Local-level criteria and indicators: an Aboriginal perspective on sustainable forest management

ERIN SHERRY[1], REGINE HALSETH[2], GAIL FONDAHL[3]*, MELANIE KARJALA[4] AND BEVERLY LEON[5]

[1]Northern Aboriginal Research and Development Alliance, University of Northern British Columbia, 3333 University Way, Prince George, BC V2N 4Z9, Canada
[2]UNBC
[3]Geography Program, UNBC
[4]Aleza Lake Research Forest, UBC/UNBC
[5]Tl'azt'en Nation, UNBC Community University Research Alliance Project
* Corresponding author. E-mail: fondahlg@unbc.ca

Summary

As tools for improving the sustainability of forest management, criteria and indicator (C&I) frameworks have grown in popularity over the last decade. Such frameworks have been largely derived from top-down approaches to determining critical measures of forest management success. While useful, they fail to capture many C&I of critical importance to local populations, who experience forest management strategies first hand and who have their own definitions of sustainability. Using archival materials, our research begins to identify one First Nation's forest values and compares these local-level C&I with three well-known C&I frameworks for sustainable forestry. We demonstrate that local-level definitions can provide additional C&I, as well as additional levels of detail to C&I that they share with the national and international frameworks. Both are crucial to developing strategies for sustainable management that meet local as well as broader needs and desires.

Introduction

Aboriginal participation in forest management is essential to the future of forestry in Canada. Many recent changes promote the inclusion of First Nations' interests and perspectives. Legislative mandates in Canada have recognized Aboriginal forest goals, including increased access to forest resources, expanded participation in forest management, and enhanced forest-based development (Jaggi, 1997; Assembly of First Nations, 1998). Many national initiatives (National Aboriginal Forestry Association, 1997; Canadian Council of Forest Ministers, 2003), forest certification standards (Collier *et al*., 2002) and planning processes (Karjala *et al*., 2004) require the co-operation of Aboriginal and non-Aboriginal parties and public and private stakeholders to ensure an equitable

Forestry, Vol. 78, No. 5, 2005. doi:10.1093/forestry/cpi048
Advance Access publication date 6 September 2005

and inclusive approach to forest management. There is growing acknowledgment of the rights of Aboriginal people with respect to land and resources (Hawley *et al*., 2005). Landmark court rulings such as *Sparrow* in 1990, *Delgamuukw* in 1997, *Haida Nation* in 2004 and *Taku River Tlingit* in 2004 dictate that industry, third-party interests, and especially government have an enforceable legal and equitable duty to consult First Nations before proceeding with development on potential treaty settlement land and to seek accommodation of Aboriginal rights. Aboriginal resource access and control have also been defined by the negotiation of land claims and self-government agreements (e.g. Inuvialuit, Gwich′in, Inuit and Nisga'a). The inherent and practical value of incorporating Aboriginal management systems into resource decision-making has been recognized; integration of Aboriginal and local people's knowledge is viewed as critical to good forest stewardship (Berkes, 1999; Sherry and Myers, 2002). Yet, the challenge remains to develop sustainable forest management institutions with Aboriginal groups (McGregor, 2002; Karjala *et al*., 2003; Parsons and Prest, 2003).

In Canada, various forms of joint forest management are emerging as possible models for partnerships involving First Nations, government, industry, and non-governmental organizations, including joint ventures, community forests and co-managed forests (Beckley, 1998; Treseder and Krogman, 1999; Sherry and Fondahl, 2003). These regimes are likely to play a significant role both prior to and after the successful negotiation of treaties in British Columbia, and during the phase of forest management capacity building among First Nations. The growing popularity of such arrangements necessitates further investigation into the requisites for success. Critically, we need to develop (1) a fuller understanding of the essential elements of effective joint management systems; (2) concrete guidelines, tools and methods to facilitate effective joint management; and (3) monitoring and evaluation frameworks that consider joint management in a comprehensive, multi-dimensional manner.

In response to these challenges, the current research is creating and appraising methods for local-level criteria and indicators (C&I) development in order to produce a flexible C&I set to direct, monitor and evaluate joint forest management arrangements, particularly those involving First Nations. The John Prince Research Forest, an equal partnership between Tl'azt'en Nation and the University of Northern British Columbia, is used as a case to explore these essential elements. During Phase 1 of this project, Tl'azt'en Nation C&I of sustainable forest management were identified through analysis of primary archival materials (Sherry and Fondahl, 2003).

This paper undertakes a comparison of these local-level, Aboriginal C&I with three popular frameworks: the Canadian Council of Forest Ministers' (CCFM) template (Canadian Council of Forest Ministers, 2003), the Local Unit Criteria and Indicators Development (LUCID) test (Wright *et al*., 2002a), and the Centre for International Forestry Research (CIFOR) generic template (Centre for International Forestry Research, 1999). The purpose is to determine how local expressions of sustainability differ from more global and top-down approaches. While it is recognized that these larger scale C&I frameworks have different goals, and are not directed toward assessing forest management at the local scale, we hope to demonstrate through comparison the relevance and importance of using a community-centred, bottom-up approach to C&I development. Our comparison focuses on five core themes: fair and effective decision-making, social sustainability, economic sustainability, increased management effectiveness, and ecological sustainability. Key similarities and differences between the local-level framework and the other three frameworks are highlighted.

Definitions

Criteria are the essential elements that must be present to achieve a community's goals. Indicators are the direct or indirect signs and signals that can be used to monitor and assess criteria. According to the CCFM (Canadian Council of Forest Minister, 1995):

> A criterion is a category of conditions or processes by which sustainable forest management may be assessed … characterised by a set of related indicators, which are monitored periodically to assess change. An indicator is a quantitative or qualitative variable which can be measured and described and which, when observed periodically, demonstrates trends.

C&I can be used to organize information for conceptualizing, implementing and evaluating sustainable forest management. Criteria and indicators (C&I) are most commonly applied to assess and report on the state of forests; a secondary use is to guide forest management planning and decision-making (Karjala and Dewhurst, 2003). Typically arranged in a hierarchical framework, C&I provide a common language for delineating management goals, and assessing progress toward these goals over time (Wright *et al*., 2002b). A C&I framework is often used to provide a clear, consistent representation of sustainability concepts and their relationships. This approach has proved effective in describing systems where a large number of variables are involved. Wright *et al*. (2002a) explain that the value of C&I hierarchies lies in their transparency, comprehensiveness and streamlining.

C&I concepts have been evolving since the early 1990s. With the release of *Our Common Future* (World Commission on Environment and Development, 1987), which popularized the concept of sustainable development, and the advent of *Agenda 21* (United Nations Commission on the Environment and Development, 1992), the need to monitor and evaluate progress towards sustainable forest management arose. One of the first organizations to take up this challenge was the Montreal Process Working Group, which began work in 1993 on the development of internationally accepted C&I for sustainable management of temperate and boreal forests. Its work led to the endorsement in 1995 of the Santiago Declaration, a comprehensive set of national-level C&I for sustainable forest management. The Declaration would become the basis for other national and international C&I initiatives, which were encouraged by environmental groups as well as private, voluntary certification systems (Wright *et al*., 2002a). Since that time, national commitments and international market incentives have stimulated C&I development worldwide (Karjala and Dewhurst, 2003). The quest for forest sustainability has resulted in numerous initiatives to monitor, evaluate and report on the state of forests in various regions (Prabhu *et al*., 1998). For example, World Wildlife Fund and the International Union for the Conservation of Nature generated C&I for environmental, social and cultural issues related to commercial plantation forestry (World Wildlife Fund and International Union for the Conservation of Nature, 1997); the Montreal Process yielded C&I for the management of temperate and boreal forests (Montreal Process Working Group, 1999); the Forest Stewardship Council advanced general principles and criteria for sustainable forestry (Forest Stewardship Council, 1999); and the CIFOR developed a generic process for the identification and evaluation of C&I for natural, tropical forests (Centre for International Forestry Research, 1999).

Overview of four C&I frameworks

Canadian Council of Forest Ministers (CCFM)

As part of Canada's commitment to sustainable forest management and the adoption of a Statement of Forest Principles embodied in United Nations Commission on the Environment and Development (UNCED)'s Agenda 21 Action plan, the CCFM established a Criteria and Indicator Task Force composed of representatives from federal, provincial and territorial governments, to undertake the development of C&I for sustainable management of Canadian forests. Through extensive consultation with officials and scientists from these various levels of government, as well as with experts from the academic community, industry and non-governmental organizations this Task Force developed and released a *national* framework of C&I for sustainable forest management in 1995 (Canadian Council of Forest Ministers, 1997). Recognizing that forest management is an adaptive process whereby assessing sustainability is a continuous activity that reflects changing values, improved data availability, and better understanding of sustainable forest management (Canadian Council of Forest Ministers, 2003), the original C&I framework underwent a review in September 2001. The review was undertaken as a three-stage process. In the first stage, focus groups were convened across Canada to identify values with respect to sustainable use of the forest. In stage two, the task force established six technical working groups, composed of technical experts drawn from various organizations, which reviewed the framework and recommended a revised set of

indicators. Finally, these indicators were presented for validation to various government and non-government organizations that use the framework (Canadian Council of Forest Ministers, 2000). As a result of this review, the CCFM released a revised framework containing the same number of principles but reducing the number of indicators to allow for their more effective use (Canadian Council of Forest Ministers, 2003). It is this updated framework that is used in the current comparative analysis.

The CCFM framework was designed for assessing the state of Canadian forests at the national level and for the purposes of international reporting. There is recognition within the CCFM document that 'while some indicators lend themselves to reporting at smaller management levels, they are not intended to assess sustainability directly at a local or forest management unit level' (Canadian Council of Forest Ministers, 2003: 3). However, the framework has served as a foundation for the development of many local C&I sets; for instance, Canadian Model Forest initiatives (Beckley *et al*., 2002; Bridge *et al*., 2002). The Canadian Standards Association also requires the development of local-level indicators that are compatible with the CCFM framework in order to achieve the Canadian Standards Association certification.

The Canadian Council of Forest Ministers (2003) C&I framework is not without critics. Significantly, the National Aboriginal Forestry Association (NAFA), representing over 400 Aboriginal communities and organizations and a member of the National Forest Strategy Coalition, has stated that the CCFM C&I framework is inconsistent with objectives and approaches outlined in the National Forest Strategy Coalition (2003), to which the CCFM is a signatory. Further, NAFA denounces CCFM C&I for recognizing First Nations only as stakeholders, not as governments with jurisdiction. In order for forest activities to be sustainable, Bombay *et al.* (1995) suggest that constitutionally recognized Aboriginal and Treaty Rights must be respected and provided for. Towards this end, NAFA, as an original member of the CCFM C&I Task Force, proposed the addition of one criterion and six indicators to the CCFM C&I set. This additional criterion is reflective of

> Canada's approach to sustainable forestry as outlined in Strategic Direction Seven (on Aboriginal Peoples) of Canada's National Forest Strategy of which the provinces are all signatories, and in Canada's international commitments such as the generally accepted UNCED's Guiding Principles on Forests, the UN conventions on Climate Change and Biodiversity, and Chapter 26 of Agenda 21 from UNCED. Further, this criterion is consistent with and has linkages to current federal policy on sustainable forest management, as demonstrated by the Model Forests Program, which includes Aboriginal Peoples as full partners in forest management in many of the projects. It is also in line with the current approach to Aboriginal issues of major significance such as self-government, land claims, economic self-sufficiency and recent legal decisions which call for the integration of Aboriginal and Treaty Rights in natural resources management (Bombay *et al*., 1995: 6).

Such a criterion was not incorporated into the CCFM 1995 framework, nor into the revised 2003 C&Is. It should be noted that Tl'azt'en Nation, as a voting member of NAFA, does not accept CCFM C&I.

Centre for International Forestry Research (CIFOR)

The second framework used in our comparative analysis is the CIFOR *Criteria and Indicators Generic Template* developed in 1999. Based on testing and refinement carried out in Germany, Indonesia, Cote d'Ivoire, Brazil, Austria, Cameroon and the United States, this template represents a comprehensive, generic set of C&I. Initially, the focus of CIFOR's C&I initiative was on identifying the smallest number of C&I needed to reliably assess forest management in order to inform forest certification processes (Prabhu *et al*., 1996). CIFOR's focus was subsequently extended to include on-site assessment of the quality, performance and systems of forest management (Prabhu *et al*., 1996). The *Generic Template* is designed to be used by a variety of user groups, including certification bodies, government officials, donors, forest managers, project managers and scientists.

The basic approach utilized to develop the CIFOR C&I template involved three stages.

First, an appropriate set of C&I was identified by building on five international sets of C&I in existence at the time of commencement. These included: Smart Wood (Rainforest Alliance, USA); Initiative Tropenwald (Germany); Woodmark (Responsible Forestry Standards, Soil Association, UK); Deskundigen-werkgroep Duurzaam Bosbeher (Dutch Working Group, the Netherlands); and the Lambaga Ekolabel Indonesia (Indonesia) (Prabhu *et al*., 1996). All were non-governmental frameworks, developed for voluntary forest certification in the private sector.

In the second stage, existing C&I sets were evaluated in five field locations. Evaluations were conducted at the forest management unit level on four different continents in order to draw global comparisons and reach conclusions about commonalities. These evaluations involved discussions and interviews with 'stakeholders', field surveys and use of documented information. The third stage consisted of a post-field workshop to review and revise the proposed C&I with input from field teams, as well as invited participants with expertise in the various disciplines. Following this, a final report was prepared on C&I selected for each site (Pierce-Colfer *et al*., 1995).

The CIFOR framework was developed through a 'top-down' process utilizing external experts rather than local knowledge and experience. C&I were developed at each site by multi-disciplinary teams that included foresters, social scientists and ecologists; three internationally recruited members; and two host country nationals (Prabhu *et al*., 1996). While an attempt was made to include differing perspectives such as those of academics, consultants, NGOs and government officials, no effort was made to derive C&I from local people. It must be remembered that CIFOR's framework was developed within the context of large-scale, commercial timber production and for tropical natural forests. A test of the CIFOR C&I conducted in North America in 1999 did, however, show that the majority of C&I were also applicable in varying degrees to temperate forest ecosystem (Woodley *et al*., 1999).

Local Unit Criteria and Indicators Development Test (LUCID)

The third framework used in the current analysis is the Local Unit Criteria and Indicators Development (LUCID) test, which evolved from CIFOR's 1999 application of its C&I framework within the Boise National Forest, Idaho. While the CIFOR North American test provided the foundation for the LUCID project, LUCID was designed to be a more thorough test of the methodology in a variety of settings (Wright *et al*., 2002a). It adopts a systems-based framework that integrates social, economic and ecological dimensions of sustainability. The intended application of LUCID was for the monitoring and assessment of the sustainability of US national forests and grasslands at the forest management unit level. The project involved collaboration among eight National Forests, their leadership teams, and the Inventory and Monitoring Institute Branch of US Department of Agriculture's Forest Service. Six test sites were selected for the LUCID project. These were the Ottawa National Forest (Michigan), Allegheny National Forest (Pennsylvania), Blue Mountain Province (Oregon), Tongass National Forest (Alaska), Modoc National Forest (California), and Mt Hood National Forest (Oregon). Each used a common approach developed by a permanent Core Team established at the Inventory and Monitoring Institute, which also provided technical coordination between the sites. The six Forest Teams were also encouraged to develop and revise the process to fit their local context and, consequently, yielded different results. At the end of the process, which took approximately 2 years, the results from the six teams were integrated.

Again, the development of the LUCID C&I framework was driven by a top-down approach, although the six Forest Teams consisted of regional experts. Forest Teams were interdisciplinary and included a sociologist, an ecologist, and an economist, as well as an analyst/GIS specialist. Deficiencies in expertise were supplemented by seeking assistance from outside experts from either government agencies or nearby universities. While some teams made efforts at public consultation, others did not. The extent of public involvement and/or collaboration was undertaken at the discretion of individual Forest Teams (Wright *et al*., 2002a). Some C&I sets were refined through discussions with affected groups including the Forest Service, staff from other federal agencies, and staff from other state agencies, as well as local stakeholders. Some of

the Forest Teams noted that in lieu of public involvement or collaborative efforts, they utilized the results of other related public involvement initiatives (Wright *et al*., 2002a). However, the lack of formalized public involvement in development of LUCID C&I generated criticism from the community level.

Local-level (Tl'azt'en) C&I

Tl'azt'en Nation, located in central interior British Columbia, is part of the Dakelh linguistic group, and is affiliated with the Carrier Sekani Tribal Council through the treaty process. Tl'azt'en Nation is comprised of four villages, supporting a population of 640 people; approximately 650 Tl'azt'enne reside off-reserve. Forty-seven reserves totalling 2422.26 ha and ranging between 0.4 ha and 817 ha are situated throughout Tl'azt'en Nation's 6560 km^2 traditional territory (Morris and Fondahl, 2002). Tl'azt'en reserve lands are currently under federal jurisdiction and are administered by Tl'azt'en Nation, although this relationship is subject to ongoing treaty negotiation. Despite this uncertainty, the majority of Tl'azt'en traditional territory is under tenure to industrial forestry companies, with two exceptions: the John Prince Research Forest and Tree Farm License 42 (TFL 42), which is held by the Tl'azt'en Nation. Tl'azt'enne rely heavily on their traditional territory: for instance, members of Tl'azt'en Nation operate 30 'keyohs' (family traplines), the summer salmon harvest on Nak'al Bun (Stuart Lake) is a dietary mainstay, and the majority of Tl'azt'enne active in the labour force are seasonally employed in the forest industry. In 1998, Tl'azt'en Nation established a Natural Resources Department that administers their forestry, fisheries and traditional use programmes. The Forestry section focuses on land use decisions within Tl'azt'en traditional territory and attempts to work with keyoh holders and other Tl'azt'enne to assess the impacts of forestry activities and, with the provincial government and timber licensees, to ensure that decisions are in keeping with Tl'azt'en priorities and values.

A local-level (Tl'azt'en) C&I framework was developed through a grounded theory content analysis (Charmaz, 2000; Berg, 2004) of over 100 interviews with members of Tl'azt'en Nation concerning sustainable forest management in the traditional territory. Analysis of archival materials was undertaken to generate a local picture of what is considered to contribute to good forest stewardship. Content analysis followed methods developed by Sherry (2002) and Karjala *et al*. (2004). After a 2-day training session, analysis was conducted over a 7-week period by five Tl'azt'en researchers and two university researchers. Archival analysis was conducted on primary materials from three sources:

1. transcripts and tapes of interviews with Tl'azt'en Nation Elders conducted around 1965–1995 focused on land use and occupancy, oral history, traditional knowledge, community well being and the impacts of forest development.
2. transcripts of interviews with a representative range of community members concerning the development of community forestry on Tl'azt'en traditional territory around 1997–1999.
3. transcripts of interviews with a representative range of community members concerning local perspectives on sustainable Aboriginal forestry and John Prince Research Forest co-management around 1999–2002.

Analysts performed content analysis on each transcript to extract and understand the broad range of forest values in the documents, and community priorities and concerns for forest management. A detailed analysis at the local-level provides the information necessary to direct on-the-ground forest management, as well as to monitor and assess forest management. For instance, Tl'azt'en C&I could be applied in an evaluation of existing or future management practices, to the development of management scenarios, to analytical forest planning, or to conflict management by articulating and incorporating alternative perspectives. As Natcher and Hickey (2002) explain, rather than simply moderating the traditional top-down approach to resource management in Canada, such local-level C&I have the potential to effectively account for community pluralism, to foster inclusiveness, and to enhance sustainability.

Cautionary comments

Variances in meaning, hierarchical structure, and scale between the frameworks may accentuate

their differences. One challenge confronted in developing this comparison was variation in the definition and interpretation of criteria and indicator concepts. This problem is widespread and can create confusion. Table 1 demonstrates discrepancies in terminology between the four C&I frameworks.

The hierarchies used to frame C&I systems are also inconsistent. While use of simple, two-level C&I frameworks is prevalent in national initiatives, the use of additional levels of organization is common in practice. For instance, criteria can be grouped under higher categories called

Table 1: Variation in criteria and indicator definitions among the Comparison Frameworks

Term	CCFM	LUCID	CIFOR	Tl'azt'en
Principle	N/A	A fundamental law or rule serving as a basis for reasoning and action	A fundamental truth or law as the basis of reasoning or action	A fundamental law or rule serving as a basis for reasoning and action (Prabhu *et al.*, 1999); an explicit element of co-management success
Criteria	Criteria represent forest values that Canadians want to enhance or sustain	A component of the structure or function of the ecological, social, or economic systems, which should be in place as a result of adherence to a principle. Criteria form the conceptual architecture of the systems under investigation	A principle or standard that a thing is judged by. A criterion can, therefore, be seen as a 'second order' principle, one that adds meaning and operationality to a principle without itself being a direct measure of performance	The concrete [components] that expand and link more abstract principles … to more specific indicators that can be measured (Lammerts van Buerem and Blom, 1997); components of the structure and function of ecological, social, and economic systems (Wright *et al.*, 2002a); priority elements that warrant full consideration in the management process
Indicators	Indicators identify scientific factors to assess the state of forests and measure progress over time	A quantitative or qualitative parameter that can be assessed in relation to a criterion. Note that indicators have no implied direction, measurement method, spatial or temporal scale or reference value	An indicator is any variable or component of the forest ecosystem or management system used to infer the status of a particular criterion. Indicators should convey a 'single meaningful message'	Specific attributes that can be measured (Lammerts van Buerem and Blom, 1997); a quantitative or qualitative parameter that can be assessed in relation to a criterion. Indicators have no implied direction, measurement method, spatial or temporal scale or reference value (Wright *et al.*, 2002a); the signs or signals used to measure advancement towards attainment of criteria

Sources: Wright, *et al.* (2002a: 83); Canadian Council of Forest Ministers (2003: 1); and Centre for International Forestry Research (1999: 7–8).

'principles', which usually refer to social, ecological and economic sustainability; 'measures' form a hierarchical level below indicators and define the characteristics to monitor and the methods to use; 'data elements' or 'verifiers' are the specific information collected for each measure; and 'thresholds', 'targets' or 'reference values' are comparisons against which the data may be evaluated (Wright *et al*., 2002a). As seen in Table 2, the national-level CCFM framework adopts essentially a two-dimensional structure, although sub-criteria (called elements) are referred to within the framework. The regional level CIFOR and LUCID schemes adopt multi-level frameworks, with four and seven levels of organization, respectively. The Tl'azt'en C&I framework, which is at an even smaller scale, adopts nine levels of analysis.

Criteria, indicators, and critical local values are the focus of the current comparative analysis. Critical local values are defined as the spectrum of values and priorities community members associate with the forest (Sherry and Fondahl, 2004). They encapsulate specific local factors related to both the process and outcomes of management and, grouped together, they provide more specific definition to broadly worded indicators. In this analysis, critical local values are used to determine the extent to which comparisons can be drawn between the four frameworks. The CCFM, CIFOR and LUCID frameworks generally contained enough information in their indicators, measures and verifiers to allow us to assess if Tl'azt'en C&I would be adequately considered.

Table 2: Variation in the hierarchical structure of the Comparison Frameworks

Hierarchy	CCFM	CIFOR	LUCID	Tl'azt'en
Principles		X	X	X
Criteria	X	X	X	X
Indicators	X	X	X	X
Critical local values				X
Verifiers		X		
Measures			X	X
Data element			X	X
Reference values			X	X
Benchmarks			X	X
Actions/strategies				X

Difficulties also arise in terms of applying criteria and indicators from one scale to another. Indeed, the national and international C&I are not designed to be used at the local level. As Table 3 illustrates, the local-level (Tl'azt'en) C&I framework contains a greater level of detail than do the national or international frameworks, a feature that would be expected.

Comparison of Tl'azt'en C&I with CCFM, LUCID and CIFOR frameworks

In the following analysis, CCFM, LUCID and CIFOR frameworks (herein referred to collectively as the Comparison Frameworks) are measured against five local-level Tl'azt'en principles. It is important to note that the 'Tl'azt'en Framework' presented here is not a complete or authoritative depiction of Tl'azt'en C&I, but rather portrays a representative range of local forest values and sustainability concerns derived from community-based analysis of archival materials. [Collaborative research to develop and verify local-level C&I, through community interviews and focus groups, is ongoing between Tl'azt'en Nation and the University of Northern British Columbia.] The five principles under investigation include:

1 fair and effective decision-making
2 social sustainability
3 economic sustainability
4 increased management effectiveness
5 ecological sustainability.

Comparative analysis followed a two-step process. For each principle, commonalities between Tl'azt'en C&I and those found in the Comparison

Table 3: Variation in the number of principles, criteria, and indicators contained within the Comparison Frameworks

C&I framework	Principles	Criteria	Indicators	Critical local values
Tl'azt'en	5	17	52	143
CCFM	0	6	46	–
LUCID	3	16	58	–
CIFOR	6	24	98	–

Frameworks were identified. This allowed us to determine to what extent each Comparison Framework addressed Tl'azt'en Nation goals. This was followed by a detailed examination of Tl'azt'en critical local values in order to delineate finer distinctions in their relationship to Comparison Frameworks. A three-code system is used to denote our evaluation of the level of correspondence between Tl'azt'en C&I and the Comparison Frameworks. The letter 'Y' identifies cases where there is close correspondence between Tl'azt'en C&I and Comparison Frameworks. The letter 'P' indicates cases where there is partial correspondence between the different frameworks, although this relationship may be quite broad. The letter 'N' denotes cases where there is little or no correspondence between the different frameworks. Judgements on 'close', 'partial' and 'little or no' correspondence were of course subjective, but corroborated by evaluation of several researchers, including one community researcher. To summarize these correspondences we are defining overall '*high* correspondence' to be where 'close correspondence' across criteria is greater than 70%, '*fair* correspondence where 'close correspondence' plus 'partial correspondence' range between 30 and 70%, and '*minimal* correspondence' where 'no correspondence (none)' is greater than 70% (see Table 4) While numerous commonalities among general theme areas were identified, Tl'azt'en C&I elucidate the elements of sustainability in much greater detail than the other frameworks.

Fair and effective decision-making

In this comparative analysis, a distinction is made between management processes and outcomes, which finds support in recent literature (Sheppard, 2003). The fair and effective decision-making principle incorporates all local-level C&I related to successful and efficient forest management processes. While there is growing recognition that institutionalizing consensus-based decision-making, transferring power and control to local level institutions, and incorporating local/traditional knowledge into the management process is essential for sustainable resource management (Berkes and Feeny, 1990; Hauck and Sowman, 2001; Hunt and Haider, 2001), to date, 'process' C&I (as opposed to 'outcome' C&I) have not been adequately considered. Processes are defined as the components of the management scheme, including the day-to-day operation and structure of the regime. It is essential to consider mechanisms and procedures that are in place, as well as the effectiveness of these in delivering results that are conducive to long-term sustainability.

Tl'azt'en Nation's desire for active involvement in decision-making is reflected in a detailed set of process C&I. This includes the need for incorporation of their way of life, values, beliefs and knowledge into management; meaningful opportunities for input into the processes of decision-making, implementation and evaluation; management that is based on equity, respect and the best available information; and inclusive representation. Similarly, Blouin (1998) identified four cornerstones of effective public participation: equitable representation of all interests; access to relevant information; fair, open and effective decision-making based on the principles of democratic participation; respect for diversity, and non-adversarial conflict resolution mechanisms; and informed participants. A summary of the commonalities between the Comparison Frameworks and critical local values demonstrates clearly that the CCFM framework does not include the management process as a key aspect of sustainability in forest management. There is only one close correspondence between CCFM and Tl'azt'en Nation C&I, and several lesser correspondences in terms of 'informed decision-making' and 'accountability mechanisms'.

Table 4: Number of correspondences with Tl'azt'en Principle 1: Fair and Effective Decision-making

C&I Framework	Close correspondence	Partial correspondence	No correspondence
CCFM	1	9	23
LUCID	14	5	14
CIFOR	9	6	18

In contrast, LUCID and CIFOR provide stronger recognition that certain management processes, actions or conditions can lead to improved sustainability. This analysis illustrates that increased consideration for Tl'azt'en traditional roles and systems, partnership building, provision of meaningful participation opportunities and cross-cultural learning, are necessary to ensure fair and effective decision-making at the local-level.

The need to create a flexible and adaptive management structure, which incorporates traditional roles and systems, is identified by Tl'azt'enne. This would provide for more meaningful Tl'azt'en involvement in forest management. None of the three Comparison Frameworks identifies this essential element. In terms of respect for traditional processes of allocating and accessing resources, there is partial correspondence between local-level and CCFM C&I. However, CCFM's recognition of *Aboriginal Traditional Land Use and Forest-based Ecological Knowledge* (Criterion 6.2) does not specifically address respect for traditional land tenure systems.

One indicator that shares close correspondence among all four C&I frameworks is the requirement that adequate knowledge is available for decision-making, particularly traditional ecological knowledge. All C&I frameworks clearly recognize the integration of scientific and traditional knowledge as an essential element of sustainable forest management. Ensuring that accountability mechanisms are in place is a common theme across all frameworks. However, the nature of these accountability mechanisms differs in the Comparison Frameworks and clearly reflects the top-down approaches utilized. While all three Comparison Frameworks identify the need for transparency and providing communities with information (especially LUCID and CIFOR), there is less agreement on how to achieve meaningful community involvement. Both the CCFM and LUCID documents make reference to public review opportunities, which can be assessed by measuring public satisfaction with the process. The CIFOR document addresses meaningful community involvement more extensively through overt statements about the need for two-way communication, use of appropriate language, and meaningful involvement of all 'stakeholders'. None of the Comparison Frameworks define meaningful community involvement at the level of detail contained in Tl'azt'en C&I; for instance, in terms of utilizing a variety of different participation methods, the frequency and timing of communication efforts, and the need to target participation opportunities to specific user groups.

A lack of resources and support to participate in resource management was often cited in Tl'azt'en interviews. The need to develop adequate human capital and partnership building, key issues for Tl'azt'enne, were identified only in the LUCID document. Relevant indicators that were expressed relate to the establishment of guiding principles, including the need for trust, accountability, mutual respect, fairness and a collaborative spirit, as well as initiatives to promote cross-cultural learning and the establishment of operating procedures and ground rules. The LUCID framework references establishing collaborative agreements such as memorandums of understanding. None of the Comparison Frameworks identified cross-cultural learning, operating procedures or relationship ground rules as areas of concern.

The final local-level criterion related to fair and effective decision-making is ensuring adequate representation on decision-making bodies. As noted in Table 5, Tl'azt'en Nation defines inclusive representation broadly to encompass different villages, generations, families and interests. Only the CIFOR framework is explicit in terms of the inclusion of all relevant stakeholders in the management process. None of the Comparison Frameworks make reference to the structure and operation of decision-making bodies such as the length of terms for decision-makers, ensuring continuity and delineating locally appropriate selection criteria.

In summary, for the topic of 'Fair and Effective Decision Making', Tl'azt'en Nation's criteria had a fair correspondence with all three Comparison Frameworks.

Social sustainability

The remaining four principles evaluated in this analysis focus on the outcomes of forest management. There is growing recognition of the need to consider sustainability in resource-dependant communities (Achiam and Sheppard, 2001; Kusel, 2001). However, studies are limited and social C&I are lacking (Woodley *et al.*, 1999; Beckley, 2000). For the most part, C&I

Table 5: Relationships between Tl'azt'en Principle 1 (Fair and Effective Decision-making) and the Comparison Frameworks

Criteria	Indicators	Critical Tl'azt'en values	CCFM	LUCID	CIFOR
Flexible and adaptive management structure	Incorporation of traditional roles and systems	Clan system	N	N	N
		Role of elders	N	N	N
		Role of hereditary chiefs	N	N	N
		Traditional involvement mechanisms	N	N	N
Local control and access over resources	Respect for traditional systems of allocating and accessing resources	Delineation of traditional hunting territories	P	Y	Y
		Respect for traditional boundaries	P	Y	Y
		Traditional allocation of trapping rights	P	Y	Y
		Traditional allocation of fishing grounds	P	Y	Y
		Traditional allocation of berry picking grounds	P	Y	Y
Informed decision-making	Adequate knowledge is available	Incorporation of traditional and local knowledge	Y	Y	Y
Accountability mechanisms	Transparency of process	Communities must have full disclosure of information	P	Y	Y
	Meaningful public involvement	Ensure adequate opportunities for public involvement	P	Y	Y
		Utilize a variety of different methods	N	P	N
		Appropriate frequency of communication efforts	N	P	N
		Appropriate timing of communication efforts	N	N	N
		Need to target communication efforts to the audience	N	N	N
		Need for two-way communication	P	P	Y
		Use appropriate language for target audience (including use of indigenous language)	P	P	Y
Decision-making process has adequate resources	Adequate capacity to undertake the process	Need for trained and educated personnel	N	Y	N
Partnership building initiatives take place	Establishment of guiding principles for decision-making	Establishment of trust	N	P	N
		Establishment of accountability	N	P	N
		Mutual respect among representatives	N	P	N
		Building collaborative spirit	N	P	N
		Fairness	N	P	N
	Cross-cultural learning	Need to develop mutual understanding	N	N	N

Table 5: Continued

Criteria	Indicators	Critical Tl'azt'en values	CCFM	LUCID	CIFOR
	Establish operating procedures and ground rules	Decision-makers need to receive technical training	N	P	P
Adequate Tl'azt'en Nation representation on decision-making bodies	Need for inclusive representation	Representation from different villages	N	N	Y
		Representation from different generations	N	N	Y
		Representation from different groups within the community who may be under-represented (e.g. women, particular families)	N	N	Y
		Ensure representation of traditional land users	N	N	Y
	Ensure adequate length of term	Length of term is long enough to allow familiarization with process but short enough to instil new ideas	N	N	N
	Ensure continuity	Membership is rotated to ensure continuity	N	N	N
	Careful selection of representatives	Use of locally appropriate, equitable methods of selecting representatives	N	N	N

processes have been initiated by members of the forest policy community with a rudimentary understanding of the social and economic aspects of sustainability, resulting in a focus on environmental definitions of sustainability (Beckley, 2000). For Aboriginal communities, where culture and community are intricately bound to the management of forest resources, social and economic C&I take on added importance. Booth (1998) argued that community development is as important for Aboriginal forestry as achieving large profits and operational efficiency. The challenge for sustainable forest management is to balance ecological functioning of natural systems with an increasingly diverse set of demands placed on those systems by human wants or needs (Beckley, 2000). These include, in addition to timber and employment, subsistence goods, recreational opportunities, tourism-based economic development, as well as spiritual connections, heritage values, social meanings and aesthetics.

Analysis of Tl'azt'en archival materials revealed two main criteria – capacity development and community health and well-being – and seven indicators, as essential for social sustainability. Social outcomes related to public involvement in decision-making were addressed under Principle 1, while social outcomes related to equity and community resilience are considered as part of Principle 3 'Economic Sustainability' (since they relate directly to the distribution of economic benefits and a community's ability to cope with economic stress).

As with Principle 1, the Comparison Frameworks do not adequately address Tl'azt'en priorities and concerns with respect to social sustainability. Some similarities occur with respect to access to land and resources, the area of land owned by Aboriginal people, and recognition and respect for Aboriginal peoples' legal and customary rights. For Tl'azt'enne, however, social sustainability encompasses many other core issues, including ways to address and resolve social problems, enhanced community cohesiveness and relationship building, increased individual financial security, and enhanced local access to education and training opportunities.

Table 6 demonstrates that none of the Comparison Frameworks adequately address issues related to social sustainability to the extent they were described at the local level. For the majority of critical Tl'azt'en values, there is no correlation with the Comparison Frameworks. In particular, CCFM narrowly defines the social outcomes related to forest management.

Many of the indicators describing Tl'azt'en perspectives on community health and well-being are not evident in the Comparison Frameworks (Table 7). In terms of improvements to quality of life in Aboriginal communities involved in forest management, there are only two associations. CCFM C&I recognize the social costs associated with community instability. As part of this recognition, CCFM identified educational attainment levels in forest-based communities as a core indicator. CIFOR also developed indicators related to a sense of good health.

None of the Comparison Frameworks adequately identified the need to address social problems. In terms of contributions to community development, there are only two themes shared with the Comparison Frameworks. LUCID clearly identifies enhancement of buildings and infrastructure, and provision of community services under its 'Capital and Wealth' criterion. Relationship building within the Tl'azt'en community was identified as vitally important to social sustainability, including increasing inter-generational connections, improving community cohesion, and building co-operation within the community. None of the three Comparison Frameworks consider relationship building as a key indicator of community health and well-being.

Local social sustainability is defined in part by community independence. Tl'azt'enne defined independence in terms of self-sufficiency, long-term secure access to land and resources, ownership of forest land, recognition and respect for legal and customary rights, individual financial security and autonomy (Table 7). Indicators used in CIFOR and CCFM frameworks correspond with many of these values. The Comparison Frameworks attend very minimally to individual financial security or freedom from major economic upheaval caused by periods of boom and bust in resource industries as important elements of independence. Some correspondence exists among local-level, LUCID and CIFOR frameworks in terms of cultural revitalization as an indicator of community health and well-being, and the need to provide for cultural values in forest management. For instance, CIFOR states that there should be no significant increase in signs of cultural disintegration.

Our research suggests capacity development is essential to community sustainability. CCFM does not adequately deal with the provision of education and training opportunities. While none of the Comparison Frameworks make reference to the need for local access to education and training, both LUCID and CIFOR highlight the need to provide a range of training opportunities.

In summary, for the topic of 'Social Sustainability', Tl'azt'en Nation's criteria had a minimal correspondence with the CCFM criteria, and a fair correspondence with the other two Comparison Frameworks.

Economic sustainability

Prior to the 1950s, little attention was given to sustainability in forest management decision-making. After 1950, forest policy in Canada shifted towards sustained yields with a clear emphasis on the economic needs of jurisdictions managing crown land forests (Williston and Keller, 1997; Hayter, 2000). More recent attention to environmental, social and cultural needs has meant that economic sustainability is now embedded within a more complex matrix.

Table 6: Number of correspondences with Tl'azt'en Principle 2: Social Sustainability

C&I Framework	Close correspondence	Partial correspondence	No correspondence
CCFM	4	1	25
LUCID	6	11	13
CIFOR	7	7	16

Table 7: Relationships between Tl'azt'en Principle 2 (Social Sustainability) and the Comparison Frameworks

Criteria	Indicators	Critical Tl'azt'en Values	CCFM	LUCID	CIFOR
Community health and well-being	Improvements to quality of life of Aboriginal communities involved in forest management	Increasing levels of education and skills (i.e. high school retention)	Y	N	N
		Increasing sense of good health	N	N	P
		Addressing and ameliorating social problems	N	N	N
	Contributions to community development	Enhanced community infrastructure and facilities (e.g. recreation, traditional learning centres)	N	Y	N
		Provision of community services	N	P	N
		Job creation as a means of building the voluntary sector	N	N	N
	Relationship building	Increasing inter-generational connections	N	N	N
		Improved community cohesiveness and unity	N	N	N
		Building cooperation within the community	N	N	N
	Independence	Self-sufficiency	Y	P	N
		Long-term, secure access to land and resources	P	P	Y
		Area of forest land owned by Aboriginal people	Y	Y	Y
		Recognition and respect for legal and customary rights	Y	P	Y
		Individual financial security	N	N	N
		Autonomy	N	P	N
	Cultural revitalization	Transmission of traditional knowledge and cultural values	N	P	P
		Restoration of traditional forms of governance	N	P	P
		Transmission of gender-specific knowledge	N	P	P
		Restoration of the role of elders as teachers	N	P	P
		Increased observational/ experiential learning opportunities	N	P	P
		Respect for the oral tradition	N	P	P
Capacity development	Training opportunities	Technical skills development	N	Y	Y
		Employable skills development	N	Y	Y
		Proximity/local access to training opportunities	N	N	N
		Work experience opportunities	N	Y	Y
		On-the-job training opportunities	N	Y	Y
		Support for the transition to employment	N	N	N

Table 7: *Continued*

Criteria	Indicators	Critical Tl'azt'en Values	CCFM	LUCID	CIFOR
	Post-secondary education opportunities	Increased exposure to college/ university opportunities	N	N	N
		Increased post-secondary attainment levels	N	N	N
		Proximity/local access to post-secondary education opportunities	N	N	N

Table 8: Number of correspondences with Tl'azt'en Principle 3: Economic Sustainability

C&I Framework	Close correspondence	Partial correspondence	No correspondence
CCFM	12	3	4
LUCID	9	2	8
CIFOR	6	4	9

Traditionally, economic sustainability has focused around issues of supply, demand, revenue flows, equity and related economic indicators. In recognition of the multi-dimensional nature of community dependency on the forest, as well as the impacts of boom and bust resource economies, a broader framework is adopted in this analysis. It is rooted in a local context and includes local economic development and subsistence land use. Unlike the principle of social sustainability, considered above, two of the three Comparison Frameworks address the issue of economic sustainability reasonably well in terms of how Tl'azt'enne define it (Table 8). The CCFM framework shares the closest association with critical local values, while CIFOR demonstrates the weakest linkage, sharing only six theme areas with Tl'azt'en C&I. Areas of interest to Tl'azt'enne not found elsewhere include local priority hiring, incentives for advancement, accountability mechanisms, as well as creation of employment opportunities in research, value-added industry and non-timber forest products.

Analysis yielded three criteria under the Economic Sustainability principle (Table 9): local economic development; continuation of subsistence land use; and employment opportunities. All Comparison Frameworks identify access to economic opportunity as an indicator and refer specifically to ensuring that opportunities and benefits are spread among small operators. However, only LUCID shares a close correspondence with Tl'azt'en values on the need to provide education and training to promote local economic development, and only CCFM is consistent with Tl'azt'en criteria regarding the need to consider the social impacts of local economic development. Of the three local-level economic sustainability criteria, subsistence land use requirements finds strongest support (Table 9). Each Comparison Framework recognizes the critical nature of opportunities to practice a range of subsistence activities. In terms of the final Tl'azt'en economic criteria, both the CCFM and LUCID frameworks clearly state the need to ensure that employment opportunities are equitable and perceived to be fairly distributed. Furthermore, CCFM is the only framework to include economic diversification as a specific indicator.

For the topic of 'Economic Sustainbility', Tl'azt'en Nation's criteria had an overall fair correspondence with all three Comparison Frameworks.

Increased management effectiveness

Curran and M'Gonigle (1998) argue that many First Nations struggle to reconcile traditional forest values and uses with the reality of industrial forestry. Aboriginal peoples occupy a unique

Table 9: Relationship between Tl'azt'en Principle 3 (Economic Sustainability) and the Comparison Frameworks

Criteria	Indicators	Critical Tl'azt'en values	CCFM	LUCID	CIFOR
Local economic development	Community capacity	Provide education and training to promote local economic development	N	Y	N
	Access to economic opportunity (extent of Tl'azt'en participation in forest-based economic opportunities)	Spread opportunities and benefits among small operators	Y	Y	Y
	Holistic economic planning	Consider social impacts of local economic development	P	N	N
Provide for subsistence land use	Opportunities for subsistence/traditional harvesting – fishing	Char, kokanee, rainbow trout, salmon, sturgeon, suckerfish, whitefish	Y	Y	Y
	Opportunities for subsistence/traditional harvesting – hunting	Bear, deer, caribou, ducks, geese, moose, grouse, rabbits, mountain goat, spring beaver	Y	Y	Y
	Opportunities for subsistence/traditional harvesting – gathering	Medicinal plants such as Labrador tea, mint, balsam, poplar; material plants such as willow, alder, cottonwood; food plants such as berries, roots and shoots	Y	Y	Y
	Opportunities for subsistence/traditional harvesting – trapping	Rabbits, beaver, coyote, fisher, fox, lynx, marmot, mink, muskrats, otter, squirrels	Y	Y	Y
Employment opportunities	Employment practices are established	Priority hiring of Tl'azt'en Nation members and Keyoh holders	N	N	N
		Incentives for advancement	N	N	N
		Accountability mechanisms	N	N	N
	Ensure equity of employment opportunities	Distribution of opportunities among families	P	P	P
		Distribution of opportunities among small contractors	Y	Y	Y
		Promotion of employment opportunities for women	Y	Y	P
		Promotion of employment opportunities for youth	Y	Y	P
		Promotion of employment opportunities for keyoh holders	P	P	P

Table 9: *Continued*

Criteria	Indicators	Critical Tl'azt'en values	CCFM	LUCID	CIFOR
	Ensure diversity of employment opportunities	Silviculture employment opportunities	Y	N	N
		Harvesting employment opportunities (timber and non-timber)	Y	N	N
		Processing employment opportunities (e.g. portable sawmills, value-added, non-timber forest products)	Y	N	N
		Research employment opportunities	Y	N	N

Table 10: Number of correspondences with Tl'azt'en Principle 4: Increased Management Effectiveness

C&I Framework	Close correspondence	Partial correspondence	No correspondence
CCFM	8	33	9
LUCID	7	38	5
CIFOR	37	10	3

position within Canadian society; the Constitution and the courts have recognized the existence of a special body of Aboriginal rights. Considering that these rights pertain, *inter alia*, to continued forest use, sustainable forest management must address the impact of forest practices on the rights and interests of Aboriginal peoples (Bombay *et al.*, 1995). In this regard, Principle 4 contains five criteria and 17 indicators that address Tl'azt'en requirements for increased forest management effectiveness. These criteria include: meaningful Tl'azt'en participation in forest management; meaningful incorporation of Aboriginal knowledge and practices into forest policy and legislation; respect for Aboriginal rights and title in forest management; holistic forest management; and fair and effective decision-making. As seen in Table 10, only CIFOR places a strong emphasis on the effectiveness of forest management, as reflected in 37 close associations with critical local values. Many critical local values are partially addressed by the LUCID and CCFM frameworks.

Bombay (1993) notes that Aboriginal people have a distinct land ethic in which people are a small and interdependent part of a larger, ecological web. This land ethic is the source of Aboriginal forestry ideals of balanced resource use and sustainable community development. Yet, we found that none of the three Comparison Frameworks address the issue of incorporating Aboriginal land ethics into management plans or practices. (Table 11) The CCFM framework provides some recognition for applying traditional resource management practices in forestry, and all three frameworks address the need to incorporate traditional knowledge. CIFOR also demonstrates concern about the environmental impacts of forestry practices and their implications for local culture and ways of life. While the Comparison Frameworks share commonalities with Tl'azt'en Nation in regards to protecting water quality and watersheds, neither the CCFM nor LUCID frameworks make direct reference to the impacts of herbicide use or logging practices on the surrounding ecosystem.

In terms of the meaningful incorporation of Aboriginal knowledge and practices in forest planning and legislation, only CCFM corresponds to the local level framework, stating explicitly the need to assess the 'extent of consultation with Aboriginals in forest management planning and in

the development of policies and legislation related to forest management' (Canadian Council of Forest Ministers, 2003: 21) (Table 11). As Tl'azt'en Nation is without a treaty settlement, the third criterion of respect for Aboriginal rights and title in forest management is vitally important. CIFOR contains indicators related to the extent of land available for hunting, fishing, trapping and gathering. To varying degrees, all Comparison Frameworks address the size and duration of land tenure, and deal to varying degrees with the issue of improving Aboriginal access to, and allocation of, resources. However, only the CIFOR framework provides any recognition for the need to provide compensation to Aboriginal people for resource extraction and damage done to traditional lands.

The criterion 'holistic forest management' is partially addressed by all Comparison Frameworks. Only CCFM makes explicit reference to the need for flexibility and adaptability in management to reflect changing values over time and only CIFOR describes the need to incorporate multiple values into management. CCFM fails to address the need to balance economic and social needs in management. Both LUCID and CIFOR call for a more holistic management approach that preserves both the economic potential and the cultural importance of the land.

Under the criterion 'equitable decision-making' Tl'azt'enne elucidated three local-level indicators, including informed decision-making, involvement of customary land stewards, and socially efficient forest management. All Comparison Frameworks identify the need to collect and use both traditional knowledge and Western science in management, and partially recognize the need to include customary land users. CIFOR C&I support socially efficient forest management. The CCFM framework was found to be lacking regarding provision of capacity-building opportunities and protection of cultural resources.

For Increased Management Effectiveness, T'lazt'en Nation's criteria had an overall fair correspondence with the CCFM and LUCID criteria, and a high correspondence with those of CIFOR.

Ecological sustainability

The principle of ecological sustainability was the most readily comparable across C&I frameworks (Table 12). To date, C&I processes have largely focused on environmental issues and definitions (Beckley, 2000). Thus, there is less disagreement about what ecological sustainability means. Most national and international C&I frameworks incorporate elements of ecosystem, species and genetic diversity; ecosystem condition, productivity, and function; soil and water conservation; and carbon cycling.

Aboriginal ways of life are integrated with the forest and the continuation of First Nations' cultures is jeopardized by either the destruction or loss of forestland. First Nations depend on the forest for a range of essential and non-essential goods and services, and have unique and useful knowledge about the land based on their long-term, local experience. For instance, although Tl'azt'enne frame ecological sustainability within a different worldview and lexicon than scientists, they identify several common requirements such as protecting critical habitats, preserving water quality, and managing the forest to maintain natural patterns and processes. Based on archival analysis, one local-level criterion – maintenance of forest ecosystem condition and function – and five indicators can be used to define ecological sustainability. To some extent, each Comparison Framework addresses all critical local values and the CIFOR framework shares close correspondence in all cases.

One key area of difference is that Comparison Frameworks emphasize scientific perspectives, while Tl'azt'en C&I integrate scientific and traditional knowledge perspectives. Since human activities in forests impact on the processes that generate and maintain ecosystem biodiversity (Stork *et al*., 1997), Tl'azt'en critical local values concerning harvesting and silviculture are included as part of the first indicator. However, because these critical local values are couched in the language of management directives, only the CIFOR document, with its heavy emphasis on management effectiveness, registered close correspondences with Tl'azt'en Nation on this indicator. For all remaining indicators – maintenance of biological diversity, protection of riparian areas, protection of soil, and protection of water quality – there were close correlations with all Comparison Frameworks (Table 13).

Ecological sustainability was the one area where the criteria of all three Comparison

Table 11: Relationships between Tl'azt'en Principle 4 (Increased Management Effectiveness) and the Comparison Frameworks

Criteria	Indicators	Critical Tl'azt'en values	CCFM	LUCID	CIFOR
Meaningful Tl'azt'en participation in forest management	Tl'azt'en land ethics are incorporated into management plans and practices	Practice respect, reciprocity, no waste – take only what you need, share resources, steward the land	N	N	N
	Tl'azt'en spiritual beliefs are respected	Everything is alive, we are all relatives, spiritual interconnections with the non-human world	N	N	N
	Traditional management practices are applied	Harvesting techniques – fisheries, trapping, hunting, fuel wood, medicine	P	N	N
	Traditional knowledge is incorporated into management	Knowledge of the land	P	Y	P
		Knowledge of plants and animals	P	Y	P
		Knowledge of habitat requirements and types	P	Y	P
		Knowledge of environmental degradation	P	P	P
	Forest management activities are planned and implemented so as to protect or enhance sites of ecological, cultural, and social significance to Tl'azt'en communities	Consider herbicide and pesticide impacts on water quality, fisheries, berries, medicinal plants, habitat composition and function, ungulates, fur-bearers, birds, small mammals	P	P	Y
		Consider logging impacts on water quality, fisheries, berries, medicinal plants, trapping areas, watersheds, habitat composition and function, ungulates, fur-bearers, birds, small mammals	P	P	Y
		Meaningful Tl'azt'en participation in forest management	P	P	Y
		Consider impacts of over-trapping	P	P	Y

Table 11: *Continued*

Criteria	Indicators	Critical Tl'azt'en values	CCFM	LUCID	CIFOR
Incorporation of Aboriginal knowledge and practices in forest policy and legislation		Ability to influence provincial forest policy and legislation (e.g. tenure reform, annual allowable cut determination, riparian management, herbicide application)	Y	P	Y
Respect for Aboriginal rights and title in forest management	Extent of land available for Tl'azt'en hunting, fishing, trapping, and gathering	Medicine, food, and material plant areas	P	P	Y
		Trap lines	P	P	Y
		Hunting areas	P	P	Y
		Fishing sites	P	P	Y
	Security of land base/tenure	Size of land base	Y	Y	Y
		Long-term tenure	Y	Y	Y
	Improved allocation of resources		P	P	P
	Improved access to resources		P	P	Y
	Extent of control over traditional lands		P	P	P
	Fair compensation for damage on traditional lands	Customary landowners	N	N	Y
	Fair compensation for resource extraction on traditional lands	Customary landowners	N	N	Y
		Community members	N	N	Y
Holistic forest management	Balance economic and social needs in management	Identify and manage for both the economic potential and cultural importance of the land	N	P	Y
		Balance economic development with community development	N	P	P
		Balance traditional use and sound business management	N	P	P
	Incorporate multiple values into management	Integrated resource management approach	P	P	Y
	Management approach is flexible to respond to changes in values over time	Adaptive management approach	Y	P	P
Equitable decision making	Informed decision-making	Collection and use of both traditional knowledge and science in management	P	P	Y

Table 11: *Continued*

Criteria	Indicators	Critical Tl'azt'en values	CCFM	LUCID	CIFOR
	Involvement of customary landowners	Keyoh holders, hereditary chiefs	P	P	Y
	Forest management is socially efficient	Cost effective	Y	Y	Y
		Provides employment opportunities	Y	P	Y
		Provides capacity building/training opportunities	N	P	Y
		Protects cultural resources	N	Y	P

Table 12: Number of correspondences with Tl'azt'en Principle 5: Ecological Sustainability

C&I Framework	Close correspondence	Partial correspondence	No correspondence
CCFM	16	4	0
LUCID	16	3	1
CIFOR	18	1	1

Frameworks had a high correspondence with Tl'azt'en Nation's criteria.

Summary of comparisons

Local-level C&I used in this analysis are based on Tl'azt'en Nation's long-term and intimate association with the land, as well as community interests in deriving benefits from an array of forest resources that can be sustained long into the future. Because of this closeness, it is no surprise that Tl'azt'en C&I are more detailed and give greater attention to the application of traditional rights and knowledge. The current analysis supports the growing recognition that C&I developed for application at other scales 'do not translate well to the forest management unit' scale and thus are not as relevant for management at the local level (Wright *et al*., 2002a: iii). International and national frameworks can provide policy context and structures to enable on-the-ground management for sustainability, and can provide a foundation for the development of local-level C&I. However, it is critical to understand how sustainability concepts are expressed by local people (Prabhu *et al*., 1996; Woodley *et al*., 1999). Scale matters: social, ecological, and economic systems differ across time and space. Locally defined C&I and methods to generate them are required.

Many similarities were identified between Tl'azt'en C&I and the Comparison Frameworks in the areas of economic sustainability and ecological sustainability (Table 14). There is clear overlap and interdependence between sustainability initiatives at various scales. National and local-level C&I programmes represent complementary tools that can be used to show progress towards sustainability. For instance, in the current research, identification of local interests reveals the multi-dimensional nature of community economic dependence on the forest and prompts greater attention to equity, diversity and capacity in relation to local employment opportunities. Local-level C&I add detail to higher level sustainability directives and enhance our understanding of the integration of economic, ecological and social factors in complex systems.

There is less correspondence between Tl'azt'en C&I and those of the Comparison Frameworks under the fair and effective decision-making, social sustainability and management effectiveness

Table 13: Relationships between Tl'azt'en Principle 5 (Ecological Sustainability) and the Comparison Frameworks

Criteria	Indicator	Critical local value	CCFM	LUCID	CIFOR
Maintenance of forest ecosystem condition and function	Maintenance of ecosystem diversity	Protection and regeneration of medicinal plants	P	P	Y
		Apply alternative silviculture practices	P	P	Y
		Use minimal impact harvesting techniques	P	P	Y
		Maintain natural ecological processes and patterns (e.g. occurrence and severity of fire, insects, disease)	Y	Y	N
		Conserve the forest land base	Y	Y	P
		Ecological restoration of damaged or degraded sites	P	N	Y
	Maintenance of biological diversity	Maintenance of viable fish populations and habitats	Y	Y	Y
		Maintenance of viable ungulate populations and habitats	Y	Y	Y
		Maintenance of viable bird populations and habitats	Y	Y	Y
		Maintenance of viable small mammal populations and habitats	Y	Y	Y
		Maintenance of viable carnivore populations and habitats	Y	Y	Y
		Maintenance of viable fur-bearer populations and habitats	Y	Y	Y
		Maintenance of medicinal plants and habitats	Y	Y	Y
		Maintenance of food plants and habitats	Y	Y	Y
		Maintenance of material plants and habitats	Y	Y	Y
		Protect rare ecological sites and special landscape features	Y	Y	Y
		Protect threatened and endangered species	Y	Y	Y
	Protection of riparian areas	Protection of wetlands, lakes, ponds, rivers, streams	Y	Y	Y
	Protection of soil resources	Prevent soil, compaction, erosion, losses, degradation; conserve soil productivity	Y	Y	Y
	Protection of water resources	Protect watersheds; water for human consumption and for fish and wildlife	Y	Y	Y

Table 14: Summary of correspondences between Tl'azt'en Principles and Comparison Frameworks

Principle	CCFM	LUCID	CIFOR
Fair and effective decision making	Fair	Fair	Fair
Social sustainability	Minimal	Fair	Fair
Economic sustainability	Fair	Fair	Fair
Increased management effectiveness	Fair	Fair	High
Ecological sustainability	High	High	High

principles. It has been easiest to report on environmental and economic C&I; they often rely on data traditionally collected in forest resource inventories or on general economic data (Bridge *et al*., 2002). However, developing effective C&I of management processes, social values, and non-timber goods and services has proved to be more of a challenge.

Local-level process C&I are critical but often neglected elements of sustainability (Pokorny *et al*., 2004); as Beckley *et al*. (2002: 634) suggest, they provide 'much of the real story of what makes a community tick'. The necessity of distinguishing between management processes and outcomes finds recent support in the literature. For instance, Muhtaman *et al*. (2000) recommend that indicator development should include a mixture of output- and process-oriented indicators. Considerable work on C&I of sustainable forest management in British Columbia makes clear that processes of decision-making and management are as important to society as the outcomes of management (Sheppard, 2003). For instance, the current research shows that Tl'azt'enne require increased attention to communication, consensus, inclusive and pluralistic representation, partnership building, and cross-cultural learning in management processes. Tl'azt'enne seek meaningful opportunities for participation, incorporation of Aboriginal knowledge and practices, and respect for Aboriginal rights and title in forest management.

The forestry community is also struggling to define what social sustainability means and how to monitor and achieve it (vonMirbach, 2000; Kusel, 2001; Kijazi and Kant, 2003). There is growing recognition of the value of social indicators as measures of community sustainability, although studies of local-level social sustainability are relatively uncommon (Parkins and Beckley, 2001; Sheppard, 2003). Muhtaman *et al*. (2000) report that more effort must be dedicated to the development of social C&I. White (2001) points out that social elements of sustainability are often an afterthought in forest management and research; for example, the British Columbia Ministry of Forests currently employs few social scientists. This research into Tl'azt'en C&I serves to deepen our understanding of social processes, relationships between groups or individuals, and people's perceptions of their well being, security and enjoyment (Achiam and Sheppard, 2001; Tindall, 2003). The local-level C&I presented in this comparison focus on the degree to which Tl'azt'en Nation is healthy and sustainable and whether a nurturing environment exists in which to live and grow, rather than focusing on forest-related indicators that have a community dimension. As Beckley *et al*. (2002: 634) report, forest managers often fail to 'start with communities and think about how forests contribute as a means of sustaining them'. Tl'azt'en C&I go beyond jobs and income to address other supportive roles forests can play in the achievement of community sustainability, such as cultural revitalization, capacity building, intergenerational equity, amenity values, and ownership of forest land. Tl'azt'en C&I call for identification of ways to address and resolve social problems, to enhance community cohesiveness and resilience, and to build relationships.

Conclusion

The last few decades have witnessed a marked interest in approaching forest management in ways that prove ecologically, economically and socially sustainable. To this end, we have seen the development of numerous C&I frameworks for monitoring sustainable forest management. These frameworks vary as to their complexity and their incorporation of local perspectives. Yet, research has suggested that definitions of social, economic and even ecological sustainability may differ

dramatically at different scales. Since most C&I frameworks have been generated using a top-down approach, our understanding of local-level C&I of sustainability remains inchoate.

Comparison of local C&I with those from other well-known forest management C&I frameworks is complicated by different terminologies and hierarchal structures, as well as scales of analysis. Nevertheless, such a comparison suggests the richness of detail regarding definitions of sustainability obtainable through local-level research. While this paper only reports on C&I derived from Tl'azt'en archival information, it gives clear preliminary substantiation of the importance of carrying out such local research, which interview-based research further confirms (Sherry *et al*., 2004). Analysis of archived community information may provide valuable context and a starting point for local C&I initiatives. Such results are not meant to represent a definitive set of C&I, but rather should be seen as an initial approximation of local values and the first step in an ongoing community-based management process. Local managers can modify this preliminary framework as information becomes available and as community members' values, expectations and needs change.

This research demonstrates the necessity of community involvement in attempts to develop more sustainable approaches to forest management. Results show that a 'bottom-up' approach to local-level C&I development increases relevance; communities define sustainability differently from each other and from experts, requiring a unique set of progress measures. Increased relevance may translate into interest and motivation on the part of local people to become involved in research, management, and monitoring. The current study also demonstrates that a C&I strategy can be applied in Aboriginal communities to give expression to local knowledge, practices and beliefs, and to assess forest management as it relates to culture, land use and community development. Disadvantages of this approach may include increased costs of data collection, the challenges inherent in comparing trends among communities where local-level C&I differ significantly, and the need for constant tracking and revision as local priorities shift over time.

The CCFM C&I framework has been criticized strongly by Aboriginal groups and by the NAFA. Our research shows that beyond the political reasons for such rejection, the framework appears to have significant general deficiencies in defining suitable sustainability C&I. LUCID and CIFOR also perform poorly in terms of representing local values of social sustainability, and somewhat better in terms of corresponding with local values related to decision making and management effectiveness. They show less correspondence in terms of economic sustainability C&I, though, like the CCFM framework, their C&I for ecological sustainability correlate well with Tl'azt'enne's. Studies concentrating on social and process C&I, and continuing support for initiatives that address the shortcomings of large-scale C&I frameworks are required (Beckley, 2000; Lee and Kant, 2003).

While more generic C&I frameworks provide important first steps toward sustainability, they need to be supplemented by research that identifies local-level C&I for sustainable forest management. The detail available from such local-level frameworks will allow forest management to be monitored, assessed and directed to better meet the ecological, economic and social goals of local communities.

Acknowledgements

Research for this paper was funded by Forestry Innovation Investment Forestry Research Program (British Columbia), and the Social Science and Humanities Research Council of Canada through their Community-University Research Alliance program. The authors thank Beverly Bird, Renel Mitchell, Dwayne Martin, Ron Winser and Terry Furlong for invaluable help with the research, a forest policy advisor provided by Tl'azt'en Nation for reviewing and commenting on a draft, and Dr Peggy Smith and an anonymous reviewer for their insightful and constructive comments.

References

Achiam, C. and Sheppard, S.R.J. 2001 *Socio-cultural criteria and indicators for the Arrow IFPA Sustainability Project*. Collaborative for Advanced Landscape Planning, Vancouver.

Assembly of First Nations 1998 *First Nations Forestry Strategy. Resolution No. 18/98*. Assembly of First Nations, Ottawa.

Beckley, T.M. 2000 *Sustainability for whom? Social indicators for forest-dependant communities in*

Canada. Sustainable Forest Management Network, Project Report 2000-34, Edmonton.

Beckley, T.M. 1998 Moving toward consensus-based forest management: a comparison of industrial co-managed, community and small private forests in Canada. *For. Chron.* **74**, 736–744.

Beckley, T.M., Parkins, J. and Stedman, R. 2002 Indicators of forest-dependent community sustainability: the evolution of research. *For. Chron.* **78**, 626–636.

Berg, B. 2004 *Qualitative Research Methods for the Social Sciences,* 5th edn. Pearson, Boston.

Berkes, F. 1999 *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*. Taylor and Francis, Philadelphia.

Berkes, F. and Feeny, D. 1990 Paradigms lost: changing views on the use of common property resources. *Alternatives* **17** (2), 48–55.

Blouin, G. 1998 Public involvement processes in forest management in Canada. *For. Chron.* **74**, 224–226.

Bombay, H. 1993 Many things to many people: Aboriginal forestry in Canada is looking toward balanced solutions. *Cult. Surv. Quart.* **17**, 15–18.

Bombay, H., Smith, P. and Wright, D. 1995 *An Aboriginal criterion for sustainable forest management*. National Aboriginal Forestry Association, Ottawa.

Booth, A.L. 1998 Putting 'forestry' and 'community' into First Nations' resource management. *For. Chron.* **74**, 347–352.

Bridge, S., Wright, P. and Rios, R. 2002 Criteria and indicators of sustainable forest management: relationships between multi-scaled initiatives. Paper presented at the XXI Session of the North American Forest Commission, 22–25 October, Hawaii, USA.

Canadian Council of Forest Ministers 1995 *Criteria and indicators for the conservation and sustainable management of temperate and boreal forests: The Montreal Process*. Canadian Forest Service, Ottawa.

Canadian Council of Forest Ministers 1997 *Criteria and indicators of sustainable forest management in Canada*. Technical Report, Natural Resources Canada, Ottawa.

Canadian Council of Forest Ministers 2000 *Criteria and indicators of sustainable forest management in Canada: National Status 2000*. Technical Report, Natural Resources Canada, Ottawa.

Canadian Council of Forest Ministers 2003 *Defining Sustainable Forest Management in Canada*. Canadian Council of Forest Ministers, Ottawa.

Centre for International Forestry Research 1999 *The CIFOR Criteria and Indicators Generic Template*. CIFOR, Jakarka.

Charmaz, K. 2000 Grounded theory. Objectivist and contructivist methods. In *Handbook of Qualitative Research*, 2nd edn, N. Denzin and Y. Lincoln (eds). Sage, Thousand Oaks, pp. 509–535.

Collier, R., Parfitt, B. and Woollard, D. 2002 *A voice on the land: an indigenous people's guide to forest certification in Canada*. National Aboriginal Forestry Association and Ecotrust Canada, Ottawa.

Curran, D. and M'Gonigle, M.R. 1998 *Aboriginal forestry: community management as opportunity and imperative*. Eco-Research Chair of Environmental Law and Policy, University of Victoria, Victoria.

Forest Stewardship Council 1999 *Principles and criteria for forest stewardship*. http://www.fscoax.org (January 1999).

Hauck, M. and Sowman, M. 2001 Coastal and fisheries co-management in South Africa: an overview and analysis. *Mar. Pol.* **25**, 173–185.

Hawley, A.W.L., Sherry, E.E. and Johnson, C.J. 2005 A biologists' perspective on amalgamating traditional environmental knowledge with resource management. *BC J. Ecosyst. Manage.* **5**, 36–50.

Hayter, R., 2000 *Flexible Crossroads: the Restructuring of British Columbia's Forest Economy*. UBC Press, Vancouver.

Hunt, L. and Haider, W. 2001 Fair and effective decision making in forest management planning. *Soc. Nat. Resources* **14**, 873–887.

Jaggi, M. 1997 Current developments in Aboriginal forestry: provincial forest policy and Aboriginal participation in forestry in Ontario, Canada. *Int. J. Ecofor.* **13**, 13–20.

Karjala, M.K. and Dewhurst, S.M. 2003 Including Aboriginal issues in forest planning: a case study in central interior British Columbia, Canada. *Landsc. Urb. Plan.* **64**, 1–17.

Karjala, M., Sherry, E.E. and Dewhurst, S.M. 2003 *The Aboriginal Forest Planning Process: a Guidebook for Identifying Community-level Criteria and Indicators*. University of Northern British Columbia, Prince George, BC (available online at: http://researchforest.unbc.ca/afpp/AFPPMain.htm).

Karjala, M.K., Sherry, E.E. and Dewhurst, S.M. 2004 Criteria and indicators for sustainable forest planning: a framework for recording Aboriginal resource and social values. *For. Pol. Econ.* **6**, 95–110.

Kijazi, M.H. and Kant, S. 2003 Conformance of Ontario's forest management planning with criteria and indicators of sustainable forest management. *For. Chron.* **79**, 652–658.

Kusel, J. 2001 Assessing well-being in forest dependant communities. *J. Sust. For.* **13**, 359–384.

Lammerts van Bueren, E.M.L. and Blom, E.M. 1997 *Hierarchical framework for the formulation of sustainable forest management standards*. Tropenbos Foundation, Leiden, Netherlands.

Lee, S. and Kant, S. 2003 *Forest Values, Perceptions, and Co-management in Northwestern Ontario*. Sustainable Forest Management Network, SFMN Research Communication, Edmonton.

McGregor, D. 2002 Indigenous knowledge in sustainable forest management: community-based approaches achieve greater success. *For. Chron.* **78**, 833–836.

Montreal Process Working Group 1999 *The Montreal Process* (available online at http://www.mpci.org/criteria_e.html).

Morris, P. and Fondahl, G. 2002 Negotiating the production of space in Tl'azt'en Territory, Northern British Columbia. *Can. Geographer* **46**, 108–125.

Muhtaman, D.R., Siregar, C.A. and Hopmans, P. 2000 *Criteria and Indicators for Sustainable Plantation Forestry in Indonesia*. CIFOR, Bogor, Indonesia.

Natcher, D.C. and Hickey, C.G. 2002 *A criteria and indicators approach to community development*. SFMN Working Paper 2002–2. Sustainable Forest Management Network, Edmonton.

National Aboriginal Forestry Association 1997 *Co-management and other forms of agreement in the forest sector*. National Aboriginal Forestry Association, Ottawa.

National Forest Strategy Coalition 2003 *National Forest Strategy: 2003–2008*. NFSC, Ottawa.

Parkins, J. and Beckley, T. 2001 *Monitoring community sustainability in the Foothills Model Forest: a social indicators approach*. Socio-economic Research Network Information Report M-X-211E, Natural Resources Canada, Ottawa.

Parkins, J., Varghese, J. and Stedman, R. 2001 *Locally defined indicators of community sustainability in the Prince Albert Model Forest*. Canadian Forest Service, Information Report NOR-X-379. Natural Resources Canada, Ottawa.

Parsons, R. and Prest, G. 2003 Aboriginal forestry in Canada. *For. Chron.* **79**, 779–784.

Pierce-Colfer, C.J., Prabhu, R. and Wollenberg, E. 1995 *Principles, criteria, and indicators: applying Ockham's Razor to the people-forestry link* (Working Paper No. 8). Centre for International Forestry Research, Jakarta.

Pokorny, B., Prabhu, R., McDougall, C. and Bauch, R. 2004 Local stakeholders' participation in developing criteria and indicators for sustainable forest management. *J. For.* **102**, 35–40.

Prabhu, R., Colfer, C.J.P., Venkateswarlu, P., Tan, L.C., Soekmadi, R. and Wollenberg, E. 1996 *Testing criteria and indicators for the sustainable management of forests: Phase 1 Final Report*. CIFOR, Jakarka.

Prabhu, R., Colfer, C.J.P. and Shepherd, G. 1998 Criteria and indicators for sustainable forest management: new findings from CIFOR's forest management unit level research. *Rural Development Forestry Network Paper (ODI)* No. 23a, 20.

Prabhu, R., Colfer, C.J.P. and Dudley, R. 1999 Criteria and Indicators Toolbox Series, CIRFOR, Jakarta.

Sheppard, S. 2003 Knowing a socially sustainable forest when you see one: implications for results-based forestry. *For. Chron.* **79**, 865–875.

Sherry, E.E. 2002 *Constructing partnership: a Delphi study of shared resource management in the north Yukon*. Ph.D. dissertation, University of Northern British Columbia, Prince George.

Sherry, E.E. and Myers, H.M. 2002 Traditional environmental knowledge in practice. *Soc. Nat. Resources* **15**, 345–358.

Sherry, E.E. and Fondahl, G. 2003 *Criteria affecting the success of co-management: new directions for improved forest management partnerships in British Columbia*. Unpublished report, prepared under Forestry Innovation Investment Project R2003-0235, 2003-2004.

Sherry, E.E. and Fondahl, G. 2004 *Methods for developing local-level criteria and indicators of joint forest management*. Unpublished report, prepared under Forestry Innovation Investment Project R2003-0235, 2003-2004.

Sherry, E.E., Parsons, S., Leon, B. and Halseth, R. 2004 *Preliminary Phase 2 Results*. Unpublished report, prepared under Forestry Innovation Investment Project R2003-0235, 2003–2004.

Stork, N.E., Boyle, T.J.B., Dale, V., Eeeley, H., Finegan, B., Lawes, M., *et al.* 1997 *Criteria and indicators for assessing the sustainability of forest management: conservation of biodiversity*. CIFOR Working Paper No. 17. Bogor, Indonesia.

Tindall, D.B. 2003 Social values and the contingent nature of public opinion and attitudes about forests. *For. Chron.* **79**, 692–705.

Treseder, L. and Krogman, N.T. 1999 *Features of First Nation Forest Management Institutions and Implications for Sustainability*. Canadian Institute of Forestry, Ottawa.

United Nations Commission on the Environment and Development 1992 *Agenda 21: Programme of action for sustainable development*. United Nations Department of Public Information, New York (available online at: http://www.un.org/esa/sustdev/documents/agenda21/index.htm).

vonMirbach, M. 2000 *A User's Guide to Local Level Indicators of Sustainable Forest Management: Experiences from the Canadian Model Forest Network*. Natural Resources Canada, Ottawa.

White, W. 2001 Social and economic aspects of community sustainability: results from the Robson Valley Enhanced Forest Management Pilot Program (EFMPP). Paper presented at the Symposium on Sustainable and Performance-based Resource Management, 24–25 October 2001, Richmond, BC.

Williston, E. and Keller, B. 1997 *Forests, Power and Policy: the Legacy of Ray Williston*. Caitlin Press, Prince George.

Woodley, S., Alward, G., Alward, G., Guitierrez, L.K., Hoekstra, T., Holt, B., *et al.* 1999 *North American test of criteria and indicators of sustainable forestry*. USDA Forest Service, Inventory, and Monitoring Institute, Report No. 3, Washington.

World Commission on Environment and Development 1987 *Our Common Future*. Oxford University Press, Toronto.

World Wildlife Fund and International Union for the Conservation of Nature 1997 *Guidelines for Timber Plantations – Environmental, Social, and Cultural Issues Relating to Commercial Afforestation*. IUCN, Gland.

Wright, P.A., Alward, G., Colby, J.L., Hoekstra, T.W., Telger, B. and Turner, M. 2002a *Monitoring for forest management unit scale sustainability: the local unit criteria and indicators development (LUCID) test (Technical Edition)*. USDA Forest Service Inventory and Monitoring Report, Fort Collins.

Wright, P.A., Alward, G., Colby, J.L., Hoekstra, T.W., Telger, B. and Turner, M. 2002b *Monitoring for forest management unit scale sustainability: the local unit criteria and indicators development (LUCID) test (Management Edition)*. USDA Forest Service Inventory and Monitoring Report, Fort Collins.

Received 17 January 2005