

Integration of woodland caribou habitat management and forest management in northern Ontario - current status and issues

Ted (E.R.) Armstrong

Ontario Ministry of Natural Resources, 435 James Street South, Suite 221, Thunder Bay, Ontario P7E 6S8, Canada (armstrte@epo.gov.on.ca).

Abstract: Woodland caribou (*Rangifer tarandus caribou*) range across northern Ontario, occurring in both the Hudson Bay Lowlands and the Boreal Forest. Woodland caribou extend south well into the merchantable forest, occurring in licensed and/or actively managed Forest Management Units (FMU's) across the province. Caribou range has gradually but continuously receded northward over the past century. Since the early 1990's, the Ontario Ministry of Natural Resources (OMNR) has been developing and implementing a woodland caribou habitat management strategy in northwestern Ontario. The purpose of the caribou habitat strategy is to maintain woodland caribou occupancy of currently occupied range in northwestern Ontario. Long-term caribou habitat needs and predator-prey dynamics form the basis of this strategy, which requires the development of a landscape-level caribou habitat mosaic across the region within caribou range. This represents a significant change from traditional forest management approaches, which were based partially upon moose (*Alces alces*) habitat management principles. A number of issues and concerns regarding implications of caribou management to the forest industry are being addressed, including short-term and long-term reductions in wood supply and wood quality, and increased access costs. Other related concerns include the ability to regenerate forests to pre-harvest stand conditions, remote tourism concerns, implications for moose populations, and required information on caribou biology and habitat. The forest industry and other stakeholders have been actively involved with the OMNR in attempting to address these concerns, so that caribou habitat requirements are met while ensuring the maintenance of a viable timber industry, other forest uses and the forest ecosystem.

Key words: *Rangifer tarandus caribou*, forest management planning, forestry, logging, ecosystem management.

Rangifer, Special Issue No. 10, 221–230

Introduction

Woodland caribou occur in low densities and a dispersed distribution across all of northern Ontario, within the northern portion of the boreal forest (Rowe, 1972). Some isolated or remnant populations still exist along the islands and shoreline of Lake Superior. In northwestern Ontario, the OMNR has been involved in the development of a woodland caribou habitat management strategy for the past several years. The objective of this strategy is to maintain current woodland caribou range occupancy in northwestern Ontario by sustaining a suitable landscape for the provision of year-round caribou habitat needs. This initiative was undertaken because of the progressive loss of caribou range and habitat over the past century - woodland

caribou range has gradually but steadily receded northward since the late 1800's (Darby et al., 1989; Cumming & Beange, 1993). While many factors are likely involved in this range recession, recent range loss appears to coincide directly with the habitat disruption and human disturbance associated with the northward expansion of timber harvesting in the boreal forest. Progress on the development of habitat management guidelines for Ontario, and on the development of a habitat management strategy, have been reported at previous sessions of the North American Caribou Conference (Racey et al., 1991, Racey & Armstrong, 1996).

The forest industry and the OMNR have been gradually implementing this strategy. The practical

realities of planning and field implementation focused attention on further issues and questions requiring resolution, within an adaptive management framework. The intent of this paper is to summarize the current status of caribou habitat management within Ontario, outlining major challenges and issues that have arisen, and how they are being dealt with.

Background

The northward recession of woodland caribou range within Ontario has been well documented (Darby *et al.*, 1989; Cumming & Beange, 1993). The current southern limit of continuous caribou range now closely approximates the northern limit of timber management operations in northern Ontario. There is a great variation in topography, drainage, soil conditions, climate and fire patterns between northeastern and northwestern Ontario. Due to this variation, there is substantially greater overlap between the southern limit of caribou range and the area of licensed and actively managed FMU's in northwestern Ontario than in northeastern Ontario

(Fig. 1). Because of this situation, the development of a caribou habitat management strategy to integrate caribou habitat needs with those of the forest industry has been focused primarily in northwestern Ontario. Greater emphasis has recently been placed on caribou management in northeastern Ontario, addressing many of the same issues being addressed to the west.

Woodland caribou have been the subject of research and management interests since the 1960's, although that interest has been sporadic and not focused on the development of management plans for the species. Woodland caribou studies essentially began with Simkin's (1965) preliminary report on caribou in Ontario and the habitat studies of Ahti & Hepburn (1976). A considerable amount of woodland caribou research, focused on caribou that summered on the islands of Lake Nipigon, was conducted throughout the 1980's (Cumming & Beange, 1987). Ontario began development of a provincial caribou policy and provincial habitat guidelines in the mid-1980's. There is as yet no provincial caribou policy in place, although a draft policy and draft habitat management guidelines

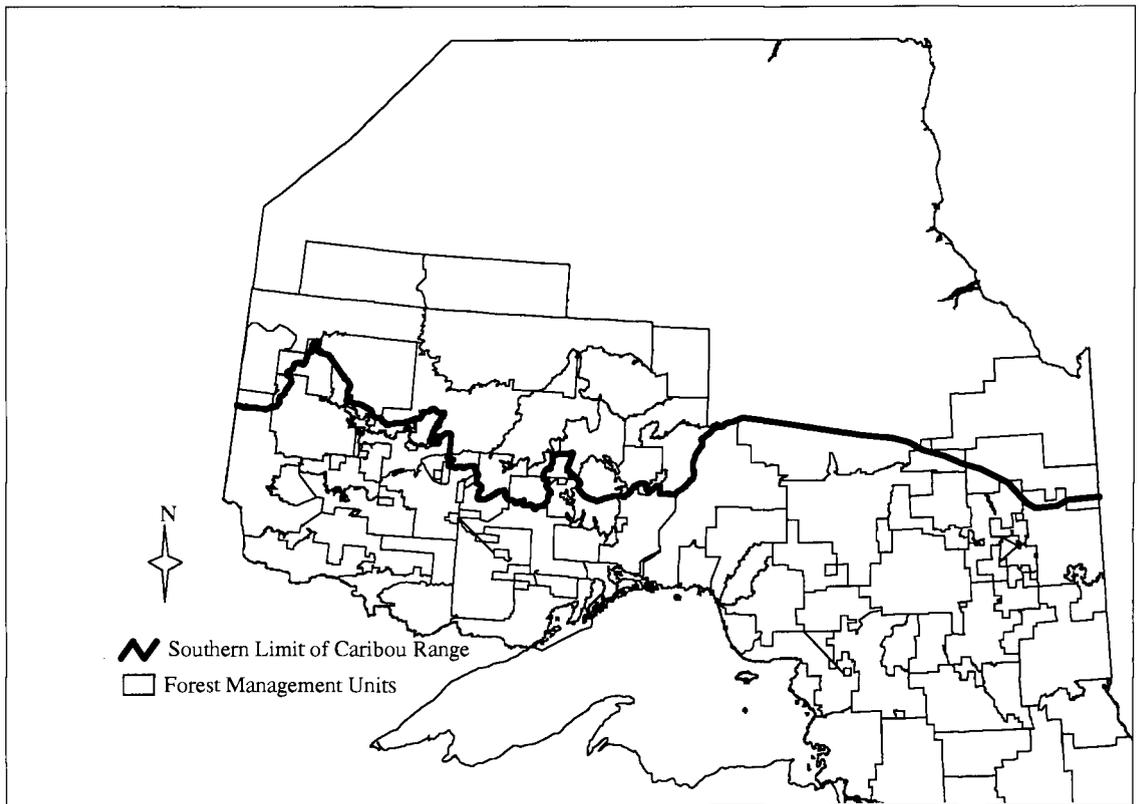


Fig. 1. The southern limit of continuous woodland caribou range in northern Ontario in relation to designated Forest Management Units.

have been developed (OMNR, 1994a), and background information compiled (Darby *et al.*, 1989).

Much of the early information on woodland caribou in Ontario resulted incidentally from surveys of moose. More intensive inventory efforts, focused specifically on woodland caribou distribution and seasonal habitat use, generally began in forested areas during the late 1980's and have continued through the 1990's. Earlier work occurred on caribou in the Hudson Bay Lowlands during the 1970's and 1980's (e.g. Thompson & Abraham, 1994). There is a much more comprehensive inventory and data base for woodland caribou in northern Ontario now than there was even a decade ago (e.g. Smith, Miller & Associates, 1995a & 1995b), although much more needs to be done. There was no consistent or coordinated attempt to address caribou habitat needs within Forest Management Plans until the late 1980's and early 1990's. Habitat inventory information was limited or lacking, and there was no corporate direction on how to address caribou habitat needs. Local staff did attempt to address specific known caribou habitat values with what they considered to be appropriate protective prescriptions; in many cases these were unsuccessful (eg. Brousseau, 1979).

At the same time that there was increasing interest in addressing woodland caribou needs within Forest Management Plans, changes were occurring within the timber management planning process to better ensure integration and environmental protection. After several years of hearings and input, the report on the Class Environmental Assessment for Timber Management on Crown Lands in Ontario was delivered, with a total of 115 terms and conditions (Ontario Environmental Assessment Board, 1994). Later in 1994, the Crown Forest Sustainability Act was enacted to "provide for the sustainability of Crown forests", where sustainability was defined as long-term forest health (Government of Ontario, 1994). One of the principles identified for forest management planning was that forest practices should, where feasible, "emulate natural disturbances and landscape patterns". These two events were followed by the development of a new Forest Management Planning Manual for Ontario (OMNR, 1996), and a number of associated manuals and guidelines. These were developed to ensure that forest planning and operations are conducted in a manner that attempts to sustain the forest ecosystem. Woodland caribou needs were specifically addressed in the Forest Operations and

Silviculture Manual (OMNR, 1995), which provided for woodland caribou habitat guidelines to be applied where "traditional forest management practices are likely to reduce permanently the amount of suitable habitat for woodland caribou and their population in that particular district". All of these developments took place against the broader international backdrop of international agreements to conserve biodiversity, movement in both the public and private sectors towards ecosystem-based approaches to resource management, and progress on the environmental certification of the forest industry (e.g. Canadian Council of Forest Ministers, 1995).

The caribou habitat management approach is a significant departure from past management practices within caribou range, which saw the broad designation of moose as the featured ungulate species, and the application of the moose habitat management guidelines (OMNR, 1988). Ontario's "Management Guidelines for Woodland Caribou Habitat" (OMNR, 1994a) have the objective of sustaining a suitable landscape for the provision of year-round caribou habitat needs. Caribou habitat must be managed on a very large temporal and spatial scale, spanning the entire rotation age of the forest and across the entire FMU. Very generally, the caribou habitat guidelines require that the forest be managed at the broad landscape level, while still considering site-specific habitat needs. Thus, currently used winter habitat, calving sites and travel corridors are identified and protected within a broader forest mosaic. This mosaic consists of large blocks of mature, undisturbed habitat that can provide a combination of winter and summer habitat, escape cover, and areas of low moose and wolf densities, as well as adjacent blocks of young, regenerating (harvested or burnt) habitat that can provide future caribou habitat. This mosaic pattern is intended to crudely emulate the natural disturbance patterns that result from wildfire, rather than the more progressive, continuous cutting of smaller harvest blocks often associated with traditional timber harvesting. While it is not appropriate to specify rigid minimum or maximum sizes for these deferred and harvested blocks, they would generally be in the range of 100 square km; however this is not a continuous clear-cut. It is also necessary to integrate plans so that caribou habitat needs are considered across several adjacent FMU's. As well as providing for suitable habitat, the caribou habitat management guidelines are intended to maintain a

predator-prey balance on the landscape similar to that which occurred before timber harvesting. The objective is to not significantly enhance the quality of moose habitat, which could lead to increasing numbers of moose, corresponding increases in gray wolf (*Canis lupus*) densities, and finally, increased predation levels on caribou by wolves. The rationale and basis for these guidelines have been described in detail by Racey *et al.* (1991).

The Northwest Region of the OMNR has been developing a regional caribou habitat strategy. Although no provincial policy and approved guidelines are yet in place, resource managers believed it was necessary to either begin to consider caribou habitat needs within forest management plans, or accept that there would be the further predictable and permanent loss of caribou habitat, and a corresponding continued recession of caribou range northward. Progress on the initiation of this strategy was reported at the last North American Caribou Conference (Racey & Armstrong, 1996). In that paper we reported on the initiation of the strategy, major issues raised through public consultation, and steps that were being taken to address these issues. The balance of this paper will report on further progress that has been made as the strategy has been implemented, and as we have attempted to integrate caribou habitat requirements with the forest management planning cycle and forest industry constraints.

Current status and issues regarding implementation of the caribou habitat strategy

Timber management implementation

Caribou habitat mosaics have been developed for each actively managed FMU within caribou range in northwestern Ontario. In most cases, these mosaics were developed jointly by OMNR biologists and foresters, and company foresters, although the degree of involvement of company representatives varied. These mosaics identify the general leave and disturbance blocks across the landscape, and the projected period of harvesting (20 year harvest periods) throughout the rotation age of the forest. Plans for ten FMU's that were approved during the 1994-97 period have considered caribou habitat needs during their development, and plans for the remaining three units within caribou range will be finalized in 1998.

The Northwest Region of the OMNR issued "Interim Direction" in 1994 to guide forest mana-

gers in considering caribou habitat needs until the final regional strategy and/or guidelines are approved and in place (OMNR, 1994b). This directed resource managers to manage for woodland caribou as "locally featured species" in FMU's within caribou range, and to manage in such a way so as to avoid adversely affecting caribou habitat. Harvest areas were allocated with a caribou habitat mosaic in mind (i.e. within the larger harvest or "disturbance" blocks), and with specific caribou habitat guidelines applied for the protection of winter habitat, calving sites and travel corridors. Moose habitat is not specifically managed north of the caribou line, except in local areas where there is high potential for moose production and very limited capability for caribou habitat. Harvest blocks are larger than under the moose guidelines, and are consolidated within larger "disturbance blocks" consistent with the overall caribou mosaic. Timber allocations avoid large deferral or "leave" areas within the mosaics, which provide for current and/or future caribou habitat. The "Interim Direction" was issued to ensure that current high value caribou habitat and future caribou habitat management opportunities were maintained. In all FMU's, the caribou mosaic has been considered but there has been variability in the degree to which it has been actively applied. In some cases, the mosaic formed a background check to ensure that the harvest pattern was consistent with the mosaic. In some other units the caribou mosaic is being more directly applied, with strategic decisions on harvest areas, access networks, and unharvested areas being made on the basis of the mosaic.

Interest in woodland caribou has increased recently in northeastern Ontario, where proposed logging areas are beginning to overlap more with areas of known caribou occurrence. A caribou habitat strategy is currently under development for northeastern Ontario. Habitat conditions differ markedly between northeastern and northwestern Ontario, and it is likely that the final habitat management strategies will be considerably different for the two regions.

Wood supply

Potential impacts of the caribou management strategy, and in particular the application of the caribou habitat mosaic, were the most commonly raised concerns from the forest industry. A study was undertaken to compare available wood supply under a caribou mosaic approach to that under a more traditional timber harvesting approach (i.e. applicati-

on of moose habitat guidelines within a progressive cut approach) (Aldridge, 1995). There were negative impacts of the caribou guidelines on available wood supply over the first rotation period of the forest: i) a reduction of approximately 23% in the sustainable conifer harvest as compared to the benchmark scenario, and ii) an increase in the distribution of balsam fir (*Abies balsamea*) mixedwood forest units over time due to increased (deferral) mortality and natural succession (Aldridge, 1995). The benchmark case considered land base reductions due to riparian reserves and expected quantities of inoperable areas.

These results must be carefully interpreted. Current management direction to more closely emulate natural disturbance patterns (e.g. Government of Ontario, 1994), and to adopt an ecosystem-based approach to resource management, will clearly place spatial and temporal constraints on the landscape even in the absence of caribou management. Aldridge (1995) concluded that the wood volume reduction that can be attributed specifically to caribou management will be less than the 23% indicated by this study. These results suggest wood supply losses can be reduced by careful analysis and refinement of caribou habitat mosaic options. In fact, participants in this study concluded that "thoughtful mosaic development can be one of the most significant steps in mitigating any reduction in wood supply, provided the mosaic is still being driven by the biology of woodland caribou" (Aldridge, 1995). This experience has been affirmed by experience in other FMU's, which has shown that the impacts can be substantially reduced by careful and thoughtful placement of mosaic blocks and harvest schedules, while also considering landscape characteristics such as landforms, disturbance history, and forest unit distribution (J. Mackenzie, pers. comm.). Wood supply impacts will clearly vary with the age class structure and species composition of the forest, with greater impacts in older-aged forests and forests with a heavy preponderance of shorter-lived species. Deferring harvest areas for an extended period beyond the normal operable life-span of the stand results in reduced stand volumes as trees decay and die. Wood supply impacts also appear to increase in FMU's which have a longer history of harvesting and access development; there are fewer options for the deferral of large habitat tracts, and mature trees that were not cut during the same period as the rest of the harvest block are not available to harvest

during the deferral period (J. Mackenzie, pers. comm.).

Wood supply impacts have also been examined from a regional perspective (McKenney & Nippers, 1996). Implementing a form of spatial adjacency requirements, such as with the caribou mosaic, was estimated to decrease the wood harvest values by 16-32% of the "unconstrained" value. There were also implications to longer term wood supply; harvest targets did not appear to be achievable beyond 50-60 years without any constraints, and beyond 30 years with caribou habitat constraints. Intensive silviculture, although expensive, was recognized as a key to reaching harvest targets.

In both studies, the reduction in projected available wood supply was likely an over-estimate. The benchmark case was determined aspatially, where every stand in the FMU could be theoretically considered for harvest at any time regardless of spatial and operational constraints such as access, adjacent stands or minimum area.

Road access costs

The forest industry has also raised concerns about access development costs (Racey & Armstrong, 1996). The spatial element of the caribou mosaic requires that road development programs be accelerated to bypass some deferred blocks of mature timber and to access identified harvest blocks. The concern is that this may have an associated increased cost, further compounded by the fact that road construction costs cannot be subsidized by harvesting wood from leave blocks that the road must bypass. There were further concerns related to road maintenance costs - a larger primary road network may be required than under a traditional harvesting pattern, although roads within identified future winter habitat blocks will likely be abandoned and regenerated soon after harvest. Road access costs remain a significant issue with the forest industry, but as yet there have been no derailed projections or estimates of additional costs that may be incurred by the application of the caribou mosaic. The regional analysis of wood supply tradeoffs suggested that road costs may not differ greatly among various management scenarios (McKenney & Nippers, 1996). The actual costs will depend on the way in which the caribou guidelines are implemented regionally. If portions of the region were harvested more heavily in some decades, with wood flow agreements between companies, then road costs would not necessarily be higher. However, road

costs will likely be higher if companies are restricted to obtaining their entire wood volume from within their own management units.

Silviculture and forestry

Considerable use has been made of the Forest Ecosystem Classification system to aid in identifying and regenerating high value caribou habitat (Racey *et al.*, 1989; Morash & Racey, 1990). Two issues have been raised regarding the ability of resource managers to successfully regenerate winter caribou habitat: i) the regeneration of lichen in second growth forests, and ii) evidence of caribou re-use of second growth managed forests as winter habitat. Lichen sampling at a number of mature stands, cutovers and burns showed that cutovers that formerly supported lichen-rich forest are likely to regenerate to similar conditions (Harris, 1992). Residual *Cladonia* spp. fragments often survive in the cutover after harvesting, and biomass recovery may actually be more rapid after logging than after a fire due to the presence of this residual lichen. Caribou use of a second growth logged forest has been documented approximately 40 years after harvest (Racey *et al.*, 1996).

A number of additional silvicultural issues remain to be addressed. A significant concern relates to the potential increase in the hardwood component, at the landscape level, after logging. A significant increase in the proportion of hardwood and mixedwood stands may decrease the quality of caribou habitat and increase the suitability for moose production, ultimately leading to changes in the predator-prey balance. This is of special concern along the southern limit of caribou range, where moose densities may be higher and where there will be less opportunity for caribou to re-colonize young stands that are currently unsuitable. In some instances herbicide treatments will likely be necessary to control hardwood regeneration. Efforts can also be made to modify harvesting and silvicultural practices to control hardwoods in other ways. The harvesting or "highgrading" of conifers within mixedwood stands is also of similar concern because of the potential for conversion to hardwoods.

Remote tourism impacts

Some concerns have also been raised by the remote tourism industry. Some outfitters perceive that implementation of the caribou habitat guidelines will have impacts in two major areas - larger cut sizes and the increased development of road net-

works. The concern about cut size relates to the potential negative aesthetic impact of larger cuts on remote tourism guests. A Remote Tourism Decision Support Model was used to conduct a preliminary evaluation of this concern, comparing the aesthetic implications of implementing moose and caribou habitat guidelines (Line & Racey, 1997). Preliminary results indicated that the evidence of logging itself has the major impact on tourist aesthetics and user preferences, with little difference between the moose and caribou guidelines. Remote tourism clients would clearly prefer outposts with no evidence of logging. Thus it appears that some criticisms by the tourism industry may reflect more general concerns about logging, rather than concerns specifically about caribou habitat management. In this study large shoreline buffers, such as those that could be used around calving lakes, were effective in minimizing the negative perceptions of logging activity. Over the rotation age of the entire forest, the caribou guidelines may actually have slightly less effect upon aesthetics than the moose guidelines, primarily because logging would occur in a more restricted time period, and then not occur for an extended period of time.

Another tourism issue raised was the potential for accelerated development of an access road network, and the possible earlier construction of logging roads near remote tourism facilities. There is a related impression that the caribou mosaic is now forcing roads into previously remote areas. On the short time scale, this may be true. In other situations, remote tourism facilities within a harvest deferral block may maintain their remote status much longer than under a conventional logging strategy. However, all licensed FMU's are intended to be accessed and harvested by the forest industry over time, so the net effect of the caribou guidelines may be to accelerate access to some specific portions of the unit earlier than under a more traditional "progressive road construction and harvest" scenario. This issue ultimately points out the need for strategic access road planning for each FMU, to ensure that access roads are planned properly to have the least impact on the tourism industry and other forest uses, over the entire rotation age of the forest.

Moose management implications

One of the objectives of the caribou management strategy is to reduce the enhancement of moose habitat potential after logging, in order to avoid

increases in predator numbers. The intent is to not enhance habitat for moose to the degree that would occur with application of the moose habitat guidelines (OMNR, 1988). This objective has been interpreted by some members of the public, including some hunters, as managing "against moose", with the perceived goal of a reduction or even the elimination of moose populations. Resource managers generally believe that moose habitat potential will still increase after logging even under the caribou guidelines, although the increase will not be as great as if the moose habitat guidelines had been applied.

Knowledge base

Gaps in knowledge base identified during public consultation included incomplete information on woodland caribou populations, habitat use and predator-prey relationships. In response to these concerns, and to provide more detailed information to Forest Management Plans, a radio-collaring project was undertaken across northwestern Ontario. Fifteen woodland caribou were captured and equipped with ARGOS satellite collars during 1995 and 1996. This study is continuing, and further animals are being captured and fitted with collars. The project included university research partners to broaden its scientific basis and applications (Hillis *et al.*, 1998). A considerable amount of information directly relevant to forest management planning has already resulted from this study, and is being applied. The large-scale movements of caribou observed in this study have reinforced the need to consider caribou management at the landscape level, rather than the stand or working circle level.

Increased emphasis is being placed upon habitat inventory and distribution surveys, including winter habitat surveys and summer calving site surveys (Timmermann, 1993a & 1993b). Woodland caribou continue to be the species with the highest priority information needs for forest management planning across the northwest.

A comprehensive bibliography of caribou related information for northern Ontario, with emphasis on northeastern Ontario, has been developed (Smith, Miller & Associates, 1995a & 1995b).

Public education and awareness of caribou occurrence and biology continues to be an area where more effort is required. There has been a gradually increasing public awareness of the presence of woodland caribou in northwestern Ontario, and of their specialized life history and habitat require-

ments. Forest industry staff have become much more familiar with caribou habitat requirements as they have attempted to address caribou habitat concerns in forest management planning, incorporate caribou mosaics into harvest allocation decisions, and deal with operational harvest and silvicultural issues related to caribou management. Woodland caribou have featured prominently in forest management planning open houses, another mechanism for increasing public awareness and understanding.

Stakeholder advisory panel

There continues to be both some misunderstanding and some concern about the basis for and application of the caribou habitat management strategy. At the same time, there has been no public consensus on the best approach to caribou management; for example, some stakeholders clearly want caribou to be protected but have concerns with the management strategy, while others have less concern about caribou conservation but are very concerned about specific aspects of the strategy that could impact upon their use of the forest (see Racey *et al.*, 1996).

An advisory panel was established to review the strategy and make recommendations on improvements and implementation. This panel had regional representation from all major forest client groups, including both the pulp and paper and the lumber industry, tourist outfitters, anglers and hunters, environmentalists, naturalists, trappers, labour and local citizens. Their discussions and recommendations took place within the context of three "givens":

- i) maintenance of caribou populations within current range;
- ii) maintenance of viable forest-based industries; and
- iii) consideration of the principles of ecological sustainability and forest health.

A series of four facilitated workshops was held at various locations across northwestern Ontario during 1995 and 1996.

While this group could not achieve consensus, they did make a number of very valuable recommendations in their final report (Greig & Duinker, 1997). Of particular significance were recommendations on the structure of a regional caribou management strategy. These included components on communications and education, increased knowledge and awareness, decision-making protocols, habitat management, other (non-habitat) management considerations, and adequate support for implementa-

tion. This report will play an important role in the future development of the caribou strategy.

A giant experiment?

A recurring criticism of any proposal to manage caribou habitat is that this is in effect a "giant experiment" that has not been tested before, and the success of which will not be known for several decades. This same criticism can similarly be directed at other past approaches to wildlife habitat management within the forest management planning process, such as application of moose habitat guidelines. It can also be argued that past management efforts, namely sequential logging and application of moose habitat guidelines to provide a fragmented habitat, have also been an experiment with a clear result - the loss of caribou from previously occupied range.

This dilemma was highlighted eloquently by Sample (1994) in an essay on the challenges of sustaining forest ecosystems: "... we don't yet - and may never - have the scientific knowledge to maintain or restore all the important pieces of a complex forest ecosystem... 'adaptive management' means we are all part of an immense, high stakes experiment, the outcome of which will remain unknown for the foreseeable future ...".

The criticism of a "giant experiment" can not be completely refuted to the satisfaction of those concerned. As for other forest management guidelines, this management strategy has been based upon a substantial foundation of scientific literature and a knowledge of local (i.e. Ontario) caribou biology. However the reality is that it will be several decades before the success of the caribou management program can be completely assessed. What is important is to monitor and evaluate shorter-term results within an adaptive management framework, so that refinements and improvements can be made to the program as new information is obtained. This is the only reasonable option to consider where timber harvesting is currently underway within caribou range - take action now, and modify as scientific knowledge and management information improves.

Conclusion and future direction

The issues associated with implementation of the caribou habitat management strategy in northwestern Ontario are many. However, significant pro-

gress is being made in many areas, and caribou habitat needs are being given more rigorous consideration in forest management planning and operations.

Resource management within Ontario is being undertaken more and more within an ecosystem management context. Caribou habitat management will continue to be important, but habitat needs will be addressed within a broader ecosystem framework that attempts to emulate natural disturbance patterns. This approach is very consistent with the caribou mosaic approach. Spatial and temporal constraints on timber harvesting can be expected to result from any application of ecosystem management approaches, whether or not caribou needs are specifically addressed.

A caribou strategy is still seen as very important, to address and integrate the variety of related habitat and non-habitat issues that affect caribou. Efforts must continue to be made to find ways to address the concerns of and reduce the impacts on the forest industry and other users, without loss of caribou range. For example, greater involvement of the forest industry in the initial stages of mosaic development will help to reduce wood supply impacts.

Woodland caribou are a key component of the fauna of the northern boreal forest in Ontario, and maintenance of caribou populations and range is critical to any biodiversity conservation strategy in the region. There will continue to be challenges to implementing any caribou strategy that requires significant changes to traditional timber harvesting practices. However, Ontario resource managers believe it is feasible to achieve the objective of maintaining caribou within their currently occupied range within the managed forest.

Acknowledgments

I would like to acknowledge all those who contributed information for this report, including the following Ministry of Natural Resources staff: Evan Armstrong, Gord Eason, Wayne Fiset, Lee Gerrish, Greg Lucking, Jim Mackenzie, Scott McAughey, Dean Phoenix, Dan Puddister, Bruce Ranta, John Thompson, Bob Watt. Helpful advice and suggestions were provided during the development of this paper by Gerry Racey and Niels Carl. Nancy Bookey assisted with the production of the map of caribou range. I would also like to thank the two anonymous reviewers for their very helpful comments.

References

- Ahti, T. & Hepburn, R. L. 1976. *Preliminary studies on woodland caribou range, especially on lichen stands in Ontario*. Ont. Dep. Lands For., Res. Rep. 74. 134 pp.
- Aldridge, C. 1995. *Wood supply and woodland caribou on the Nakina/Geraldton Forests and the Lac Seul Forest*. Ont. Min. Nat. Resour., NWST Tech. Rep. TR-97. 93 pp.
- Brousseau, C. 1979. *Trends in the woodland caribou (Rangifer tarandus) population in the Cliff Lake area of the Dryden District*. Ont. Min. Nat. Resour., MS Rep., Dryden. 25 pp.
- Canadian Council of Forest Ministers. 1995. *Defining sustainable forest management: A Canadian approach to criteria and indicators*. Can. For. Serv. Ottawa. 22 pp.
- Cumming, H. G. & Beange, D. B. 1987. Dispersion and movements of woodland caribou near Lake Nipigon, Ontario. – *J. Wildl. Manage.* 51 (1): 69–79.
- Cumming, H. G. & Beange, D. B. 1993. Survival of woodland caribou in commercial forests of northern Ontario. – *For. Chron.* 69 (5): 579–588.
- Darby, W. R., Timmermann, H. R., Snider, J. B., Abraham, K. F., Stefanski, R. A. & Johnson, C. A. 1989. *Woodland caribou in Ontario: background to a policy*. Ont. Min. Nat. Resour., Wildlife Branch, Toronto. 38 pp.
- Government of Ontario. 1994. *Bill 171 (Chapter 25, Statutes of Ontario, 1994) An act to revise the Crown Timber Act to provide for the sustainability of Crown Forests in Ontario*. 37 pp.
- Greig, L. & Duinker, P. 1997. *Toward a strategy for caribou habitat management in northwestern Ontario*. Final report of Northwest Region Caribou Strategy Advisory Panel for the Ont. Min. Nat. Resour. ESSA Technologies Ltd., Richmond Hill. 45 pp.
- Harris, A. 1992. *Post-logging regeneration of reindeer lichens (Cladina spp.) as related to woodland caribou winter habitat*. Ont. Min. Nat. Resour., NWST Tech. Rep. TR-69. 33 pp.
- Hillis, T. L., Mallory, F. F., Dalton, W. J. & Smiegielski, A. J. 1998. Preliminary analysis of habitat utilization by woodland caribou in northwestern Ontario using satellite telemetry. – *Rangifer Spec. Issue No. 10*: 191–198.
- Line, J. & Racey, G. 1977. *Estimate of relative aesthetic impact of Northwest Region caribou strategy on remote tourism*. Ont. Min. Nat. Resour. NWST Tech. Rep. TR-110. Thunder Bay. 17 pp.
- McKenney, D. & Nippers, B. 1996. *A spatial analysis of caribou-wood supply trade-offs in northwestern Ontario*. Draft Rep. Can. For. Serv., Sault Ste. Marie. 42 pp.
- Morash, P. R. & Racey, G. D. 1990. *The northwestern Ontario Forest Ecosystem Classification as a descriptor of woodland caribou (Rangifer tarandus caribou) range*. Ont. Min. Nat. Resour., NWOFSTDU Tech. Rep. 55. 22 pp.
- Ontario Environmental Assessment Board. 1994. *Reasons for decision and decision – Class Environmental Assessment by the Ministry of Natural Resources for timber management on Crown lands in Ontario*. Report produced for the Ontario Ministry of the Environment. 561 pp.
- Ontario Ministry of Natural Resources. 1988. *Timber management guidelines for the provision of moose habitat*. Ont. Min. Nat. Resour., Wildl. Br., Toronto. 33 pp.
- Ontario Ministry of Natural Resources. 1994a. *Management guidelines for woodland caribou habitat*. Draft report (Oct. 6 1994). Ont. Min. Nat. Resour. Northwest Region, Thunder Bay. 24 pp.
- Ontario Ministry of Natural Resources. 1994b. *Northwest Region interim caribou habitat management direction March 14, 1994*. Ont. Min. Nat. Resour. Unpub. Rep. Northwest Region, Thunder Bay. 4 pp.
- Ontario Ministry of Natural Resources. 1995. *Forest operations and silviculture manual*. Ont. Min. Nat. Res. Manual, Sault Ste. Marie. 64 pp.
- Ontario Ministry of Natural Resources. 1996. *Forest management planning manual for Ontario's Crown forests*. Tech. Series 1, Ont. Min. Nat. Res., Sault Ste. Marie. 454 pp.
- Racey, G. D., Abraham, K., Darby, W. R., Timmermann, H. R. and Day, Q. 1991. Can woodland caribou and the forest industry coexist: The Ontario scene. – *Rangifer Spec. Issue No. 7*: 108–115.
- Racey, G. D. & Armstrong, E. R. 1996. Towards a caribou habitat management strategy for northwestern Ontario, running the gauntlet. – *Rangifer Spec. Issue No. 9*: 73–83.
- Racey, G. D., Harris, A. G. & Foster, R. F. 1996. *Caribou winter habitat in the new forest: lessons from Lucy Lake*. Ont. Min. Nat. Resour. NWST Tech. Rep. TR-103. 9 pp.
- Racey, G. D., Whitfield, T. S. & Sims, R. A. 1989. *Northwestern Ontario forest ecosystem interpretations*. Ont. Min. Nat. Res. NWOFSTDU Tech. Rep. 46. 90 pp.
- Rowe, J. S. 1972. *Forest regions of Canada*. Can. For. Serv. Publ. No 1300. 172 pp.
- Sample, V. A. 1994. Why ecosystem management? – *Amer. For.*
- Simkin, D. W. 1965. *Preliminary report of the woodland caribou study in Ontario*. Ont. Dep. Lands For. Sect. Rep.(Wildl.) no. 59. 75 pp.
- Smith, Miller & Associates, Ltd. 1995a. *Bibliography of literature pertaining to woodland caribou (Rangifer tarandus caribou) habitat use, requirements and range in northeastern Ontario*. MS Rep. Prepared for the Ont. Min. Nat. Resour. Kapuskasing. 10 pp.
- Smith, Miller & Associates, Ltd. 1995b. *Report on woodland caribou data synthesis in northeastern Ontario*. MS Rep. Prepared for the Ont. Min. Nat. Resour. Kapuskasing. 19 pp.
- Thompson, J. E. & Abraham, K. F. 1994. *Range, seasonal distribution and population dynamics of the Pen*

- Islands caribou herd of southern Hudson Bay.* Ont. Min. Nat. Res. Rep., Moosonee. 94 pp.
- Timmermann, H. R. 1993a. Identification and delineation of woodland caribou winter habitat. – *In*: Ranta, B. W. (ed.). 1993. *Selected wildlife and habitat features: inventory manual for use in timber management planning.* Ont. Min. Nat. Resour. Draft Rep., Toronto. 6 pp.
- Timmermann, H. R. 1993b. Identification of woodland caribou calving sites. – *In*: Ranta, B.W. (ed.). 1993. *Selected wildlife and habitat features: inventory manual for use in timber management planning.* Ont. Min. Nat. Resour. Draft Rep., Toronto. 8 pp.