ADAPTIVE MANAGEMENT OF MOOSE IN ONTARIO

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ABSTRACT: Early policy decisions affecting moose (*Alces alces*) management in Ontario were based on data that were not reliable, but were the only basis available for policy development. As data collection increased in accuracy and reliability, policy decisions have also improved. In the last decade of the 20th century, adaptive management has been discussed and advocated as the best approach to managing natural resources since it was first developed in the early 1970s. The Ontario Ministry of Natural Resources has instituted at least some of the characteristics of adaptive management in managing moose. The 1960s and 1970s were periods of extensive learning and maturation for biologists and wildlife managers with respect to Ontario's moose herd. The experience and knowledge gained from these periods were used to develop goals and objectives which would eventually become Ontario's 1980 moose policy and the first steps of adaptive management. The later phases of the adaptive approach, to evaluate the earlier objectives and learn from them, are reviewed and discussed. The goals established in 1980, probably cannot be achieved, however, the learning associated with the process is important in order to manage adaptively.

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Moose (*Alces alces*) management in Ontario began with R. L. Peterson's investigations during 1949-51 which provided the basis for early management policy and the starting point for subsequent investigations (Cumming 1974). Early management objectives of the 1940s grew from a philosophy of conserving and protecting wildlife via enforcement of regulations made under The Game and Fish Act (Cumming 1974). Moose management at this time was in its infancy as biologists and wildlife managers strove to uncover the uncertainties of age and sex ratios, herd numbers, preferred habitats, diet, birth rates, range, influence of predators, and anthropogenic impacts. Some 50 years have past since Peterson's first investigations, and it is time to review progress in managing Ontario's moose herd.

Using Ontario as a case study, the objective of this paper is to evaluate past management decisions with respect to current theories of adaptive resource management. This discussion will examine, in chronological order, Ontario's use of adaptive management techniques, with specific attention paid to Ontario's 1980 Moose Policy. It should be noted that this paper is a commentary, which portrays the opinions and views of the authors with regards to Ontario's use of adaptive management to manage moose.

ADAPTIVE MANAGEMENT

Although there is no clear consensus on what does or does not constitute adaptive

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management, it is generally known "as a formal process for continually improving management policies and practices by learning from their outcome" (Taylor et al. 1997: 2). The most common difference between adaptive and traditional approaches to management is that traditional approaches typically lack reliable feedback mechanisms that encourage learning. Furthermore, adaptive management differs from traditional approaches because it is a systematic, rigorous approach to learning by doing, rather than a haphazard, trial and error approach.

The first critical step in adaptive management is to develop clear, defined management objectives in terms of ecosystem function. The adaptive process is a systematic, cumulative approach to learning, where without clearly defined objectives, learning cannot begin. Thus, management objectives must contain measurable goals, specified over appropriate time frames and spatial scales from which to learn about the ecosystem.

Once management objectives have been stated, the next step is to identify questions and uncertainties about the ecosystem in order to develop the best policy (Taylor et al. 1997). Management must ask the "need to know questions" that will distinguish whether or not the objectives have been achieved. As well, recognizing uncertainty about the ecosystem is necessary to avoid asking "nice to know" questions, rather than those that contribute to learning. Unfortunately recognizing uncertainty is difficult because it often leads to controversy and adverse reaction from peers or the public.

The third step in adaptive management is to explore potential effects of alternative hypotheses on key response indicators (Taylor et al. 1997). In the context of moose management, key response indicators may be changes in hunter harvest rates, sex or age distributions, or population counts. This exploration is achieved through the design of (experimental) management policies (or models) and monitoring schemes for reliable feedback. Staff creativity and experience is of the utmost importance at this stage, especially when discrimination between alternative hypotheses becomes difficult, sometimes requiring new approaches that deviate from the norm (Hilborn et al. 1979, Walters 1986, McAllister and Peterman 1992). For example, traditional approaches used in the natural sciences (biology, forestry, and ecology) may give way to new approaches developed in the social sciences (human dimensions) as a way of exploring alternative hypotheses (Applegate and Witter 1984, Lautenschlager and Bowyer 1985, Decker and Richmond 1994, Decker and Enck 1996, Bottan 1999, Bottan et al. 2001).

Perhaps one of the most important steps in the process of adaptive management is monitoring. Gibbs et al. (1999) described monitoring as the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting management objectives. Several proponents of the adaptive process (Holling 1978, Ringold et al. 1996) have advocated the role of monitoring in the adaptive management process. This is particularly important when evaluating the utility of several alternative hypotheses and the success of stated management objectives (Gibbs et al. 1999).

The last steps in the adaptive management process are feedback loops, where collected data are analyzed, management objectives are adjusted, and information is communicated to policy makers and the public. Predetermined changes (qualitative or quantitative) in key indicators should trigger predetermined changes in management activities or objectives (Taylor et al. 1997). Although there are many other steps in the adaptive process where failure may

occur, perhaps the feedback process is the most critical. To quote Hilborn (1992: 12), "if you cannot respond to what you have learned, you really have not learned at all". Even the best management objectives, monitoring programs, and data analyses will go to waste if one cannot apply what one has learned.

In conclusion, despite the intuitive appeal of the adaptive management concept, there are few examples in wildlife management where it has been applied successfully (Gibbs et al. 1999). There are numerous pitfalls such as technical, economic, ecological, institutional, and social challenges that affect the implementation and effectiveness of adaptive management. Adaptive management requires managers and decision makers who are willing to learn by doing, and who acknowledge that making mistakes is part of learning (Taylor et al. 1997).

CASE STUDY

The objective of this paper is to discuss Ontario's use of adaptive management in the context of managing moose. Due to the vast number of management decisions that have occurred over the past 50 years, only a few points from selected decades will be used to illustrate Ontario's use of adaptive management or the lack thereof. Special attention is paid to Ontario's 1980 Provincial Moose Policy.

The 1960s

The 1960s witnessed for the first time in Ontario's moose management history a new Division of Fish and Wildlife policy statement containing 4 management principles. The thrust of these principles concentrated on maximum sustainable yield, multiple and full uses of the resource, and recognition of public uses. The intent was to provide hunters with more hunting opportunities, to protect and increase the existing herd, and to provide others with opportunities to use the same land in which moose inhabit (Cumming 1974).

These policy statements, written at a time when adaptive management was not well developed, were typical for that time. For example, in 1967, one of the statements of purpose concerning moose management in Ontario was: "To provide the most hunting and viewing of moose which can be sustained without interfering with other interests" Cumming (1974 : 676). In 1969, the purpose was revised "To provide: (1) a moose population as large as can be reconciled with timber production and forest management in general, and (2) as much hunting and viewing as the populations will sustain." Cumming (1974 : 676).

While these statements indicate a great purpose, they have little or no measurable attributes. Thus, after the policy was implemented and several years elapsed, little or no opportunity was available to learn from the policy. Adaptive management advocates that clear management objectives be established with measurable outcomes in order to foster learning. Without that first critical step, subsequent learning is much more difficult, if not impossible.

The 1970s

The 1950s and 1960s were periods in which Ontario's moose herd was able to sustain the demands management placed upon it; but by the 1970s it was apparent that these demands had begun to take a toll on herd numbers. Steadily increasing hunter population and increased access (Eason et al. 1981; Eason 1985, 1989; Bisset 1991) attributable to changes in forestry practices (e.g., mechanization) (Thompson and Stewart 1998) resulted in high hunter success rates (Timmermann and Gollat 1983). Moose managers realized that there were significant problems with the moose population, which made the 1970s a critical period

for Ontario's moose (OMNR 1990).

To deal with the problem, the Ontario Ministry of Natural Resources (OMNR) implemented a number of passive approaches. For example, control measures were instituted to reduce the number of moose harvested in the province. Control measures such as the delay of opening season were used to prevent the rut coinciding with the opening day of the hunting season. A full-scale telemetry project was initiated in 1972 and aerial survey techniques developed by Fowle and Lumsden (1958) and Cumming (1958) in the 1950s were standardized in 1973. Wildlife Management Units (WMUs) were established in 1975 to "allowed managers to organize wildlife population data in separate geographic areas on the basis of land form, forest types, and habitat potential" (OMNR 1990: 28). The establishment of WMUs reduced moose management from a provincial scale to a local scale. Each of these initiatives were designed to gain a better understanding of moose behaviour, habitat preferences, range, and numbers. As well, the information gained from these initiatives was used to improve the effectiveness of moose management objectives and to develop solutions to increase Ontario's moose herd.

Although the approaches (initiatives) managers applied to the problem of a declining moose herd were well meant, these steps failed to increase the herd (Bisset 1991) and truly lacked clear policy objectives that are conducive to adaptive learning. The research initiatives were positive developments and the management efforts all moved moose management towards a solution to a difficult problem.

The 1980s

Continuing their efforts to rectify the problems in moose management discovered a decade earlier, Ontario's provincial government established a new management policy, in 1980, that set specific goals and objectives for the herd: (1) to increase the herd from 80,000 to 160,000 animals by 2000; (2) to harvest 25,000 moose annually by 2000; (3) to provide 875,000 hunter days annually by 2000; and (4) to create sites where 1 million people annually can observe moose by 2000 (OMNR 1980, 1990; Timmermann and Buss 1998).

With this policy, the Ontario Ministry of Natural Resources established its first clear goals and objectives for wildlife that one day could be measured. Setting clear goals and objectives is one of the first steps to managing adaptively. For the most part, the fear of failure leads agencies to establish well-meaning statements of intent, that are so vague that an observer cannot judge if the goals have been accomplished (Taylor et al. 1997). The 1980 policy was in contrast to the policies of the 1960s that advocated maximum sustained yield and "best use" ideas, but with no indication of exactly what was intended. Whether they knew it or not, wildlife managers in Ontario had taken the first step towards managing adaptively.

The goal of 160,000 moose was based on the idea that Ontario moose populations in areas with good habitat, with wolves and bears present, but no human hunting, (e.g., Quetico Provincial Park and Chapleau Crown Game Reserve) had approximately 0.40 moose per square kilometer. Moose density in these areas was supplied to one of us (Euler) by field staff working in those areas at that time. Subsequent publications, (Crête et al. 1981, Allen et al. 1987, Crête 1989) demonstrated that moose populations in similar conditions were capable of attaining similar densities, although sometimes predation or human hunting reduced the population below these levels. With this population goal in mind, the herd was expected to sustain by 2000 an annual harvest

of 25,000 moose, provide hunters with 875,000 hunting days afield, and 1 million viewing opportunities for people province-wide. These targets were selected because they seemed attainable, and if not attained, would constitute an opportunity to learn more about moose management.

The most significant addition to the 1980 policy was the adoption of the Selective Harvest System in 1983 (Euler 1983, Heydon et al. 1992, Timmermann and Rempel 1998). Selective harvest requires hunters to identify the age and sex of the moose before shooting, something some hunters found difficult (Timmermann and Gollat 1984). The system permits only a limited number of adult moose to be harvested, while shifting unlimited hunting pressure onto calves where the chance of over-harvesting is lower. This was a difficult period of transition for hunters due to the fact that the old system of unlimited hunting, long seasons, and few restrictions had been in place for such a long period of time. However, these changes were necessary if Ontario's moose herd was to be protected and expected to grow.

Management also took steps towards manipulating habitat as a means of increasing Ontario's moose population. Habitat guidelines were discussed and studied in the early 1980s (Euler 1982), but were not formally released until 1988, when Timber Management Guidelines for the Provision of Moose Habitat were formally endorsed by the Ministry (OMNR 1988). The primary purpose of these guidelines was to assist resource managers in planning timber management activities with regard to forest access, harvest operations, site preparation, regeneration, and maintenance. While the habitat guidelines were supportive of the broad policy objectives, they were not laws and did not contain clear goals or objectives that could be measured at some later point.

The 1990s

In the 1990s, Ontario took the next step on the road to adaptive management by instituting a long-term research project to test the effectiveness of the Timber Management Guidelines for the Provision of Moose Habitat (Rodgers et al. 1996). The Moose Guidelines Evaluation Program was established in 1989 to evaluate the effectiveness of fine-scale components of the guidelines within an individual moose's home-range, including protection of aquatic feeding areas, corridors, and leave-strips (Rodgers et al. 1996). Rempel et al. (1997) set out to test OMNR policy, in particular, moose harvest regulations and the timber management guidelines. Their study was designed as a mensurative, large scale experiment in which results suggested a strong interaction between hunter access to moose and habitat quality (Rempel et al. 1997). Furthermore, study results demonstrated that coordinated harvest and habitat management is required to successfully manage moose populations as simply managing habitat alone is insufficient to achieve 1980 policy objectives. McKenney et al. (1998) explored the power of spatial population models using geostatistical interpolation techniques to evaluate moose harvest policies. Point survey data were used to generate a map of moose density in 5-year time periods, and wildlife management units (WMUs) were subsequently overlaid on the map. This allowed for the identification of "spatial anomalies", where WMU moose densities were unexpectedly low, or high, relative to densities in surrounding areas (McKenney et al. 1998).

In conjunction with this work, some effort was also directed at evaluating moose demographic responses to the selective harvest system (Timmermann and Rempel 1998), and re-evaluating the provincial moose targets based on sub-regional environmen-

tal capability to support moose populations. To various degrees, these research projects involved both predictive modeling and empirical monitoring of moose response at the individual and population levels. The habitat research has an inherent feedback to moose management through the mandate to revise the moose habitat guidelines based on findings from the work. The population modeling research cycled back to management by providing science support for the project to reset moose population targets.

Although these research components contribute to an adaptive approach to moose management, they are essentially passive, retrospective studies evaluating policies that have already been implemented. A more direct and powerful approach would be to actively implement various management policies and guidelines on the landscape, such as altered cut block size and placement, or altered moose harvest rules, and then design a monitoring program to test the effects of these various management elements on moose populations. Without this step it is difficult, if not impossible to attribute cause and effect to management options.

Consider, for example, the documented increase in moose density since implementation of the moose habitat guidelines (McKenney et al. 1998). Spatially explicit maps of moose population increase clearly show that the herd has been increasing across Ontario since the mid 1980s. However, at the same time habitat guidelines were implemented, the selective harvest system was also implemented, which dramatically decreased hunting pressure. Which of the two policies has contributed the most to the observed increase in moose density? If we either created more edge habitat or further decreased hunting pressure, then which of these two actions would create the greatest population response? Answers to these questions cannot be easily achieved through such a retrospective analysis. A controlled, large-scale management experiment is best suited, and this form of adaptive management is essential to quick, effective learning from management actions. None-the-less, if the study is well designed, factorial mensurative experiments using retrospective data can be conducted to statistically examine the effects and interactions of management actions. Rempel et al. (1997) did this in their study on the effects and interaction of disturbance and road access on moose populations. But the knowledge gained by such work lacks the reliability of true manipulative experiments because of the inability to control for environmental variance and other factors that may be driving population response.

DISCUSSION

Ontario took the first step in adaptive management for moose by establishing goals and objectives in 1980 that were clear and measurable. Methods of controlling human hunting were introduced and habitat guidelines were developed for managers to help produce habitat conditions favorable for moose. These steps fulfill the first directive that emanates from adaptive management; managers must be explicit about what they expect.

The subsequent steps of adaptive management, collecting information and comparing that information with expectations, has been recorded in Timmermann and Gollat (1986), Heydon et al. (1992), Timmermann and Whitlaw (1992), Rempel et al. (1997), McKenney et al. (1998), and Timmermann and Rempel (1998). These authors suggested that the goal of 160,000 moose as well as the other targets would likely not be reached by 2000. Despite the fact that the stated population goal has not been achieved, it is clear that the moose population has increased since 1980. Ontario's moose population is now in the 100,000

to 120,000 range (Simmons 1997, Provincial Auditor 1998, Timmermann et al. 2002), considerably higher than the earlier estimate of about 80,000 in the early 1980s (Bisset 1991). Thus, the management approach was the appropriate one, however, the total goal of 160,000 moose in the province may not be possible given the current conditions of forest management, hunting management, and other ecological factors in the province. Ontario's moose harvests remain in the range of 10,000 to 12,000 animals, about half of the projected target of 25,000 by the year 2000 (Simmons 1997, Timmermann and Buss 1998, Timmermann et al. 2002). Although these figures are below expectation, possibly a more important problem is that in Ontario there currently lacks an accurate and timely way to measure the annual harvest. Support for mandatory registration, including a variety of methods, has been documented by OMNR (1980), Hansen et al. (1995), and Bottan (1999). As well, several others have advocated its use and importance to accurately assess annual harvests and adjust harvest quotas quickly (Crichton 1992, Timmermann and Whitlaw 1992, Timmermann et al. 1993, Timmermann and Rempel 1998).

The remaining 1980 policy goals, 875,000 hunter days afield and 1 million viewing opportunities by 2000 are difficult to evaluate because there was little or no effort to integrate, and data that were collected are only reasonably accurate on a regional or provincial level (Timmermann et al. 1993). Timmermann et al. (1993) recommended that higher quality district mail survey data should be phased in to replace broad provincial statistics.

Thompson and Stewart (1998) have reviewed habitat management strategies in the context of adaptive management and propose a more flexible approach to habitat for moose based on principles of natural disturbance. However, in Ontario, Rempel et al. (1997) suggest that the Moose Habitat Guidelines designed to mimic natural disturbances solely will not increase moose densities. Thus, if managers attempt to follow the idea of designing timber harvest to mimic natural disturbance patterns, management plans must also include restrictions on hunter access in order to increase moose densities (Rempel et al. 1997).

CONCLUSIONS

Despite the intuitive appeal of the adaptive management concept, there are startlingly few examples in wildlife management in which the adaptive management loop has been completed (Gibbs et al. 1999). Adaptive management is an approach to management, not a single cookbook of steps that can be applied by rote to every management issue. Cookbook approaches tend to stifle the creativity that is crucial for dealing effectively with uncertainty and change (Taylor et al. 1997). Unless a management agency adopts an adaptive approach to natural resource management, very little learning can take place and attempts to correct errors will not have a high success rate. While implementing adaptive management will not be easy, the alternative is to continue to learn slowly, repeating mistakes, reaching invalid conclusions, and missing opportunities to manage better (Taylor et al. 1997).

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