FOREST MANAGEMENT PLANNING STRATEGY FOR BIOENERGY IN REMOTE ABORIGINAL COMMUNITIES IN CANADA*

DAVID PUTTOCK,

Silv-Econ Ltd,
913 Southwind Ct, Newmarket, Ontario, Canada L3Y 6J1

DEBORAH McGREGOR,

Whitefish River First Nation,
General Delivery, Birch Island, Ontario, Canada P0P 1A0

and ED BEVILACQUA

SUNY College of Environmental Science & Forestry,
1 Forestry Drive, Syracuse, New York 13210-7900 United States

(Received for publication 24 September 1999; revision 21 February 2000)

ABSTRACT

This paper presents a framework for community-based forest management planning for bioenergy in remote Aboriginal communities in Canada. Modelled after work done by the National Aboriginal Forestry Association and provincial government agencies, the proposed approach to forest management planning provides the necessary information and format to develop a long-term and integrated resource management plan. It is designed to be adapted as part of a small-scale forestry operation to supply wood-chips for burning in biomass heating facilities. The framework allows individual communities to modify the format to suit their needs, and recognises and plans accordingly for the unique circumstances and characteristics of remote Aboriginal communities. The framework includes information for completing a plan including: period, land description, history, maps, biomass and non-timber inventories, sustainable harvest levels, activity schedules, monitoring, and review. Aboriginal involvement in broad district-level forest management plans is discussed in relation to and comparison with participation requirements for management planning for community-based bioenergy projects.

Keywords: aboriginal; bioenergy; community forest; forest management; management plan; traditional ecological knowledge.

INTRODUCTION

The unique legal status of Aboriginal people in Canada and their close association with the land and its natural resources provides impetus for Aboriginal participation in forest

---

* Paper presented at IEA Bioenergy Task 18 "Conventional Systems for Bioenergy" Workshop, Charleston, S.C., 19–25 September 1999.

management planning on provincial Crown lands in Canada (Brubacher & McGregor 1998; Graham 1999; Smith 1995). Provincial Crown lands are public lands administered and managed by the provinces. The importance of involving Aboriginal communities in forest management has been recognised in the National Forest Strategy (Canadian Council of Forest Ministers 1992) and in the criteria and indicators for the sustainable management of Canadian forests (Canadian Council of Forest Ministers 1997). In addition, recently developed Canadian and international principles and criteria for certification of forest products include Aboriginal participation in forest management as a key indicator of forest sustainability (Smith *et al.*1995). These principles and criteria should help guide the forest management planning processes and the implementation of management plans.

There is general consensus that planning success in Aboriginal communities can best be achieved through adherence to the following general management principles (The Scientific Panel for Sustainable Forest Practices in Clayoquot Sound 1995);

- respect traditional values and spirituality;
- incorporate existing Aboriginal people's knowledge and practices into planning;
- encourage meaningful community involvement in the management planning process and implementation of the plan;
- incorporate established Aboriginal forest land management guidelines (Smith *et al.* 1995).

Approximately 150 remote Aboriginal communities in Canada are surrounded by vast forested areas creating potential forest management opportunities for small-scale, integrated, forest harvesting. Expanding the use of forest biomass in remote communities requires, among many other things, an integrated sustainable approach to forest management to ensure a continued supply of wood while maintaining the ecological integrity and productive capacity of the forest. It is perhaps of greater importance to ensure that non-timber values, including spiritual and cultural forest values and traditional and ecological knowledge and values of the Aboriginal community, are highly regarded in all stages of the process.

This paper focuses on a community-based approach to sustainable forest management planning for bioenergy on forested Federal Reserve lands and other classes of Aboriginal land. Reserve lands are land set aside by the Federal Government for the use of and occupancy by an Aboriginal group or band. Federal Reserve lands are administered and managed under the Indian Act. The Act, first passed in 1876, sets out certain Federal Government obligations, and regulates the management of Federal Reserve lands.

COMMUNITY PARTICIPATION IN FOREST MANAGEMENT PLANNING

Aboriginal people have a unique constitutional and legal status in Canada. This unique status is based upon the recognition of their historical occupancy and use of the land and is formally recognised in various treaties between the Crown and Aboriginal peoples. Although Aboriginal and treaty rights are still being interpreted in the courts, it is becoming increasingly expected that Aboriginal rights be recognised and accounted for in resource management plans.

Aboriginal participation in forest management planning on provincial Crown lands, long considered a mere formality, has evolved to the point where some jurisdictions have now developed formal Aboriginal consultation programmes for timber management (Ontario Ministry of Natural Resources 1996). While these formal requirements for Aboriginal participation in forest management have addressed many past inequities in the management planning processes, they have not always been accepted by Aboriginal communities (Smith 1995). For those Aboriginal communities which choose to participate in provincial planning processes, the technical, financial, and human resource capacity of the community is often insufficient to permit effective and informed participation. In some planning situations, Aboriginal communities, because of the size of their traditional territories in relation to Provincial forest districts, are trying to maintain involvement with three or four planning processes, spanning perhaps two or three different forest districts. Aboriginal participants are often at a disadvantage due to their lack of familiarity and experience with the management planning process. There are few Aboriginal professional foresters in Canada, and the need for natural resource managers and technicians is critical (Smith *et al.* 1995; Hopwood *et al.* 1993). In the short-term, Aboriginal communities may find it helpful to retain the services of a forestry professional to assist with training community members who are likely to participate in forest management planning and plan implementation.

Where communities are involved in forest management planning, such as for small-scale bioenergy projects, local planning concerns will likely take precedence over broader district-level issues. Trust, and respect for community structures and protocols, are essential for community-based forest management planning (The Scientific Panel for Sustainable Forest Practices in Clayoquot Sound 1995).

The structure of Aboriginal government varies across communities. Most Aboriginal communities or groups of communities are governed by an elected Chief and Council. However, community participation and consensus building are essential elements in setting forest management goals and objectives. Community participation has several components, including the views of political and administrative staff, technical support staff, traditional leaders such as Elders (Dene Cultural Institute 1991), forest users, and the general community (Smith *et al.* 1995). Community education regarding forest management principles and practices may be required before community-based management planning can proceed (Smith *et al.* 1995). For example, a community may hold vast knowledge about the surrounding forest land (Bombay 1996), yet possess relatively little information about conventional forest management practices (Merkel *et al.* 1994).

Community goals (e.g., maintaining environmental integrity and balance, sustainable forest management) and objectives for forest management may already exist (e.g., maintain and enhance habitats for wildlife, manage forests to provide wood-chips for energy, forest fire control). Goals and objectives may also exist informally and are often expressed orally rather than in writing. Informal goals may also be expressed in past and present uses of the forest, as well as in attempts the community may have made to regain control of the forest and/or to change the way the forest has been managed by others. Existing community planning studies and other community information may also provide useful background information on forest management goals.

MANAGEMENT PLANNING SYSTEMS

A forest management plan is a written document which establishes the long-term strategies and objectives for sustainable forest management for a defined forest area. The management plan guides proposed forest operations over the duration of the plan through recommended forest development and improvement activities (Smith *et al.* 1995). For remote Aboriginal communities which may be contemplating integrated forestry operations, including wood-chip production for energy, the forest management plan could form part of a broader outline for forest development identified in a community business plan.

An Aboriginal forest management plan should integrate forest management planning objectives with broader community objectives. The forest management plan guides forest operations by establishing sustainable forest harvest schedules, silvicultural prescriptions, and operating guidelines. Monitoring and evaluation of management activities are important elements of forest management plans. This process, to be repeated at periodic intervals, identifies those activities that are working well and allows for changes to activities that are not sustainable.

There are numerous forest management planning systems in use across Canada and elsewhere. Many of these systems are designed to accommodate large-scale (e.g., 50 000 ha or more) landscape- or forest-level planning. In addition to the formal planning requirements, most planning systems include silvicultural guidelines, best practice guidelines, and forest auditing protocols. Many large-scale forest management planning systems are also accompanied by sophisticated wood supply models and Geographic Information Systems (GIS). The data requirements for these planning systems are generally beyond the scope of forest-level data which would be available in most remote communities. Although useful for strategic forest-level multi-resource planning, the plans derived from these planning systems are generally not site-specific and often do not accommodate the various intangible forest values and traditional environmental knowledge which are important to Aboriginal communities.

Many Aboriginal communities are actively engaged in forest management (Bombay 1996) and there is much to be learned from their approaches to management planning. The scale and scope of forest management planning in Aboriginal communities are perhaps more closely mirrored by the planning requirements of non-industrial forest owners and smaller commercial forest operations. These small-scale (i.e., less than 10 000 ha) forest management planning systems provide useful models for developing a framework and guidelines for sustainable forest management in remote communities. These planning approaches include greater flexibility to accommodate non-timber values, simple but effective data requirements, and are often associated with a more intimate knowledge of the forest land and all values.

A community-based approach to sustainable forest management planning is proposed for reserve lands and other classes of Aboriginal lands. This approach does not attempt to address all of the planning requirements which might apply where access is granted to provincial Crown lands, either as tenure-holders or as parties to co-management agreements. Forest management on provincial Crown lands may also affect the forest management objectives and land use decisions of Aboriginal communities on adjacent reserve lands.

FRAMEWORK OF A FOREST MANAGEMENT PLANNING SYSTEM

A forest management plan should summarise the community's objectives, the character of the property, and proposed long-term (e.g., 20 years) and short-term (e.g., 5 years) management activities. The proposed framework of a forest management planning system is modelled after forest management planning guidelines proposed by the National Aboriginal Forestry Association (NAFA) (Smith *et al.* 1995), and guidelines for non-industrial private and small-scale commercial forest management plans (Ontario Ministry of Natural Resources 1997; Decker *et al.* 1990).

The framework includes many components which are common to both large-scale industrial and small-scale non-industrial forest management plans such as: plan period, land description, history, maps, biomass and non-timber inventories, sustainable harvest levels, activity schedules, and monitoring and review. The framework is extended to address the unique requirements for Aboriginal community participation in plan development and implementation, and approaches for including traditional aboriginal knowledge in management plans.

Plan Period

Aboriginal planning horizons commonly span several decades. This is consistent with the seventh generation principle which is embodied in Aboriginal society—that is, planning or thinking ahead seven generations. At the very minimum, a 20-year plan accompanied by a 5-year schedule of management activities is recommended. For those areas where forest biomass will be produced or where other management activities will be undertaken, an annual work schedule is also recommended. The annual work schedule establishes a time frame for undertaking harvesting, forest renewal (regeneration), and stand tending (e.g., thinning, weed control) activities. The work schedule also provides access plans for each stand that will be actively managed during the year.

Forest Land Description

It is often convenient to separate the forest into compartments or blocks according to forest types, land uses, or management goals. The forest land description is a legal and physical description of the forest land represented in the plan, including a compartment- and forest-level summary of area by broad land classes. Land classes might include forest land, lakes and wetlands, development area (community), area excluded from management, and roads and quarries (Table 1).

Area History

As much as possible, the plan should summarise the history of the forest, perhaps over the last 20 years although many Aboriginal communities may be able to recall events which

TABLE 1–Area summary for an example forest.

Land class	Compartment 1 (ha)	Compartment 2 (ha)	Total (ha)
Forest land	427.4	596.8	1024.2
Lakes and wetlands	77.6	172.7	250.3
Development area (community)	45.8	–	45.8
Area excluded from management	7.2	50.7	57.9
Roads and quarries	–	15.6	15.6
Total	558.0	835.8	1393.8

occurred several decades past. This includes a history of land use by the community, traditional Aboriginal uses such as hunting and fishing, trapping, fuelwood harvesting, and cultural uses. There may also have been previous industrial uses of the land such as forestry and mining. It is also useful to record a history of natural disturbances such as forest fires, insect outbreaks, and areas of significant windthrow. Recording past management practices will help the community and forestry professionals or managers understand the current condition of the forest and may also clarify future objectives or modify existing ones. For example, previous harvesting activities or recent forest fires may have created scattered patches of juvenile forest which may require thinning. Areas of juvenile forest often provide wildlife habitats which are not available in mature forest conditions. Therefore, although these areas may not be harvested over the duration of the plan, they may be important to achieving the overall forest management objectives of the community. Describing and documenting the natural history of the forest may also further a community's understanding of its relationships with the land and the effects of community activities on the land. As plans are renewed, a historical record of management activities and evaluation of accomplishments is established. This assists in the evaluation and revision of objectives and management strategies.

Forest Land Map

Maps provide a record of generally permanent features as a backdrop for forest stand data and management decision-making. Such maps will usually show forest compartment boundaries, water bodies (lakes, rivers, wetlands), roads and trails (including winter access routes, access points to lakes, canoe portages), ecologically sensitive sites, and forest areas with potential for biomass and timber production, among other information. Communities may be reluctant to release information on traditional harvesting sites (hunting, fishing, trapping, and gathering), or historic, cultural, and sacred sites due to concerns that the information might be misused or that the sites might be vandalised.

While base maps are generally available from provincial government agencies, in more remote locations base maps may not be available. In these circumstances, their creation will be based on the acquisition of remotely sensed imagery, such as aerial photographs or digital satellite imagery. For small-scale bioenergy applications in northern remote communities, black and white panchromatic photography with scales in the 1:15 000 to 1:20 000 range are recommended. At these small scales, photo interpretation provides an efficient means of delineating forest stands and collecting information on species composition, stand height, stocking or crown density, and sometimes age or maturity class. If more detailed stand information is required, larger scale photography at 1:5000 may be necessary.

Physical boundaries such as lakes and rivers can be used to delineate compartment boundaries. Alternatively, compartments could be separated according to forest types or land use. A compartment could contain one or more forest stands. These compartments may also be shown on the forest land map which may serve as both an area and compartment map. For more complicated areas, several maps may be required.

Maintenance of base maps and compartment maps, specifically in keeping them as up-to-date as possible, is facilitated through the use of GIS. The initial time and cost of data entry may be quite high, but longer term cost savings in data maintenance, management, and analysis are possible. Using forest inventories for other applications, such as wildlife habitat mapping, is greatly facilitated through the use of a GIS. At some point, a community may consider acquiring a GIS and investing in the technical training and support required to operate the system. Where this is not practical, the community could retain a GIS contractor to assist with forest management planning.

Forest Resource Inventory

Forest resource inventory needs should be defined in close relation to forest management planning objectives, the type of forest products to be produced (e.g., wood-chips for energy), and the decision-making process that requires the inventory data. The methods used to estimate biomass resources for small-scale forest biomass installations will parallel those established for estimating timber volumes for conventional forest products such as sawtimber and pulpwood. These established procedures have been described by Gillis & Leckie (1993), among others. Most forest inventory procedures across Canada use a forest classification that separates productive forest land into forest units based on species composition, either predominant species or species group—i.e., hardwood, softwood, or mixedwood. For biomass inventories, it may only be necessary to have the inventory separated into species groups, rather than predominant species. However, a more narrowly defined classification system, such as a system which further stratifies species groups into age or site classes, may permit the application of the biomass inventory for other management applications, such as wildlife habitat identification and mapping.

All inventory procedures require a certain amount of ground-truthing to confirm, and where necessary, refine the image interpretation. Avery (1994) provided details on determining sampling intensity. Actual ground locations for field samples are usually subjective, with attention often given to accessibility. The primary difference between volume-based inventories for conventional forest products and biomass inventories occurs during the field sampling. The differences deal mainly with the treatment of small diameter trees and the inclusion of limbs and tops in biomass inventories. Almost always, the primary data recorded in a field plot includes basal area* by species, species and diameter-at breast-height for all trees in the plot, with height (needed for tree biomass equations) and age also recorded. Information for individual sample plots within a stand is aggregated to determine stand-level averages and totals (Table 2). Aggregation of stands within a compartment yields compartment-level information.

Other supplementary stand level information that can be recorded during a field survey includes topography, soil, regeneration, ground vegetation, wildlife habitat information such as nesting or cavity trees, potential access routes, and proposed season of harvest. This information will assist in broadening the application of the biomass inventory to other uses, such as wildlife habitat mapping and habitat suitability analysis. It may also be useful to include an assessment of timber quality and potential for sawlogs or pulpwood should markets for these products become available.

Traditional knowledge of the forest land around the community can be incorporated into the sampling design (Smith *et al.* 1995). Many Aboriginal communities have, to varying degrees, already completed traditional land use studies and/or maps. Non-timber uses that

---

* The area (m^2/ha) of the cross-section of all trees in the field plot measured at 1.3 m above the ground.

TABLE 2–Field tally and calculations for biomass inventory. Example forest.

Owner: Example forest	Type of survey: 1	1 = Fixed plot	Plot area:	0.06 ha
Compartment code: 1 Stand # 221		2 = Prism sweep	No. of points tallied:	18

(1)	(2)	(3)	(4)[1]	(5)[2]	(6)[3]	(7)[4]															
		Species 1: **Pj**					Species 2: **Sb**					Species 3:					Species 4:				
Dbh class (cm)	BA/ tree (m^2)	Tally	Whole-tree biomass (kg)	Stems (#)	BA (m^2)	Biomass (tonnes)	Tally	Whole-tree biomass (kg)	Stems (#)	BA (m^2)	Biomass (tonnes)	Tally	Whole-tree biomass (kg)	Stems (#)	BA (m^2)	Biomass (tonnes)	Tally	Whole-tree biomass (kg)	Stems (#)	BA (m^2)	Biomass (tonnes)
4	0.001						2	2.7	2	0.0	0.0										
6	0.003	1	9.7	1	0.0	0.0	3	7.0	3	0.0	0.0										
8	0.005						20	13.7	20	0.1	0.3										
10	0.008	3	28.6	3	0.0	0.1	40	23.1	40	0.3	0.9										
12	0.011	4	42.2	4	0.0	0.2	46	35.3	46	0.5	1.6										
14	0.015	5	58.6	5	0.1	0.3	53	50.5	53	0.8	2.7										
16	0.020	20	77.9	20	0.4	1.6	59	69.0	59	1.2	4.1										
18	0.025	31	100.0	31	0.8	3.1	29	90.8	29	0.7	2.6										
20	0.031	46	125.2	46	1.4	5.8	21	116.1	21	0.7	2.4										
22	0.038	80	153.3	80	3.0	12.3	5	144.9	5	0.2	0.7										
24	0.045	120	184.5	120	5.4	22.1	3	177.5	3	0.1	0.5										
26	0.053	88	218.8	88	4.7	19.3	3	213.9	3	0.2	0.6										
28	0.062	64	256.2	64	3.9	16.4	4	254.2	4	0.2	1.0										
30	0.071	26	296.7	26	1.8	7.7	3	298.6	3	0.2	0.9										
32	0.080	11	340.4	11	0.9	3.7	8	347.1	8	0.6	2.8										
34	0.091	16	387.3	16	1.5	6.2	1	399.7	1	0.1	0.4										
36	0.102	21	437.4	21	2.1	9.2	3	456.7	3	0.3	1.4										
38	0.113	4	490.7	4	0.5	2.0															
40	0.126	6	547.3	6	0.8	3.3															
42	0.139	2	607.2	2	0.3	1.2															
44	0.152																				
46	0.166																				
48	0.181																				
50	0.196																				
TOTALS		548		548	27.7	114.3	303		303	6.3	23.0										
TOTAL/ha[5]				507	25.6	105.9			281	5.9	21.3										

Note 1.		column(4) = whole tree biomass estimate for dbh class based on established relationship in literature
Note 2.	Plot:	column(5) = column(3)
	Prism:	column(5) = column(3)/column(2)
Note 3.		column(6) = column(2) * column(5)
Note 4.		column(7) = column(4) * column(5)
Note 5.	Plot:	TOTAL / ha = TOTALS / (plot area * # plots tallied)
	Prism:	TOTAL / ha = TOTALS * BAF / # plots tallied

Compartment Summary

Species	Stems/ha	BA/ha	Biomass/ha
Pj	507	25.6	105.9
Sb	281	5.9	21.3
TOTAL	788	31.5	127.2

may be identified include medicinal plants, food supply (animals and plants), sacred areas, trapping, hunting, fishing, and other areas of special significance.

Assessing Needs and Determining Sustainable Harvest Levels

After completion of the forest inventory, an assessment of the needs or demand for timber is undertaken. For small-scale bioenergy installations, the biomass requirements are expected to be small relative to the timber resources available (McCallum 1998). However, the quantity and quality of biomass will depend on the forest characteristics and whether the biomass is produced from whole trees or from logging residues in an integrated harvesting operation such as might be used to produce both sawlogs and wood-chips for energy. For example, with an integrated operation, harvesting of sawlogs might be confined to mature conifer or mixed forests. Wood-chips for energy could be produced from the logging residues. "Candidate" forest areas which meet the criteria for the various forest products are identified through the forest inventory and the forest land maps. From these "candidate" areas, a sub-set of areas is identified for timber production in the next 5-year period. For example, many forest-based remote communities in Canada have access to mature stands of aspen or poplar. In the absence of other market opportunities for these species, those stands could be the first ones harvested for wood-chips for energy. Thinnings from juvenile conifer stands can also be chipped into wood fuel.

An integrated approach to forest ecosystem management often requires adaptive management strategies such as strip-cutting or the use of single-tree selection, small-group selection, and uniform shelterwood silvicultural systems for biomass production.

Five-Year Management Schedule and Implementation Strategies

The 5-year management schedule provides details of the management activities proposed for the current 5-year period, for each compartment where activities are to be carried out (Table 3).

Operating Guidelines and Best Management Practices

A plethora of guidelines now exist covering practices such as recommended size of harvest blocks and logging systems recommended for different terrains, to the preservation of habitats or sites of cultural significance. These guidelines provide scientific and technical information to assist in implementing the plan and mitigating against potential negative impacts of management activities. Smith *et al.* (1995) listed a number of guidelines relevant to integrated forest management in Aboriginal communities. These guidelines are generally available from provincial and territorial forestry agencies.

Establishing a Plan Approval Protocol

Aboriginal communities reach consensus on forest management based on their range of values of the forest resource. Community involvement throughout the planning process is essential for building a consensus in support of the management plan and proposed management activities (Smith *et al.* 1995). Most Aboriginal communities in Canada are governed by an elected Chief and Council. It is a part of many Aboriginal protocols to consult

TABLE 3–Five-year management schedule for an example forest.

Comp	Objectives	Prescription	Stand #	Area treated (ha)	Year(s) scheduled	Expected outputs
1	• Enhance community fire safety • Produce sawlogs and wood-chips for energy	• Individual tree selection to harvest 25% of basal area and reduce fuel loading and risk of fire • Manual felling and skidding whole trees to minimise residues left on site • Chip logging residues at roadside for energy • Protect advance regeneration following best management practices	221 219	40.0 12.5	1999–2004	• 52.5 ha thinned and fuel loading reduced • 625 m^3 sawlogs • 1390 gt wood-chips for energy
2	• Produce wood-chips for energy • Encourage natural regeneration • Provide browse for moose	• Preparatory cut uniform shelterwood system • Harvest 15% basal area, follow provincial guidelines for provision of moose habitat • Manual felling and wheeled skidder • Winter access only • Retain tops on site as seed source for natural regeneration	250	25.5	1999	• 25.5 ha uniform shelterwood preparatory cut • 510 gt wood-chips • 17.5 ha browse habitat produced

Chief and Council when undertaking any activity. A resolution, supported by Chief and Council, may be required for plan approval. In some cases Federal approval may also be required. Among its many provisions, the Indian Act requires federal approval of Aboriginal community by-laws, and may limit certain management activities (Smith *et al.* 1995).

Monitoring and Review of the Plan

Most forest management systems provide for periodic monitoring and auditing of forest management activities recommended in the plan. A successful community involvement programme will include a system for monitoring and incorporating community feedback and traditional environmental knowledge as part of the forest management plan. This allows for assessment and evaluation of what is and is not working, as well as for making changes necessary for the continued success of the plan (Smith *et al.* 1995). At some point, an Aboriginal community may wish to seek certification for Reserve land under one of the sustainable forest management certification systems. Forest certification requires independent forest management audits.

Costing Forest Management Plans

The cost of preparing a management plan will depend upon the amount of forest land involved, accessibility, the availability of aerial photographs and maps, and the time required for community participation in the planning process. Experience from small-scale planning systems suggests that 30–40 person-days are required to complete the planning process for approximately 1000 ha of forest land.

Including Traditional Ecological Knowledge

Numerous terms have been coined to describe Aboriginal forest-based ecological knowledge, including "traditional ecological knowledge", "indigenous knowledge", "indigenous science", and "naturalised knowledge systems". These terms refer to the knowledge that Aboriginal peoples have accumulated over countless generations of intimate contact with all aspects of local ecosystems. James Brant, a Mohawk working with the Cree and Ojibway of the northern boreal forest, describes this knowledge as:

> *"... a body of information about the interconnected elements of the natural environment which traditional Indigenous people have been taught, from generation to generation, to respect and give thanks for"* (Bombay 1996).

The methodology for applying Traditional Ecological Knowledge (TEK) in forest management planning is in its infancy (Bombay 1996). TEK is used for developing various forest inventories such as traditional-use maps and historical land-use patterns (Smith *et al.* 1995; Dene Cultural Institute 1991), current forest uses, identification of cultural and environmentally sensitive areas, databases of geophysical features, soil and forest types, and identification and classification of local flora and fauna (Bombay 1996; Smith *et al.* 1995; The Scientific Panel for Sustainable Forest Practices in Clayoquot Sound 1995). TEK could also be used to "inform the analysis of forest practice standards ... along with an analysis of what long term regional harvest rates would be appropriate" (Pinkerton 1990). Pinkerton (1990) also suggested that TEK has considerable potential to help in environmental monitoring after a harvesting regime has been implemented and for predicting the effects of forest management practices, a feature which remains largely unexplored.

The use of TEK continues to be a highly controversial subject in Aboriginal communities. TEK is cultural knowledge, much of which is sacred and central to the continued existence of the community and the culture. Aboriginal peoples wish to retain control over the documentation, distribution, and application of this knowledge in order to preserve its meaning and to prevent its being abused. Thus, TEK application and community decision-making go hand in hand (Bombay 1996; Dene Cultural Institute 1991). Attempts to apply TEK without granting the community decision-making capacity on how and where TEK will be used have resulted in limited and improper use of the knowledge (Bombay 1996).

Attempts at incorporating TEK into forest management planning must involve key community members such as Elders, resource users (e.g., trappers and hunters), and other knowledgeable individuals. Chief and Council can usually identify individuals who have traditional ecological knowledge. As in other stages of planning, it is important to follow community processes with respect to establishing open lines of communication and trust. Various consultation techniques will need to be followed to share information effectively with different groups within the community.

CONCLUSIONS

A community-based approach is recommended for forest management planning for small-scale bioenergy production in remote communities. The proposed framework for management planning is modelled after the planning requirements of non-industrial forest owners and smaller commercial forestry operations. This approach respects traditional Aboriginal values and spirituality, incorporates existing Aboriginal people's knowledge and practices into planning, and provides for meaningful community involvement in the management planning process. Experience acquired by participating in management planning for community bioenergy projects will also assist the community in contributing more effectively to broader district-level forest management plans.

ACKNOWLEDGMENTS

The authors wish to thank Joe DiFranceschi, Maureen McIlwrick, and Rick Greet, Canadian Forest Service, and the anonymous reviewers for their helpful comments and suggestions. This paper is based on earlier work by G. D. Puttock, D. McGregor, and E. Bevilacqua (1998) A forest management planning strategy for remote communities. Natural Resources Canada, Canadian Forestry Service, Great Lakes Forestry Center Information Report GLC-X-2, and has been adapted for an international audience.

REFERENCES

AVERY, T.E. 1994: "Forest Measurements" 4th ed. McGraw-Hill, New York, NY. 408 p.

BOMBAY, H. 1996: Aboriginal forest-based ecological knowledge in Canada. Discussion Paper. National Aboriginal Forestry Association, Ottawa. 55 p.

BRUBACHER, D.; McGREGOR, D. 1998: Aboriginal forest-related ecological knowledge in Canada. A contribution to the technical paper for presentation to the nineteenth session of the North American Forest Commission, Villahermosa, Mexico. Prepared for the Canadian Forest Service, Natural Resources Canada, Ottawa, ON.

CANADIAN COUNCIL OF FOREST MINISTERS 1992: Sustainable forests: A Canadian commitment. National Forest Strategy. Hull, P.Q.

———1997: Criteria and indicators of sustainable forest management in Canada. Canadian Forest Service, Natural Resources Canada. Ottawa, ON. 47 p.

DECKER, D.J.; KELLEY, W.; SEAMANS, T.W.; ROTH, R.R. 1990: Wildlife and timber from private lands: A landowner's guide to planning. *Cornell Cooperative Extension, Cornell University, Ithaca, N.Y., Information Bulletin 193.* 56 p.

DENE CULTURAL INSTITUTE 1991: Guidelines for the conduct of participatory community research to document Traditional Ecological Knowledge for the purpose of environmental impact assessment and environmental management. A paper submitted to the Environmental Assessment Research Council. 41 p.

GILLIS, M.D.; LECKIE, D.G. 1993: Forest inventory mapping procedures across Canada. *Canadian Forestry Service, Petawawa National Forestry Institute, Information Report PI-X-114.*

GRAHAM, J. 1999: Exploring the relationship between Aboriginal People and the Canadian Forestry Industry. *Forestry Chronicle 75(1)*: 67–72.

HOPWOOD, A.; MACTAVISH, J.; MOAR, A.; SCOTT, G.; SMITH, P. 1993: Aboriginal forestry training and employment review (AFTER): Final report phase 1. National Aboriginal Forestry Association, Ottawa. 81 p.

McCALLUM, B. 1998: Woodchip supply systems for Canada's remote communities (Draft). Canadian Forest Service, Natural Resources Canada, Sault Ste. Marie.

MERKEL, G.; OSENDARP, F.; SMITH, P. 1994: Sectorial study: Forestry. An analysis of the forest industry's views of Aboriginal participation. Prepared for the Royal Commission on Aboriginal Peoples. 61 p.

ONTARIO MINISTRY OF NATURAL RESOURCES 1996: "Forest Management Planning Manual for Ontario's Crown Forests". Queens Printer for Ontario, Toronto, ON.

———1997: A guide to the managed forest tax incentive program (MFTIP). Peterborough, Ontario. 15 p.+Tables.

PINKERTON, E. 1990: "Conclusion: Where Do We Go From Here? The Future of Traditional Ecological Knowledge and Resource Management in Native Communities". School of Community and Rural Planning, University of British Columbia, Vancouver. 22 p.

SMITH, P. 1995: Aboriginal participation in forest management: not just another stakeholder. NAFA Position Paper. National Aboriginal Forestry Association, Ottawa, ON.

SMITH, P.; SCOTT, G.; MERKEL, G. 1995: "Aboriginal Forest Land Management Guidelines: A Community Approach". National Aboriginal Forestry Association, Ottawa. 113 p.+App.

THE SCIENTIFIC PANEL FOR SUSTAINABLE FOREST PRACTICES IN CLAYOQUOT SOUND 1995: First Nations' perspectives: Relating to forest practices standards in Clayoquot Sound. *The Scientific Panel for Sustainable Forest Practices in Clayoquot Sound, Victoria, Report 3.* 82 p.