Raising the Bar: Recognizing the Intricacies of Cultural and Ecological Knowledge (CEK) in Natural Resource Management

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Abstract

In these rather tumultuous social and economic times, Aboriginal groups and natural resource practitioners often express the real need to look more closely at the importance and complexities of cultural ecological knowledge (CEK). To understand these intricacies and apply these principles on the ground, some theoretical constructs and practical examples need to be highlighted. Such constructs and examples can help explain the divergent world views of Indigenous knowledge and Western science within natural resource management. The objective of this article is to synthesize current literature and contemporary thought on the importance and complexities of cultural ecological knowledge (CEK) in natural resource management. In addition, it examines practical examples of the differences and similarities between Indigenous knowledge and Western science. The scope of this article is the breadth of understanding of Indigenous peoples and non-Indigenous Western scientists the world over, with the intended audience being natural resource managers, scientists/academics, and traditional knowledge practitioners. The author takes the position that natural resource managers should create social legitimacy processes through collaborative learning and systems-thinking approaches. These processes can often be validated through transfer of oral and written "ways of knowing," even when there are divergent world views. Success relies on designing clear objectives and outcomes when incorporating cultural/ecological knowledge in resource management as well as implementing systematic and culturally sensitive heritage assessments and characterizing cultural pluralism. Finally, there is a need for managers to incorporate CEK and to facilitate legislative, political, and ethical processes that help create social and cultural legitimacy in natural resource management.

KEYWORDS: *collaborative learning; cultural ecological knowledge; cultural values; indigenous knowledge; natural resource management; oral knowledge; world views*

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Introduction

In many Aboriginal[1] cultures today, there is a deep interest in conserving and preserving cultural heritage and traditional knowledge[2] (TK) (Agrawal 1995; Donovan and Puri 2004; Puri 2000; Timins-Martelle Heritage Consultants 2011). Considered a subset of TK, cultural ecological knowledge (CEK) generally includes language and symbols, folklore, ceremonial and ritual objects and performances, costumes, rituals, use of plants and animals, artistic designs, works and expressions, songs, dance, and stories.

The POLIS Project (University of Victoria) looks at Collective Biocultural Heritage as *cultural* heritage (both tangible and intangible, including customary law, folklore, spiritual values, knowledge, innovations, and practices) and *biological* heritage (e.g., diversity of genes, species varieties, ecosystem provisioning, and regulating and cultural services)[3] (Bannister and Hardison 2006). This heritage includes the landscape as the spatial dimension in which the evolution of Indigenous biocultural heritage takes place (Bannister and Hardison 2006). Collective biocultural heritage also includes the development of education and public consultation materials (websites and other teaching resources to promote cultural awareness). In a more generalized context, Kreps (2003) eloquently describes cultural heritage (and the associated traditional knowledge) as a "rubric of ever-expanding scope, seen globally as a basis for multinational, national, state, and local programs" (Kreps 2003:2).

Cultural ecological knowledge is important within natural resource (NR) management because it embodies living knowledge systems possessed by Indigenous people and the mechanisms through which they pass on their biocultural knowledge or heritage embedded in cultural forms of expression (Teaero 2010), cultural codes (Borge and Villalobos 1995), and oral narratives (see Figure 1). According to Harmon (2001), evolutionary history tells us that cultural diversity is intimately related to the biological diversity of the non-human

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world. For natural resource managers, therefore, CEK is complex, holistic, and can overlap with many aspects of integrated resource management, including

- developing protocols and guidelines for Intellectual Property (IP) rights for archaeological investigations within traditional territories;
- identifying sacred sites and burial grounds;
- repatriating human remains and tissues, sacred objects, and artifact collections;

FIGURE 1. BriBri Elder as facilitator in ethnobotanical study, Talamanca, Cost Rica. (Photo: D. Orcherton 2005). Used with participant permission.

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1 The words "Aboriginal," "Indigenous," "Native," and "First Nations" people(s) are used interchangeably. The author is aware that these terms have distinct meanings within defined cultural contexts.

2 For the purposes of this article, the author draws on the following working understanding as found in Bannister and Hardison (2006): "The term traditional knowledge refers to the inter-generational accumulation of the collective stories, experiences, practices, genealogies, legends, mythologies, customs, laws, lore, spiritual teachings, wisdom, values and knowledge that have been passed down from one generation of Indigenous or traditional peoples to the next. Most, if not all traditional knowledge based systems, share the commonly held belief that there is an inter-dependence and holistic relationship existing between the physical and spiritual worlds" (Bannister and Hardison 2006:4)

3 The Millennium Ecosystem Assessment defines human well-being as all of the elements one needs to have a "good life," including both the basic needs for survival (such as food, water, and shelter) and cultural, spiritual, and personal needs. These are "cultural services" and are valued elements of what nature provides to humanity.

- establishing artifact repositories;
- negotiating with government concerning cultural heritage sites on First Nations lands; and
- investigating archaeological sites that contribute to an understanding of First Nations history.

Eventually, CEK has an impact on training and capacity-building with First Nations community members in ethnographic data collection, archaeological field-lab and curation methods, and the collection and preservation of oral history and traditional knowledge (Timins-Martelle Heritage Consultants 2011). CEK is the focal point of ideas and programs generated by hundreds of non-governmental organizations, community-based and advocacy groups, and businesses (Kreps 2003). Yet the *concept* of CEK is vastly under-theorized.

The author views holistic relationships with Aboriginal people from a more pragmatic approach (see Figure 2). CEK, as mentioned, is a subset of traditional knowledge and considered an emergent property[4] (Woodley 2002) that encompasses cultural context, practice, and beliefs, and which emphasizes the qualities and attributes of places that have aesthetic, historic, scientific, or social value for past, present, or future generations. Immersed in this are the processes of production, diffusion, and application of knowledge systems. Teaero (2010) also places CEK within the concept of cultural forms of expression,[5] what the United Nations Educational, Scientific and Cultural Organization (UNESCO 2011) calls traditional cultural expressions (TCEs). TCEs include folklore (or
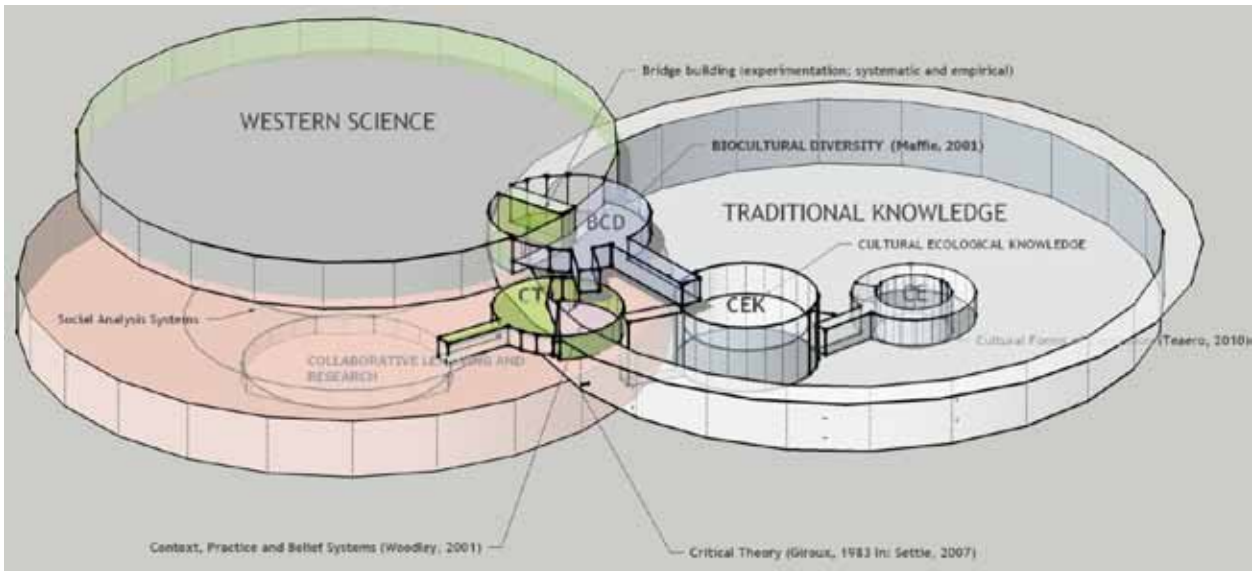

FIGURE 2. Schematic representation of two world view "pools" and the differences between Western science, traditional knowledge, and cultural ecological knowledge (CEK). A third pool is collaborative learning (CL), participatory research, and social analysis systems (SAS). These overlapping spheres illustrate (conceptually) CEK as a subset of the traditional knowledge "pool." Biocultural diversity (BCD), including the notion of biocultural heritage previously outlined, has a more direct (functional) relationship with Western science (because its congruency with empirical thought); whereas traditional knowledge (TK) is an emergent property (Woodley 2002). Critical theory (CT) is a tool of inquiry to illuminate pertinent and complex issues addressing Indigenous knowledge (Giroux 1983). Cultural forms of expression (CE) (Teaero 2010) are traditional cultural expressions that are folklore, traditional, and popular culture, comprising the totality of traditional based creations of the cultural community (IPC/CE 2011:4). Even though divergent world views exist, interconnecting "bridges" or "linkages" exist between these different ways of knowing. BCD, CT, and CL are the three main connective points between Western science and traditional knowledge.

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4 Basically, a philosophical term taking into consideration systems theory, science, and art. Emergence is the way complex systems and patterns arise out of a multiplicity of relatively simple interactions (Yudkowsky 2007).

5 Cultural forms of expression are traditional cultural expressions (TCEs): creations of the cultural community, expressed by a group or individuals and recognized as reflecting expectations of the community insofar as they reflect its cultural and social identity. Its standards and values are transmitted orally, by imitation or by other means. CE (cultural expressions) are, among others, language, literature, music, dance, games, mythology, rituals, customs, handicrafts, architecture, and other arts (IPC/CE 2011).

traditional and popular culture) comprising the totality of traditional-based creations of the cultural community (IPC/CE 2011). Aboriginal world views represent an appropriate balance of scientific rigour, validation, and ethics. These are often coincidental in some ways with the academic (compartmentalized or disciplinary) structure of Western science. Attempts to integrate the two types of science have only been covered by a few theoretical papers, and often have left the bearers of CEK out of the discussion.

The limitations of this article reside in the fact that not all theoretical constructs or comparisons described by the author are comparable, compatible, or necessarily coincide with the viewpoints of all natural resource managers or Indigenous people. This is a work in progress; the findings in this article will require further insight if they are to be validated in more a robust way.

Practical Approaches to Merging Cultural Ecological Knowledge and Western Science

Bannister and Hardison (2006) describe the merging of CEK and Western science as "a pragmatic or linear approach to incorporating traditional knowledge and expertise into dominant western scientific and legal paradigms . . . inadequate and potentially detrimental" (Bannister and Hardison 2006:3). The potential merger of CEK and Western science often creates knowledge gaps in understanding both world views adequately. Bannister and Hardison (2006) further state that this merger can be potentially detrimental "to both biological diversity and those Indigenous, traditional and local communities whose existences and wellbeing are interdependent with biological and ecological systems" (page 3).

Parallel to this previous notion of filling knowledge gaps by merging CEK and Western science, resources managers strive to incorporate a practical understanding (or description) of cultural heritage and Indigenous knowledge), in their management plans. They are often confronted with many interrelated social and cultural complexities regarding how to undertake integrated natural resource management, especially when Aboriginal groups try to implement positive change to the sustainable management of their resources. Conflict usually arises based on divergent viewpoints or other incompatibilities with Western thought. Vilsoni Hereniko, a Maori (New Zealander) researcher, ad-

equately describes what has happened culturally over the years, which resonates with some First Nations realities:

Chief among the reasons for pushing Indigenous sources of knowledge to the margins is the process of colonization, particularly the usurpation of oral narratives by the dominant culture's narrative fiction: fairy tales, myths and legends, short stories, novels, and biblical stories. The school and church are institutions that work hand in hand to colonize the mind. As native people were taught to read and write, they paid less and less attention to oratory. (Hereniko 2000:82–83)

Recent PhD thesis work by a First Nations Swampy Cree woman, Pricilla Settee, also partially explains the dilemma faced by Indigenous researchers:

I found that legitimated discourses of power privilege what books may be read by students, validate what instructional methods may be utilized, and authorize what belief systems and views of achievement may be taught. In so doing, power discourses undermine the cultural interpretations of language establishing one correct reading that implants a particular hegemonic message into the consciousness of Indigenous readers. (Settee 2007:3)

These examples illustrate the dilemmas faced by Indigenous researchers, arising from the fact that European colonization, power struggles, and Western scientific views have shaped how researchers and resource managers interpret CEK [or how it is "supposed to be used" in research. As Hereniko (2000) explains,

FIGURE 3. Ethnobotanical study, Talamanca, Costa Rica. (Photo: D. Orcherton 2005). Used with participant permission.

"People [outside researchers] do not understand the unseen, which is the reality of our lives; they do not realize its power" (Hereniko 2000:85). Involvement, therefore, of Indigenous peoples in research is a fundamental link to recognizing the importance of CEK in natural resource management (see Figure 3).

Indigenous involvement in research is reflected in the oral histories of First Nations groups in northwestern British Columbia; shedding new light on the relevance or practicality of Indigenous research. A research project by scientists from Northwest Community College and the University of British Columbia, for example, examined the oral history of cultural heritage, hunting and fishing resources of the Tsimshian and what are now the Tahltan people. This study focused on enhancing Indigenous perspectives[6] related to holistic resource management, adding to the archaeological records of Dundas Islands, situated in the mouth of the Skeena River. The Tsimshian cultural landscape, as defined in their oral histories, was seen as important in order to help "dispel the myth that social complexity arose here [on the Northwest Coast] in the absence of food production by demonstrating that the 'hunter-gatherers' of the region were not simple 'affluent foragers,' but active managers who have cultivated, sustained, overseen, and promoted culturally valued plant resources" (Turner and Peacock 2005:102). Similar work was carried-out by Orcherton (2005) in Talamanca, Costa Rica where the Indigenous BriBri and Cabecar oral histories and socio-cultural roles were highlighted as a way to conserve traditional agroforestry systems.

Hunn (1999) further underscores the importance of Indigenous knowledge in his chapter titled "The Value of Subsistence for the Future of the World": "[N]o longer can we take refuge behind the myth of the superiority of Western Civilization as the source of all science . . . [We must recognize] the importance of documenting and learning from the CEK of indigenous peoples the world over, knowledge that enabled them to adapt to diverse local environments." Hunn (1999) muses that such recognition "may be the key to the future of the sustained subsistence of the human species" (Hunn 1999:5-6).

These previous examples illustrate the use of CEK in NR management, which invariably comes down to *how* the dominant (non-Aboriginal) culture is attempting to rationalize and integrate distinct world views based on divergent cultural values and beliefs. What we often *see* are examples of Aboriginal peoples' manifested (or indoctrinated) resilience to change at the community level. Human-ecological resilience at this level encompasses an entire community (physical infrastructure; economic, cultural, and social capital; natural environment; and systems/essential services) and gives communities the ability to resist and/or rapidly recover from extreme events (Human-ecological resilience, consilience, and consciousness 2011).[7]

This notion of resilience has profound effects on how Aboriginal people view or rationalize non-Aboriginal involvement (and vice versa) in natural resource management. According to Berry (2003), the integration of CEK and Western science is often initiated by the conjunction of two or more autonomous cultural systems, termed *acculturation*. Acculturation within an anthropological context is a process in which members of one cultural group adopt the beliefs and behaviours of another group (usually the minority group adopting the beliefs and behaviours of the dominant group).[8] Berry (2003) describes acculturative change as the consequence of direct cultural transmission sometimes derived from non-cultural causes, such as ecological or demographic modification induced by a dominant or impinging culture (Berry 2003). Though interesting and indirectly related to how we interpret CEK, acculturative change falls outside the scope of this article. Coincidental theoretical (and some practical) work on resilience analysis[9] shows us there is a partial explanation for acculturative change.

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6 Indigenous perspectives are connected to history and culture but are really a way of including Indigenous knowledge and practice into all areas of NR management (Q&A Fact Sheet. Reconciliation Australia, 2011. Retrieved from *http://www.reconciliation.org.au/home/resources/factsheets/q-a-factsheets/indigenous-perspectives*

7 This resistance and resilience is often a response to shocks or stresses within dominant Western science (or Eurocentrism). Western science contends that knowledge of Eurocentrism's history is a necessary component in a new cultural politics of difference (Graveline 1998). Academics and others are accustomed to ethnographic encounters that reveal the cultural belief-sets of Aboriginal and other peoples. They are unaccustomed, however, to the application of similar analysis to the "White-way" (Graveline 1998:24).

8 According to Hazuda et al. (1988), although acculturation usually occurs in the direction of the minority group adopting habits and language patterns of the dominant group, it can be reciprocal—that is, the dominant group also adopts patterns typical of the minority group. Assimilation of one cultural group into another may be evidenced by changes in language preference, adoption of common attitudes and values, membership in common social groups and institutions, and loss of separate political or ethnic identification.

9 According to Dyer and McGuinness (2004), resilience analysis describes a process whereby people bounce back from adversity and go on with their lives. It is a dynamic process highly influenced by protective factors: specific competencies necessary for the process of resilience to occur.

Whether the description of CEK is "Aboriginal" or "non-Aboriginal," what seems to be on most resource managers' minds is how can we better understand these complexities and what tools and techniques can be used to understand and facilitate mutually acceptable or co-operative relationships based on these two distinct types of science. Table A1 (see Appendix) highlights the differences between Indigenous knowledge and Western science, focusing on land use from a historical perspective, on forest ecology, and on ecosystem management. As mentioned, what Table A1 reveals are contrasting world views and notable differences in the way forest resources (for example) are perceived, interpreted, and managed.

Lynam et al. (2007) try to explain some of the tools and methods used to incorporate community and Indigenous knowledge into decision-making in natural resource management. This approach breaks away from the conventional thinking (technical or scientific approach) on natural resource management and integrates holistic Aboriginal world views, attitudes, beliefs, or preferences to the people managing or depending on their resources. This integration of world-views is never easy, and is especially true when looking at cultural/ecological values in forest resource and land-use management, where intrinsic differences exist between these types of management and the science behind the two approaches.

As evidenced in Lynam et al. (2007) and other experiences, "Aboriginal perspectives" can be incorporated into natural resource management in a way that ensures mutual respect, co-operation, and support for the values encompassed in the Indigenous world view, which are firmly established in the hearts and minds of all participants (O'Flaherty et al. 2008). Openness to innovative programming compatible with Indigenous teaching and learning styles and a strong commitment to a shared vision are characteristics that lay the foundation for including Indigenous knowledge in natural resource management (O'Flaherty et al. 2008).

To better understand these processes, we need to look at ways of bridging the gap between two distinct types of science: Western science and Indigenous or Aboriginal science. Though not definitive or exhaustive in scope by any means, the following five approaches can be examined as a practical means of approaching, describing, and/or finding a solution to this dichotomy:

1. Acknowledging Aboriginal peoples' own perceptions and contributions to science.

2. Creating social legitimacy through collaborative learning and integrating systems thinking and conflict management.
3. Designing and implementing intuitive valuations of CEK (transfer of oral to written cultural/ecological knowledge).
4. Designing clear objectives and outcomes and implementing systematic and culturally sensitive heritage assessments.
5. Defining cultural pluralism (ideology of world views) and problem-solving strategies within a continuous acculturation process.

Aboriginal Peoples' Perceptions and Scholarly Contributions

Aboriginal scholars' own writings are worthy of recognition. Some key Aboriginal scholars have also contributed to a better understanding of holistic relationships within a natural resource management setting, which has helped to some extent to bridge the gap in terms of understanding these divergent world views. Relevant works by Aboriginal authors are summarized in Table 1.

All of these authors have contributed to an influential body of literature, building an awareness of traditional knowledge and taking a more "common sense" approach to explaining some of the human-ecological relationships within natural resource management. Michel and Gayton's work (2002) also highlights the fact that Indigenous knowledge and Western science are, in their words:

products of two vastly different cultures and as such, are not subject to comparison. The other caution here is that it is difficult to talk about a world view from within a world view. Western science has one strong commonality with CEK and that is the overwhelming importance of direct observation. One area in which the systems diverge, however, is in what constitutes "proof." Scientific disciplines, such as biology or forestry, have an elaborate, scripted process for arriving at proof that proceeds from hypothesis to null hypothesis, to the isolation of variables, to experimental design, replication, and quantification, and finally to statistical analysis. Our [Western scientific] system is heavily reliant on numerical data—to prove things, we use numbers. Indigenous peoples' knowledge, relies on experience as a proof. Western science, in contrast, tends to use

TABLE **1.** Aboriginal authors and principle publications that help to explain relationships and linkages between Western science and traditional knowledge

Author	Publication
T. Okey, L. Loucks, A. Day, J. Spenser, K. Head, C. Pinelli, and D. Dalmer	*Drum of Life Frameworks* (2011)
Four Arrows, Greg Cajete, and Jongmin Lee	*Critical Neurophilosophy and Indigenous Wisdom* (2010)
Maria Battiste	*Reclaiming Indigenous Voice and Vision* (2000)
Marie Battiste and James Youngblood Henderson	*Protecting Indigenous Knowledge and Heritage: A Global Challenge* (2000)
James Youngblood Henderson	*The Mi'kmaw Concordat* (1997)
Gregory Cajete	*Look to the Mountain: An Ecology of Indigenous Education* (1994)
Jeanette Armstrong	*"Words," in Telling It* (1990)

experience as raw material for the construction of theories. (Michel and Gayton 2002:4)

The underlying message here is that, despite the competitive, institutionalized, "publish or perish" academic environment, the fundamental research experience contains positive aspects, but there is a need to think beyond just how science itself is viewed. As Michel and Gayton (2002) suggest, "[L]earning provides the opportunity to deeply and passionately explore subject, to temporarily devote oneself completely to learning and to develop ideas and how some small part of the world works" (Michel and Gayton 2002:4). Understanding these complexities, and perhaps simplifying the linkages, helps better explain CEK and its relationship to science.

CEK overlaps with collaborative learning and social action, as explored in the next section. *Nature Across Cultures* (Selin 2003) reviews societal relations with nature and the environment from a non-Western perspective: from the Pacific (Hviding's "Both Sides of the Beach: Knowledge of Nature in Oceania") to the North (Bielawski's "Nature Doesn't Come as Clean as We Can Think It") to Africa (Kesby's "Perceptions of Nature and the Environment in Sub-Saharan Africa"). All of these works accentuate a common theme: that collaborative learning, participatory research, and social analysis help resource managers find ways to better understand these divergent world views and work together to incorporate different ways of knowing.

How Collaborative Learning Can Help Natural Resource Managers "Bridge the Gap"

According to Daniels and Walker (2001) and Smith and MacGregor (1992), collaborative learning (CL) is an approach appropriate for natural resource, environmental, and community decision-making situations with the following features: multiple parties, deeply held values, cultural differences, multiple issues, scientific and technical uncertainty, and legal and jurisdictional constraints. It emphasizes activities that encourage systems thinking, joint learning, open communication, constructive conflict management, and a focus on appropriate change.

Like CEK, collaborative learning has been written about extensively (Daniels and Walker 2001; Gonzalez and Meitner 2005) but not placed in practice, especially when it comes to policy decision-making, public dialogue, and integrating this concept from a First Nations perspective. To place CL in practice, natural resource practitioners need to respond to these challenges by synthesizing work in multiple interdisciplinary fields (Daniels and Walker 2001). CL and the study of biocultural diversity (BCD) functions well in building linkages or "bridging the gap" between Western science and CEK. This is evident in a study by Zent (2009), where it states that CEK

> is intimately tied on one hand to local language, social organization, and economic goals, religious beliefs, aesthetics, ritual observances and material

culture, and on the other hand, to resource appropriation and management practices, environmental impacts, variety and distribution of natural species, the structure and functioning of biotic communities, and long-term landscape modifications. However[,] the particular substance and structure of these interrelationships may vary considerably by place and group. Thus, local level studies of CEK can contribute to a more coherent understanding about cultural diversity precisely by documenting the complex, variable and often subtle ways that knowledge is systematically connected to elements of the surrounding culture and natural environment.(Zent 2009:104)

NR practitioners need a thorough understanding of these interrelationships to obtain a better conceptual and on-the-ground understanding of these interconnections. This requires more fine-grained investigations at the empirical and comparative levels (Zent 2009).

One possible investigative method is collaborative (or participatory) research (CR or C*p*R). This can be defined as researchers working together to achieve the common goal of producing new scientific knowledge (Katz and Martin 1997). CR differs from CL in terms of its approach and applicability on the ground. For example, in a study done by Parrado-Rosselli (2007), a CR approach was adopted, in which Indigenous people and Western scientists worked together to incorporate both systems of knowledge. This approach has led to a better understanding of tropical rainforests by both Indigenous people and Western researchers, as well as improved working relationships:

> What in principle was simply a working dynamic within a scientific research project resulted in a series of activities that have had a tremendous impact on the recuperation of traditional knowledge by young indigenous people, and has encouraged new relationships between western and indigenous people. (Parrado-Rosselli 2007:10)

For such positive results to occur, managers need to partner with Indigenous leaders or researchers and work collaboratively to build a framework to address the fundamental complexities and controversies that define policy decisions and to improve public dialogue and communication in the natural resource sector.

Social Analysis and Links to Collaborative Learning

Social analysis helps NR managers create profiles of involvement in a core problem or action. These profiles are based on four factors: 1) power; 2) interests; 3) legitimacy; and 4) existing relations of collaboration and conflict (see Figure 4). Social analysis techniques allow managers to describe the characteristics and relationships of key stakeholders in a concrete situation (such as a conflict of interests among key stakeholders) and to explore ways to resolve social problems (such as building trust or empowering marginalized groups).

Social analysis systems (SAS)[10] is a collaborative inquiry (participatory action research) approach that emphasizes the skill sets people need to develop to create and mobilize knowledge that is socially relevant and embraces dialogue (SAS² Dialogue 2011). This inquiry results in collaborative learning between people with a common purpose: to create "fertile ground" for group thinking and action for a common good (Chevalier and Buckles 2008). SAS is a strongly collaborative, stakeholder-based process that incorporates CEK and social learning systems. This is precisely what NR managers need to adopt in order to understand the social and cultural dimensions of Indigenous knowledge within an integrated natural resource management process.

Social action (SA)[11] reinforces existing ties of collaboration and conflict resolution that affect manager decisions in certain situations and which they can use to influence a problem or an action. Social action, therefore, is what NR managers "do," are "confronted with," and "resolve" in the field in conjunction with other managers or resources users.

The author views collaborative learning (CL), therefore, as a function of collaborative participatory research (C*p*R) plus social action (SA) and social analysis systems (SAS), expressed in the following formula:

$$CL = \int (CpR + SA + SAS)$$

This functional relationship supplements adult and experimental learning theory as well as organizational communication and team learning through mutual trust, respect, and guidance (see Figure 4). As such, it

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10 The model of collaborative learning made up of collaborative research + social action, encompassing educational and cultural knowledge insights and perspectives.

11 Social action includes the acronym CLIP, a novel SAS technique that helps examine how factors of collaboration (or conflict), legitimacy, interests, and power shape the stakeholder structure in a specific situation. NR managers can use this technique to identify possible strategies to manage social problems or mobilize support for proposed actions (SAS² Dialogue 2011).
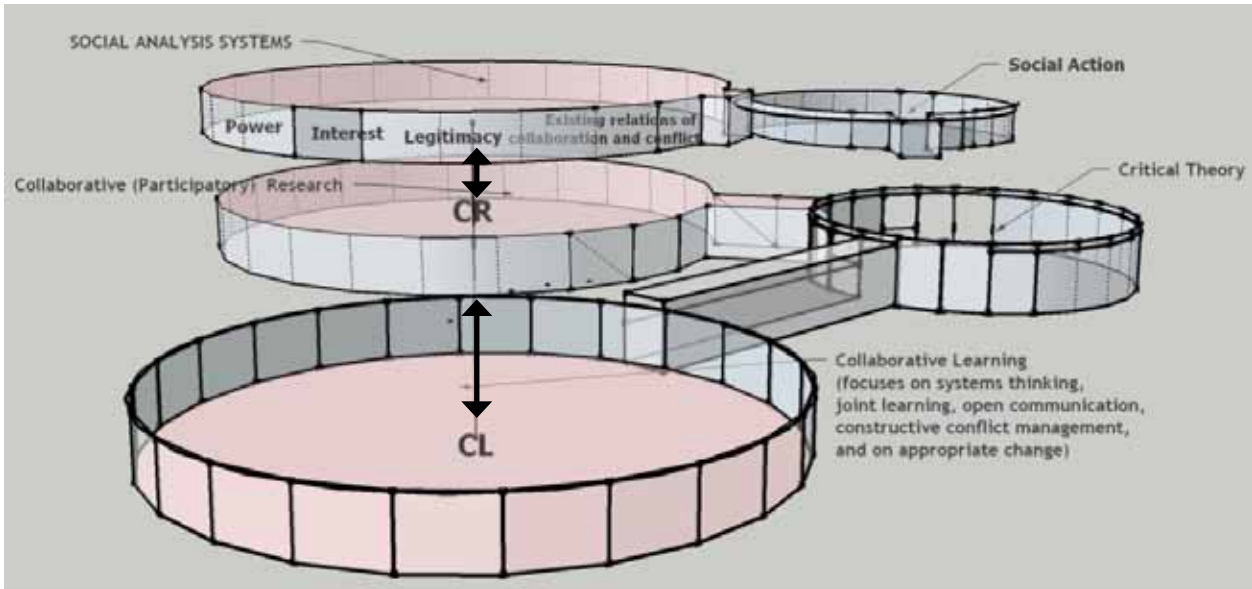
FIGURE 4. Schematic knowledge "pools" explaining hypothetical linkages and/or relationships between collaborative learning (CL), collaborative research (CR or C*p*R), social analysis systems (SAS), and critical theory. SAS, social action (SA), and C*p*R can become embedded in CL. CL, in turn, reinforces C*p*R and SAS (downward and upward arrows) that influence SA in the field. These concepts are included (schematically as a pink "pool") slightly separated from Western science and CEK world views, but connected through CT (see Figure 2).

applies to both decision teams that arise entirely within organizations and various public involvement activities and to public policy decisions that transcend organizational and divergent world views.

From within the CL framework surfaces the notion of critical theory as an explanation of how CEK can be better explained, used, or, to some degree, measured intuitively. Settee (2007) states:

> Critical Theory is a tool of inquiry to illuminate pertinent and complex issues addressing Indigenous Knowledge. It focuses on the relationships among culture, power, and domination. Critical researchers have argued that culture has to be viewed as a domain of struggle where the production and transmission of knowledge is always a contested process. Dominant cultures employ differing systems of meaning based on the forms of knowledge produced in their cultural domain. (Settee 2007:9)

Critical theory does therefore, provide some explanation of how to critically analyze insights into Indigenous participation within the academic community (Settee 2007), and paves a clearer path towards capturing cultural values.

Intuitive Valuations of CEK and the Dilemma of Going from Oral to Written

One of the fundamental obstacles to resource management decision-making is the valuation of CEK and discrepancies between the attitudes and beliefs of government managers, biologists, and traditional hunter-gatherer communities within co-management regimes (Kruse et al. 1998). These differences, besides representing obstacles to resource management decision-making, represent the existence of a space for engaging multiple ways of knowing (Kendrick 2003).

Capturing cultural value

When we speak of valuation, what comes to mind is some level of economic net benefit, as valuation generally refers to the act or process of determining the value of a business, business ownership interest, security, or tangible or intangible assets. But the concept often does not sufficiently describe the complexities of CEK, nor the intricacies of the value of cultural goods or resources. The literature abounds with studies that look at ways to incorporate non-market goods (including cultural

values) but the more consistent approaches have centred on contingent valuation methods (CVM) and on developing cultural value chains (Krutilla 1967; Dasgupta and Pearce 1972; Hanneman 1984; Judge et al. 1985; Sellar et al. 1985, 1986; Tobias and Mendelsohn 1991; Echeverríaa et al. 1994; Smith 1993; Shultz et al 1998). Recent work by Holden (2004), Bolwig et al. (2008), Gerst et al. (2010), and Hoermann et al. (2010) highlights the usefulness of value chains in NR management and important considerations related to climate change. In summary, these authors recommend some considerations for NR managers:

- make explicit the range of values addressed in the funding process to encompass a much broader range of cultural, non-monetized values;

- look at the whole cultural system and all its subsystems, and understand how systemic ecosystem health and resilience are maintained;

- recognize that professional (academic, technical, or scientific) judgment must extend beyond evidence-based decision-making;

- overturn the concept of centrally driven, top-down delivery and replace it with systemic, grassroots value creation (modified from Holden 2004, pp. 9–10); and

- understand that value chains are influenced by a set of specificities that provide comparative advantages, such as the availability of unique and niche products and services, limited accessibility, fragility, diversity, and marginality. These advantages have a strong impact on value chain analysis and the selection of value chain development options (Bolwig et al. 2008).

In most cases outsiders, including both powerful state authorities and entrepreneurs, have defined the valuations of cultural resources (Xu et al. 2005). In addition, there are often intrinsic qualitative (non-measurable) indicators of valuation that cannot express, for example, the true value of the harvest to residents because there is no way to translate, for example, the complexities of cultural values inherent in harvest procurement into dollars.

Chalabi and Dowie (2003), however, contend that valuation "technology" is a way of establishing the error tradeoffs—by supplying the inputs needed for all types of decisions. (Error tradeoffs would be, for example, tradeoffs between different kinds of errors, usually data dependent, varying across data sets.) Any type of traditional knowledge must be an amalgam of traditional

beliefs. These beliefs are based on the probabilities of things "happening" or "being," and on traditional values about the desirability and worth of particular states, outcomes, and processes. The amalgam may be implicit, deep, and holistic. It may appear impossible to decompose this whole into its components. Possibly such deconstruction will go against its very spirit and spiritual basis (Chalabi and Dowie 2003).

Valuing cultural heritage and knowledge through the use of ecosystem services and valuation schemes has been demonstrated by using ecosystem and well-being (multi-scale and participatory) assessments (Millennium Ecosystem Assessments 2003). The Millennium Ecosystem Assessment (MEA or MA) was the largest study ever conducted on the linkages between ecosystems and human well-being. It was unique in that it was carried out at multiple scales, from the local to the regional to the global. The multi-scale nature of the MEA acknowledges that people and ecosystems interact in different temporal and spatial domains, as illustrated in its conceptual framework (Millennium Ecosystem Assessments 2003).

Several important *in situ* case studies were conducted within the MEA framework to show local application of these assessments. Ishizawa (2004) conducted a review of Indigenous cosmovisions and environmental governance (*in situ* conservation of native cultivated plants and their wild relatives in Peru). He found that bridging epistemologies "seems a viable idea if the underlying cosmovisions are considered and made explicit" (Ishizawa 2004:223). Article 8(j) of the Convention on Biological Diversity was highlighted in this study as an attempt to develop fruitful collaboration between scientists and holders of vernacular wisdom. Ishizawa's study provides a good example of how MEAs can be applied locally.

Fabricius et al. (2004) provide another good example in a South African MEA that was undertaken at a variety of spatial scales from regional to local (at the village level, single protected area, and micro watershed). Approaches to validating knowledge and ways of mobilizing knowledge for integrated ecosystem assessments were the main focus of this study. The authors determined that local and tacit knowledge can help address some of the shortcomings of informal, explicit knowledge, as an expression of Western science in ecosystem assessments—if the local knowledge can be moved into the explicit domain where such assessments reside (Fabricius et al. 2004).

Other important work was done in Costa Rica and Nicaragua, under the auspices of the Tropical Agronomic Centre for Research and Higher Education (CATIE), the Global Environmental Facility (GEF), and similar research centres, institutions, and organizations throughout the Americas (see Pearce and Mourato 2004; Zamora-Lopez 2006).

According to a publication by the Millennium Ecosystem Assessment (2003):

> The strength of the MA is not only that it is firmly science driven, dedicated to producing and synthesizing reliable scientific data, but that it goes beyond this to identify trends, scenarios, tradeoffs, and response options. Central to the MA vision is that it provides information that is not only scientifically credible but salient and legitimate as well. (MEA 2003:135)

Reid (2000), writing in the journal *Issues in Science and Technology*, explores the issue of legitimacy of scientific information:

> Scientific information is salient if it is perceived to be relevant or of value to particular groups who might use it to change management approaches, behaviour, or policy decisions . . . It is legitimate if the process of assembling the information is perceived to be fair and open to input from key political constituencies, such as the private sector, governments, and civil society. (Reid 2000:137)

What if these criteria for legitimacy were applied not only to objective scientific information, but to local and Indigenous knowledge as well? If we sought information from local people, we would ask not only about their knowledge of the natural world, but also for their analysis of the policy/legislative or political world. Their assessments of threats differ from Western researchers particularly if they are asked about trends, scenarios, trade-offs, or response options. In other words, instead of treating our informants as reservoirs of CEK, it would perhaps be better to treat them as change agents, with their own ideas about the salience and legitimacy of various forms of knowledge (Brosius 2009). Incorporating Indigenous views on knowledge itself into scientific or policy-relevant documents remains a challenge.

Oral to Written

Within the realms of both the Western and Indigenous approaches to science, there remains the dilemma of appropriately capturing CEK. Indigenous people have recognized the importance of recording their oral tradition in a written form:

> With the arrival of non-Aboriginal cultures, many Aboriginal people have learned to write. However, little of the knowledge within their oral tradition has been recorded and used to create a written tradition that is meaningful in their own culture. Over time Aboriginal people have realized the importance of having a written tradition as well as an oral one. This means that many of their traditions can be preserved and passed along to future generations in writing. (Hart 1995:3)

Documenting traditional oral histories requires NR managers to be sensitive to the ethical treatment of knowledge keepers, within the confines of Intellectual Property (IP) rights, Indigenous property rights (IPR), culturally acceptable data-gathering techniques, and human ethics.

These protocols are usually found both within and outside the legal system. They generally encompass Aboriginal treaty rights; section 35 of the Constitution Act, 1982; and the Van der Peet Test, which emphasizes certain clauses and community outcomes, and provides guidelines on Indigenous decision-making perspectives within the realms of CEK and testimony of knowledge keepers (holders of CEK may be questioned about the reliability of their knowledge) (Darwin n.d.).

Schoenhoff (1993) argues that the transfer of knowledge from oral to written, printed, and electronic forms implies movement across cultures and symbolic translations of ideas. Experts along the way will have their associated "community of belief" and leave a mark on the knowledge documented (Schoenhoff 1993:1). Systems of knowledge are embedded, expressed, or recorded and decontextualized,[12] which changes the nature of knowledge itself. In many Aboriginal cultures, their CEK has been eroding over time and this knowledge (when it is needed to be included in cultural heritage surveys or assessments) is only a snapshot of what was once an integral part of their culture.

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12 This refers to knowledge systems that are taken out of context or considered in isolation from their original intent or context.

By its very nature, many types of CEK are not recorded or written down; they are generally passed from generation to generation in the form of songs, stories, plays, and rituals—oral traditions or oral narratives. These oral ways of knowing are usually in the form of stories, fables, and legends that have been transmitted across generations and go beyond the confines of living memory (Field as cited in Gordon 2004). This process is vital to some communities in transmitting information. For example, in Mario Vargas Llosa's book *The Storyteller* (2008), he tells of how, for a scattered group of Peruvian forest dwellers, the travelling *hablador* was the lifeline of a non-literate community on the edge of extinction. Always on the move, he conveyed information of every type (cited in Slim and Thompson 1993). Oral tradition can also be vital in literate societies, where many communities have specialist narrators of local tradition. There are still many societies today that rely on this form of communication for the dissemination of information and for socialization (Gordon 2004).

One problem for consideration is that the collection of knowledge through oral testimony analysis involves recollecting, remembering, rediscovering: memorializing (Gordon 2004). "Life memories are nested and enveloped in their habitus—their environment of assumptions and languages—through which they make sense and can be told" (Bourdieu 1984:5). Oral history in particular may be seen as a "powerful tool for discovering, exploring, and evaluating the nature of the historical memory—how people make sense of their past, how they connect individual experience and its social context, how the past becomes part of the present and how people use it to interpret their lives and the world around them" (Frisch 1990:188).

Once again, there is an abundance of literature on the subject, but little commentary that brings this issue down to a practical, working level—required so that both First Nations and non–First Nations resource managers can come to some mutual understanding on the subject. The challenge is to bridge knowledge gaps or provide a common interface between Western science and Aboriginal "ways of knowing" and to improve understanding of how these types of science can be used to create mutually acceptable management plans.

Leaving Oral Knowledge As Is

With respect to oral tradition and how this can be expressed in written terms, Gordon (2004) summarizes:

The challenge is to bridge knowledge gaps or provide a common interface between Western science and Aboriginal "ways of knowing" and to improve understanding of how these types of science can be used to create mutually acceptable management plans.

Once an oral history is written down it is set and fixed. Written memory may reify life into something it is not. This is particularly pertinent to the interaction between knowledge which is inherently oral and development knowledge due to the latter's documentary bias. (Gordon 2004:5)

Life stories and oral narratives are part of many Aboriginal societies' spiritual connection to natural life systems and the continuation of their culture—a "survival technique," if you will. Western science compartmentalizes knowledge and does not recognize traditional ways of knowing. In many perspectives, this type of traditional knowledge stands outside the various disciplines of Western science. "Data mining" oral knowledge is inherently risky, particularly if traditional belief systems have been disrupted and if oral knowledge is misinterpreted or inappropriate transcriptions of knowledge are made.

Transcriptions must be done ethically and appropriately, and managers need to be reminded that community-directed science (including participatory techniques) may not require detailed oral information. According to Michel and Gayton (2002), "[T]he storyteller has enormous creative leeway as long as a metaphor and symbolism stay intact. Cultural and spiritual as well as vital survival information is passed on through the story" (Michel and Gayton 2002:8). Natural resource managers need to reconcile the need to retrieve oral knowledge and the question of how this will benefit them in the long term. It is important for practitioners to put into practice Article 8(j) of the Convention on Biological Diversity (CBD), which is to respect, preserve, and maintain knowledge, innovations, and practices of Indigenous and local communities (CBD 2010, Table A2).

Assessing Cultural Heritage and Designing Registries of Cultural-Biodiversity and Related Knowledge

In the past few years, the United Nations Educational, Scientific, and Cultural Organization has developed a convention concerning the protection of the world's cultural and natural Heritage (UNESCO 2011). UNESCO has recognized the state of conservation of World Heritage properties, inscribed on the List of World Heritage in Danger and on the World Heritage List, lists that include cultural and natural properties. UNESCO has identified this body of cultural heritage resources as forming a critical part of the world's "environmental infrastructure." Recognized sites focus on human activity from the earliest times and are known to potentially contain a sequence of well-preserved buried landscapes dating from the early prehistoric period onwards.

The aim of Cultural Heritage Assessments is to study these finite and irreplaceable resources and ensure that they are managed effectively in the future, not only for the benefit of the people who currently live in the relevant areas, but also for those who will come to live and work there in the future. Many of these cultural assessments, however, use Western ideologies and methodologies, including the collection of information by means of surveys, or compartmentalized or structured research techniques. What needs to be seen on the ground are more holistic, integrated organizing principles based on open-mindedness and empirical observations in a natural setting.

On a regional scale, for example, British Columbia's Forest and Range Evaluation Program (FREP) Cultural Heritage Resource Monitoring have been collaborating with several First Nations groups across the province to develop a monitoring framework, data collection tools, and implementation strategy. Levesque (2009) provides further insight into the program's aims through posing the following question:

> Are cultural heritage resources being conserved, and where necessary protected for First Nations' cultural and traditional use as a result of forest practices in British Columbia? Essentially the program incorporates CEK to ensure access to an abundance and diversity of plants for continued cultural use and the potential for incorporating traditional knowledge into the monitoring framework. (Levesque 2009:1)

Implementing practical, systematic, and culturally sensitive heritage assessment will help resolve current (and mounting) dichotomies between Western science and CEK. Recognition of different world views and problem-solving strategies within a continuous acculturation process is the first stage, and developing working solutions that satisfy the scientific and Indigenous communities alike is a subsequent stage (though one does not necessarily preclude the other).

Defining Cultural Pluralism and Problem-solving Strategies

Indigenous ways of knowing draw on knowledge from many surrounding language groups, as opposed to dominant cultural thinking that favours a monoculture approach to education. Though difficult to define precisely, cultural pluralism is a term used when small groups within a larger society maintain their unique cultural identities. In a pluralist culture, for example, unique groups not only coexist side by side, but also consider qualities of other groups as traits worth having in the dominant culture (Frank and Anderson 2008). In other words:

> Cultural pluralism is the dynamic by which minority groups participate fully in the dominant society, yet maintain their cultural differences. A pluralistic society is one where different groups can interact while showing a certain degree of tolerance for one another, where different cultures can coexist without major conflicts, and where minority cultures are encouraged to uphold their customs. (All About Religion n.d.:para. 1)

So, how does recognizing and adopting cultural pluralism help natural resource managers understand the dynamics of both Western and Aboriginal culture, where obvious differences still undermine the natural resource management process? As a starting point, we need to examine the ideologies of different world views and try to build on strategies for solving problems, we need to recognize the need to adopt policies for harmonious inter-ethnic and race relations to maintain social cohesion, and we need to create employment equity plans to avoid economic polarization of diverse ethnic and racial groups, and so on (Das 2004). What is important here in terms of natural resource management essentially incorporates the following interpretation of interculturality.

"The notion of cultural pluralism and interculturality [embrace] two essential methodological tools for under-

standing realities of our pluralistic world and of human conditions" (Das 2004:3). The same author further recognises that:

> "Perspective pluralism is understood to be inherent to reality and the world is fundamentally plural. These plural worlds are interrelated. First Nations cultures are custodians of knowledge and experiences that are different from the dominant Western culture. As such, one of the features of interculturality is to recognize the fact that different cultures have different things to say about the world and human experiences. So there is no one universal world-view and we need to take seriously the cultural differences which mean to attempt to understand the world from the point of views of diverse cultures otherwise we shall continue to fall back to the monocultural world-view that leads to domination." (Das 2004:2)

Yunkaporta (2007) also presents in summary form a series of categories of how CEK contrasts with Western ways of knowing, giving us a broad picture of the different complexities and advantages of Aboriginal world views and Indigenous cosmologies. These broad categories can be juxtaposed with those in Table A1 and used to partially explain these differences. It is also important for resource managers to incorporate the views and knowledge of Aboriginal women in safeguarding CEK (see Figure 5).

FIGURE 5. Members of Michener Park Aboriginal community, University of Alberta, Edmonton. Aboriginal Women have a strong voice as key repositories of CEK. (Photo: D. Orcherton 2005). Used with participant permission.

Governing Cultural Ecological Knowledge

Cultural heritage, Indigenous knowledge rights, and resources worldwide are guided/governed by a number of legislative regulations, acts, agreements, and articles. Some of the most important pieces of legislation related to CEK are listed in Table A2 (Appendix).

The *Canadian Environmental Assessment Act* (1995; CEAA) sets out in legislation the responsibilities and procedures for carrying out the environmental assessment of projects that involve, at some level, the federal government. According to Paci et al. (2001), the legislation offers very little in the way of concrete involvement of First Nations and their CEK. However, efforts have been made to develop ways to increase the opportunities for First Nations involvement in some of the reviews that the Act has undergone since its inception in 1995. Paci et al. (2001) further maintain:

> It is apparent that while TEK may have benefited policy makers, it was often not sought. The assessment process requires a fundamental shift in how Canadians value the environment by knowing as much as possible about dynamic ecosystems and cultures. Indigenous knowledge and values must be included in assessment legislation or development will proceed according to its own implicit and explicit needs. (Paci et. al:123)

In British Columbia, several acts of legislation or treaties[13] (mostly enacted between 1996 and 1999) have helped educate and guide resource managers and users toward "bridging the gap" and harmonizing relationships. Other examples worldwide show how legislation with respect to Indigenous knowledge is being used as a policy tool to instigate or facilitate change (see Table A2). As stated previously, one of the more important pieces of legislation is the Convention on Biological Diversity (CBD) Article 8(j), which highlights respect for and the preservation and maintenance of knowledge innovation and practices of Indigenous and local communities, embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promoting their wider application with the approval and involvement of stakeholders (CBD 2010).

What Western science has shown us is the fact that there is still a need to incorporate CEK ideologies into mitigation measures to safeguard intellectual property

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13 Aboriginal Rights to Cultural Property in Canada: The New Relationship. UBCIC Chiefs Council Resolution 2005-01 (April 15, 2005).

and knowledge. The onus seems to be more on governments and legislative policy to implement these actions, but in reality, the keepers of knowledge (elders, community leaders, and other gatekeepers) should be designing legislation so that this fits within original protocol and spiritual values, beliefs, and customs.

The Politics of Recording Cultural Knowledge

Publication of cultural knowledge reflects power relations between researchers and research participants, and it raises a number of ethical, social, and political questions with regard to representation and property rights (Laird and Kate 2002).

The use of access and benefit-sharing (ABS) systems is suggested by Laird and Kate (2002) as an approach to research carried out for either scientific or commercial purposes. ABS involves accessing organisms, or parts thereof, and related CEK obtained (accessed) from a country that is party to the CBD. In addition, other international treaties, accords, and agreements have added new legal ABS regimes legislation owing to the acquisition and use of biological material (e.g., non-timber products such as medicinal plants) and related information.

Free, Prior, and Formed Consent

Access and benefit sharing is not the only ethical consideration here. There is a need for free, prior, informed consent; the need to address confidentiality concerns; and the need to include original participants in every stage of the research process, including interpretation of results. According to Carmen (2011), for Indigenous peoples,

> the Right of Free, Prior and Informed Consent (FPIC) is a requirement, prerequisite and manifestation of the exercise of the fundamental, inherent right to Self-determination as defined in international law. FPIC began as a medical term to guarantee the rights of patients to informed consent before any medical treatment or drug was given to them. Now it is recognized as a political right that also is applicable in many other situations facing Indigenous Peoples. Free, Prior and Informed Consent is a basic underpinning of Indigenous Peoples' ability to conclude and implement valid Treaties and Agreements, to have sovereignty over and protect our lands and

natural resources, and to develop and participate in processes that redress violations of our land and Treaty rights. (Carmen 2011:1)

It is extremely important for natural resource practitioners to be sensitive to FPIC, and to practise it (in principle) by incorporating these concepts in field-based planning and programming (Tamang 2005).

Summary

It seems unequivocal on the surface but perhaps only complacently understood in a deeper sense) that in incorporating CEK expertise and balancing this with Western science. These challenges require that CEK be addressed differently or viewed through a different lens. This may be done by creating social legitimacy through collaborative learning as a function of collaborative (participatory) research (C*p*R) plus social action and social analysis systems. Adopting this framework requires NR managers to apply innovative systems-thinking approaches as well as evoke intuitive validations through transfer of oral and written ways of knowing. It also requires designing clear objectives and outcomes when incorporating CEK in resource management; implementing systematic and culturally sensitive heritage assessments; and characterizing cultural pluralism (ideology of distinct world views) in problem solving.

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Appendices

TABLE A1. Fundamental differences between Indigenous knowledge and Western scientific perspectives for forestry and natural resource programs (adapted from O'Flaherty et al. 2008).

Natural resource, forestry, and other land-management systems	Indigenous knowledge perspective	Western scientific perspective
Land use from a historical perspective	• Historical context illustrates Indigenous relations with the natural world juxtaposed against the lack of connectivity in Western world views. • Links exist between traditional ecological knowledge and current forest practices. • Identification of traditional-use sites such as burial grounds and ceremonial places and the current regulations concerning protection of cultural sites. • Historical land-use policies in relation to Indigenous people described in a political context. • Knowledge of the land is spiritually framed. • The role of the Indian Act [RSC, 1985] (wherein it defines who is an "Indian" and contains certain legal rights and legal disabilities for registered Indians) highlights the importance of Indigenous knowledge and policy and legislation. • Assumptions around rights to land as they relate to the idea of caring for land. • Land and treaty rights related to managing for sustainability and the importance of non-timber forest products. • Emphasis on global impacts versus local actions in relation to land use.	• Dissimilar historical roots and lack of connectivity. • White Eurocentric hegemony. • Weak direct linkages with the natural world established. • Separation from tradition and language. • Historically significant sites located via maps, exploration, field studies, and/or other physical (hard-copy) or digital cartographic references. Some sites may not be available or able to be referenced due to cultural protocols. • Knowledge of the land is not spiritually framed, but learned through textbooks or lessons. • Materialistic ideologies and rational approaches to tenure and land ownership. • Individual title is adhered to. • The role of multinationals and corporations (e.g., in land use) is linear and not co-operative or collaborative by nature. • Reductionist or Eurocentric hegemonies, are applied. • Customarily insular and static "ways of knowing."

TABLE A1. Continued

Natural resource, forestry, and other land-management systems	Indigenous knowledge perspective	Western scientific perspective
Forest ecology and ecosystem management	• The concept of interconnection between land, people, and culture. • Natural laws derived from an Indigenous perspective. • The human relationship with and in forests and between forests and other life forms. • The relationship of Indigenous people to the land: how land and resources dictated their lives as they moved about and carried on their livelihood in affinity with the seasons. • Traditional land management and agricultural practices integrated and inter-related through the use of bush fires for habitat regeneration, brush fires for vegetation regeneration, soil replenishment, fish weirs, and deer fences, etc. • Traditional ecology includes management of the entire landscape, including material, spiritual, recreational, and medicinal aspects of the world. • Holistic traditional knowledge in biodiversity, soil, water, and forest products.	• Tools expand scale of direct and indirect observations and measurements. • Testing and experimentation based on logic. • Human relationships are seen outside the forests, and their relationships are not inter-related. • Agriculture practices and forestry practices seen as separate, or not connected. • Fire is seen as a "silviculture prescription" only, and as a disturbance and risk to human health and well-being. • "Traditional" ecology and ecological principles based on facts and some historical accounts derived from Aboriginal or European accounts or records. • De-contextualized knowledge of traditional folkways. • Dendrology tools and techniques derived from textbooks, research, field or classroom teachings, and brief practicums.
	• Dendrology from a traditional perspective (oral histories and tacit knowledge) Identification, collection, cataloguing, and preparation of traditional plants, and the management or philosophy behind plant collection). • Sustainability from a traditional perspective: harvesting and management practices. • Rituals, ceremonies, and mythology that express Indigenous relationships to management of plant and animal life and the land. \ • Socio-economic factors affecting and affected by forest activity from the Indigenous perspective.	• Compartmentalized management and use are factors of landscapes. • Hierarchical identification of physical attributes in landscapes. • No rituals, ceremonies, or mythology attached per se. Historical accounts of traders and settlers, artefact registries, and Indian encounters.

TABLE A2. Legislation regarding cultural heritage, Indigenous knowledge rights, and resources.

Acts, agreements, or legislation	Subject to, or embodies
Convention on Biological Diversity, Article 8(j), Traditional Knowledge, Innovations and Practices	"National legislation; respect, preserve, and maintain knowledge, innovations, and practices of Indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations, and practices, and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations, and practices" (CBD 2010:1).
World intellectual Property Organization	Twenty-four treaties are administered by WIPO, including the WIPO Convention.
United Nations Educational, Scientific and Cultural Organization (UNESCO)	Convention Concerning the Protection of the World Cultural and Natural Heritage, signed in November 1972.
Declaration on the Rights of Indigenous Peoples	An international statement adopted by the United Nations in 2007 that embodies the aspiration of Indigenous peoples in all aspects of their lives. The draft declaration contains several provisions that deal with Indigenous peoples' intellectual and cultural property rights. Article 42 states that the rights defined within it shall constitute the minimum standard for "the survival, dignity and well-being of the Indigenous peoples of the world." (WACC 2011,p.1). Article 29 states that "Indigenous people are entitled to the recognition of full ownership, control and protection of their cultural and intellectual property" (WACC 2011:2).
TRIPs agreements	In 1994, the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) was completed, bringing into existence the first multilateral trade negotiated agreement for trade in services and goods. As part of the GATT negotiations, an agreement was reached on the Trade Related Aspects of Intellectual Property Right (TRIPs). Article 27 provides that "patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application." TRIPs allows members to exclude from "patentability inventions, the prevention within their territory of the commercial exploitation of which is necessary to protect public or morality, including to protect human, animal or plant life or health or to avoid serious prejudice to the environment, provided that such exclusion is not made merely because the exploitation is prohibited by their law" (WTO 2011; WACC 2011).

TABLE A3. Useful conceptual approaches and practical tools for theoretically integrating Western science and Indigenous knowledge in natural resource management.

General approach or tool	Conceptual/theoretical problem *(what they involve)*	Practical approach or solution *(how these can be applied)*	Author(s) or other useful references
Merging CEK and Western science	Involves social and cultural conflict resolution, which usually arises based on divergent world views and viewpoints or other incompatibilities with Western thought.	Work hand in hand with awareness-building of both Indigenous and Western science "ways of knowing." Improve understanding of both world views. Look for commonalities in how natural resources are being managed and build on compatibilities.	Hereniko (2000) Berry (2003) Chun et al. (2003) Turner and Peacock (2005) Bannister and Hardison (2006) Downs (2006) Lynam et al. (2007) Settee (2007) O'Flaherty et al. (2008)
Human ecological resilience analysis	Profound effects on how Aboriginal people view or rationalize non-Aboriginal involvement (and vice versa) in natural resource management. Berry (2003) commented that this is initiated by the conjunction of two or more autonomous cultural systems.	Examine how Indigenous people have coped with change, and understand different levels of acculturation. NR managers must look (or quietly observe) "beyond just the trees" and involve Indigenous NR managers for holistic (all-encompassing) insights and perspectives.	Hunn (1999) Worcester, K.W. (2001) Berry (2003) Chun et al. (2003) Dyer and McGuinness (2004) Downs (2006) Human-ecological resilience, consilience and consciousness (2011)
Differences between Indigenous knowledge and Western science	Involves contrasting world views and notable differences in the way these resources are perceived, interpreted, and managed.	Incorporate community and Indigenous knowledge into decision-making in natural resource management. This aids in breaking away from the conventional thinking (technical or scientific approach) on NR management. Provide more holistic Aboriginal world views, attitudes, beliefs. or preferences of the people managing or depending on their resources (Lynam et al. 2007). This is especially important when looking at cultural/ecological values in forest resource and land-use management, where some intrinsic differences exist between these types management and the science behind these approaches. Also refer to Table A1.	Lynam et al. (2007)

TABLE A3. Continued

General approach or tool	Conceptual/theoretical problem *(what they involve)*	Practical approach or solution *(how these can be applied)*	Author(s) or other useful references
Incorporation of Aboriginal perspectives	"Perspectives" can be incorporated in an atmosphere of mutual respect; co-operation and support for the values encompassed in the Indigenous world view are firmly established in the hearts and minds of all participants (O'Flaherty et al. 2008). Involves a practical means of approaching, describing, and/or finding a solution to "bridge the gap" between Western science and Indigenous knowledge.	Openness to innovative programming compatible with Indigenous teaching and learning styles and strong commitment to a shared vision are characteristics, which lay the foundation for including Indigenous knowledge (O'Flaherty et al. 2008). NR managers need to look at ways of "bridging the gap" between two distinct types of science: Western science and Indigenous science. Five practical approaches are: 1. Acknowledging Aboriginal peoples' own perceptions and contributions to science. 2. Creating social legitimacy through collaborative learning and integrating systems thinking and conflict management. 3. Designing and implementing intuitive valuations of CEK (transfer of oral to written cultural/ecological knowledge). 4. Designing clear objectives and outcomes and implementing systematic and culturally sensitive heritage assessments. 5. Defining cultural pluralism (ideology of world views) and problem-solving strategies within a continuous acculturation process.	Hazuda et al. (1988) Graveline (1998) Dyer and McGuinness (2004) Lynam et al. (2007) O'Flaherty et al. (2008)

TABLE A3. Continued

General approach or tool	Conceptual/theoretical problem *(what they involve)*	Practical approach or solution *(how these can be applied)*	Author(s) or other useful references
Collaborative learning (CL), participatory research, and social analysis	• Collaborative learning approaches • Participatory research • Social analysis Collaborative learning is a function of collaborative (participatory) research (C*p*R) plus social action (SA) and social analysis systems (SAS): CL= ∫ (C*p*R + SA + SAS)	NR managers need to partner together and work collaboratively on building a framework to address the fundamental complexities and controversies that define policy decisions and improve public dialogue and communication in the natural resource sector. Social analysis helps NR managers create profiles of involvement in a core problem or action. These profiles are based on four factors: 1) power, 2) interests, 3) legitimacy, and 4) existing relations of collaboration and conflict (refer to Figure 4 in text). NR managers need to step back and look at *how* CL can assist them, *and how this can be applied* in the real world. This will require knowledge of ways to gather information from Indigenous participants and how this can be used in the field (social action). Social analysis systems are strongly collaborative, stakeholder-based processes that incorporate CEK and social learning systems. This is what NR managers need to adopt in order to understand the social and cultural dimensions of Indigenous knowledge within an integrated natural resource management process.	Katz and Martin (1997) Daniels and Walker (2001) Gonzalez and Meitner (2005) Parrado-Rosselli (2007) Chevalier and Buckles (2008) Zent (2009)

TABLE A3. Continued

General approach or tool	Conceptual/theoretical problem *(what they involve)*	Practical approach or solution *(how these can be applied)*	Author(s) or other useful references
Capturing cultural value through valuation	The valuation of CEK	Authors recommended some practical approaches for NR managers: • Make explicit the range of values addressed in the funding process to encompass a much broader range of cultural, non-monetized values. • View the whole cultural system and all its sub-systems, and understand how systemic ecosystem health and resilience are maintained. • Recognize that professional (academic, technical, or scientific) judgment must extend beyond evidence-based decision-making. • Overturn the concept of centrally driven, top-down delivery and replace it with systemic, grassroots value creation. (modified from Holden 2004, pp. 9–10). Value chains are influenced by a set of specificities that provide comparative advantages, such as the availability of unique and niche products and services, limited accessibility, fragility, diversity, and marginality. These have a strong impact on value chain analysis and the selection of value chain development options (Bolwig et al., 2008).	Krutilla (1967) Hanneman (1984) Judge et al. (1985) Sellar et al. (1985, 1986) Tobias and Mendelsohn (1991) Echeverríaa et al. (1994) Kruse et al. (1998) Shultz et al. (1998) Chalabi and Dowie (2003) Kendrick (2003) Holden (2004) Xu et al. (2005) Bolwig et al. (2008) Gerst et al. (2010) Hoermann et al. (2010)
Cultural pluralism	Integrating the ideology of world views and problem-solving strategies	NR managers need to examine the ideologies of different world views. Build on strategies for solving problems by recognizing the need to adopt policies for harmonious inter-ethnic and race relations in order to maintain social cohesion.	Despres et al. (1968) Das (2004)

Test Your Knowledge . . .

Raising the Bar: Recognizing the Intricacies of Cultural and Ecological Knowledge (CEK) in Natural Resource Management

How well can you recall some of the main messages in the preceding Research Report? Test your knowledge by answering the following questions. Answers are at the bottom of the page.

1. What does the abbreviation CEK stand for?
   A) Cultural ecological knowledge
   B) Coincidental ecological knowledge
   C) Chiefs' ecological knowledge

2. Why is CEK a subset of traditional knowledge?
   A) CEK encompasses the cultural context, practices, and beliefs and emphasizes the qualities and attributes of places that have aesthetic, historical, and scientific value.
   B) CEK is embedded in general scientific knowledge.
   C) CEK incorporates Aboriginal world views that are imbalanced and does not provide an appropriate mechanism for traditional knowledge studies.

3. How is collaborative learning legitimized?
   A) By acknowledging Aboriginal peoples' perceptions and contributions to science.
   B) By incorporating community and traditional knowledge into decision-making.
   C) By creating social legitimacy through collaborative learning and integrating systems thinking and conflict management.