PROPOSAL TO COMBINE CREE AND SCIENTIFIC KNOWLEDGE FOR IMPROVED MOOSE HABITAT MANAGEMENT ON WASWANIPI EEYOU ASTCHEE, NORTHERN QUÉBEC

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ABSTRACT: First Nations involvement in forest management is necessary to achieve sustainability, even more in northern Québec where the Cree have constitutional rights on the land. An innovative research approach has been undertaken to improve forest management on *Eeyou Astchee*, the Cree territory. This project targets moose (*Alces alces*) because of its importance to the Cree people and because it is a representative species of the northern black spruce ecosystem. The research aims at combining native and scientific knowledge to overcome trust, communication, and cultural barriers, and to build a common vision of moose habitat needs in this northern area. In this poorly known ecosystem, combining Cree and scientific knowledge about moose seems to be a promising avenue to achieve sustainable forest management. Based on new knowledge of this common vision, socioecologicaly-adapted habitat management strategies will be proposed for the study area. The involvement of key stakeholders, and recognition of their knowledge, should promote better support for the research project and better social acceptability of the proposed management recommendations.

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Key words: *Alces alces*, Cree, forest management, local ecological knowledge, moose, Québec, Waswanipi

RÉSUMÉ : L'implication des peuples autochtones dans la gestion forestière est une prémisse au développement durable, tout particulièrement dans le Nord du Québec, où les Cris détiennent des droits constitutionnels qui protègent leur utilisation distincte du territoire. Dans la présente recherche, nous proposons une approche novatrice permettant d'améliorer l'aménagement forestier sur l'*Eeyou Astchee*, le territoire des Cris. Le projet cible l'orignal (*Alces alces*) par l'importance qu'il revêt pour les Cris et par le fait qu'il est considéré comme une espèce représentative de la pessière noire nordique. La recherche vise à combiner les connaissances scientifiques et celles des Cris afin de surpasser les barrières culturelles, idéologiques, de confiance et de communication, et de bâtir une vision commune des besoins en habitat de l'orignal. Dans cet écosystème encore peu étudié, la combinaison des connaissances cries et scientifiques semble une avenue prometteuse pour tendre vers l'aménagement forestier durable. Sur la base de cette vision commune, des stratégies d'aménagement adaptées au contexte socio-écologique seront proposées pour le territoire à l'étude. L'implication adéquate des parties prenantes, et la prise en considération de leurs connaissances respectives devraient promouvoir un support accru au projet de recherche en cours et une meilleure acceptabilité sociale des stratégies d'aménagement proposées.

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Mots clés: aménagement forestier, *Alces alces*, connaissance écologique locale, Cri, orignal, Québec, Waswanipi

Large-scale forest harvesting, as done in northern Québec, is viewed by some as a conflict with the fundamental needs of aboriginal peoples and has sparked significant conflict among native people, government authorities and the forest industry (Tobias 1991, Beaulieu 2000). One of the primary causes of these conflicts is the negative impact that forest harvesting has on certain wildlife habitats and populations that are important for the Cree (MCE 1998). Under certain circumstances, large-scale forest harvesting induces immediate and substantial loss of productive wildlife hunting territory (Johnston and Elliot 1996, Morel and Bélanger 1998), and decreases local wildlife populations (Messier 1993, Potvin et al. 1999) for Cree hunters and trappers. This is particularly true for moose (*Alces alces*), which seem to avoid recent clear-cut areas (Thompson and Vukelich 1981, Courtois 2002).

The Waswanipi Cree First Nation, in this conflicting context, created a Model Forest in order to understand and improve the coexistence of their intensive use of the land with large-scale forest exploitation. This Model Forest is a partnership led by the Cree, with forest industries, provincial and federal governments, and universities, contributing to sustainable forest management. Management of moose habitat on *Eeyou Astchee* (Cree territory, Fig. 1) has always been one of the major subjects of disagreement between Cree and government representatives (MCE 1998) and thus turned out to be a research priority for the Model Forest. Despite their constitutional rights on the land (Gagnon 1973), the Cree have had little influence on management policies for moose habitat even though they have requested input. Undertaken in 2003 with the support of the Waswanipi Cree Model Forest, this project aims at developing a framework to include Cree concerns and knowledge in the science-based management structure. To do so, we are trying to link native and non-native natural resources management systems by combining Cree and scientific knowledge about moose.

Moose are certainly one of the most interesting wildlife species on which to focus collaboratively since it is one of the most important in the Cree culture (Feit 1999, Jacqmain and Bélanger 2002) and represents the main ''bush food'' intake for Cree hunters (Gagnon 1973, Feit 1999). Moose can also be considered a representative species of the boreal forest (Courtois et al. 1998) and can be used to quantify and qualify this ecosystem (Jackson et al. 1991). Specific seasonal needs of moose, in terms of habitat composition and structure, make this species interesting for tallymen (official Cree land managers of family hunting grounds) and forest managers as an important component in the implementation of integrated resource management on a family hunting ground (trapline), at both the stand and the landscape level (Hénault et al. 1999, Potvin et al. 1999, Jacqmain and Bélanger 2002). Furthermore, habitat at the northern limit of the species' range, where moose populations have been at low densities since the 1980s (Messier 1993), could be improved or at least protected to reduce moose vulnerability to predation (Joyal 1987).

This paper presents the existing theory on aboriginal participation in forestry and suggests a mechanism to implement it on Waswanipi *Eeyou Astchee*. A literature review of moose habitat needs, according to both scientific and Cree perceptions, reveals some knowledge gaps which restrain sustainable management of moose habitat in the northern black spruce ecosystem. More important, this review allows a better understanding of similarities and differences between the Cree and the scientific visions of moose needs and behaviour. At the end, a brief description of the research protocol il-

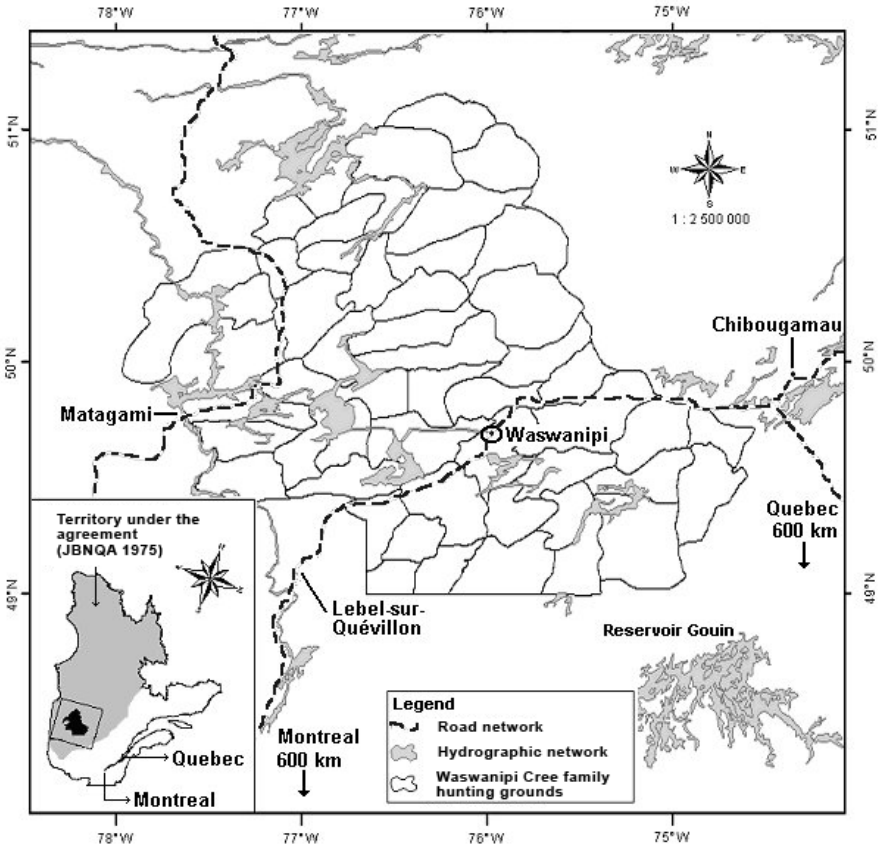

Fig. 1. *Eeyou Astchee* (Waswanipi Cree family hunting grounds).

lustrates how this project could contribute to building a common understanding between both visions of the biological requirements of moose and fill knowledge gaps to better serve Cree and non-Cree forest managers. Since the project will end in 2006, no results are presented in this paper.

SHIFTING PARADIGM IN NATURAL RESOURCES MANAGEMENT

The existence of aboriginal and treaty rights in the Canadian Constitution, and the formal recognition of their attachment to and dependence on nature (Gagnon 1973, Croteau 1999), sustainable forest management on Crown lands should involve distinct participative processes for aboriginals (Western and Wright 1994). Many now suggest that complementary native and scientific management systems could generate improved sustainable natural resource management strategies (Taiepa et al. 1997, Duerden and Kuhn 1998). Integration of local indigenous collective knowledge (Brassard 2001), needs, and values in a science-based management framework that recognizes the legitimacy of aboriginal peoples in the decision-making process, could facilitate resolution of management conflicts (Daniels and Walker 2001). Aboriginal knowledge about the natural environment could complement scientific knowledge gaps about northern ecosystems (Fast and Berkes 1994), and enhance the resilience of aboriginal socioecological systems (Begossi 1997). Considering humans as a component of the ecosystem (Gerlach and Bengston 1994), this approach is in line

with the practical definition of ecosystem management for which social acceptability and economic profitability must be attained within the limits of historical ecosystem variability and integrity (Gilmore 1997, Leduc et al. 2000).

GOAL AND OBJECTIVES

The goal of this project is the development and evaluation of the potential outcomes of a management process which uses two distinct sources of information (the Cree and scientific knowledge) and evaluates their convergence to define moose habitat needs on *Eeyou Astchee*. Based on this learning, innovative management strategies for moose habitat will be proposed to research partners. The first objective is to fill an inherent lack of scientific information about moose habitat needs in northern ecosystems. The study is mainly oriented toward establishing habitat preferences in terms of composition and structure of habitat types, to evaluate annual fidelity to specific areas (e.g., winter yards, calving sites), and to assess the importance of riparian habitats for moose. The second objective is to evaluate the impact of forest harvesting on moose habitat. This objective focuses on the duration of the negative impact of forest harvesting on moose (delay in habitat restoration) and the influence of habitat spatial patterns (e.g., buffer strips, mosaic cutting) on moose habitat use. The third objective is to elaborate on socioecologically-adapted moose habitat management strategies that will encourage participation of the Cree in resource management and improve moose habitat.

STUDY SITE

The research was conducted on land occupied by the Waswanipi Cree (*Eeyou Astchee*), and covers 35,000 km^2 of boreal forest 600 km north of Québec City, Canada (Fig. 1). The Waswanipi Cree have occupied this land since time immemorial (Gagnon 1973) and trapped and hunted on it for subsistence needs: food, clothing, and tools (Krech 1999). They took part in fur trade with a post in Waswanipi Island operated by the Hudson Bay Company from 1819 to 1960 (Marshall 1987). Now, the small northern community numbers 1,200 people and the land is divided into 53 distinct family hunting grounds (Fig. 1). In this area, the Québec government granted the first industrial timber license in the early 1970s, which represented the first contact of the Cree with modern forest exploitation (Feit 1978). After a 30-year cutting period, the rift between the needs of the Cree hunters and trappers and those of the forest industry has forced the provincial government to implement an adapted and exclusive forest regime in *Eeyou Astchee*. The objective of this new forest regime is to have better participation from the Cree in the forest management planning process and better habitat management for featured species, such as moose. The court case (Cree vs. Québec and forest industry) which led to the adoption of this new forest regime, began on a family hunting ground where a yarding area for moose, protected for a long time by the tallyman, had been logged.

Eeyou Astchee, which is part of the spruce–moss bioclimatic domain, is located in the most northern forest harvesting zone in Québec (MRNQ 2000), where the average annual climate is cold and humid with a mean annual temperature around -0.1 °C (Beauchesne et al. 2000). More than 17% of forested land is unproductive (from a wood fibre aspect) and is comprised of muskeg, swamp, exposed rock, and open areas. The productive forest is composed of coniferous (89.2%), mixed (9.2%), and deciduous stands (1.5%). Coniferous stands are dominated by black spruce (*Picea mariana*) in association with balsam fir (*Abies balsamea*) and jack pine (*Pinus banksiana*).

In mixed stands, balsam fir is the dominant species, and is found in association with deciduous species such as paper birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloïdes*) (Bergeron et al. 1998). The climax forest is composed of large homogeneous stands of black spruce interspersed with small stands of intolerant deciduous trees (Joyal 1987).

STATE OF THE KNOWLEDGE ON MOOSE HABITAT IN NORTHERN ECOSYSTEMS (FROM A SCIENTIFIC POINT OF VIEW)

Food-Cover Trade-Off

Within their annual home range, moose travel between preferred habitat types according to specific seasonal needs (Peek et al. 1992) and the degree of interspersion of different habitat components that can meet these needs (LeResche 1974). Generally, moose respond more to food availability than to cover accessibility compared with other ungulates (Westworth et al. 1989). Usually, prime food habitats and prime cover habitats are found in different areas within the animal's range which may explain density changes between large areas (Lima and Dill 1990, Dussault 2001). At a small scale, corresponding to a forest stand, open areas which are visited by moose for their high food availability usually do not provide adequate cover from adverse climatic elements; conversely, good shelter usually offers low food availability (Lieffers et al. 1999). Trade-offs between stands offering sufficient food and cover are more pronounced for females with calves than for males (Thompson and Vukelich 1981, Courtois et al. 2002, Dussault et al. 2005) or females without calf (Dussault 2001).

Food availability has a significant influence on habitat selection by moose, at both coarse and fine scales (Joyal 1987, Crête 1989, Courtois et al. 2002). In the boreal forest, moose are mostly associated with mixed and deciduous stands (Grenier and Audet 1974, Joyal 1987, Crête and Courtois 1997) and young stands of post fire origin, windfall, insect outbreaks, and forest harvesting (Loranger et al. 1991). These stand types supply an abundant shrub layer of deciduous twigs and balsam fir, which are the main food intake for moose in winter (Girard and Joyal 1984, Crête 1989). The importance of mixed and deciduous stands is a significant variable that explains the variation in moose densities in northern environments (Gingras et al. 1989). In northern coniferous forests, moose must extend their home range to travel between suitable patches of available food (Crête and Courtois 1997). Scanty distribution of forage can lead to suboptimal nutrition and high in utero or perinatal mortality (Verme 1977) and, consequently, can influence moose productivity in northern regions following unfavourable weather conditions (Crête and Courtois 1997).

The quality of the cover has an impact on moose mortality due to hunting and natural predation (Girard and Joyal 1984, Eason 1989), which are the two most important limiting factors for moose populations (Courtois 1993). Good cover is also important for thermoregulation (Dussault 2001), as moose are easily stressed by warm temperatures throughout the year. Coniferous canopies which retain snow are generally preferred over deciduous cover for deer (Ozoga 1968) during periods of high snow accumulation. While coniferous cover does not seem to be a strong limiting factor for moose, this species does show a higher preference for such habitats in late winter presumably due to the higher interception properties of conifers (Dussault et al. 2005).

Forestry and Habitat Management

Although forestry can be a useful wildlife management tool in rejuvenat-

ing old forest stands (Peek et al. 1976, Hundertmark et al. 1990) creating young productive feeding sites in terms of browse availability (Crête 1977, Girard and Joyal 1984), large cutovers can have negative impacts on moose habitat, productivity, and population densities (Joyal 1987, Eason 1989). Moose generally avoid large clear cuts and this negative impact can last more than 10–15 years post cutting (Potvin et al. 1999). Reduction of forest cover can increase moose vulnerability to hunting and natural predation (Girard and Joyal 1984, Joyal 1987, Rempel et al. 1997). Moose usually react to clear cutting by increasing daily movements and avoiding clear cut patches having a sparse shrub layer (Courtois et al. 2002). Concentration of moose in patches of residual forest in a clear cut area can theoretically increase predation risk (Girard and Joyal 1984, Joyal 1987).

Corridors and Riparian Habitats

Conventional forest harvesting in Québec produces a patchwork of large cut blocks divided by 60-100m residual forest strips between cutovers and 20 m riparian reserves along lakes and streams. For some species, corridors composed of residual mature forest in a recently harvested area fulfill an inherent need for movement (Hobbs and Hopkins 1991) and can be considered as habitats (e.g., riparian communities; Johnson 1989). However, there is little information on the importance of movement corridors for moose in the literature. It seems that moose do not seek buffer strips in conventionally cut landscapes (Potvin and Courtois 1998). On the other hand, some authors have documented the use of shoreline timber reserves by moose as resting cover and travel corridors (Brusnyk and Gilbert 1983) and the use of frozen, narrow river channels as bedding and feeding sites (Hundertmark et al. 1990). In migrating moose populations in northern habitats, Sandegren et al. (1983) determined that routes between seasonal ranges are located in valleys near rivers, which contain accessible shrubby growth (Audet and Grenier 1976). Thus, riparian habitats can be considered as an important part of moose range even in the supposedly non-migrating populations of northern Québec (Joyal 1987).

Particular Habitats, Annual Fidelity, and Site Reutilization

Unlike white-tailed deer (*Odocoileus virginianus*), moose generally do not use exactly the same areas year after year (Crête and Jordan 1981). However, in northern regions, where the core matrix of the landscape is composed primarily of poor habitats interspersed with small scattered patches of good habitat, moose may seek these good habitats and thus use them repeatedly (Nault and Martineau 1983, Potvin et al. 2001). The exclusivity and the specificity of these habitats can make them essential for moose (Crête and Courtois 1997), and thus may be reused year after year (Jacqmain et al. 2003).

STATE OF THE KNOWLEDGE ON MOOSE HABITAT IN NORTHERN ECOSYSTEMS (FROM A CREE POINT OF VIEW)

Food-Cover Trade-Off

According to the Cree point of view, moose seem to associate more with undisturbed forests (Jacqmain and Bélanger 2002). In this view, forest fires are perceived mainly as a habitat destroyer and as a cause of starvation rather than as a nutrient recycling natural phenomenon that can rejuvenate over-mature forests and benefit moose (Marshall 1987, Dupont et al. 2005). However, regenerating stands are good feeding grounds for moose if they are close to coniferous cover (Jacqmain and Bélanger 2002, Saganash 2004). In mature forest landscapes, moose are seen

as preferring mixed and deciduous mature stands, which offer simultaneously good cover and available food (Feit 1987, Lajoie et al. 1993, Jacqmain et al. 2003, Dupont et al. 2005).

Forestry and Habitat Management

For the Cree, forest harvesting is not perceived a priori to benefit moose in the short term (MCE 1998, Dupont et al. 2005), although the Cree now visit some old clearcuts because of their good hunting potential (Saganash 2004). Compared with the foresters' view, in which moose are perceived as benefiting in the mid-term from logging, this observation does not appear to be well accepted or confirmed by the Cree (MCE 1998). However, some moose hunters have noticed that moose may use regenerated areas about 20 years after harvesting when deciduous regeneration and available browse near good cover are present (Jacqmain and Bélanger 2002, Saganash 2004).

Another Cree concern relative to logging is that the riparian strips (residual mature tree corridors along water bodies) do not seem wide enough to be used by moose (Hébert and Bélanger 2004, Saganash 2004, Dupont et al. 2005). Width and effectiveness of buffer strips between cut blocks are also criticized for the same reason, since habitat contiguity is a concern for native hunters (Jacqmain and Bélanger 2002, Saganash 2004, Dupont et al. 2005). For the Cree, some special habitat types must be protected from logging, and need to be surrounded by a large residual buffer with traveling corridors to be continually used in a clearcut landscape (notion of ecozone) (Lajoie et al. 1993, MCE 1998, Jacqmain and Bélanger 2002, Saganash 2004). For some tallymen, the management vision of a healthy trapline that integrates with forest harvesting would be represented by several permanently protected seasonal habitats (ecozone), surrounded by large residual mature stands, and interconnected by large mature forest corridors, including riparian habitats (Lajoie et al. 1993, Jacqmain and Bélanger 2002, Saganash 2004). Furthermore, access to the land must be controlled to reduce the impact of over harvesting and poaching of wildlife (MCE 1998, Saganash 2004).

Corridors and Riparian Habitats

The Cree people suggest that moose annual cycle can be divided into 4 main seasons (spring–summer, mating time, winter, and late winter) for which needs and habitat preferences differ (Feit 1987, Jacqmain and Bélanger 2002). Moose need connectivity between these specific habitats to travel safely and to find enough food and water while traveling. In uncut landscapes, riparian habitats are thus very important because they offer good availability of deciduous twigs and accessible water and are bordered by dense mature cover for protection (Jacqmain and Bélanger 2002).

Particular Habitats, Annual Fidelity, and Site Reutilization

To fulfill some particular needs, the Cree recognize that there are a few restricted, specific habitats (such as wintering and calving areas) that are critical. Calving sites are normally situated in isolated areas, such as swamps or peninsulas, where moose can find protection and quiet. Females may sometimes travel a long distance to find such places (Feit 1987). Wintering areas, known as moose yards, are typically described as elevated terrain, intersected by valleys, with mature mixed or deciduous stands used for food and mature coniferous stands for cover (Lajoie et al. 1993, Jacqmain and Bélanger 2002, Dupont et al. 2005). Topography is also an important characteristic of moose yards where moose, in late winter, are primarily located in hilly terrain for several

reasons such as reduced risk of predation and lower snow depth (Feit 1987). The Cree have observed that, over time, moose consistently use these preferred and critical seasonal habitats (MCE 1998, Jacqmain et al. 2003).

RESEARCH APPROACH

Since the project's objective is to gather new information about moose habitat which will give a better portrait of such habitats in northern ecosystems, both Cree and scientific visions must be investigated. This will allow filling gaps in the scientific and Cree knowledge previously enunciated. To do so, two distinct but complementary research processes are used. These strategies tackle the same topics but will generate different information to help identify the similarities and differences in knowledge and build a common vision about moose habitat requirements. Research hypotheses have been oriented based on several issues presented by the Cree which seem to contradict available scientific literature and/or for which little scientific information is available for the study area.

Scientific Investigation of Moose Habitat Needs

Moose habitat use is being assessed using Global Positioning System (GPS) radio collars. GPS technology is the most appropriate tool for studying large mammals' habitat use that otherwise has a high cost-benefit ratio (Rodgers et al. 1997). Furthermore, as proposed by Weber (2000), a participatory management process will greatly benefit from using the "best" available science to bring new information to the decision-making table. This study targets only adult females as sample units (Aebischer et al. 1993), because they are known to have more specific habitat requirements than adult males, particularly when they are accompanied by calves (Thompson and Vukelich 1981, Courtois et al. 2002, Dussault et al. 2005). Moose were selected on the hunting grounds of Cree families from whom we received permission by the tallymen to radio collar. This selection was made to optimally cover the study area (ecological variability and different forest management practices). Net-gunning will be used for capturing moose, as tranquillizers require a 45-day consumption ban, which is incompatible with the winter subsistence hunting of the Cree. The same 15 females will be monitored for 3 years with annual replacement of the collar battery packs.

Cree Hunters' Needs and Knowledge about Moose Habitat

Cree knowledge about moose, moose habitat needs, and the impact of forest activities on moose will be collected through interviews with recognized knowledgeable tallymen and Cree hunters. Hunters and trappers have based this knowledge on that of their ancestors and have amended it with their personal experiences, following an ecological empirical understanding process (Gauthier 2002). Although this knowledge is characterized as "less technological" (Berkes 1993), its value and usefulness in natural resource management for data acquisition and for elaboration of management guidelines is factual, demonstrated, and recognized (McDonald 1988, Johnston and Ruttan 1992, Healy 1993, Craig and Smith 1996).

Gathering local ecological knowledge (Davis and Wagner 2003) involves following fundamental requirements when working with First Nations. The research ethic includes developing a complete and understandable presentation of the project, gaining the support of the local community, involving a Cree assistant in the project, presenting results, validating the results, and making sure that useful results will be available to the community.

As the desired information concerns

moose habitat and needs of moose hunters, questions are mainly addressed to full-time moose hunters and tallymen who are considered to be dependent on local natural resources (Gagnon 1973, Mongeon 1993, Croteau 1999). The majority of the interviews are in Cree, with the Cree research assistant translating from English to Cree, as our targeted public (Cree who live in the bush) are more at ease in the Cree language.

Development of a Common Understanding and Proposal of Socio-Adapted Management Strategies

All interview questions are developed and formulated to obtain qualitative and quantitative information on the same topics tackled with scientific habitat analysis. Although some comparisons can obviously be made, one must keep in mind that the goal of the project is not to rank Cree knowledge versus scientific information, but rather to evaluate the degree of convergence between these two, and to understand those parts that do not appear to be congruent.

Based on new knowledge about moose habitat and the impact of forest harvesting, and with respect to the needs of tallymen and Cree hunters, moose habitat management strategies will be proposed and developed. By considering scientific and Cree knowledge, we expect that these management strategies will better suit stakeholders' needs, while ensuring a suitable environment for moose. Through a working committee within the Model Forest (Cree, governments, industries, and university), results will be presented to the authority in charge of natural resources management in the study area for analysis and hopefully field implementation.

POTENTIAL OUTCOMES OF THE PROJECT

To our knowledge, there are few ongoing studies involving a true combination of aboriginal and scientific knowledge related to strategies for natural resource management. The use of GPS collars and the involvement of the principal and knowledgeable stakeholders, allow managers to predict that results will be suitable and accurate within the socioecological context. Better management of northern moose habitat, at the periphery of the animal's range where the habitat may be restrictive (Crête and Courtois 1997), in combination with an adjusted population harvesting strategy will certainly benefit the species and allow densities to increase. The high degree of local, regional, and provincial support and the participation of principal stakeholders are good signs that the proposed approach has a high potential to resolve management conflicts. All the processes will be monitored and reported so they can be used or adapted in other areas involving resource management and First Nations.

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