data needs for moose management. In November 1994, Chris Davies, Milan Vukelich, Bill Dalton, Rick Gollat, Ken Morrison, Jan McDonnell and Howard Smith reaffirmed the principles on which this plan is based.

All those who have conducted surveys over the past three years have contributed the valuable new information used to revise this inventory plan. Special thanks to Karen Punpur for editing, artistic talent and enthusiastic dedication during the process of moving the document from draft to published format.

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Introduction

Aerial surveys have been the technique of choice to estimate the status of moose populations in Ontario from the mid-1950s. There were several province wide surveys in the 1950s and 1960s, but most were done on a local level using a variety of sample designs and survey techniques.

In 1975, efforts were begun to standardize the collection and analysis of moose survey data to the greatest practical extent. It has been policy to conduct an aerial population survey in each Wildlife Management Unit (WMU) every three years, as described in *The Standards and Guidelines for Moose Population Inventories* (OMNR 1981, Bisset, 1996) and the *Minimum Standards for a Wildlife Program* (OMNR 1989). Fiscal constraints had prevented many WMUs from following this policy but, the situation has improved over the last three years. Never the less, some units have been surveyed with insufficient regularity to obtain a confident estimate of the population size or trend. Both staff and the public believe the lack of information is one reason why the moose populations in Ontario have failed to increase to the expected targets.

In recent years, the Ministry has also moved from a position of managing specific resources to a more holistic approach of managing for the sustainability of all resources and the health of ecosystems. With this change, the reasons for needing good inventory information have expanded. In particular, the Terms and Conditions associated with the *Class Environmental Assessment of Timber Management on Crown Lands in Ontario* (Timber EA) require us to provide provincial population trends for representative forest vertebrates. The Terms and Conditions also require MNR to undertake research to demonstrate whether the habitat guidelines for moose (and for other species) do in fact provide good habitat. Population size can be used as one measure of habitat suitability.

In addition to moose information, these aerial inventories have the potential to provide information on population trends of wolves and other species and to identify specific sites that require protection, such as eagle nests. Collecting this information is consistent with EA terms and enhances the value of the technique.

The purpose of this document is to provide a framework for a population inventory system that will provide essential information for decision support systems to manage moose harvest and will also provide the information needed to assess whether moose are maintaining their position as a major component of healthy ecosystems.

Economic Impacts

A 1993 economic study estimated that moose hunting generated $57.2 million in direct expenditures. Indirect and induced impacts equal about $77.5 million for a total of $134.7 million (Legg 1995). This generated 1690 person-years of employment, $60.7 million in labour income and $32 million in tax revenues. In 1996, moose hunting licenses provided about $4.1 million to the government. Tourism related to viewing moose probably contributes an equal amount to the Ontario economy. A viable moose population is essential to maintain or increase these economic benefits.

This plan estimates that about $630,000 is required annually for aircraft and pilot travel costs to gather information on the size and structure of the moose population. This is a small amount (about 15 per cent of licence revenues) relative to the financial benefits to the province.

The Importance of Aerial Surveys

The value of population inventories and the method to conduct them must be considered in relation to the size of the population, impacts on or created by those populations and rate of change that a population might experience. If a population is very low and threatened, or relatively high and potentially harmful, then inventories are more important and cost is less important than if a population is very abundant, stable and relatively harmless.

Moose are one of the few species for which direct and reasonably reliable population estimates can be made, but these estimates are perceived to be relatively costly. At the same time, moose are economically important. Their populations have been depressed below recent historic levels and hunter demand is high relative to the capability of the herd to produce animals. In addition, moose habitat has been substantially altered through forest management in ways that are not always beneficial to moose. Under these conditions, aerial inventories are warranted and costs can be easily justified.

As the potentially negative impacts of hunting and habitat change are brought under management control and moose populations increase to meet defined objectives, then the importance of aerial inventories might be reduced. Alternative, less expensive methods (e.g. hunter surveys) may become more cost-effective assessment tools, especially if correlated with rigorously standardized aerial survey estimates. Because of the need for age-sex information and the variety of factors that affect moose populations, it is not likely that aerial inventories will be eliminated entirely. In future, the survey schedule might be extended, perhaps to five or six years, in stable WMUs or the nature of surveys may change toward greater emphasis on age-sex transects.

Risk Assessment

Wildlife and fish species are subject to a number of factors that affect population levels, including predation, disease, parasites, accidents, regulated harvest and (for some) unregulated harvest. Most species are secretive or live in habitats where it is difficult to make direct population estimates. Moose can be directly counted and managers, therefore, do not have to rely on indirect measures of population size (such as counts of sign or catch per unit effort). In addition, good quality population size estimates which incorporate estimates of productivity (e.g. percent calves) integrate the impacts of the combined factors which act on those populations and facilitate management decisions. For these reasons, aerial inventories provide a decided advantage to the moose manager.

The standards for survey frequency, overall survey methods and levels of statistical precision set out in *Standards and Guidelines for Moose Population Inventories* (OMNR 1981, Bisset 1997). The current standard is to survey each WMU every three years. Although there has been discussion about lengthening the interval between surveys, professional staff have concluded that a three-year interval was most appropriate to ensure that adequate information was available to set harvest quotas. Some WMUs that have gone longer than three years, and especially some of those units that have gone five or more years between surveys, have suffered serious population reductions because information to justify quota reductions was not available. In a few instances, populations have increased but the potential recreational and economic opportunities were lost, again because of lack of information to justify quota changes.

While some of the far northern units (specifically 1A, 1C, 1D) do have moose hunting seasons and are listed in the planning tables, they do not have a budget allocation for surveys. These units have very low densities of moose (7,000-9,000 total but less than 0.01 per km^2), are distant from airports and are very expensive to survey in both absolute and relative terms. They also have very few hunters (less than 700 in total in 1997) and low moose harvests (less than 100) so recreational hunting is not considered to be a significant impact on populations. Estimates of moose populations in these units should either be funded as a special project (perhaps every 10 years) or done in conjunction with surveys for other important species such as caribou.

Principles

The following principles are those that we feel are important to an effective and efficient moose population monitoring plan.

- Moose population surveys contribute to three distinct Ministry responsibilities: 1) appropriate decision support for managing the harvest of an economically valuable resource, 2) ensuring compliance with the Environmental Bill of Rights, and 3) the legal responsibility under Term and Condition 81 of the Timber EA to monitor representative forest vertebrates (specifically moose and wolves). More detailed information, and at a finer scale, is required for the first two than the last.
- Central funding should be available to meet the minimum survey level set out in this plan. Districts can find extra funding if they feel a more frequent survey schedule is necessary for local management or if they wish to use more expensive aircraft that planned.
- The central fund should include contingency funding to survey four WMUs (200 hours of flying) in the event that the previous survey plan was incomplete (due to factors such as weather) or results of individual surveys are substantially inconsistent with other information.
- Surveys must be done consistently according to the standards and guidelines so that a temporal series of population size estimates with consistent precision can be obtained. Once a stable inventory program is established the same type of aircraft should be used from year to year but, more importantly, the level of effort should not change (e.g. do not increase time-on-plot by flying lower and slower when surveying with a helicopter). Continually changing survey design and search effort hinders effective management and confuses trend analysis by changing visibility bias. This should not happen.
- Optimal sampling intensity is the best statistical approach. Intensive survey designs with too many plots or extending survey times too long are a waste of money unless they can be shown to contribute to better decisions leading to target achievement. They reduce availability of aircraft and funds for other surveys.
- Adequate information on overall moose population levels and change in productivity (per cent calves) for management of moose harvest can be obtained using suitable fixed-wing aircraft.
- Specific age-sex information (i.e. acquired by helicopter with transect or plot sample design) is not essential in most WMUs and should be planned to provide baseline data (through a set of representative units across the province). Additional surveys should be justified with data which suggests sex

ratios are significantly skewed beyond acceptable (guideline) expectations and that this is negatively affecting target achievement. This does not imply that age-sex information should not continue to be gathered as a part of normal (fixed-wing) population size surveys.

- Logistic realities must be recognized in the consideration of which aircraft will be used for surveys. Generally, costs are based on time allocations of 30 and 40 minutes per plot for fixed and rotary wing aircraft, respectively, plus positioning, ferry and aircrew support costs. Because MNR helicopters provide greater safety and fixed costs (maintenance and pilot costs) must still be paid, their use is planned before commercial fixed-wing flights. Helicopters are generally assigned to units where baseline age-sex information is most needed, where ferry costs are minimized or where additional safety due to rugged terrain is a concern.
- All WMUs within the core range are considered to be equally important. Aircraft allocation should be based on a variety of information needs, not an individual attribute, such as hunter numbers or moose density.
- If funding is available, a few very high density units (or parts of units) should be surveyed more frequently than three years to determine potential population density for other units and to look for signs of stress which might predict overpopulation.
- It is unlikely that MNR aircraft will be able to meet all survey needs. Biologists and Air Services staff must work closely together to ensure that appropriate aircraft are available. Priorities for units and aircraft must be set each year. At least regional and perhaps provincial coordination will be required to ensure that overall objectives are met. Criteria for dealing with contingencies and constraints are provided in Appendix I.

Aircraft Availability and Characteristics

Minimum aircraft requirements include a four-seat, high-wing aircraft, with an internal communications system for the crew, fog free windows (or defogging devices) and with a slow flight speed of 90 mph or less. Desirable features include on-board GPS and a wide range of visibility (e.g. centerline visibility, bubble windows).

At this time, the Ministry has five De Havilland Turbo Beavers in service, and sux helicopters (Bell 206L and A-Star AS350B2) available to do moose surveys. The Ministry also has two De Havilland Twin Otters which are a suitable aircraft for transect surveys in the far north, but these have not been available for moose surveys in recent years due to low demand. The Ministry has three Turbo Beavers which are presently unassigned, two are leased out and one is in Sault Ste. Marie.

The normal winter placement of these aircraft is as follows:

Dryden: 1 Light Helicopter (AS350B2); 2 Turbo Beaver

Thunder Bay: 1 Light Helicopter (AS350B2)

Sudbury: 1 Turbo Beaver; 2 Light Helicopter (1 Bell 206L1, 1 AS350B2)

Timmins: 1 Turbo Beaver; 2 Light Helicopter (Bell 206L1)

Muskoka: 1 Turbo Beaver; 1 Light Helicopter (Bell 206L1)

Turbo Beavers cruise at 120 knots (kts) and have an average 4.5 hours flight time (including reserve). Current MNR cost is $410.00 per hour. The Bell Jet

Ranger 206L cruises at 105 kts and has a range of 3.1 hours, while the Astar AS350B2 cruises at 115 kts and has a range of 3.4 hours. MNR rate for light helicopters is currently $650.00 per hour, but the rate for the Astar is expected to increase during the period of the plan (as owner servicing replaces warrantee servicing). The ranges of all aircraft will be extended somewhat by slower flight speeds while on plot.

Cessna 180/185 type aircraft are the most common commercial aircraft used for surveys. Airspeed is in the order of 110 kts to 125 kts, range is three to four hours and costs range from $250.00 to about $310.00 per hour.

Safety

Low level surveys are a relatively high-risk style of flying. This is particularly true when steep turns are required to observe moose. Engine failure and wing stalling are probably the two most significant factors that could contribute to accidents. Most aircraft accidents are due to “pilot error” rather than “mechanical failure” and for this reason pilots with considerable experience in low level surveys are essential.

Ministry aircraft are believed to offer the greatest safety for observation crews. They have reliable turbine engines, high-lift wings and space for winter survival gear. Most available commercial aircraft with four place seating arrangements (e.g. Cessna 180/185 type) have piston engines and high-speed wings. When commercial aircraft are flown, it is essential that the contract specify the use of pilots with appropriate experience that recognizes both total hours and low level skills. The plan uses MNR aircraft as much as possible.

Experienced MNR pilots, reliable aircraft and experienced observers form a safe and effective survey team the value of which should not be underestimated from the perspective of either efficiency or economics.

Survey Needs

Since the original moose population inventory plan in 1995, guidelines have been revised, survey manuals have been written or revised (Oswald 1998, Bisset 1998) and surveys have become more standardized. One of the objectives for standardization is to be able to use both fixed and rotary wing surveys interchangeably if necessary. In spite of this, some differences in aircraft use persist, and these have been incorporated into this plan. Summary information from the most recent surveys is presented in Table 1. Over the last three years, time-on-plot has averaged about 30 minutes for fixed-wing surveys and 40 minutes per plot for helicopters. These values have been used for planning purposes.

To some extent ferry time (in minutes per plot) is determined by the distance from the base to the WMU and the choice of WMUs selected for fixed versus rotary wing surveys. However, other major differences are the speeds and airtime ranges of the two types of aircraft. Airspeeds are similar but the airtime is considerably different (4.5 hours for the Beaver versus about 3.2 hours for the helicopters). This requires helicopters to return to base or fuel depots more often than Beavers, under similar circumstances. Ferry time was about 20 minutes per plot for both fixed-wing aircraft and helicopters in 1996-97 and 1997-98 although this varied considerably due to distance from the airport to the unit. Estimated ferry times are based on distance from the expected base of operations and considered equivalent for both aircraft types.

At this level of planning, emphasis is placed more on having an acceptable cycle of surveys and adequate total funding than on exact estimates for each WMU. Factors such as ferry time and therefore costs may change if aircraft can be based locally during surveys rather than ferrying back to a MNR base. This possibility appears to be more prevalent with helicopters in Southcentral region. While an effort is made to estimate costs as accurately as possible for each WMU, it is recognized some estimates will be excessive and others too low. If costs are paid through a central funding source the "errors" should compensate, and the program delivered within planned costs.

Age-Sex Surveys

The demand for age-sex surveys using helicopters exceeds the aircraft and funds available to obtain them within the desired rotation period and survey window. At present, the available evidence indicates that excessive harvesting is probably a more important reason why herds have not increased than is the age-sex structure of the population. This does not mean that age-sex structure information is not important for future management or not required now. In order to obtain representative information on herd structure, MNR helicopters are planned for 'combined surveys' and allocated where they will be most beneficial. An effort has been made to distribute these surveys equitably among districts and in different habitat types across the province. In some units age-sex information has been collected as part of a fixed wing survey with good success.

If there is evidence that age-sex information is essential in units where only fixed-wing aircraft have been allocated, it is recommended that a specific age-sex survey (i.e. transect survey) be done. This plan estimates that, provincially, about $20,000 per year may be necessary for specific age-sex surveys.

Changing Ministry, Changing Needs

In recent years, the Ministry of Natural Resources has been both reorganized and downsized. Many staff with the needed knowledge and experience have retired or been laid off. Efforts to find volunteers with the time and interest to do the "job" of surveying have met with limited success. There are also ethical and practical concerns to this practice (e.g. accepting people with Game and Fish Act convictions, minimum time commitments). In addition, there is often a considerable expenditure of staff time to find and train volunteers and results may be unreliable if a stable cadre of knowledgeable people cannot be maintained.

The single most common complaints about the 1996-1998 inventory plan related to the lack of helicopters. This affected the availability of aircrews (both within and outside the MNR) because helicopters are more exciting and comfortable to fly while circling and the odor of fuel used in Turbo Beavers is nauseating to some people.

The air service has been selling or decommissioning its fleet of Turbo Beavers and replacing them with light helicopters, with a recent preference for the Astar 350B2. Commercial aircraft of the Cessna 180/185 type are becoming harder to find. Cessnas are generally too cold to use computers, quite crowded for crew members when wearing winter clothing, and not especially safe for low level surveys.

Table 1a. Northwest Region Flight Centres - Calculated parameters for most recent, and estimates for the next moose population survey.

			Last Survey									
	Survey	Total		Years				Total	Time-On	Ferry	Time	Pop.
Unit	Area	Area	Year	Since	Type	SRC	Plots	Hours	-Plot	/Plot	/Plot	Density
01G *		60700										
01R *		33854	1985	13	OTTER	MNR	312					
01S *		74698	1985	13	OTTER	MNR	729	62.0				
02	8525	8525	1996	2	TURBO	MNR	38	32.1	28	23	51	0.16
02P	4400	4400	1996	2	TURBO	MNR	35	33.3	32	25	57	0.21
03	13000	13000	1998	0	TURBO	MNR	40	29.0	32	8	40	0.26
04	10800	11100	1998	0	TURBO	MNR	38	32.9	32	15	47	0.29
05	10425	10500	1998	0	TURBO	MNR	37	38.7	40	18	58	0.37
06	4625	4625	1998	0	TURB/HE	MNR	37	43.9	46	19	65	0.38
07A	1000	1000	1997	1	HELI	MNR	14	18.9	52	19	71	0.67
07B	9250	9250	1997	1	TURBO	MNR	39	34.9	37	17	54	0.19
08	5600	5600	1997	1	TURBO	MNR	35	40.0	49	20	69	0.50
09A	4500	4500	1996	2	HELI	MNR	32	47.2	54	35	89	0.25
09B	3950	3950	1996	2	HELI	MNR	34	48.2	46	39	85	0.28
10	2875	2875	1997	1	TURBO	MNR	25	17.1	26	15	41	0.03
11A	3225	3225	1997	1	TURBO	MNR	31	26.5	33	18	51	0.16
11B	1750	1750	1996	2	HELI	MNR	23	18.7	27	22	49	0.39
11Q	4675	4675	1996	2	TURBO	MNR	33	33.9	41	21	62	0.54
12A	4200	4200	1998	0	HELI	MNR	33	34.5	38	18	56	0.35
12B	6550	6550	1996	2	HELI	MNR	35	32.4	37	19	56	0.32
13	13325	13325	1996	2	HELI	MNR	34	45.3	61	19	80	0.29
14	3000	3000	1997	1	HELI	MNR	32	22.4	29	13	42	0.11
15B	17675	17675	1997	1	HELI	MNR	40	49.6	37	37	74	0.37
15A	11000	11000	1998	0	TURBO	MNR	49	45.0	39	12	51	0.36
16A	16664	16664	1996	2	TURBO	MNR	59	56.8	26	32	58	0.05
16B	9850	9850	1997	1	TURB/TO	MNR	46	36.5	28	20	48	0.16
16C	6175	10825	1997	1	TURBO	MNR	29	25.5	24	29	53	0.09
17	18450	29900	1997	1	OTTER	MNR	40	38.3	25	32	57	0.03
18A	8500	8500	1992	6	TURBO	MNR	61	50.7	30	20	50	0.09
18B	4000	11100	1997	1	TURBO	MNR	40	35.0	27	26	53	0.24
19	10825	11500	1996	2	TURBO	MNR	43	36.3	37	14	51	0.16
20**	425	2700	1998	0	HELI	MNR	25	18.4	20	19	39	0.03
21A	15700	15700	1997	1	HELI	MNR	46	48.6	28	35	63	0.28
Total	**234939**	**261464**		**2**			**2144**	**1132.6**	**35**	**22**	**57**	**0.25**

* Transect surveys not included in plot totals or averages.
** Plots are not standard size.

Table 1b. Northeast Region Flight Centres - Calculated parameters for most recent, and estimates for the next moose population survey.

			Last Survey									
	Survey	Total		Years				Total	Time-On	Ferry	Time	Pop.
Unit	Area	Area	Year	Since	Type	SRC	Plots	Hours	-Plot	/Plot	/Plot	Density
01M *		61004										
21B	13500	13500	1998	0	TURBO	MNR	40	47.5	38	17	55	0.29
22	7575	7575	1998	0	HELI	MNR	37	43.2	41	24	65	0.42
23	9450	9450	1997	1	HELI	MNR	40	45.4	40	28	68	0.17
24	15375	19475	1996	2	TUR/HE	MNR	55	46.0	30	20	50	0.10
25	6000	40400	1998	0	TURBO	MNR	*808	75.5	5	3	8	0.04
26	10000	27750	1997	1	TUR/HE	MNR	*362	76.2	6	4	10	0.03
27	8525	8800	1996	2	HELI	MNR	41	40.1	40	19	59	0.23
28	10250	10250	1998	0	HELI	MNR	47	61.6	50	24	74	0.27
29	7700	7700	1998	0	HELI	MNR	40	45.6	35	32	67	0.21
30	13600	13600	1996	2	HELI	MNR	39	52.8	52	29	81	0.21
31	10475	10475	1996	2	HELI	MNR	43	63.1	49	39	88	0.26
32C	7175	7175	1996	2	HELI		39	41.3	43	21	64	0.17
32	4375	4375	1998	0	HELI	MNR	29	33.9	41	37	78	0.27
33P	2500	2500					Pukasaw National Park					
33	5700	5700	1997	1	HELI	MNR	34	35.5	43	20	63	0.23
34	3000	3000	1996	2	HELI	MNR	31	60.4	81	36	117	0.27
35	9375	9375	1997	1	TURBO	MNR	41	49.0	46	26	72	0.20
36	5575	7325	1997	1	TURBO	MNR	34	43.6	51	26	77	0.22
37	4675	6550	1996	2	TURBO	MNR	45	36.6	35	14	49	0.13
38	11700	11700	1998	0	HELI	MNR	42	57.5	55	28	83	0.22
39	6000	6000	1997	1	HELI	MNR	35	39.6	42	26	68	0.14
40	9850	9850	1998	0	HELI	MNR	39	46.5	43	29	72	0.29
41	9850	9850	1997	1	HELI	MNR	36	36.7	40	21	61	0.19
42	4700	8700	1996	2	HELI	MNR	45	53.8	52	20	72	0.30
45	575	575	1997	1	TURBO	MNR	9	9.9	38	28	66	0.03
46	3200	4100	1997	1	TURBO	MNR	40	40.5	28	33	61	0.07
47	4500	4500	1998	0	TURBO	MNR	37	23.5	27	3	30	0.10
49	3100	3800	1996	2	TURBO	MNR	40	44.9	33	34	67	0.15
Total	**95850**	**274050**		**1**			**958**	**1250.2**	**40**	**24**	**64**	**0.19**

* Transect surveys not included in plot totals or averages.

** Plots are not standard size.

Table 1c. Southcentral Region Flight Centre - Calculated parameters for most recent, and estimates for the next moose population survey.

			Last Survey									
	Survey	Total		Years				Total	Time-On	Ferry	Time	Pop.
Unit	Area	Area	Year	Since	Type	SRC	Plots	Hours	-Plot	/Plot	/Plot	Density
48	3950	3950	1996	2	TURBO	MNR	42	52.3	43	32	75	0.30
50	1700	1700	1996	2	HELI	MNR	24	29.6	56	18	74	0.38
51	4300	4300	1998	0	C180	COM	23	21.7	25	32	57	0.21
52	2825	2825	1998	0	C180	COM	22	20.0	22	33	55	0.17
53	2400	2400	1998	0	HELI	COM	30	24.6	40	9	49	0.17
54	1500	1675	1997	1	TURBO	MNR	20	15.1	26	19	45	0.08
55A	1150	1150	1996	2	TURBO	MNR	28	21.9	31	16	47	0.14
55B	1300	1300	1996	2	TURBO	MNR	19	17.7	24	32	56	0.11
56	2500	2500	1998	0	HELI	COM	20	23.9	33	38	71	0.03
57	1875	1875	1998	0	HELI	MNR	24	24.3	41	16	57	0.08
58	1250	2000	1998	0	TURBO	MNR	27	14.7	20	12	32	0.00
59	550	1875	1997	1	TURBO	MNR	10	5.2	23	8	31	0.00
60	2375	4225	1997	1	HELI	MNR	40	28.4	35	8	43	0.12
61	1325	2500	1997	1	TURBO	MNR	28	21.6	39	7	46	0.08
62	725	2200	1997	1	TURBO	MNR	15	9.1	32	4	36	0.02
63	1775	3400	1998	0	HELI	MNR	20	13.2	31	6	37	0.07
65 **	250	6555	1998	0	TURBO	MNR	2	13.8	132	282	414	
76	550	4500	1998	0	HELI	MNR	9	6.7	37	3	40	0.11
Total	**31750**	**46430**		**1**			**394**	**357.1**	**32**	**24**	**56**	**0.12**

** Plots are not standard size.

Provincial Summary												
	127600	**151505**		**1**			**3496**	**2740**	**36**	**23**	**59**	**0**

Moose populations are increasing in south central Ontario. This is resulting in more motor vehicle accidents and demand for better moose management. Snow conditions in this area are generally less suitable than in more northern areas and this makes the survey window shorter. Moose populations have also increased to relatively high densities in all or parts of some units. This increases the amount of circling and the risk of accident.

While helicopters do not appear to be justified for moose surveys from the biological or decision support perspectives, all of these factors dictate that they are required more from the social, safety and corporate economic perspectives. It makes little economic sense to do a survey with a less expensive fixed-wing aircraft if the survey cannot be done well, crewmembers or managers have little faith in the results and MNR aircraft sit on the ground. This plan recognizes these changes and attempts to accommodate them by recommending an increased number of surveys with helicopters. If adequate funding is not provided, then surveys will either be done with MNR or commercial fixed-wing aircraft or be cancelled.

Helicopters are assigned to WMUs in the following priority:

- for safety in rugged terrain and very high density units (to minimize low level turning),
- to parks located close to suitable air bases, in order to obtain good baseline age-sex information from representative unhunted areas,
- to provide equality among district/area offices (normally one rotary and one fixed-wing survey to each), and,
- to high profile units (i.e. on the basis of important social considerations).

These changes acknowledge several concerns that should be addressed before the next plan is written. Survey costs have escalated from $340,200 in 1995-96 (Bisset *et al.* 1997) to an estimated average of about $630,000. This difference may increase if more Turbo Beavers are decommissioned or if twin blade helicopters (e.g. Bell 206L) are replaced with triple blade helicopters (e.g. Astar 350B2). The twin blade aircraft can be stored in the Ministry of Transportation garages that are found in most small communities, while three blade helicopters cannot and may need to return to an MNR base or other secure airport at the end of each day.

Many of the WMUs in the southcentral part of the province are very small, have relatively small moose populations and are relatively expensive to survey. Consideration should be given to amalgamating some of these units for moose management purposes.

The principles on which this plan is based should be discussed with stakeholders and reaffirmed or modified. Options to ensure the availability of qualified survey crews and alternative mechanisms to deliver the program with greater cost efficiency should be considered.

Priority Setting

In the past three years, all units in the core moose range within the province, except 18A, have been surveyed at least once (Table 1). The objective of this plan is to maintain the three-year cycle and try to balance the demand for aircraft with their availability. Appendix 1 lists the criteria that should be used to help establish priorities among units should this become necessary. Other infor-

mation, primarily information from harvest and hunter statistics suggesting that a particular WMU is experiencing a large decline in population, may be used to modify decisions made by these criteria.

Table 2 presents a nine-year cycle of surveys, including surveys completed over the past six years. The schedule attempts to equalize hours of flying among years and to reduce logistic problems for several districts. To further balance the survey schedule some WMUs may need to be done two years apart and others four years apart.

The schedule provides for a survey in every core unit at least once every three years. To maintain the three year cycle to the greatest extent possible, units that are missed in a particular year (because of weather or other factors) will become the highest priority for contingency survey funds (mentioned under "Principles") in the following year. Contingency surveys may either fit into the overall schedule (as extra surveys) or be used to modify the survey cycle to provide a more efficient and cost effective program.

Districts are free to obtain other funding to increase the frequency of surveys, but are cautioned against exceeding optimal sample intensity or "upgrading" surveys with extra plots or long survey times. Where this is done, enhancements will have lower priority than 'core surveys' in order to maintain the logistical feasibility of the plan.

Logistic Considerations

From a regional or provincial perspective, the number of plots surveyed in each WMU and the time spent searching can have major effects on the availability of aircraft for other surveys and, from the overall cost perspective, the total number of surveys conducted. Time-on-plot can also affect the visibility bias and therefore the population estimate relative to estimates from surveys of different search intensity. Observed changes in population estimate may not be real due to the change in search effort.

This plan provides the required number of plots to achieve 90 per cent confidence limits on estimates that are within 20 per cent of the true population size (excluding visibility bias). The 90 per cent confidence level is considered the minimum acceptable level to provide reliable trend-through-time information (designed for precision, not absolute accuracy). If funding is inadequate to do a 90 per cent confidence level survey, then a survey should not be conducted. In a few instances, mainly parks, the sample has been set at a nominal level slightly below the optimal level (e.g. 25 instead of 30 plots) to reduce costs. Populations in these areas are not expected to change dramatically and a lower level of confidence may be more acceptable than for harvest control purposes.

Each Ministry aircraft is assumed to be able to survey about 90 plots per year. This is based on the assumptions that there are approximately 22 suitable days for moose surveys from early December to January 31 (January 1 to mid-February in the south), surveys are conducted on weekdays, no surveys are flown Christmas week and that four plots are flown per day of flying. With the current fleet of five Turbo-Beavers and six helicopters, Ministry aircraft can fly about 990 plots per year, assuming an average of one hour per plot.

These estimates are supported by information from past years. During the implementation of the last aerial inventory plan, when there was a full survey program and a comparable fleet of aircraft, an average of 1,155 hours and a maximum of 1,350 hours were flown annually. A relatively small number of these hours were flown with Twin Otters and commercial aircraft.

Table 2a. Northwest Region Flight Centres - Moose aerial inventory schedule.

	1992/3	1993/4	1994/5	1995/6	1996/7	1997/8	1998/9	1999/0	2000/1	2001/2
Unit	**Plots**	**Plots**	**Plots**	**Plots**	**Plots**	**Plots**	**Hours**	**Hours**	**Hours**	**Hours**
01G							-	-	-	-
01R							-	-	-	-
01S							-	-	-	-
02				38			34	-	-	34
02P				35			-	30	-	-
03			62			39	-	-	35	-
04		49	44			37	-	-	34	-
05			50			37	-	-	40	-
06			37			33	-	-	36	-
07A		20			20	NSS[1]	-	22	-	-
07B		45			39		-	42	-	-
08		46			35		-	33	-	-
09A				32			38	-	-	38
09B				34			35	-	-	35
10					25		-	23	-	-
11A				31	31		-	29	-	-
11B	40				23		23	-	-	23
11Q				33			33	-	-	33
12A			31			33	-	-	36	-
12B				35			35	-	-	35
13				34			41	-	-	41
14					32		-	-	33	-
15A			40			38	-	-	41	-
15B					40		-	42	-	-
16A				59			45	-	-	45
16B	50				46		-	50	-	-
16C				29			-	-	41	-
17					40		-	43	-	-
18A						CAN'D[2]	-	-	46	-
18B					40		-	43	-	-
19				43			38	-	-	38
20						10	-	-	12	-
21A		50			47		-	44	-	-
Total/Avg.	**90**	**210**	**264**	**403**	**418**	**227**	**321**	**401**	**352**	**321**

Note: Shaded areas represent completed surveys.

[1] Unsatisfactory Survey

[2] Survey Cancelled

Table 2b. Northeast Region Flight Centres - Moose aerial inventory schedule.

	1992/3	1993/4	1994/5	1995/6	1996/7	1997/8	1998/9	1999/0	2000/1	2001/2
Unit	**Plots**	**Plots**	**Plots**	**Plots**	**Plots**	**Plots**	**Hours**	**Hours**	**Hours**	**Hours**
01M							-	-	-	-
21B		56				40	-	-	36	-
22				40		37	-	-	44	-
23		40			40		-	43	-	-
24	92			55			50	-	-	50
25			TRANS			73	-	-	43	-
26		TRANS[1]			TRANS		-	40	-	-
27	40			41			37	-	-	37
28			50	38		38	-	-	31	-
29			40			38	-	-	45	-
30	40			39			42	-	-	42
31				45			-	45	-	-
32C				39			35	-	-	35
32			47			32	-	-	26	-
33P							-	-	-	-
33		57			32		-	30	-	-
34	19			31			30	-	-	30
35				46	41		45	-	-	45
36					34		-	39	-	-
37				45			42	-	-	42
38			55			41	-	-	52	-
39					35		-	32	-	-
40		50			37	39	-	42	-	-
41		51			36		-	34	-	-
42				45			41	-	-	41
45					9		-	14	-	-
46					40		-	51	-	-
47			44			40	-	-	36	-
49				40			54	-	-	54
Total/Avg.	**191**	**254**	**236**	**504**	**304**	**378**	**376**	**371**	**312**	**376**

Note: Shaded areas represent completed surveys.

[1] Transect Survey

Table 2c. Southcentral Region Flight Centre - Moose aerial inventory schedule.

	1992/3	1993/4	1994/5	1995/6	1996/7	1997/8	1998/9	1999/0	2000/1	2001/2
Unit	**Plots**	**Plots**	**Plots**	**Plots**	**Plots**	**Plots**	**Hours**	**Hours**	**Hours**	**Hours**
48	27			42			32	-	-	32
50	23			24			28	-	-	28
51	33	33	37	37		32	-	-	32	-
52	25	25	23	24		31	-	-	34	-
53			27			31	-	-	25	-
54					20		-	26	-	-
55A				28			21	-	-	21
55B		15		19			25	-	-	25
56						20	-	18	-	-
57					26	33	-	38	-	-
58					13	15	-	13	-	-
59					10		-	8	-	-
60		19			40		31	-	-	31
61				11	38		27	-	-	27
62					15		-	26	-	-
63				37		32	-	31	31	-
65				NSS[1]		10	-	-	8	-
76						10	-	-	8	-
Total/Avg.	**108**	**92**	**87**	**222**	**162**	**214**	**164**	**160**	**138**	**164**

Note: Shaded areas represent completed surveys.
[1] Unsatisfactory Survey

Total plots flown and future hours required.

Contingency	**0**						**200**	**200**	**200**	**200**
Total	**389**	**556**	**587**	**1129**	**884**	**819**	**1061**	**1131**	**1002**	**1061**

Ministry aircraft should be able to accommodate a full survey program as laid out in this plan once an optimal three-year rotation is re-established.

Survey Costs

Table 3 presents the number of plots needed to obtain a population estimate that is within 20 per cent of the true population size, 90 per cent of the time. Sample sizes are generally based on the results of the most recent survey. In most cases, optimal sampling intensity was calculated without stratification and using average density values. For several units, the most recent survey was not considered reliable and the density from the previous survey was used. In most instances stratification should reduce the number of plots required.

The time-on-plot allocated for each survey is 30 minutes for fixed-wing and 40 minutes for helicopter. This is about the provincial average for each aircraft type and it exceeds the minimum time-on-plot recommended in the Standards and Guidelines. It takes about 22 minutes to survey a plot with five lines at 80 kts (90 mph) if no moose are seen. The additional time allocation is intended to permit circling, accommodate slower helicopter speeds (required in rougher terrain and at higher moose densities) and to obtain age-sex information.

Ferry time was calculated as presented in Appendix II. Times were reduced for units where it was possible to base an aircraft closer to the WMU being surveyed than the normal base of operations.

For WMUs that are largely unhunted, primarily within caribou range or are on the southern edge of moose range, Table 3 provides an estimate of survey time and costs only for the portion of the unit that is considered to be significant moose range. While this approach might underestimate the total size of the population available to hunting, this should be by only a small number and the density of moose outside the “moose range” does not warrant the cost of a full survey.

In some units, a very large number of plots are required because the expected moose population density is very low. Again, this occurs primarily at the northern and southern edges of the moose range. It is logistically impractical and financially unreasonable to fly this number of plots. A nominal sample of plots has been allocated to these WMUs. The number of plots might be elevated if surveys provide information to suggest it is warranted. Alternatively, it may be possible to obtain the required information for moose as part of other surveys (e.g. for caribou) in some of these WMUs.

A resurvey of a sample of plots is important to build an understanding of the bias and level of accuracy of surveys. Costs have been included to resurvey 10 per cent of the plots in each unit at the same search intensity and with half the ferry time per plot.

Costs per hour are presented in 1998 MNR aircraft rates at $410.00 for Turbo Beavers and $650.00 for helicopters. The estimated average rate of $275.00 is used for commercial aircraft of the Cessna 180/185 type.

Pilot expenses, when aircraft are positioned away from the home base, were estimated at $100 per day (assuming three plots per day). Crew expenses of $4.50 per person per day (again based on three plots per day) and additional costs of $300.00 per survey are included in the cost estimate.

Table 4 provides annual cost assessment and the aircraft hours required.

Table 3a. Northwest Region Flight Centres - Moose aerial inventory cost estimates.

		Aircraft		Survey Parameters					Costs			
	District/				Res'y	Min/	Ferry			Pilot		
Unit	Area	Type[1]	$/hr.	Plot	Plots	Plot	Time	Hours	AC	Exp	Other	Total
01G	Geraldton											
01R	Sioux Lookout											
01S	Sioux Lookout											
02	Red Lake	MF	410	37	4	30	20	34	13735	1233	467	15435
02P	Red Lake	MF	410	34	3	30	20	30	12437	1133	453	14023
03	Red Lake	MF	410	39	4	30	20	35	14418	1300	476	16194
04	Sioux Lookout	MF	410	37	4	30	20	34	13735	1233	467	15435
05	Dryden	MR	650	37	4	40	20	40	26217		467	26683
06	Kenora	MR	650	33	3	40	20	36	23075	1100	449	24624
07A	Kenora	MR	650	20	2	40	20	22	14083	667	390	15140
07B	Kenora	MR	650	39	4	40	20	42	27517	1300	476	29292
08	Dryden	MR	650	33	3	40	15	33	21206		449	21655
09A	Fort Frances	MR	650	33	3	40	25	38	24944	1100	449	26492
09B	Fort Frances	MR	650	32	3	40	20	35	22425	1067	444	23936
10	Fort Frances	MF	410	25	3	30	20	23	9362	833	413	10608
11A	Fort Frances	MF	410	32	3	30	20	29	11753	1067	444	13264
11B	Thunder Bay	MF	410	25	3	30	20	23	9362	833	413	10608
11Q	Atikokan	MR	650	33	3	40	15	33	21206	1100	449	22755
12A	Atikokan	MR	650	33	3	40	20	36	23075	1100	449	24624
12B	Atikokan	MR	650	35	4	40	15	35	22913	1167	458	24537
13	Thunder Bay	MR	650	38	4	40	20	41	26867		471	27338
14	Nipigon	MR	650	33	3	40	15	33	21206	1100	449	22755
15A	Ignace	MF	410	38	4	30	30	41	16810	1267	471	18548
15B	Thunder Bay	MF	410	39	4	30	30	42	17220	1300	476	18996
16A	Sioux Lookout	MF	410	45	5	30	25	45	18365	1500	503	20367
16B	Sioux Lookout	MF	410	46	5	30	30	50	20398		507	20905
16C	Thunder Bay	MF	410	45	5	30	20	41	16742	1500	503	18744
17	Geraldton	MF	410	40	4	30	30	43	17630	1333	480	19443
18A	Geraldton	MF	410	46	5	30	25	46	18740	1533	507	20781
18B	Geraldton	MF	410	40	4	30	30	43	17630	1333	480	19443
19	Geraldton	MF	410	42	4	30	20	38	15443	1400	489	17332
20 **	Nipigon	MR	650	10	1	40	25	12	7610	333	345	8289
21A	Terrace Bay	MR	650	41	4	40	20	44	28817	1367	485	30668
Sum/Avg.			**522**	**1060**	**108**	**35**	**22**	**1073**	**554940**	**30200**	**13770**	**598910**
Fixed-wing:	Time available =		180 hr		Average annual needs			198	81260	6267	2515	90041
Helicopter:	Time available =		180 hr		Average annual needs			160	103720	3800	2075	109595

** Plots are not standard size. Cost estimates are based on an equivalent area of standard plots.

[1] MF = Ministry Fixed Wing; MR = Ministry Helicopter; CF = Commercial Fixed Wing

Table 3b. Northeast Region Flight Centres - Moose aerial inventory cost estimates.

		Aircraft		Survey Parameters					Costs			
	District/				Res'y	Min/	Ferry			Pilot		
Unit	Area	Type[1]	$/hr.	Plot	Plots	Plot	Time	Hours	AC	Exp	Other	Total
01M	Moosonee											
21B	Manitou	MF	410	40	4	30	20	36	14760	1333	480	16573
22	Hearst	MR	650	37	4	40	25	44	28329	1233	467	30029
23	Kapuskasing	MR	650	40	4	40	20	43	28167	1333	480	29980
24	Kapuskasing	MF	410	55	6	30	20	50	20432	1833	548	22813
25	Moosonee	MF	410	40	4	30	30	43	17630	1333	480	19443
26	Cochrane	MF	410	40	4	30	25	40	16195	1333	480	18008
27	Cochrane	CF	300	41	4	30	20	37	11050	1367	485	12901
28	Kirkland Lake	CF	300	38	4	30	15	31	9300	1267	471	11038
29	Gogama	MR	650	38	4	40	25	45	29033		471	29504
30	Timmins	MR	650	39	4	40	20	42	27517		476	27992
31	Chapleau	MR	650	42	4	40	20	45	29467	1400	489	31356
32C	Wawa	MF	410	39	4	30	20	35	14418	1300	476	16194
32	Wawa	MF	410	32	3	30	15	26	10609	1067	444	12119
33P	Parks Canada			0	0	0	0					0
33	Wawa	MF	410	34	3	30	20	30	12437	1133	453	14023
34	Wawa	MR	650	30	3	40	15	30	19419		435	19854
35	Sault Ste. Marie	MR	650	38	4	40	25	45	29033	1267	471	30771
36	Sault Ste. Marie	MR	650	36	4	40	20	39	25567		462	26029
37	Sault Ste. Marie	MF	410	39	4	30	30	42	17220	1300	476	18996
38	Espanola	MR	650	41	4	40	30	52	33475		485	33960
39	Espanola	MF	410	35	4	30	20	32	13052		458	13509
40	North Bay	MR	650	39	4	40	20	42	27517	1300	476	29292
41	North Bay	MF	410	37	4	30	20	34	13735	1233	467	15435
42	Sudbury	MR	650	38	4	40	20	41	26867		471	27338
45	Sault Ste. Marie	MF	410	15	2	30	20	14	5672		368	6039
46	Parry Sound	MF	410	52	5	30	25	51	20995	1733	534	23263
47	North Bay	MF	410	40	4	30	20	36	14760	1333	480	16573
49	Parry Sound	MR	650	50	5	40	20	54	35208	1667	525	37400
Sum/Avg.			**509**	**1045**	**107**	**33**	**21**	**1058**	**551862**	**25767**	**12803**	**590431**
Fixed-wing:	Time available =		180 hr		Average annual needs			185	82966	5444	2369	90779
Helicopter:	Time available =		360 hr		Average annual needs			168	100988	3144	1899	106032

[1] MF = Ministry Fixed Wing; MR = Ministry Helicopter; CF = Commercial Fixed Wing

Table 3c. Southcentral Region Flight Centre - Moose aerial inventory cost estimates.

		Aircraft		Survey Parameters					Costs			
	District/				Res'y	Min/	Ferry			Pilot		
Unit	Area	Type[1]	$/hr.	Plot	Plots	Plot	Time	Hours	AC	Exp	Other	Total
48	Pembroke	MF	410	33	3	30	25	32	13274	1100	449	14822
50	Bracebridge	MR	650	25	3	40	20	28	17875	833	413	19121
51	Algonquin Park	MR	650	32	3	40	15	32	20610		444	21054
52	Algonquin Park	MR	650	31	3	40	20	34	21775		440	22215
53	Bracebridge	MF	410	31	3	30	15	25	10301		440	10741
54	Minden	MF	410	29	3	30	20	26	10728	967	431	12126
55A	Bancroft	MF	410	23	2	30	20	21	8405	767	404	9575
55B	Pembroke	MR	650	25	3	40	15	25	16440	833	413	17685
56	Minden	MF	410	20	2	30	20	18	7380		390	7770
57	Bancroft	MR	650	33	3	40	25	38	24944	1100	449	26492
58	Pembroke	MF	410	15	2	30	15	13	5125		368	5493
59	Pembroke	MF	410	10	1	30	15	8	3331		345	3676
60	Bancroft	MF	410	32	3	30	25	31	12898	1067	444	14409
61	Mazinaw	MF	410	27	3	30	25	27	11019	900	422	12340
62	Carlton Place	MF	410	24	2	30	30	26	10455	800	408	11663
63	Mazinaw	MF	410	32	3	30	25	31	12898	1067	444	14409
65 **	Carlton Place	CF	300	10	1	30	15	8	2438	333	345	3116
76	Huronia	MF	410	10	1	30	15	8	3331	333	345	4010
Sum/Avg			**471**	**442**	**41**	**33**	**20**	**431**	**213227**	**10100**	**7389**	**230716**
Fixed-wing:	Time available =		90 hr		Average annual needs			91	37194	2444	1744	41383
Helicopter:	Time available =		90 hr		Average annual needs			52	33881	922	719	35522

** Plots are not standard size. Cost estimates are based on an equivalent area of standard plots.

[1] MF = Ministry Fixed Wing; MR = Ministry Helicopter; CF = Commercial Fixed Wing

Provincial Summary												
Sum/Avg.			**1501**	**2547**	**256**	**34**	**21**	**2562**	**1320028**	**66067**	**33962**	**1420057**
Fixed-wing:	Time available =		450 hr		Average annual needs			475	201420	14156	6628	222203
Helicopter:	Time available =		540 hr		Average annual needs			379	238590	7867	4693	251149

Table 4a. Northwest Region Flight Centres - Moose aerial inventory schedule and costs.

	1998/99 Surveys			1999/2000 Surveys			2000/01 Surveys			2001/02 Surveys		
Unit	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**
01G												
01R												
01S												
02	34	13735	15435							34	13735	15435
02P				30	12437	14023						
03							35	14418	16194			
04							34	13735	15435			
05							40	26217	26683			
06							36	23075	24624			
07A				22	14083	15140						
07B				42	27517	29292						
08				33	21206	21655						
09A	38	24944	26492							38	24944	26492
09B	35	22425	23936							35	22425	23936
10				23	9362	10608						
11A				29	11753	13264						
11B	23	9362	10608							23	9362	10608
11Q	33	21206	22755							33	21206	22755
12A							36	23075	24624			
12B	35	22913	24537							35	22913	24537
13	41	26867	27338							41	26867	27338
14							33	21206	22755			
15A							41	16810	18548			
15B				42	17220	18996						
16A	45	18365	20367							45	18365	20367
16B				50	20398	20905						
16C							41	16742	18744			
17				43	17630	19443						
18A							46	18740	20781			
18B				43	17630	19443						
19	38	15443	17332							38	15443	17332
20 **							12	7610	8289			
21A				44	28817	30668						
Sum/Avg.	**321**	**175259**	**188799**	**401**	**198052**	**213436**	**352**	**181629**	**196675**	**321**	**175259**	**188799**
Fixed-wing	139	56905	63742	260	106429	116681	196	80445	89701	139	56905	63742
Helicopter	182	118354	125057	141	91623	96755	156	101183	106974	182	118354	125057

** Plots are not standard size. Cost estimates are based on an equivalent area of standard plots.

Table 4b. Northeast Region Flight Centres - Moose aerial inventory schedule and costs.

	1998/99 Surveys			1999/2000 Surveys			2000/01 Surveys			2001/02 Surveys		
Unit	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**
01M												
21B							36	14760	16573			
22							44	28329	30029			
23				43	28167	29980						
24	50	20432	22813							50	20432	22813
25							43	17630	19443			
26				40	16195	18008						
27	37	11050	12901							37	11050	12901
28							31	9300	11038			
29							45	29033	29504			
30	42	27517	27992							42	27517	27992
31				45	29467	31356						
32C	35	14418	16194							35	14418	16194
32							26	10609	12119			
33P												
33				30	12437	14023						
34	30	19419	19854							30	19419	19854
35	45	29033	30771							45	29033	30771
36				39	25567	26029						
37	42	17220	18996							42	17220	18996
38							52	33475	33960			
39				32	13052	13509						
40				42	27517	29292						
41				34	13735	15435						
42	41	26867	27338							41	26867	27338
45				14	5672	6039						
46				51	20995	23263						
47							36	14760	16573			
49	54	35208	37400							54	35208	37400
Sum/Avg.	**376**	**201164**	**214258**	**371**	**192802**	**206934**	**312**	**157896**	**169240**	**376**	**201164**	**214258**
Fixed-wing	127	52070	58002	244	110252	120257	141	57759	64709	127	52070	58002
Helicopter	249	149094	156256	127	82550	86677	171	100138	104531	249	149094	156256

Table 4c. Southcentral Region Flight Centre - Moose aerial inventory schedule and costs.

	1998/99 Surveys			1999/2000 Surveys			2000/01 Surveys			2001/02 Surveys		
Unit	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**	**Hrs.**	**Aircraft**	**Total**
48	32	13274	14822							32	13274	14822
50	28	17875	19121							28	17875	19121
51							32	20610	21054			
52							34	21775	22215			
53							25	10301	10741			
54				26	10728	12126						
55A	21	8405	9575							21	8405	9575
55B	25	16440	17685							25	16440	17685
56				18	7380	7770						
57				38	24944	26492						
58				13	5125	5493						
59				8	3331	3676						
60	31	12898	14409							31	12898	14409
61	27	11019	12340							27	11019	12340
62				26	10455	11663						
63				31	12898	14409	31	12898	14409			
65 **							8	2438	3116			
76							8	3331	4010			
Sum/Avg	**164**	**79910**	**87953**	**160**	**74861**	**81628**	**138**	**71353**	**75544**	**164**	**79910**	**87953**
Fixed-wing	111	45595	51146	122	49918	55136	73	28968	32275	111	45595	51146
Helicopter	53	34315	36806	38	24944	26492	65	42385	43269	53	34315	36806

** Plots are not standard size. Cost estimates are based on an equivalent area of standard plots.

Provincial Summary												
Fixed-wing	377	154570	172890	625	266599	292074	410	167172	186685	377	154570	172890
Helicopter	484	301763	318119	306	199117	209924	392	243706	254773	484	301763	318119
Contingency Surveys	200	82000	82000	200	82000	82000	200	82000	82000	200	82000	82000
Age/Sex Surveys	30	20000	20000	30	20000	20000	30	20000	20000	30	20000	20000
Training			30000			30000			30000			30000
Sum/Avg.	**1091**	**558333**	**623009**	**1161**	**567715**	**633998**	**1032**	**512878**	**573459**	**1091**	**558333**	**623009**

Funding Flexibility

This plan is designed to meet the minimum statistical requirements to conduct aerial inventories suitable for current moose management purposes. During implementation, many things (usually other work pressures or weather conditions) may intervene to affect the final delivery of the surveys. To the greatest extent possible, an effort will be made to maintain the integrity of the plan by switching surveys among units. This will be done to minimize logistic problems that will result if surveys are postponed. The plan also includes contingency funding to refly surveys that were not completed satisfactorily.

While a plan of this nature uses very detailed cost estimates to arrive at a reasonable total program cost, it is unrealistic to expect expenditures to be entirely accurate. The plan is based on the principle that one central fund should be maintained to cover all survey costs and that Districts charge expenses to that account. This will ensure, to the greatest extent possible, that there is flexibility to maintain the scientific integrity of the surveys. To do otherwise would mean that some surveys would be over funded (and the surplus funds "wasted") while other surveys would be under funded and insufficient sampling would be done.

It is imperative with central funding that flying be done according to the *Standards and Guidelines for Moose Aerial Inventory in Ontario* and with regard to the time allocations laid out within this plan. Survey implementation will be monitored by aircraft dispatchers to assess how closely individual surveys are conforming to time and budget allocations. Where expenditures may significantly exceed the planned allocation, decisions will be made on a case by case basis whether to complete a planned number of plots and accept the added costs, require the district to pay for additional costs or terminate the survey early and reassign the aircraft to the next planned unit.

The small size of the many Wildlife Management Units has been identified as a significant factor in the high cost of surveys especially in south central Ontario. There are also related logistic and social problems. A review of moose management problems is anticipated in this area and this may impact both the survey cycle and survey costs.

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Appendix I: Criteria for Establishing Priority for Surveys.

This list is based on three principles: first, obtaining sufficient population numbers to monitor the provincial herd (the Terms and Considitons of Approval of the Timber EA); second, cover WMUs with sufficient frequency to provide reliable information for tag allocations; and third, contribute to an understanding of the population potential for moose.

1. Length of time since previous survey: Policy states a survey should be done once every three years.
2. WMUs in which the moose herd has been declining over previous surveys or in which there are indications from other information (harvest surveys), that the population may be declining.
3. Location of the WMU: WMUs located in core moose range should have high priority.
4. Hunting pressure: WMUs with heaviest hunting pressure should have high priority. Hunting pressure can be estimated by dividing best estimate we have of population size by the number of P1C1 (pool 1, choice 1) (bulls + cows) applicants. The smaller the number the greater the hunting pressure. Also WMUs with a high per cent of tourist outfitter tags should have high priority.
5. WMUs that are below the year 2000 target or population potential.
6. WMUs scheduled for a survey last year but were not done for logistical reasons.
7. WMUs of special interest. WMUs that are above the year 2000 target and approaching what is believed to be the carrying capacity and so may be close to a crash. WMUs that are the subject of ongoing moose research.

The foregoing criteria establish the order in which surveys are conducted both within and among years to ensure that essential information is obtained for sustainable management of moose populations. The type of aircraft recommended in the survey plan is based on both biological and social needs. In the event that adequate funding is not obtained to implement the plan as intended, then the biological needs should supercede the social ones and aircraft should be changed to less desirable ones, rather than postponing or cancelling surveys.

Appendix II. Estimate of Ferry Time from the Nearest Airbase

In establishing this *Moose Population Inventory Plan*, time-on-plot was set at 30 minutes for fixed wing aircraft and 40 for helicopter. Ferry time was estimated from previous surveys, but in some instances there were differences between fixed and rotary wing aircraft, proposed changes in the allocation of aircraft type from past surveys and apparent errors in the information on which ferry time calculations were made. As one way of attempting to establish equity in the funding for aircraft ferry time, a separate estimate was calculated from distance to the unit as presented below.

Distance was measured (in kilometres) from the town where the aircraft would normally be based for the survey and from which daily flying would be expected. Usually this was the location of an MNR district office. For WMUs 46 and 49, the distance was taken from Bracebridge rather than Sudbury, because it was closer. For WMUs 25 and 26, the measure was to the center of "moose range" and for WMUs 51 and 52 from the MNR base in the park. WMU 65 was estimated from Ottawa.

The estimate does not consider whether fixed or rotary wing aircraft are used and does not consider positioning costs. This has an impact for the Muskoka flight center, since the helicopter is based in Bracebridge and the Turbo in Pembroke. Presumably, aircraft will be positioned to the appropriate location for optimal survey completion and not ferried each day. Further, in many instances, helicopters can make use of fuel caches not available to fixed wing aircraft and this may help reduce ferry time.

The formula for average time per plot assumes four plots per day, ferry distance per day (km ⌉ 2 = nautical miles (nm); nm ↔ 2 = distance there and back), divided by an average air speed of 110 knots. Total hours equals number of plots multiplied by the average time per plot.

This assessment is not intended as an accurate estimate of ferry time but is only one piece of a more complex allocation process. The method does not effectively include ferry time between plots. This is largely a function of unit size and the number of plots surveyed. Smaller units and those with lower densities have relatively more plots and lower ferry time between them. It would be possible to estimate this time and positioning times, but it is probably best to leave these to *post hoc* assessments once surveys are completed with appropriate aircraft and actual flight times determined.

Time allocations were assigned more or less in the following manner:

- less than 50 km equals 15 min,
- 55 to 90 km equals 20 min,
- 95 to 120 km equals 25 min, and
- great than 120 km equals 30 min.

In small southern Ontario units times are reduced because plots are expected to be close together. Times should be amended as surveys are flown and more accurate estimates become available.

Appendix Table 1a. Northwest Region Flight Centres - estimated ferr times.

WMU	Plots	AC Type	Position Distance	Ferry Time	Total Time
01G *					
01R *					
01S *					
02	37	MF	90	20	12
02P	34	MF	80	20	11
03	39	MF	60	20	13
04	37	MF	75	20	12
05	37	MR	60	20	12
06	33	MR	55	20	11
07A	20	MR	55	20	7
07B	39	MR	60	20	13
08	33	MR	35	15	8
09A	33	MR	95	25	14
09B	32	MR	55	20	11
10	25	MF	65	20	8
11A	32	MF	90	20	11
11B	25	MF	80	20	8
11Q	33	MR	45	15	8
12A	33	MR	70	20	11
12B	35	MR	35	15	9
13	38	MR	65	20	13
14	33	MR	45	15	8
15B	39	MF	140	30	20
15A	38	MF	170	30	19
16A	45	MF	110	25	19
16B	46	MF	140	30	23
16C	45	MF	80	20	15
17	40	MF	190	30	20
18A	46	MF	110	25	19
18B	40	MF	150	30	20
19	42	MF	75	20	14
20**	10	MR	110	25	4
21A	41	MR	70	20	14
Total/Avg.	**1060**		**85**	**22**	**387**

* Transect surveys not included in plot totals or averages.
** Plots are not standard size.

Appendix Table 1b. Northeast Region Flight Centres - estimated ferry times.

WMU	Plots	AC Type	Position Distance	Ferry Time	Total Time
01M *					
21B	40	MF	85	20	13
22	37	MR	95	25	15
23	40	MR	85	20	13
24	55	MF	80	20	18
25	73	MF	125	30	37
26	60	MF	100	25	25
27	41	CF	65	20	14
28	38	CF	45	15	10
29	38	MR	95	25	16
30	39	MR	80	20	13
31	42	MR	75	20	14
32C	39	MF	90	20	13
32	32	MF	45	15	8
33P	0				0
33	34	MF	60	20	11
34	30	MR	45	15	8
35	38	MR	100	25	16
36	36	MR	55	20	12
37	39	MF	150	30	20
38	41	MR	130	30	21
39	35	MF	55	20	12
40	39	MR	70	20	13
41	37	MF	70	20	12
42	38	MR	60	20	13
45	15	MF	55	20	5
46	52	MF	95	25	22
47	40	MF	65	20	13
49	50	MR	75	20	17
Total/Avg.	**1098**		**80**	**21**	**402**

* Transect surveys not included in plot totals or averages.
** Plots are not standard size.

Appendix Table 1c. Southcentral Region Flight Centre - estimated ferry times.

WMU		AC	Position	Ferry	Total
	Plots	Type	Distance	Time	Time
48	33	MF	100	25	14
50	25	MR	60	20	8
51	32	MR	40	15	8
52	31	MR	65	20	10
53	31	MF	25	15	8
54	29	MF	60	20	10
55A	23	MF	75	20	8
55B	25	MR	30	15	6
56	20	MF	55	20	7
57	33	MR	95	25	14
58	15	MF	50	15	4
59	10	MF	45	15	3
60	32	MF	110	25	13
61	27	MF	115	25	11
62	24	MF	135	30	12
63	32	MF	95	25	13
65 **	10	CF	50	15	3
76	10	MF	50	15	3
Total/Avg.	**442**		**70**	**20**	**153**

** Plots are not standard size.

Province					
Total/Avg.	**2600**		**78**	**21**	**942**

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