MANAGEMENT OF MOOSE POPULATIONS: WHICH PARAMETERS ARE USED?

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ABSTRACT: This paper discusses the collection and application of moose aerial survey data by management jurisdictions in North America. Of 17 jurisdictions sampled, 16 flew surveys and of these 15 did population surveys and classified counts while one did classified counts only. The frequency of aerial surveys varied from 1 to 10 years with most flying at 2 to 5 year intervals. Information relative to how the data are used and criteria for assessing population health are presented. Eleven agencies collected age data and the use of it is presented. Ten agencies indicated that they use a population model for simulating populations. Twelve parameters for assessing the health of moose populations are presented and recommended for use. In the interest of maintaining long term monitoring programs, parameters used should be simple, stable and cost effective. These are more likely to be used by managers. Monitoring programs should be directed at those parameters which will be leading indicators of future trends in moose populations.

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Karns *et al* (1974) and Crichton (1987, 1988) have dealt holistically with moose management in North America and the associated issues and problems, and suggested the direction such management should take. They did not deal with those parameters available to assess herd status which are essential in formulating management decisions. Some authors (Addison and Timmermann 1974, Bubenik 1971, Bubenik *et al* 1975, Crête and Dussault 1987, Fraser 1976, Moen and Ausenda 1987 and Myrberget 1988) have dealt with specific parameters which can be used. A list of parameters currently used by management agencies in assessing population well being has not been compiled.

Crichton (1987) suggested nine impediments to sound moose management, including lack of funding, and he further suggested (Crichton 1988) that managers must look at new initiatives to raise funds for management. At the same time, managers should demonstrate an ability to fully analyze and use the available data before new funding is accepted or is likely to be offered. Mercer (1976) suggested that much of the data collected are used superficially and this may be due to a lack of qualified people to do in-depth analyses. There is a pressing need to utilize all techniques for analysis of data on population status. Page (1983) suggested that management requires innovative ideas to handle increasingly complex tasks and decisions. The difficulty arises because many of the most advanced and powerful ideas are commonly couched in mathematical terms and formulations that are obscure to biologists. There have been relatively few attempts by biological mathematicians to reach field level biologists. I suggest that the reverse is also true.

The purpose of this paper is two-fold. First, I report on a survey of North American management agencies to ascertain: (1) if they fly aerial surveys for moose and how they use the data, (2) if they collect age data on harvested animals and how they use the data and, (3) if they use a simulation model. Secondly, I recommend parameters that management agencies should consider in assessing the status of moose populations. This compilation can be added to as new techniques and ideas are verified as useful.

METHODS

Seventeen jurisdictions were surveyed and asked the following questions:

1) Do you fly aerial surveys for moose?
2) If yes to 1), what type of aerial surveys and how frequently?
3) From the survey data generated what parameters are used to assess population status?
4) Do you collect teeth from harvested animals and what parameters are generated from this to assess population status?
5) Do you use a simulation model for moose?

RESULTS

Of 17 jurisdictions (9 Canadian provinces, 2 Canadian territories and six states in the United States) surveyed, 16 indicated they flew aerial surveys, one agency indicated they would no longer do these starting in 1990, one did not. Of the 16, 15 did population surveys and classified counts while one did only classified counts. The frequency of aerial surveys varied from 1 to 10 years with 3 indicating surveys were not on a set schedule. Eleven indicated that surveys were flown at intervals of 2 to 5 years. Statements relative to the use of these data are as follows:

- to justify license quotas and allocations for commercial use.
- to set population objectives and harvest levels.
- used in population models.
- to determine recruitment (calves/100 cows).
- to ascertain population size (density) and composition.
- to examine the ratio of large versus small antlered bulls.
- to determine the annual allowable harvest.
- in public discussions to explain management decisions or need for action.
- to identify key areas for moose that are used in land utilization discussions.
- to determine success of specific hunting strategies.
- to determine moose sighted per hour of survey time (trend data).
- the data are not used.

Eleven agencies collect teeth, determine ages of the harvested animals and use the data in the following manner:

- to examine age structure of adults harvested (animals one year of age and older).
- used along with harvest and survey data to construct a picture of population dynamics of specific herds.
- as a public relations gesture by advising hunters of the age of their animal. The presence of hunters in Department offices allows for communication between managers and the public which otherwise would not occur or be minimal.
- to determine percentage of 1.5 year old animals in the population and females 2.5 years of age and older.
- when reproductive tracts are submitted, to ascertain age of females.
- to ascertain if hunting seasons occur too early.
- to ascertain success of selective harvest systems.
- examine along with antlers to look at antler structure in relation to age (particularly the difference between 1.5 and 2.5 year old animals) which is done because of strict hunting regulations. Ten of the 17 agencies indicated that they used population models. Four indicated they did not have access to one. Models were used for setting harvest quotas, to develop an index of population condition and to assess populations trends.

DISCUSSION/RECOMMENDATIONS

Given the variation that can occur annually in specific parameters, it is essential that monitoring of moose populations be done with as many parameters as possible. It is by this method only that managers can have a realistic chance of quickly detecting changes in populations, to determine if population objectives are being met, and to enact remedial measures. In addition, monitoring pro-

grams which give direction for management of moose should be directed at those parameters which managers believe will be leading indicators of future trends in moose populations.

In interpreting data, an adequate baseline must be established if monitoring results are to be correctly interpreted; this exemplifies the value of long term monitoring. Classified counts, for example, flown every three or four years represent little more than point estimates in time and are not reliable indicators of trends in a population because of annual variations. It is suggested that managers should also gather data on those factors which have the potential to impact the management parameters being used.

Because of current fiscal restraints and in the interest of maintaining long term monitoring programs, the indicators collected should be simple, stable and cost effective. The added benefit is that simple measurements require less complex analysis and interpretation and are more likely to be collected and used by managers. Stable measurements are those that are not sensitive to small variations in technique. For management purposes it is suggested that a set of simple and stable measurements be identified and collected over the long term to provide a basis for detecting critical changes in moose populations.

Long term monitoring programs for moose management are an essential aspect of management recognizing that in some cases expensive programs such as aerial surveys may not be possible nor needed on an annual basis (this was suggested by all agencies who fly surveys). The availability of computer programs for monitoring annual changes in populations negates the need for annual surveys. In addition to computer modeling, other opportunities to augment management data must be examined. Population counts may only be needed every 3-5 years for most populations where human harvest and predation are known variables. Where bull only seasons exist classified counts may be needed more frequently and perhaps on an annual basis.

Timing of such monitoring activities is critical and can severely impact the results. Lynch (1975) has suggested the importance of flying population surveys in late November or early December because of post rut movement characteristics. Aerial surveys must be done within appropriate time horizons to minimize variations and maximize the usefulness that can be attained over the long term.

It is important to examine each management scenario and use those factors which will assist in assessing population well being. In Quebec, a set of 11 factors have been identified as essential in assessing the population dynamics of specific herds.

Advanced planning is necessary to ensure all issues are evaluated. This provides managers, administrators and the public, when appropriate, the opportunity to be proactive rather than reactive. A proactive approach allows managers to enact a planned management strategy for the resource as suggested by Crichton (1987) whereas the latter generally leaves them reacting to daily issues with little time for in depth planning, data analyses, and setting a course of action for dealing with contemporary issues/concerns.

The challenge is to develop a set of criteria for use by managers which will illustrate that data use is being maximized and that management is being conducted at the highest professional level. It is important in managing moose that changes and the potential impact of such changes be identified early enough so that remedial action can be undertaken to overcome identified concerns.

Myrberget (1988) has suggested that yield statistics may indicate major changes in the population levels of large mammals. Hunting and/or kill statistics are essential for proper management of many game species but should be supplemented with data on age, reproduction and sex ratios in order to obtain an adequate

picture of the health of moose populations.

Successful management of moose is based upon a good inventory of living animals and the number of animals which have been harvested or died due to various causes. Bubenik (1971) and Bubenik *et al* (1975) have suggested that in order to manage moose for optimum social well being managers should rely not only on numerical censuses, but must also have an inventory of population structure. Bubenik has stimulated interest in age and sex specific harvesting. He recommends a balanced age and sex structure to reduce social strife and produce healthy moose with better antler growth.

Population data can be useful in demonstrating the impact and merits of assorted management programs. Crête (1987), Gasaway and Dubois (1987), Page (1987) and Van Ballenberghe (1987) have illustrated how our understanding of moose population dynamics and management has been enhanced by improving population data.

I recommend the following parameters to assess the health of moose herds.

- mean age of adults.
- percentage of 1.5 year old animals in the harvest.
- harvest by area.
- moose seen per hour of survey time.
- percentage of adult males and females in the population.
- ratio of calves/100 females.
- ratio of bulls/100 females.
- estimates of animals removed by poaching, subsistence users and predators.
- sex of calves in the population.
- productivity of females 2.5 years of age and older.
- percentage of 1.5 year old females breeding.
- moose seen and/or harvested per day by hunters.

Those applicable in each jurisdiction will depend on the type of hunting strategy employed and other factors unique to specific populations. These factors may include non hunting mortality, uncontrolled harvest, sex variability in foetuses, predation, access, habitat maturation and logging activities. Although these parameters are recommended, each jurisdiction should develop proactive management programs and use these criteria to ascertain if population objectives are being met and herds are socially balanced. Hopefully, jurisdictions will view these as a basis for developing suitable parameters for their respective management programs. Those referenced are presently used by management agencies but it is not implied that each is used by all.

Individual parameters used alone are of little value but when used in conjunction with others may give the manager an indication of trends and/or health of the population.

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