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Insight, part of a Special Feature on Understanding Adaptive Capacity in Forest Governance

Comparing Sustainable Forest Management Certifications Standards: A Meta-analysis

Michael Rawson Clark [1] *and Joelyn Sarrah Kozar* [2]

ABSTRACT. To solve problems caused by conventional forest management, forest certification has emerged as a driver of sustainable forest management. Several sustainable forest management certification systems exist, including the Forest Stewardship Council and those endorsed by the Programme for the Endorsement of Forest Certification, such as the Canadian Standards Association – Sustainable Forestry Management Standard CAN/CSA - Z809 and Sustainable Forestry Initiative. For consumers to use certified products to meet their own sustainability goals, they must have an understanding of the effectiveness of different certification systems. To understand the relative performance of three systems, we determined: (1) the criteria used to compare the Forest Stewardship Council, Canadian Standards Association – Sustainable Forestry Management, and Sustainable Forestry Initiative, (2) if consensus exists regarding their ability to achieve sustainability goals, and (3) what research gaps must be filled to improve our understanding of how forest certification systems affect sustainable forest management. We conducted a qualitative meta-analysis of 26 grey literature references (books, industry and nongovernmental organization publications) and 9 primary literature references (articles in peer-reviewed academic journals) that compared at least two of the aforementioned certification systems. The Forest Stewardship Council was the highest performer for ecological health and social sustainable forest management criteria. The Canadian Standards Association – Sustainable Forestry Management and Sustainable Forestry Initiative performed best under sustainable forest management criteria of forest productivity and economic longevity of a firm. Sixty-two percent of analyses were comparisons of the wording of certification system principles or criteria; 34% were surveys of foresters or consumers. An important caveat to these results is that only one comparison was based on empirically collected field data. We recommend that future studies collect ecological and socioeconomic data from forests so purchasers can select certified forest products based on empirical evidence.

Key Words: *Canadian Standards Association – Sustainable Forestry Management; CSA-SFM; forest certification; Forest Stewardship Council; FSC; meta-analysis; public forests; SFI; sustainable forest management; Sustainable Forestry Initiative*

INTRODUCTION

Anthropogenic pressures on forests for products are major contributors to reductions in global forest ecological integrity. The consequences of these pressures differ by geographic location and ecosystem (Gullison 2003, FRA 2005), and include the degradation of forest capacity to protect and clean water, air, and soils; and loss of biodiversity, employment, and other social and ecological services (Kneeshaw et al. 2000). When combined with natural factors, such as climate change, the threats to global forest health and integrity are significant (Easterling and Apps 2005). Forest certification for sustainable forest management ([SFM] i.e., forest management that prevents the negative effects of forestry in the long-term while maintaining the benefit to society) emerged in the early 1990s as a remedy to anthropogenic forest degradation (Auld et al. 2008, Vogel 2008).

Certification systems allow consumers to directly influence forest management by purchasing certified products. As demand for certified products increases, so does the pressure on forest companies to become certified to maintain their market share

[1]University of Alberta, [2]Campus Sustainability Coalition

(Auld et al. 2008). Citizens assume that certified forest products come from sustainably managed forests, making certification a de facto "quality assurance" mechanism for the sustainability performance of a forest product. Furthermore, consumers may assume that all certification standards are equivalent, which may not be true. A major problem is that consumers cannot determine which labels signify the most sustainably managed forests.

The sizes of future market shares of different certification systems may have the potential to impact the rate at which SFM occurs. For instance, widespread market acceptance of a certification system may cause more firms to become certified under that label than others. If that certifier meets fewer SFM goals than other certification systems, the total benefit of certification to global forest health will be depleted. Therefore, it is important that the forest industry and consumers have accurate information about each system's strengths and weaknesses.

For consumers, there is an increasing amount of choice in certified forest products, covered by two main certification bodies. The Forest Stewardship Council (FSC) was created in 1993 to stop irresponsible tropical forestry (Auld et al. 2008). FSC now certifies 2.7% of all the world's forests (FPAC 2009, Metafore 2009). As well, the Programme for the Endorsement of Forest Certification (PEFC) is an umbrella group that provides international markets to national and regional certification bodies. The combined certification schemes endorsed by PEFC certify 5% of all the world's forests (Metafore 2009).

In this paper, we review the literature that compares different certification systems to determine which most effectively meets SFM goals. We focus on two PEFC certification systems in Canada: the Canadian Standards Association – Sustainable Forest Management Standard CAN/CSA - Z809 (CSA-SFM), a Canadian government derived system, and the Sustainable Forestry Initiative (SFI), an American industry derived system. However, we also included the FSC system in our review. CSA-SFM and SFI certify 26% and 12% of all Canadian forests, respectively; FSC certifies 9% (FPAC 2009).

We also examined the methods used in these comparisons to find knowledge gaps that are impeding the understanding of how effectively certification systems meet SFM goals. Our research questions were as follows: (1) how have certification systems been compared, (2) is there consensus in their effectiveness at achieving sustainability goals, and (3) what gaps in comparative analyses must be filled to determine which forest certification systems improve SFM the most? Understanding the knowledge gaps will speed the empirical research needed to provide the forestry industry and consumers with the ability to select the certifier with the best performance.

METHODS

Literature review

We searched for comparisons of FSC, CSA-SFM, and SFI within the grey and primary literature. Books, technical reports, and other industry or nongovernmental organization (NGO) publications not published in academic journals were considered grey literature. Primary literature was defined as articles published in peer-reviewed academic journals.

Database searches were the main technique used to find the appropriate literature. Primary literature searches were conducted with specific search terms in ISI Web of Science (Thompson ISI) in July 2008, March 2009, and November 2009. We used several search terms and combinations of search terms to ensure we found all literature pertaining to FSC, CSA-SFM, and SFI. The search terms were:

1. "Forest Stewardship Council" OR "Forest Stewardship Council AND Forest Certification"
2. "Canadian Standards Association AND Forest Certification"
3. "Sustainable Forestry Initiative" OR "Sustainable Forestry Initiative AND Forest Certification"
4. "Public forest* AND sustainabil* OR comparisons AND stewardship"
5. "Sustainable forest management AND Monitoring"
6. "Forest Certification"
7. "Comparison of forest certification"

Grey literature was located by searching the standard Google web browser, by conducting informal interviews with local SFM experts, and by searching the reference sections of other literature that compared certification systems. Google searches were conducted during three periods: July 2008–August 2008, 15 March 2009–1 April 2009, and November 2009. The Google search term used was "forest certification comparison".

Informal discussions with local SFM experts from academia and industry identified credible websites that were sources of comparisons between different certifiers. Those involved in the project identified the experts based on previous relationships. The experts recommended many of the same websites that were found through Google, but they also provided others. Grey literature was considered credible and was included in our analysis if it was recommended by an expert or was referenced in another publication, and if it compared two or more certification systems. Literature from industry and NGO groups was included regardless of the source. It was not our intention to investigate the existence of bias in NGO, industry, or academic papers. We excluded review papers. Pertinent literature that compares certified forests to non-certified forests is referenced in the discussion.

Websites found included BC Market Outreach Network, Confederation of European Paper Industries (CEPI), European Conference of Postal and Telecommunications Administrations (CEPT), Ecologic Institute, ÉM Inc., Forests and the European Resource Network (FERN), Forest Products Association of Canada (FPAC), Greenpeace, Meridian Institute, Metafore, Oregon State University, and Pinchot Institute for Conservation. All information from websites was copied and saved in pdf file format.

Studies of individual certification systems

Peer-reviewed articles that were excluded from our analysis were filtered according to whether they examined FSC, CSA-SFM, or SFI individually. We did this only with peer-reviewed literature because we assumed that the publication process eliminated bias that might appear in unreviewed documents published by industry or NGOs.

Determining how comparisons have been made

The themes, criteria, and indicators used to assess certification system effectiveness were identified from the literature that met our search criteria, and for 11 single certifier studies that did not meet our search criteria. Themes were defined as overarching categories pertaining to a functional aspect of certification. Criteria were defined as tools used to judge whether principles of SFM have been fulfilled (Prabhu et al. 2001). Indicators were defined as any measure of the performance of a certification system (Prabhu et al. 2001). Indicators were placed within criteria, and criteria were grouped within appropriate themes.

Comparisons were made in two time periods, before and after 2002, which correspond with revisions to both CSA-SFM and SFI. CSA-SFM revised its standards in 2002 (CSA-SFM 2009), and SFI introduced its 2002–2004 standards at that time (SFI 2009). References are displayed according to these time periods to denote changes after revision (Appendix 1).

Comparative methods varied between studies, and as a result, the data we used for indicators were either quantitative or qualitative. Quantitative variables often came from surveys, and provided a variety of numerical and nominal variables. These were often linked to themes, criteria, or indicators. Qualitative variables were descriptions of certification systems found in the discussions of the reviewed literature. They provided descriptions about how a certification system failed or succeeded in promoting a specific SFM principle, and we linked them to themes, criteria, or indicators accordingly.

Meta-analysis to determine consensus of certifier performance

The principles of meta-analysis were used to determine the level of consensus regarding FSC, CSA-SFM, and SFI performance. Meta-analysis combines data sets that have been collected during multiple studies, and searches for statistical trends that are unobservable in single studies (Gurevitch and Hedges 2001). We could not conduct a statistically robust meta-analysis because the response variables used in each study were often inconsistent, and the number of studies using each indicator was highly variable. We relied on graphs alone for our assessment.

With meta-analysis we sought to answer which certification system best achieves SFM goals. To do this, we converted the qualitative and quantitative data found for each indicator into a binary value (1 or 0), where values of 1 were awarded to successes and 0 was awarded to failures.

One area in which we sought to avoid bias was the Credibility criterion. Within all sectors there are groups and individuals that endorse and use each certification system. Therefore, we made conservative estimates of credibility. We considered a system as credible only if authors reported that over 75% of a sampled population thought the system was credible.

Conversions to binary values differed as a consequence of study methodology. For quantitative studies that used continuous rankings to compare certification systems, we followed the author's metrics for what constituted a pass or fail. For example, in Mater et al. (2002), foresters ranked FSC and SFI along a gradient from 0 to 7 for 54 SFM "elements" (synonymous with indicators as defined here). The rank of 5 was taken as the cut-off for failing to meet an SFM goal. For qualitative studies, when authors discussed the failure of a certification to meet an SFM goal, we assigned a value of 0. Values of 1 were assigned when authors said that a certification standard performed well.

We calculated the average percentage of indicators that met SFM goals under each criterion with these numerical values:

$$CI_x = (\Sigma i_x) / (\Sigma i_x + \Sigma j_x) \quad (1)$$

The score for each criterion (CI) was the summation of the CI indicators (i) that met SFM goals, divided by the total number of indicators that met and did not meet SFM goals (j) per criterion (x). Percentage values were not calculated for indicators that lacked data for all three certification systems (all indicators can be found in Appendix 1). The average indicator scores for each criterion were plotted in radar plots (Figs. 2-4).

RESULTS

Literature review

Nine peer-reviewed journal articles and 26 grey literature sources met our criteria. Of the 368 peer-reviewed articles identified, 98% were discarded. Excluded literature often referenced certification systems superficially or not at all. Many papers reviewed the SFM industry generally, or provided criteria and indicators or monitoring techniques that could be used to evaluate SFM goal achievement under any regulatory environment.

Within the excluded articles, 41 examined a single certifier, mainly FSC (investigated in 71% of references. CSA-SFM was investigated in 8% of references, SFI in 29%). The three most common study types were surveys of the forest industry or consumers (37%), reviews (22%), and evaluations of the wording of FSC principles and criteria (12%). The remaining papers were forest industry case studies that focused on FSC (5 papers) and SFI (1 paper), modeling studies of SFI forests (3 papers), studies of economic impacts of certification (3 papers), and other studies (4 papers). Only 11 of the 41 articles evaluated a certifier with qualitative or quantitative criteria and indicators (Table 1). The criteria or indicators were inconsistent between studies, and none were used to compare systems.

Themes, criteria, and indicators used in comparisons

Three themes were extracted from the comparative literature, and all related to the functioning of certification systems in markets and forestry operations. Product tracking and claims (Metafore 2006), and quality of forest management (ÉEM 2007) were drawn from the literature. System function was based on subjective groupings of variables that describe how forestry companies use certifications. Each theme had at least one criterion, and each criterion had between 4 and 14 indicators (Appendix 1). A total of 77 indicators were extracted from the 35 sources that met our search criteria.

The number of studies examining each indicator was highly variable (Fig. 1), though the methods used to compare systems were consistent. Only one reference based conclusions on data collected in forests (Sverdrup-Thygeson et al. 2008). Two-thirds of papers based comparisons on analyses of the wording of certification system principles and criteria (e.g., Hickey et al. 2005). The remaining third evaluated certification systems by surveying perceptions of workers in the forest industry (e.g., Mater et al. 2002) or consumers (Perera et al. 2008).

Table 1. Criteria and indicators from studies that examined a single sustainable forest management certification system and which were excluded from comparative analysis (see Methods for details). Variables used to measure indicators or criteria are omitted.

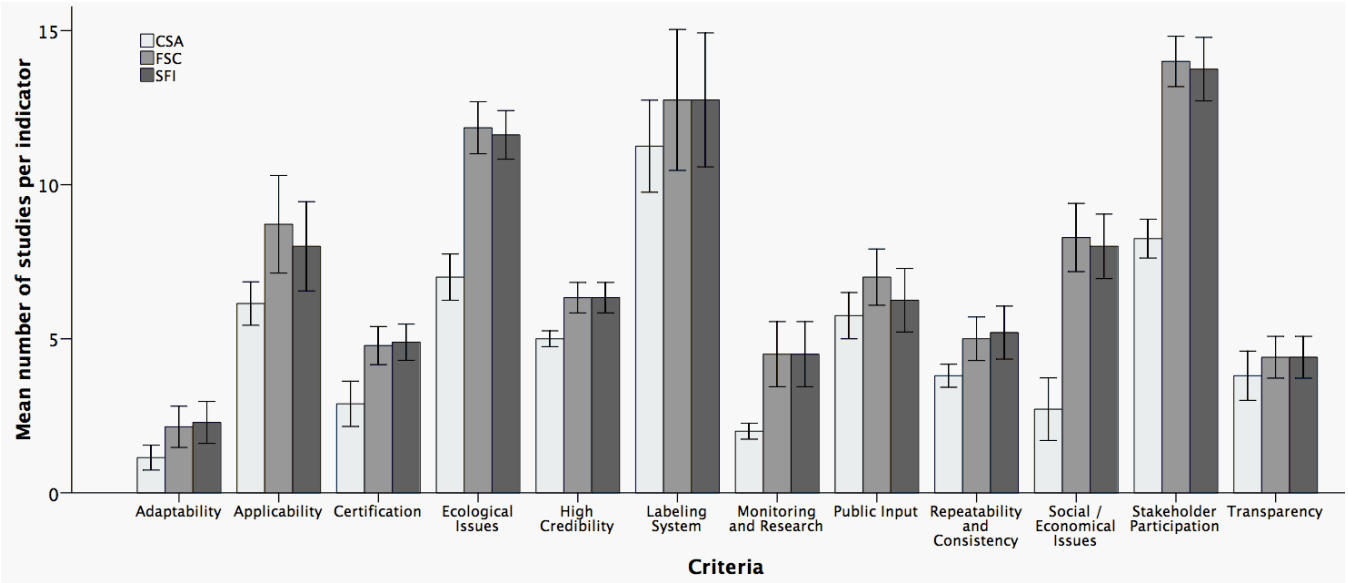
Source	Certifier assessed	Criteria	Indicators
Hickey and Innes (2008)	Literature review	Biological diversity	Ecosystem diversity Species diversity Genetic diversity
		Ecosystem condition and productivity	
		Soil and water	
		Role in global ecological cycles	Carbon cycle
		Economic and social benefits	Economic benefits Distribution of benefits Sustainability of benefits
		Society's responsibility	Provision for duly established Aboriginal and treaty rights
			Aboriginal traditional land use and forest-based ecological knowledge
			Forest community well-being and resilience
			Fair and effective decision making
			Informed decision making
Ebeling and Yasue (2009)	FSC†	Success of certification	Certified forest area (absolute number and share of total forest cover)
			Number of forest management and Chain-of-Custody certificates
		Size of eco-sensitive markets	Share of country’s export market
		Government support for certification	
		Nongovernmental organization and official development assistance agency support for certification	
		Forest legislation and policy	High compatibility of forestry laws with FSC certification High predictability of future forest legislations and policy
		Quality of law enforcement	Corruption levels Secure funding for enforcing agencies Number of monitoring staff
		Security of land tenure	Clear land titles or usage rights Prevalence of squatting
		Industry structure	
		Information availability	
Kant and Brubacher (2008)	FSC, CSA-SFM‡	Aboriginal and treaty rights	Recognize and implement Aboriginal and treaty rights
	(but no comparison)		Identify and map areas of importance to Aboriginal people
			Ensure that Aboriginal people have access to areas of importance to them
			Protect areas of importance to Aboriginal people

(con'd)

		Participatory decision making	Meaningful involvement of First Nations
			Regular reports by Minister of Natural Resources and industry to First Nations
			Incorporate Aboriginal knowledge into forest management planning and operations
		Environmental values and sustainable forest management	Tree planting and other regeneration and management practices
			Manage forests to ensure that forest products are available for Aboriginal people
			Protection of wildlife and their habitat
			Protect water, wetlands, and watersheds
		Economic opportunities and development	Partnerships between industry, government, and First Nations
			Increased involvement by Aboriginal loggers
			Government support for a profitable, commercial forest products industry that can support local opportunities
			Education, training, and capacity-building programs
			Sharing of the revenues from treaty forest lands
Eden (2008)	FSC		Amounts of old-growth, ancient woodland, and veteran trees
			Amount of deadwood
Dingwerth (2008)	FSC		Participation of southern hemisphere representatives
Cerutti et al. (2008)	FSC		Minimum cutting diameter
			Inconsistencies in legal frameworks
Newsom et al. (2006)	FSC	Forest management activities	
		Forest ecology	
		Social and economic impacts	
		Systems elements	
Brown and Zhang (2005)	SFI§		Stumpage rates
			Costs of implementation
Azevedo et al. (2005)	SFI		Habitat suitability index for *Dendroica pinus* (pine warbler) Water runoff and sediment load
Azevedo et al. (2005)	SFI		Water runoff and sediment load
Subak (2002)	FSC	Carbon sequestration	

†FSC: Forest Stewardship Council
‡CSA-SFM: Canadian Standards Association – Sustainable Forestry Management Standard
§SFI: Sustainable Forestry Initiative

Fig. 1. Mean (± SE) number of studies examining each indicator for all criteria. (CSA: Canadian Standards Association; FSC: Forest Stewardship Council; SFI: Sustainable Forestry Initiative)



Certification system performance

FSC outperformed CSA-SFM and SFI in terms of ecological and most social and economic criteria. FSC performed poorly under repeatability and consistency, stakeholder participation, and credibility (Fig. 2). CSA-SFM was the intermediate certifier, performing poorly under ecological issues, socioeconomic issues, applicability, credibility, stakeholder participation, and labeling system (Fig. 3). SFI was the most variable, performing poorly under credibility, ecological issues, stakeholder participation, labeling system, public input, repeatability, certification, applicability, and socioeconomic issues (Fig. 4).

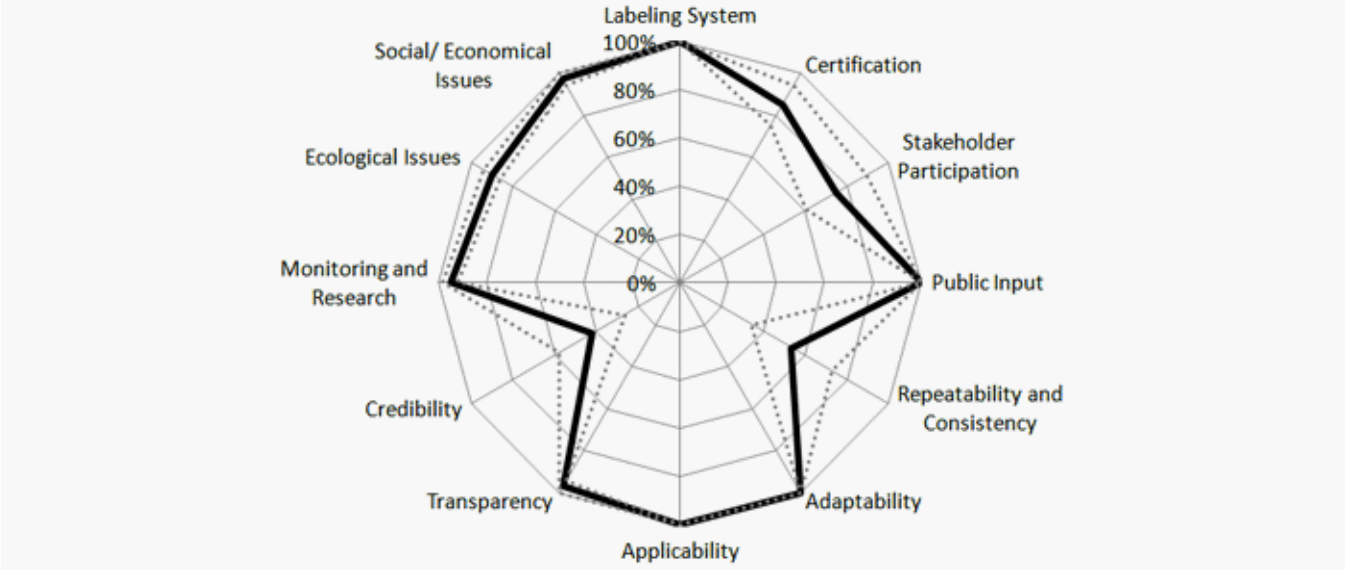
Theme 1: Product tracking and claims
Criterion 1.1: Labeling system

FSC met 100% ± 0% (mean ± 1 SE) of indicators, CSA-SFM met 88% ± 7%, and SFI met 39% ± 17% (Appendix 1, Figs. 2–4). FSC was the first to implement both the chain-of-custody and labeling systems for sustainably managed forest products (Ozinga 2001, BC Market Outreach Network 2008). CSA-SFM added chain-of-custody in 2002, achieving the best developed chain-of-custody of the three certifiers (Ozinga and Krul 2004). SFI failed because its chain-of-custody is optional and its auditing process is poor (Anderson and Hansen 2003, Metafore 2006).

Theme 2: System function
Criterion 2.1: Certification

FSC, CSA-SFM, and SFI met 86% ± 9%, 76% ± 13%, and 71% ± 15% of indicators, respectively (Appendix 1, Figs. 2–4). The certification process across all three systems is thorough and well defined but inconsistent (Ozinga and Krul 2004). Qualified teams complete certification for FSC, CSA-SFM, and SFI, and all systems are periodically updated. FSC fell short because of poor coordination through the audit process (Cubbage et al. 2003, Sample et al. 2003, Hickey et al. 2005), clarity of its certification, and inconsistencies in its auditing (Cubbage et al. 2003, Tan 2003, Ozinga and Krul 2004, EEM 2008). CSA-SFM failed under the indicator of clarity and consistency in its auditing. Over time, SFI has improved its clarity of certification but fails to meet the indicator of performance measurement. SFI was not originally based on measures of a minimum performance, and there is disagreement as to whether SFI's 2002

Fig. 2. Radar plot of the mean (± SE) percent of indicators meeting sustainable forest management goals within each criterion for the Forest Stewardship Council. Means are solid black lines, and dashed lines represent one SE.



revision adequately improved this (Sprang et al. 2006, CEPT 2008a).

Criterion 2.2: Participation of stakeholders in standard setting and certification

FSC, CSA-SFM, and SFI met 75% ± 14%, 69% ± 16%, and 43% ± 22% of indicators, respectively (Appendix 1, Figs. 2–4). By the second time period, FSC and CSA-SFM had balanced representation of all stakeholder types (Auld and Bull 2003, Ozinga and Krul 2004, CEPT 2008a, ÉEM 2008). FSC participation is open, but participation by industry stakeholders is restricted (Oliver 2001, Ozinga 2001). CSA-SFM's social participation is questionable (Ozinga 2001, Kill 2001). SFI failed to have clear ecological and social participation, and was unbalanced towards economic stakeholders (e.g., Ozinga 2001).

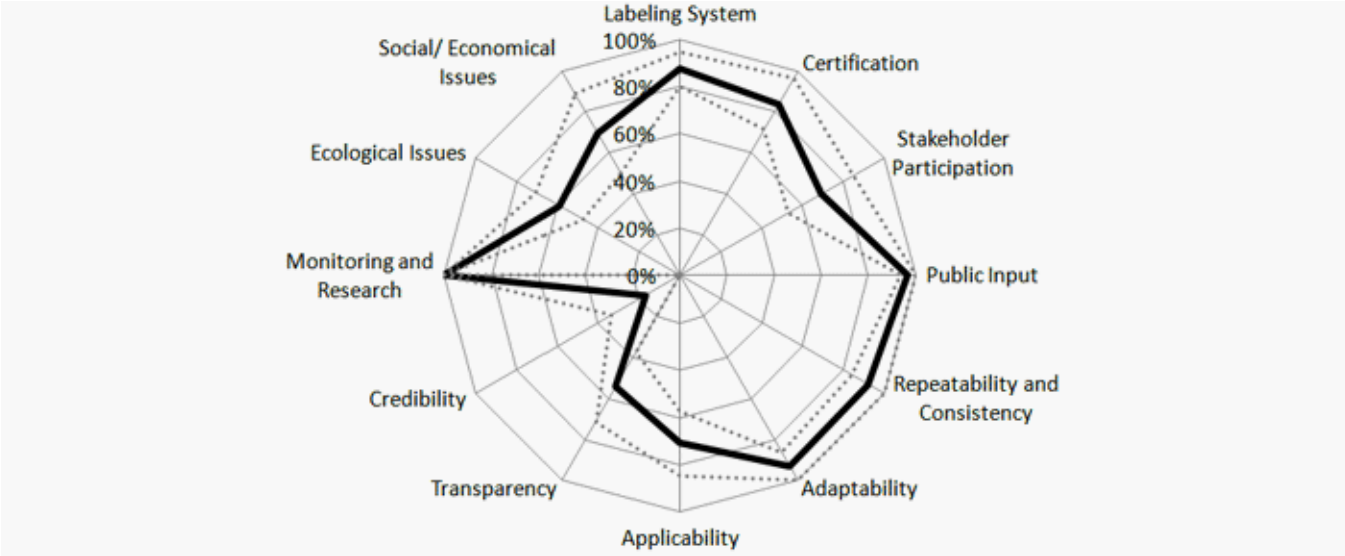
Criterion 2.3: Public input

FSC, CSA-SFM, and SFI met 100% ± 0%, 97% ± 3%, and 43% ± 6% of indicators, respectively (Appendix 1, Figs. 2–4). By 2005, all certification systems encouraged public participation. FSC and CSA-SFM have encouraged public participation since their inception, though there is disagreement about the quality of CSA-SFM's process. Hansen et al. (2006) stated that CSA-SFM public input for developing standards is limited because it is based on a selected group of stakeholders, but Abusow (2006) states that public landowner considerations ensures a rigorous public participation process. After its 2003 revisions, SFI improved by addressing training, outreach, and procurement for private land suppliers (Abusow 2006, CEPT 2008a).

Criterion 2.4: Repeatability and consistency

FSC, CSA-SFM, and SFI met 54% ± 19% 92% ± 8%, and 61% ± 17% of indicators, respectively (Appendix 1, Figs. 2–4). Clarity of all three standards has improved through time. FSC failed in communicating procedures for standard setting, certification, and accreditation. CSA-SFM began providing clear and rigorous procedures for standard setting, certification, and accreditation after 2002. SFI scored poorly under indicators of annual monitoring and field assessments because

Fig. 3. Radar plot of the mean (± SE) percent of indicators meeting sustainable forest management goals within each criterion for the Canadian Standards Association – Sustainable Forestry Management Standard. Means are solid black lines, and dashed lines represent one SE.



documentation that ensures certification requirements are upheld ceased to be obligatory after 2002 (Sprang et al. 2006).

Criterion 2.5: Adaptability

FSC and SFI met 100% ± 0% of indicators, while CSA-SFM met 93% ± 6% (Appendix 1, Figs. 2–4). Very few papers examined the indicators of adaptability, and indicators were not consistent across studies or time periods. The only measure represented across all time periods and certification systems was whether systems required forest managers/owners to be committed to continuous improvement of forest management.

Criterion 2.6: Applicability

FSC, CSA-SFM, and SFI met 100% ± 0%, 71% ± 13%, and 67% ± 14% of indicators, respectively (Appendix 1, Figs. 2–4). FSC is an international organization that certifies forests with standardized forest management requirements across multiple countries and all forest types and firm sizes. CSA-SFM and SFI are North American based organizations that certify nationally and regionally. For CSA-SFM and SFI, forest size needs to be considered because both score low under these indicators. CSA-SFM could be applied to small forest sizes but was not reported as accrediting them (Oliver 2004). The size of forests certified by SFI needs to be explored (Oliver 2004, Hickey et al. 2005).

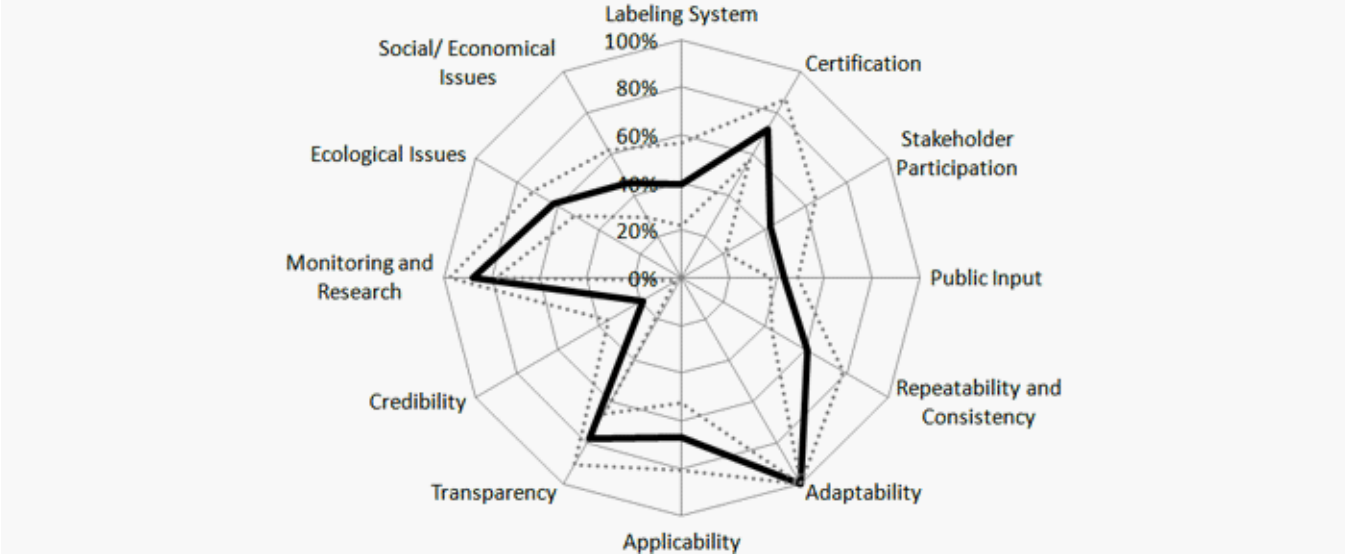
Criterion 2.7: Transparency

FSC, CSA-SFM, and SFI met 97% ± 3%, 54% ± 17%, and 78% ± 12% of indicators, respectively (Appendix 1, Figs. 2–4). All systems have improved through their revision processes. FSC failed before 2003 because foresters could request that information be withheld from the public certification report (Ozinga 2001). CSA-SFM does not provide information publicly about its certified foresters (ÉEM 2008). SFI met all transparency indicators by the second time period.

Criterion 2.8: Credibility

FSC, CSA-SFM, and SFI met 42% ± 15%, 17% ± 17, and 19% ± 17% of indicators, respectively (Appendix 1, Figs. 2–4). FSC was credible with

Fig. 4. Radar plot of the mean (± SE) percent of indicators meeting sustainable forest management goals within each criterion for the Sustainable Forestry Initiative. Means are solid black lines, and dashed lines represent one SE.



industry, government, academia, and environmentalists. CSA-SFM and SFI were credible with industry, while SFI has had support from environmentalists since 2008 (ÉEM 2008).

Criterion 2.9: Monitoring and research

FSC, CSA-SFM, and SFI met 95% ± 3%,100% ± 0%, and 88% ± 10% of indicators, respectively (Appendix 1, Figs. 2–4). Few studies analyzed indicators of certifier monitoring and research. CSA-SFM was examined the least, which makes it difficult to make generalizations across all three certification systems. Only a subset of FSC and SFI firms conducted monitored and research (Hickey et al. 2005), possibly as low 50% (CEPT 2008a).

Theme 3: Quality of forest management
Criterion 3.1: Ecological issues

FSC, CSA-SFM, and SFI met 90% ± 4%, 59% ± 12%, and 62% ± 10% of indicators, respectively (Appendix 1, Figs. 2–4). All three certifications scored poorly for exotic species indicators because exotic species are allowed to varying degrees (Cashore et al. 2004). FSC performed the best but failed under several indicators. Mater et al. (2002) found that of several ecological indicators, natural regeneration was ranked in the lowest range for SFI and FSC, and soil conservation and protection were also found lacking in FSC forests. Hickey et al. (2005) found that some FSC certified companies use erosion control to protect and conserve soil, but they have limited soil conservation policies otherwise. While FSC is supposed to prohibit use of pesticides and genetically modified organism (GMO) trees, prior to 2002 there were instances where exceptions were made (Ozinga 2001).

CSA-SFM scored poorly under six indicators. Prior to 2002, SFM criteria violations included unfettered clear-cutting, and use of pesticides and GMO trees. Tan (2003) reported that CSA-SFM methods resulted in poor preservation of aquatic habitat. CSA-SFM failed under wildlife habitat preservation because it limits preservation to those habitat areas that are already restricted by government (ÉEM 2007), suggesting a complete failure to protect areas of high conservation values (Tan 2003, CEPT 2008a).

SFI's shortcomings included the permissible use of exotic species, acceptance of GMO trees, and allowance of conversion of natural forests to

plantations (Cashore et al. 2004). SFI has improved in the realms of clear-cutting and logging, soil conservation, and pesticide allowance. There is disagreement in the quality of water resource management in the SFI system. Mater et al. (2002) found that managers felt water resources were maintained comparable to FSC, but Hickey et al. (2005) point out that monitoring of resources does not equate to SFM.

Criterion 3.2: Social/economic issues

FSC, CSA-SFM, and SFI met 91% ± 3%, 69% ± 19%, and 46% ± 16% of indicators, respectively (Appendix 1, Figs. 2–4). FSC failed under the indicator of "Promoting sustainability with the public and staff" (ÉEM 2008). CSA-SFM was not perceived as protecting indigenous peoples' rights (Ozinga and Krul 2004). Little other information exists for CSA-SFM because it was evaluated under only five of seven indicators. SFI fell short under the categories of workers' rights (Meridian Institute 2001a, Ozinga and Krul 2004), protecting cultural and historical areas (Meridian Institute 2001a), indigenous peoples' rights (Mater et al. 2002, BC Market Outreach Network 2008), local benefits and opportunities (Meridian Institute 2001a, Mater et al. 2002), and promoting sustainability (Mater et al. 2002).

DISCUSSION

The strengths of FSC differed from those of the PEFC endorsed certifiers. FSC performed better regarding ecological and social issues, and showed the greatest amount of consensus among studies (as signified by the standard error in Fig. 2). The strengths of CSA-SFM and SFI were in maintaining forest productivity to ensure the economic longevity of a firm, not in addressing social or ecological issues. Consensus about the performance of these two systems was less than that for FSC (Fig. 2).

Each system received a different amount of study, which made it difficult to make generalizations from this meta-analysis. FSC and SFI were compared in similar numbers of studies, but CSA-SFM was examined the least (Fig. 1). FSC also received the most attention in the literature that examined just one system (Table 1). These conclusions about SFM performance are important, but they have several caveats that are linked to the methods used to compare systems.

The main methods of analysis involved examining the wording of certifier principles and criteria, and analyzing surveys. Wording and survey analyses are both limited as tools for assessing certification systems because the data they generate are based on perceptions, not on empirical evidence of on-the-ground impacts.

Analyses of wording

Analyses of wording are qualitative, do not generate original data, and use a predetermined set of SFM criteria. Authors outlined elements required to meet SFM criteria and then examined certification system principles and criteria to determine whether any were missing (Oliver 2001, Ozinga 2001, Cashore et al. 2004, Abusow 2006). Analyses of wording are appropriate for a criterion (and its indicators) such as "Chain-of-custody" because success can be determined based on written protocols. Other indicators, such as "Protects genetic and biodiversity", should be measured by field data. It should not be assumed that the wording of principles or criteria translates into tangible impacts.

Bias may be created if the authors favor one point of view, such as industrial or NGO (Kneeshaw et al. 2000). For example, the "Applicability" criterion preferred systems that were international in scope rather than regional. This created a bias towards FSC. It should not be assumed that an international system has greater impacts than a regional system. However, other biases towards FSC from the analyses of wording may be reasonable given its clear standpoint on human rights and ecological issues. The 10 principles of FSC focus specifically on human and indigenous peoples' rights, biodiversity, GMOs, and other issues. CSA-SFM and SFI do not address these issues as explicitly (Meridian Institute 2001a, McDermott et al. 2008).

Surveys

While surveys generate new data, those data are based on perceptions and do not represent measurable variables in forests. Some studies rated certifiers across a set of common criteria relative to one another (e.g., Mater et al. 2002, Newsom et al. 2006). Others collected data through surveys about audit processes (Wilson et al. 2001, Hickey et al. 2005) or about forest product user opinions (Perera et al. 2008). For example, Mater et al. (2002) worked

with state and university forest managers and owners to rank the FSC and SFI systems after going through the certification feasibility audits of both systems. These methods are appropriate for criteria such as certification or stakeholder participation, which are measured by indicators that are based on user experience.

Advancements in comparative analyses

To understand the actual impact of SFM, social or ecological data must be collected in field studies. Certification systems have integrated new ideas and norms into forestry management and public engagement with forestry, but little is known about their field performance (Tikina and Innes 2008). Only one study drew its conclusion from field-collected data, which looked at tree retention in Sweden (Sverdrup-Thygeson et al. 2008). We propose that the conclusions from analyses of wording and surveys presented here can be used to generate hypotheses about how each certification system performs.

Each certification system can be viewed as an unintentional experiment to reach SFM goals. All certification systems are loosely based on the same definition of sustainable development. Sustainable development was originally defined as "economic development that meets the needs of the present generation without compromising the ability of future generations to meet their needs" (WCED 1987). This definition has been adapted for business as the preservation of ecological, social, and other non-business resources while business proceeds (WBCSD 2000). The different focuses of FSC and the PEFC endorsed systems may be due to different interpretations of SFM (Cashore et al. 2004, Vogel 2008).

Analyses of wording could link the interpretation of SFM inherent in a system's principles or criteria to a hypothesis that can be field tested. For example, Suzuki and Olson (2007) hypothesized that the wording of FSC's principles and criteria support the conservation of biodiversity, but they did not test their hypothesis. Future research could build on this by examining the wording of other systems for how they deal with conservation areas. Then the number and impact of conservation areas in FSC, SFI, and CSA-SFM forests could be measured and compared.

Social indicators

Many social indicators have been proposed (Table 1). We provide certification impacts on Aboriginals as an example of how existing frameworks could guide future research. Aboriginal groups are prominent indicators of certifier success in the studies that examined a single certification system (Hickey and Innes 2008, Kant and Brubacher 2008; Table 1). For example, Hickey and Innes (2008) included several indicators of Aboriginal rights and traditions, including economic considerations. Gale and Gale (2006) also created a framework (without assessing a certification system) that included Aboriginal rights as a criterion in addition to broader social criteria of employment realities and subsidies paid from public funds. While impacts on Aboriginals were a common indicator of socioeconomic impacts in the comparison literature, they were under-represented. In our analysis of comparison studies we found that indigenous groups were absent from the "Credibility" criterion, where Aboriginal approval of certification could be a meaningful indicator. For example, Kant and Brubacher (2008) surveyed Canadian Aboriginals and found that certification systems did not meet their expectations of environmental values, Aboriginal community inclusion in decision-making, respect of Aboriginal treaty rights, or economic opportunities and development. Future research could be based on existing indicators, and we suggest that existing data sets could be mined for information to compare certification system impacts on Aboriginal communities, such as has already occurred for comparisons of different nations (Ebeling and Yasue 2009) and tree sizes (Cerutti et al. 2008; Table 1).

Ecological indicators

Although "Ecological issues" was one of the most studied criteria, too little is understood about actual impacts on forest ecosystems. For example, of the 18 studies that assessed whether wildlife habitat was protected, none examined field data. Future research must draw on existing models and monitoring data sets, as well as new field data to advance our understanding of ecological impacts.

Several modeling studies show that both FSC and SFI have positive or neutral impacts on ecological variables (Table 1). Models of SFI hydrological

impacts predict that SFI will reduce sediment loads by as much as 50% compared to forestry practices that do not leave riparian buffers (Azevedo et al. 2005b). Coarse woody debris was predicted to be three times greater in FSC forests than in conventional forests (Ranius et al. 2003), and SFI may have no negative effects on habitat suitability for birds (Azevedo et al. 2005a). Unfortunately, there seems to be insufficient monitoring of riparian zones, wetlands, and site damage to test hypotheses empirically (Hickey et al. 2005). Existing data sets may present opportunities to compare different certification systems.

Data sets of governments and firms certified under different systems are being mined for studies of the impacts of FSC. We found that FSC's impacts were studied using government data sets in Africa, and in North and Central America (Newsom et al. 2006, Cerutti et al. 2008, Ebeling and Yasue 2009). Future study could include other certification systems that are endorsed by the PEFC label. Firm data sets were used in studies that were excluded from our analysis to infer ecological impacts by looking for improvements in management practices that are required through the certification process (Gullison 2003, Newsom et al. 2006). However, data sets have also been used to examine ecological indicators. Using regeneration data collected by the forestry company, Kukkonen et al. (2008) found that neotropical forest regeneration was lower in certified forest compared to uncertified forest due to greater logging disturbance prior to certification.

Several theoretical indicators have been developed for SFM forests. Bio-indicators include carabid beetles and spiders (Pearce and Venier 2006), rodents (Pearce and Venier 2005), and birds (Venier and Pearce 2004). One of the benefits of bio-indicators is that they can be studied across years, which avoids bias created by inter-annual population variability (Pearce and Venier 2005). Other areas of focus for SFM performance include climate change impacts like carbon sequestration (Ogden and Innes 2009), amount of fragmentation (Brown et al. 2001), soil variables (Cline et al. 2006), and genetic diversity (Geburek and Konrad 2008). While we found some of these ecological indicators (e.g., soils) were included in analyses, many others were not, such as climate change or fragmentation.

It is likely that the impacts of certification systems manifested most in the first 17 years since FSC certification began. Only by knowing whether these systems induce positive changes, and the effect sizes of those changes, in variables that are adversely affected by conventional forestry (e.g., biodiversity, employment), can these systems be effectively compared (Vogel 2008, Auld et al. 2008).

The superiority of FSC over SFI and CSA-SFM may not hold up after a more rigorous examination. It remains to be seen whether the wording of these systems is related to improvements in forest and human health and well-being. Only assessment of ecological data will determine whether all certification systems are created equal, regardless of their underpinnings. If, after more than 10 years of certification, no distinct benefits exist between competing systems, then arguments supporting FSC as the premier certifier out of these three certification systems will be undercut.

CONCLUSIONS

Despite their existence for more than a decade, little is known about how well forest certification systems achieve their SFM goals. FSC, CSA-SFM, and SFI have been compared on the basis of the wording of their criteria and indicators or on user surveys. As such, we found a strong consensus that FSC certified forests achieve higher levels of sustainable forest management compared to CSA-SFM or SFI. However, empirical comparisons based on ecological or socioeconomic field data are lacking. Empirical data collection in forests must be used to field test hypotheses about the merits of different certification systems. Only by understanding the effectiveness at which different certification systems meet SFM goals can consumers select the products that most effectively advance sustainable forestry goals.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol16/iss1/art3/responses/

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APPENDIX 1. Themes of criteria and each criterion's underlying indicators that were used to compare the sustainable performance of Forest Stewardship Council, Canadian Standards Association – Sustainable Forestry Management Standard, and Sustainable Forestry Initiative. Numbers refer to the reference in which the data were extracted. Bolded numbers correspond to references that found a certification system successfully met a sustainable forest management indicator. Italicized numbers correspond to references that found a certification system did not meet a sustainable forest management indicator. See Methods for details about how success and failure were assigned.

Theme, Criterion, and Indicators	Time	System		
		Forest Stewardship Council	Canadian Standards Association's – Sustainable Forestry Management Standard	Sustainable Forestry Initiative
Theme 1. Product tracking and claims[5]				
1.1 Labeling system[7]				
Has a product label[5, 7]	Pre – 2002	**7,12, 20, 21, 22, 25, 28**	*7, 12, 24*	*7,* **20,** *21, 23, 25, 28*
	2003–2009	**2, 5, 8, 15, 16, 17, 18, 19, 26, 27, 32**	**2, 5, 8, 15, 16, 17, 18, 19, 26, 27, 31**	**2, 5, 8, 15, 16, 17, 18, 19, 26, 27, 33**
Has a credible Chain of Custody[7]	Pre – 2002	**7, 20, 21, 25**	*7, 24*	*7, 20, 21, 23, 25*
	2003–2009	**5, 8, 11, 15, 16, 18, 19, 26, 27, 32**	**5, 8, 11, 15, 16, 18, 19, 26, 27, 31**	*5,* **8, 11, 15, 16,** *18,* **19, 26, 27, 33**
Chain of Custody is audited[7]	Pre – 2002	**7, 25**	*7, 24*	*7, 25*
	2003–2009	**8, 16, 18, 27, 32**	**8, 16, 18, 27, 31**	*8, 16, 18, 27, 33*
Does not use uncertified or illegal sources in product line[5]	Pre – 2002	**7, 25**	**7, 24**	*7, 25*
	2003–2009	**2, 5, 8, 16, 17, 18,19, 27, 30, 32**	**2, 5, 8, 16, 17, 18, 19, 27, 30, 31**	**2, 5, 8, 16, 17, 18, 19, 27, 30, 33**
Theme 2. System function				
2.1 Certification				
Assessment process with auditors is well coordinated[4]	Pre – 2002	*4,* **9**		**4, 9**
	2003 – 2009	*8, 13*	**8**	**8, 13**
Clarity of certification4 and consistency in auditing	Pre – 2002	*4, 7,* **9, 25**	*7, 24*	**4, 7, 9,** *25*
	2003 – 2009	*8, 11, 13, 16*	*8, 11, 16*	**8, 11, 13, 16**
Third party certification team was of overall quality and expertise[4]	Pre – 2002	**4, 7, 9, 25**	**7, 24**	**4, 7, 9, 25**
	2003 – 2009	**13, 16**	**16**	**13, 16**
Evaluation was thorough in all aspects[4]	Pre – 2002	**4, 9**		*4,* **9**
	2003 – 2009	**13, 16**	**16**	**13, 16**

(con'd)

Assessment was efficient[4]	Pre – 2002	**4, 9**		**4, 9**
	2003–2009	**13**		**13**
Certification is at the Forest Management Unit and not regionally[7]	Pre – 2002	**6, 7, 25**	**7, 24**	**6, 7, 25**
	2003–2009	**5, 8**	**5, 8**	**5, 8**
Scheme is based on a minimum performance-based threshold	Pre – 2002	**7, 9, 25**	**7, 9**	*7, 25*
	2003–2009	**8, 11, 26, 32**	**8,** *11,* **26,** *31,* **34**	*8, 11, 26,* **33**
Certification is cost-effective for companies[7]	Pre – 2002	*4,* **7, 9**	**7, 24**	*4, 7, 9, 25*
	2003–2009			
Certification is updated periodically	Pre – 2002	**7, 25**	**7, 24**	**7, 25**
	2003–2009	**5**	**5**	**5**
2.2 Stakeholder participation in certification and standard setting				
Clear ecological participation	Pre – 2002	**4, 6, 7, 9, 20, 21, 22, 25**	*7, 24*	**4, 6,** *7,* **9, 20, 21, 23, 25**
	2003–2009	**8, 11, 16, 17, 19, 29, 32, 34**	**8, 11, 16, 17, 19, 29, 31, 34**	**8,** *11, 16, 17, 19, 29, 33,* **34**
Clear social participation	Pre – 2002	**4, 6, 7, 9, 20, 21, 22, 25**	*7, 24*	*4,* **6,** *7, 9, 20, 21, 23, 25*
	2003–2009	**8, 11, 16, 29, 32, 34**	*8,* **11,** *16, 29, 31,* **34**	*8, 11, 16, 29, 33,* **34**
Clear economic participation	Pre – 2002	*4,* **6,** *7, 9, 20, 21, 22, 25*	**7, 24**	**4, 6, 7, 9, 20, 21, 23, 25**
	2003–2009	**8, 11, 16, 29, 32, 34**	**8, 11, 16, 29, 31, 34**	**8, 11, 16, 29, 33, 34**
Balanced and equal participation by all stakeholders	Pre – 2002	*4,* **7,** *9, 20, 21, 22, 25*	*7, 24*	*4, 7, 9, 20, 21, 25*
	2003–2009	**8, 16, 29, 32, 34**	**8, 16, 29, 31, 34**	*8,* **16,** *29, 33, 34*
2.3 Public input[4]				
On certification[4]	Pre – 2002	**4, 7, 9, 25**	**7, 24**	*4, 7, 9, 25*
	2003–2009	**17, 32, 32**	**17, 31, 34**	**17, 33**
On forest management practices[4]	Pre – 2002	**4, 7, 9, 25**	**7, 24**	*4, 7, 9, 25*
	2003–2009	**17, 32**	**17, 31, 34**	**17, 33**
On developing the standard[5]	Pre – 2002	**4, 7, 9, 25**	**7, 24**	*4, 7, 9, 25*
	2003–2009	**5, 8, 15, 17, 32**	**5, 8,** *15,* **17, 31, 34**	**5, 8, 15, 17, 33**
On judging conformance to the standard[5]	Pre – 2002	**7, 24, 25**	**7, 24**	*7, 25*
	2003–2009	**5, 17**	**5, 17, 34**	**5, 17**
2.4 Repeatability6 **and consistency**[7]				

(con'd)

Standards have clarity[4]	Pre – 2002	*4, 7, 9, 25*	**7, 24**	**4, 7, 9, 25**
	2003–2009	**8**	**8**	**8**
Standards are consistent, comprehensive, and balanced[4]	Pre – 2002	*4, 7, 9, 25*	**7, 24**	*4, 7, 9, 25*
	2003–2009	**8, 32**	**8, 31**	*8, 33*
Field visits are required[8]	Pre – 2002	**7, 25**	**7, 24**	**7, 25**
	2003–2009	**8**	**8**	*8*
Annual monitoring and audits[8]	Pre – 2002	**7, 25**	**7, 24**	**7, 25**
	2003–2009	**8, 26**	**8, 26**	*8, 26*
Clear and rigorous procedures for standard setting, certification, and accreditation	Pre – 2002	*4, 7,* **9**	*7, 24*	**4, 7, 9,** *25*
	2003–2009	*8, 11, 13, 16*	**8, 11, 16**	**8, 11, 13, 16**
2.5 Adaptability				
Forest managers/owners are committed to continuous forest management improvement[7]	Pre – 2002	**4, 7, 9, 25**	*7*	**4, 7, 9, 25**
	2003–2009	**3, 5**	**3, 5**	**3, 5**
When monitoring reveals that forest practices can be improved, the management plan changes[3]	Pre – 2002			
	2003–2009	**3**	**3**	**3**
Demonstrated deficiencies in knowledge are identified and monitoring is adjusted[3]	Pre – 2002			
	2003–2009	**3**	**3**	**3**
Standards are easily applied at the local level and accommodates additional strengthening measures[4]	Pre – 2002	*4, 9*		**4, 9**
	2003–2009			
Accommodates unique forest management objectives at a local level[4]	Pre – 2002	**4, 9**		**4, 9**
	2003–2009			
Standards are periodically revised to respond to new information[3]	Pre – 2002			
	2003–2009	**3, 5**	**3, 5**	**3, 5, 34**
Discrepancies between results and expectations are taken into account in the next management plan[3]	Pre – 2002			
	2003–2009	**3**	**3**	**3**
2.6 Applicability[6]				
Certifies a variety of forest tenures[7]	Pre – 2002	**6, 7, 24, 25**	7, 24	**6,** *7, 25*

(con'd)

	2003–2009	**3, 14, 34**	*3*, **14, 34**	*3*, **14, 34**
Certifies small forest companies	Pre – 2002	**7, 25**	*7, 24*	*7, 25*
	2003–2009	**14, 34**	**14, 34**	**14, 34**
Certifies large forest companies	Pre – 2002	**7, 25**	**7, 24**	**7, 25**
	2003–2009	**14, 34**	**14, 34**	**14, 34**
Certifies a wide variety of forest types and sizes[7]	Pre – 2002	**7, 24, 25**	**7, 24**	**7, 25**
	2003–2009	**3, 5, 14, 34**	*3, 5,* **14, 34**	*3, 5,* **14, 34**
Certifies regions	Pre – 2002	**6, 12, 20, 21, 22, 28**	**12**	**6, 20, 21, 23, 28**
	2003–2009	**2, 3, 5, 14, 15, 26, 34**	**2, 3, 5, 14, 15, 26, 34**	**2, 3, 5, 14, 15, 26, 34**
Certifies nationally	Pre – 2002	**6, 12, 20, 21, 22, 28**	**12**	**6, 20, 21, 23, 28**
	2003–2009	**2, 3, 5, 14, 15, 26, 34**	**2, 3, 5, 14, 15, 26, 34**	**2, 3, 5, 14, 15, 26, 34**
Certifies globally	Pre – 2002	**6, 12, 20, 21, 22, 28**	*12*	*6, 20, 21, 23, 28*
	2003–2009	**2, 3, 5, 14, 15, 26, 34**	*2, 3, 5, 14, 15, 26, 34*	*2, 3, 5, 14, 15, 26, 34*
2.7 Transparency[6, 7]				
Standard is transparent	Pre – 2002	**7, 25**	*7, 24*	*7, 25*
	2003–2009	**8, 17, 19, 26, 32**	**8, 17, 19, 26, 31**	**8, 17, 19, 26, 33**
Certification is transparent	Pre – 2002	**6,** *7*, **25**	*7, 24*	**6,** *7*, **25**
	2003–2009	**16, 17, 19, 32**	**16, 17, 19, 31**	**16, 17, 19, 33**
Scheme is fully transparent (freely available)[7]	Pre – 2002	**6, 7, 25**	*7, 24*	**6, 7, 25**
	2003–2009	**16**	*16*	**16**
Has a complaint procedure[7]	Pre – 2002	**6, 7, 25**	**7, 24**	**6, 7, 25**
	2003–2009	**16**	**16**	**16**
Complaint procedure is effective and transparent[7]	Pre – 2002	**7, 25**	*7, 24*	*7, 25*
	2003–2009	**32**	**31**	**33**
2.8 High credibility[4]				
With industry[4]	Pre – 2002	*4, 7, 9, 25*	**7, 24**	**4, 7, 9, 25**
	2003–2009	**2, 16, 26**	**2, 16, 26**	**2, 16, 26**
With landowners[4]	Pre – 2002	*4, 7, 9, 25*	*7, 24*	*4, 7, 9, 25*
	2003–2009	*2, 16*	*2, 16*	*2, 16*
With government[4]	Pre – 2002	*4, 7, 9, 25*	*7, 24*	*4, 7, 9, 25*
	2003–2009	**2, 16, 26**	*2, 16, 26*	*2, 16, 26*

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With academia[4]	Pre – 2002	**4, 7, 9, 25**	*7, 24*	*4, 7, 9, 25*
	2003–2009	*2, 16*	*2, 16*	*2, 16*
With public[4]	Pre – 2002	*4, 7, 9, 25*	*7, 24*	*4, 7, 9, 25*
	2003–2009	*2, 16, 35*	*2, 16, 35*	*2, 16, 35*
With environmentalists[4]	Pre – 2002	**4, 7, 9, 25**	*7, 24*	*4, 7, 9, 25*
	2003–2009	**2, 16, 26**	*2, 16, 26*	*2,* **16,** *26*
2.9 Monitoring and research[3]				
Crop performance and ecological conditions (soil, water, biodiversity, etc.) are monitored[3]	Pre – 2002	**20, 21, 22, 28**		**20, 21, 23, 28**
	2003–2009	*3,* **32**	**3, 31**	**3, 33**
Results from monitoring exercises influence policy, regulations, standards, etc.[3]	Pre – 2002	**20, 21, 22**		**20, 21, 23**
	2003–2009	**3, 32**	**3, 31**	**3, 33**
Procedures are consistent and replicable to allow comparisons[3]	Pre – 2002			
	2003–2009	**3, 32**	**3, 31**	**3, 33**
A long-term monitoring procedure is in place[3]	Pre – 2002	**6, 7, 20, 21, 22, 25, 28**	**7, 24**	**6, 7, 20, 21, 23, 25, 28**
	2003–2009	*3*	**3**	*3*
Records are accurate, accessible, and protected against mishap[3]	Pre – 2002			
	2003–2009	**3**	**3**	**3**
Environmental impact assessments are conducted[3]	Pre – 2002	**20, 21, 22**		*20, 21, 23*
	2003–2009	**3, 32**	**3, 31**	**3, 33**
Theme 3. Quality of forest management[2]				
3.1 Ecological issues				
Prohibits or limits use of exotic species	Pre – 2002	**4, 9, 20, 21, 22**		*4, 9, 20, 21, 23*
	2003–2009	*1, 15*	*1, 15*	**1, 15**
Protects rare, threatened, and endangered species	Pre – 2002	**4, 9, 28**		**4, 9, 28**
	2003–2009	**1, 2, 3, 11, 15, 32**	**1,** *2,* **3, 11,** *31*	**1, 2, 3, 11, 15, 33**
Prohibits or limits clear-cutting	Pre – 2002	**7, 20, 21, 22, 25**	*7, 24*	*7, 20, 21, 23, 25*
	2003–2009	**1, 2, 15, 16, 17, 19**	*1,* **2,** *15, 16, 17, 19*	**1, 2, 15, 16, 17, 19**
Forest is regenerated/reforested after harvesting	Pre – 2002	**4, 7, 9, 20, 21, 22, 25, 28**	**7, 24**	**4, 7, 9, 20, 21, 23, 25, 28**

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	2003–2009	**2, 3, 16**	**2, 3, 16**	**2, 3, 16**
Percentage of forest soil is protected and conserved[3]	Pre – 2002	**7, 20, 21, 22, 25**	**7, 24**	*7,* **20, 21, 23, 25**
	2003–2009	*3,* **16, 17, 19, 32, 34**	**3, 16, 17, 19, 31**	**3, 16, 17, 19, 33**
Prohibits or limits use of harmful chemical pesticides	Pre – 2002	*4,* **7,** *9, 20, 21, 22, 25, 28*	*7, 24*	**4,** *7,* **9, 20, 21, 23, 25, 28**
	2003–2009	**1, 2, 11, 15, 16, 32**	*1,* **2,** *11,* **15,** *16, 31*	**1, 2, 11, 15, 16, 33**
Prohibit or limits use of genetically modified organisms	Pre – 2002	*7,* **20, 21, 22, 25**	*7, 24*	*7, 20, 21, 23, 25*
	2003–2009	**1, 2, 8, 15, 16**	*1,* **2,** *8, 15, 16*	*1, 2, 8, 15, 16*
Prohibits or limits conversion of natural forest to plantation	Pre – 2002	**4, 7, 9, 20, 21, 22, 25**	*7, 24*	*4, 7, 9, 20, 21, 23, 25*
	2003–2009	**1,** *2, 8,* **15, 16, 19**	*1, 2, 8, 15, 16, 19*	*1, 2, 8, 15, 16, 19*
Protects genetic- and bio-diversity	Pre – 2002	**4, 7, 9, 20, 21, 22, 25, 28, 29**	**7, 24, 29**	*4, 7, 9, 20, 21, 23, 25,* **28,** *29*
	2003–2009	**2, 16, 17, 19**	**2, 16, 17, 19**	**2,** *16,* **17, 19**
Respects and protects reserves and high conservation value forests	Pre – 2002	**7, 20, 21, 22, 25**	**7, 24**	*7, 20, 21, 23, 25*
	2003–2009	**3, 8, 10, 15, 16. 17, 19, 29, 32, 34**	**3, 8, 15, 16, 17, 19, 29, 31, 34**	**3, 8, 15, 16, 17, 19, 29, 33, 34**
Protects riparian forests and water bodies.3, 11 Water bodies are kept in good quality.[4]	Pre – 2002	**4, 7, 9, 20, 21, 22, 25, 28**	**7, 24**	**4, 7, 9, 20, 21, 23, 25, 28**
	2003–2009	*3,* **11, 17, 19, 32, 34**	*3, 11,* **17, 19, 31, 34**	*3, 11,* **17,** *19, 33,* **34**
Protects wildlife habitat[4]	Pre – 2002	**4, 7, 9, 20, 21, 22, 25, 28**	**7, 24**	**4, 7, 9, 20, 21, 23, 25, 28**
	2003–2009	**1, 2, 3, 10, 11, 15, 16, 17, 19, 32**	**1, 2, 3,** *11,* **15, 16, 17, 19,** *31*	**1, 2, 3, 11,** *15, 16,* **17,** *19, 33*
Site damage is minimal[4]	Pre – 2002	**4, 9, 20, 21, 22**		**4, 9, 20, 21, 23**
	2003–2009	*3,* **19, 32**	**3, 19, 31**	**3, 19, 33**
3.2 Social/economic issues				
Requires training and safety for all workers[4]	Pre – 2002	**4, 6, 9, 20, 21, 22**		**4, 6, 9, 20, 21, 23**
	2003–2009	**32**	**31**	**33**
Protects workers rights	Pre – 2002	**20, 21, 22, 28**		*20, 21, 23,* **28**
	2003–2009	**8, 10, 32**	**8, 31**	*8,* **33**
Protects cultural and historical areas	Pre – 2002	**4, 7, 9, 20, 21, 22, 25**	**7, 24**	*4,* **7,** *9, 20, 21, 23, 25*
	2003–2009	**2, 15, 16, 17, 19**	**2, 15, 16, 17, 19**	**2, 15, 16, 17, 19**
Protects indigenous peoples rights	Pre – 2002	**4, 7, 9, 20, 21, 22, 25, 28**	*7, 24*	*4, 7, 9, 20, 21, 23, 25, 28*

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	2003–2009	**8, 10, 11, 17, 19**	*8, 11,* **17,** *19*	*8, 11,* **17,** *19*
Provides local economic benefits and opportunities[4]	Pre – 2002	**4, 7, 9, 20, 21, 22, 25**	**7, 24**	*4, 7, 9, 20, 21, 23, 25*
	2003–2009			
Waste is utilized as much as possible[4]	Pre – 2002	**4, 9, 20, 21, 22, 28**		**4, 9, 20, 21, 23, 28**
	2003–2009			
Promotes sustainability with staff and public[4]	Pre – 2002	**4, 9, 20, 21, 22**		**4, 9, 20, 21, 23**
	2003–2009	*16*	*16*	*16*

[1]Cashore et al. (2004), [2]ÉM (2007), [3]Hickey et al. (2005), [4]Mater et al. (2002), [5]Metafore (2006), [6]Oliver (2001), [7]Ozinga (2001), [8]Ozinga and Krul (2004), [9]Sample et al. (2003), [10]Sverdrup-Thygeson et al. (2008), [11]Tan (2003), [12]Wilson et al. (2001), [13]Cubbage et al. (2003), [14]Oliver (2004), [15]Hansen et al. (2006), [16]ÉM (2008), [17]Abusow (2006), [18]Anderson and Hansen (2003), [19]BC Market Outreach Network (2008), [20]Meridian Institute (2001a), [21]Meridian Institute (2001b), [22] Meridian Institute (2001c), [23]Meridian Institute (2001d), [24]Kill (2001), [25]Heaton (2001), [26]Sprang et al. (2006), [27]Wingate and McFarlane (2005), [28]Rickenback et al. (2000), [29]Auld and Bull (2003), [30]CEPT (2008a), [31]CEPT (2008b), [32]CEPT (2008c), [33]CEPT (2008d), [34]McDermott et al. (2008), [35]Perera et al. (2008)