Translation of Indigenous/Western Science Perspectives on Adaptive Management for Environmental Assessments

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Abstract

This project integrated two Canadian Environmental Assessment Agency R&D priority areas on Adaptive Management and the Meaningful Involvement of Indigenous Peoples. The goal of this project was to develop and evaluate a reciprocal translation of principles and processes of Adaptive Management for EAs; a translation which is understandable, meaningful and practical for both Indigenous and Western science collaborators. The project employed several research methodologies, including a search and review of the literature as well as interviews with knowledge holders with expertise in Indigenous and/or Western science perspectives. The interviews were established to solicit detailed and thoughtful information to enrich the literature and expand understanding on a variety of topics related to Adaptive Management and EAs. Quotations were selected to express important ideas, and convey them in the original words of the people who know the subject best.

This report describes the key concepts of Western science and the principles and processes of Adaptive Management, followed by a discussion of Indigenous and Western science perspectives on Adaptive Management in EAs. The report concludes with a comparison of the similarities and differences in Indigenous and Western science perspectives on Adaptive Management. Finally, the report offers recommendations if the Agency decides to invest in true collaborative, cross-cultural relationships, including: (1) development of a terminology guide; (2) development and testing of reciprocal knowledge exchange protocols for local Indigenous and Western science knowledge holders; (3) the compilation of specific practical examples of Adaptive Management (generally, and specifically for EAs); and (4) support of cooperative work with willing Indigenous communities as equal partners in EA test projects for application of Adaptive Management.

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Executive Summary

The current project is relevant to the integration of two Canadian Environmental Assessment Agency (hereafter referred to as the Agency) Research & Development Priority Areas; the current 2009-2010 focus on Adaptive Management (AM), and its integration with a previous 2006-2008 focus on Meaningful Involvement (of Indigenous peoples).

The Agency indicated that technical guidance on Adaptive Management "*remains limited and innovative practices are largely untested in the context of environmental assessments,*" especially the development of more detailed best practices or guidelines for the design, implementation and review of Adaptive Management in environmental assessments (EA). It is clear that if the Agency is committed to expanding the practical application of Adaptive Management in federal EA follow-up programs, it will be necessary to have effective communication of the associated principles and process of Adaptive Management.

The Canadian Environmental Assessment Act (hereafter referred to as the Act) also states that one of its primary purposes is "*to promote communication and cooperation between responsible authorities and Aboriginal peoples with respect to environmental assessment*", and that "*Community knowledge and Aboriginal traditional knowledge may be considered in conducting an environmental assessment.*" In general, local community knowledge has been recognized as having tremendous potential for grounding EAs with strategically- and tactically-important information that would otherwise elude non-residents. However, local Indigenous knowledge engages a knowledge system which - when meaningfully engaged - can provide completely new dimensions to the EA, in a cultural context that requires knowledge holders in both systems to reconsider their fundamental assumptions, observations, theories and knowledge.

The goal of this project is to develop and evaluate a reciprocal translation of principles and processes for AM in EAs; a translation that is understandable, meaningful and practical for both Indigenous and Western science collaborators.

In order to develop this reciprocal translation, several research methodologies were employed. First, a thorough search and review of the available scholarly and technical literature surrounding AM was completed. Second, knowledge holders with expertise in Indigenous and/or Western science perspectives were engaged in interviews to solicit opinions on a variety of topics related to AM and EAs.

Quotations from the literature and participant interviews were selected to express important ideas, and convey them in the original words of the people who know the subject best. In this way, we hope to share these important ideas with the widest possible audience; from Agency senior management to people who live on the land; from Western science university professors to Indigenous traditional people; from Elders to Youth in both cultures.

In its most general sense, the word 'science' (L. *scientia*) simply means 'knowledge.' Use of the word 'Western' in the phrase Western science refers to a specific knowledge system that developed from a Greek-Roman cultural context (and their respective origins), into European and subsequent colonial culture. In a modern sense, Western science has become strongly associated with use of the 'scientific method,' which is a specific technique for learning (i.e. creating new knowledge) about the condition of the world and how it works. Although the scientific method is often poorly described by many scientists and teachers, the essential principles can be effectively explained to anyone.

With the fundamentals of Western science in mind, we turn our attention to the closely related process of Adaptive Management (AM), which is all about learning through management. It is designed to identify and address key questions about environmental dynamics, and to use information from the system being managed to answer those key questions. Key questions can be associated with management objectives, with data, or with models that we create to help us describe and understand the interactions between the various components of the system. From a management perspective, AM can provide information to managers on “what works and what does not work.” In this sense, every management planning session is a learning opportunity.

Designing and implementing an AM program is a lot of work: it requires a high level of organization, meaningful discussion with collaborators - including those with very similar and very different opinions about objectives and ecosystems, identification of key uncertainties and associated hypotheses, predictions, and tests, and finally a commitment to using the results to update knowledge and adjust management actions. Some people just might not want to do the work; others might forget some important steps in the AM process.

We have not tried to create or evaluate the many detailed definitions that have been proposed for Indigenous Knowledge, Aboriginal Traditional Knowledge, Traditional Ecological Knowledge, Local Knowledge, etc. Rather, we are asking the reader to consider that Indigenous communities are knowledge systems, made up of individual people (smaller knowledge systems), and communities combine to make up cultural groups (larger knowledge systems).

It should be clear from the way we have approached this project that the concept of knowledge systems (Indigenous, Western science) is much more important than knowledge. Of course, the meaningful discussion about similarities and differences between Indigenous and Western science knowledge systems needs to take place directly between individual knowledge holders in those local knowledge systems. It is at this level that the prospects for collaboration must be evaluated.

While Adaptive Management may be a culturally specific form of a general solution in human ecology, Indigenous communities must determine for themselves whether they see common elements and/or opportunities between Adaptive Management and their own culturally specific knowledge systems. If so,

then the Agency and other responsible authorities can offer Adaptive Management as a viable framework within which Indigenous and Western science knowledge holders can learn together: asking questions, putting forward possible explanations, generating and evaluating predictions as 'proof in the pudding,' and building trust in each other's commitment to ongoing improvement of our environmental assessments. If not, then Adaptive Management and Western science cannot and should not be forced on Indigenous cultures for environmental assessments, or any aspect of resource management for that matter. This would only produce conflict, mistrust and bad management - the complete opposite of what Adaptive Management seeks to achieve.

So, the key question really has to do with dialogue between community-based Indigenous and Western science knowledge holders, to determine if Adaptive Management in EA is a viable framework for true collaborative management. If the Agency decides that it is strategically willing to invest in these kinds of cross-cultural relationships, then we can identify a handful of tactically important recommendations for making progress:

1. The Agency should develop an internal concept and terminology guide to promote understanding and consistency in their policy and guidance. The concepts and terms in the guide should not be dictated as required definitions, but rather the guide should be offered to provide a clear starting place for discussion between Indigenous and Western science knowledge holders.

2. The Agency should support the development and field testing of a process to help local Indigenous and Western science knowledge holders create their own local reciprocal knowledge exchange protocols to (a) describe the ways that their respective knowledge systems work, (b) determine if there is sufficient compatibility to consider working with Adaptive Management within EA, and (c) if so, exchange knowledge to try to implement the AM learning cycle on specific projects.

3. The Agency should support the compilation, study and description of specific practical examples of Adaptive Management (in EA and otherwise), with sufficient detail and clarity of presentation that Indigenous and Western science knowledge holders would be able to make their own evaluations regarding feasibility and effectiveness.

4. The Agency should work cooperatively with willing Indigenous communities to design and implement workable Adaptive Management approaches for specific EA test projects in which Indigenous and Western science knowledge holders are required to serve as full and equal partners.

1. Introduction

The 2009-2010 Research & Development Call for Proposals issued by the Canadian Environmental Assessment Agency (hereafter referred to as the 'Agency') identified Adaptive Management as a Priority Area, stating that technical guidance on Adaptive Management (occasionally referred to here as 'AM') "remains limited and innovative practices largely untested in the context of environmental assessments" (occasionally referred to here as 'EAs'), especially the development of more detailed best practices or guidelines for the design, implementation and review of Adaptive Management in EAs (CEAA, 2009a). If the Agency is committed to expanding the practical application of Adaptive Management in federal EAs, it will be necessary to have effective communication of the associated principles and processes of Adaptive Management - especially with non-technical managers, participants and local communities.

The *Canadian Environmental Assessment Act* (hereafter referred to as the 'Act') states that one of its primary purposes is "*to promote communication and cooperation between responsible authorities and Aboriginal peoples with respect to environmental assessment*" (S4.1), and that "*Community knowledge and Aboriginal traditional knowledge may be considered in conducting an environmental assessment*" (S16.1). Indigenous[1] governments and communities have a special role in federal EAs, largely due to the fact that the Crown has a fiduciary responsibility for meaningful consultation in matters where Indigenous and Treaty Rights may be infringed by proposed activities (Usher, 2000). This special relationship is reflected in the previous Agency R&D Priority Area regarding Meaningful Involvement, much of which was focused on the identification of barriers to engaging Indigenous peoples (CEAA, 2009a). Indigenous involvement in federal EAs extends far beyond participation in a Western science process for evidence-based decision-making. In general, local community knowledge has been recognized for its potential to ground EAs in strategically- and tactically-important information that would otherwise elude non-residents (Brosius, 2006). However, local Indigenous knowledge engages a knowledge system which - when meaningfully engaged - can provide completely new dimensions to the EA, in a cultural context that requires knowledge holders in both systems to consider their fundamental assumptions, theories and observations (Ellis, 2005).

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[1] The term ‘Indigenous’ rather than ‘Aboriginal’ is used in this report (with the exception of direct quotations), to refer to the First Nations, Inuit and Métis Peoples in Canada. The authors understand the significance of the term Aboriginal under the Constitution Act of 1982 but respect that not all Indigenous People identify with the term. Readers should be aware that there is no single term to describe Indigenous Peoples, and every effort should be made to use the name preferred by the group to which you are referring.

Indigenous involvement in Adaptive Management for federal EAs should be a high priority for achieving purposes of the goals of the Act, including:

- Ensure continuous improvement in EA practice for sustainable development;
- Identify new approaches to dealing with existing issues;
- Prepare for the future by identifying challenges and solutions;
- Build EA capacity in Canada; and
- Build partnerships with other organizations." (CEAA, 2009a)

Much of the conceptual and research effort has already been invested in the development of Adaptive Management by both knowledge systems. The key uncertainty addressed in this project is whether Adaptive Management can be carried forward practically so they can be used together by people from both Indigenous/Western science cultures.

Goal and Objectives

The goal of this research and development project is to develop and evaluate a translation of principles/processes of Adaptive Management for EAs; a translation that is understandable and meaningful for both Indigenous and Western science collaborators.

To achieve this goal, it will be necessary for the project to achieve the following specific objectives:

1. Describe the principles and processes of Adaptive Management for EAs in common, verbal, graphical and written descriptions designed to be understandable and meaningful to non-experts and experts in both Indigenous and Western science knowledge systems.

2. Review the principles and processes of Adaptive Management for EAs from the perspective of Indigenous knowledge systems, based on interviews with knowledge holders and available literature.

3. Review the principles and processes of Adaptive Management for EAs from the perspective of the Western science knowledge system, based on interviews with knowledge holders and available literature.

4. Identify general similarities and differences between Indigenous and Western science perspectives on the principles and processes of Adaptive Management for EAs, in the context of future cross-cultural collaboration in EAs.

2. Relevance of the Issue to EA and Priority Areas

The current project is relevant to the integration of two Agency R&D Priority Areas; the current 2009-2010 focus on Adaptive Management, and its integration with a previous 2006-2008 focus on meaningful involvement (of Indigenous peoples).

The Role of Adaptive Management in EAs

In 2003, the practice of Adaptive Management was explicitly amended to the Canadian Environmental Assessment Act:

> "*The results of follow-up programs may be used for implementing adaptive management measures or for improving the quality of future environmental assessments.*" (CEAA, 2009a, S38.5)

There were no definitions or explanations for Adaptive Management provided in the Act, however the Agency developed an Operational Policy Statement (OPS) and made it available on the Agency's website in order to "strengthen the understanding and application of Adaptive Management in environmental assessments" (CEAA, 2009a). This Statement defined the concept of "Adaptive Management" and "Adaptive Management Measures" within the context of federal EAs as follows:

> "*In general, adaptive management is a planned and systematic process for continuously improving environmental management practices by* <u>*learning*</u> *about their outcomes. Adaptive management provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. Planning for adaptive management should commence as early as possible in the EA process. While specific adaptive management measures may not be identifiable at that point, a strategy or plan should be developed to provide context on when, how and where adaptive management may be used. Decisions to adopt specific adaptive management measures can be identified later during the project life-cycle as a result of the analysis of data generated by a rigorously implemented follow-up or monitoring program. Consequently, the concepts of follow-up and adaptive management are directly linked under the Act and in practice.*" (CEAA, 2009a, <u>emphasis</u> added)

While explanations like this provide readers with a general sense of Adaptive Management as it relates to EA methodology, the actual principles and processes of Adaptive Management remain elusive for the non-expert. The task of explaining principles and practices of Adaptive Management is not trivial. The Agency must define more clearly the principles and processes of Adaptive

Management, so that Western science practitioners will be more likely to understand and actually implement Adaptive Management in EAs.

Meaningful Involvement (of Indigenous Peoples) in EAs

The Act also makes explicit references to the involvement of Indigenous Peoples:

> "*The purposes of this Act are [...] (b.3) to promote communication and cooperation between responsible authorities and Aboriginal peoples with respect to environmental assessment*" (S4.1)
>
> "*The objectives of the Agency are [...](h) to engage in consultation with Aboriginal peoples on policy issues related to this Act.*" (S62)

and, specifically with respect to the "Environmental Assessment Process,

> "*Community knowledge and Aboriginal traditional knowledge may be considered in conducting an environmental assessment.*" (S16.1)

During the period 2006-2008, the Agency focused on Meaningful Involvement as a Priority Area for support by the Research & Development Program. The involvement of the public, including Indigenous peoples, is viewed by the Agency as a practical and essential component of EAs, especially to help ensure that EAs are effectively informed by local community and traditional knowledge (CEAA, 2009a). The guiding principle in this research area is to develop means for enhancing EA process transparency and clarity through public involvement, with research priorities that include:

- The benefits and challenges of engaging Indigenous peoples in EA processes within Canada;
- The identification of barriers to public participation, including barriers for engaging Indigenous peoples;

The Agency's Adaptive Management OPS (CEAA, 2009a) also identifies several considerations in planning for Adaptive Management, including several key factors regarding participation of Indigenous governments and knowledge holders, which should be considered when planning for Adaptive Management, including:

<u>Jurisdictional Considerations</u>. "Some methods for ensuring the implementation of adaptive management measures may exist within other jurisdictions, such as a provincial or territorial government. For example, conditions related to adaptive management may be specified by way of provincial regulations or existing provincial permitting processes. Working in collaboration with other regulators and jurisdictions will maximize the potential for ensuring effective adaptive management implementation."

<u>Aboriginal Traditional Knowledge and Public Involvement.</u> "Aboriginal traditional knowledge, local community knowledge, and public participation are potentially

important considerations that may influence the planning, design and implementation of adaptive management. It is important to understand communities' interests in the project and the potential role that they might wish to play in designing and implementing adaptive management strategies and follow-up programs." (CEAA, 2009a)

The Agency (2009b) Interim Principles for "Considering Aboriginal traditional knowledge in environmental assessments conducted under the Canadian Environmental Assessment Act" identifies several reasons for considering Indigenous knowledge in EAs:

- Helping identify potential environmental effects;
- Improving project design, including follow-up programs;
- Providing relevant biophysical information that is otherwise unavailable; and
- Leading to better EA decisions.

The Agency also presents six general methodological principles for Western scientists considering Indigenous knowledge in EAs:

1. Work with the community.
2. Seek prior informed consent.
3. Access Indigenous traditional knowledge with the community support.
4. Respect intellectual property rights.
5. Collect Indigenous traditional knowledge with community collaboration.
6. Bring Indigenous traditional knowledge and Western knowledge together.

Enhancing the Role of Indigenous Peoples in EA Adaptive Management

Given the facts that (i) the concept of Adaptive Management has been incorporated into the section of the Act dealing with federal EAs, and (ii) there is a duty for meaningful consultation with Indigenous governments and communities during the design and implementation of these EA programs it will be essential for the Agency to ensure that both Indigenous and Western science knowledge holders share a common understanding of the principles and processes of Adaptive Management.

3. Research Methods

The goal of this project is to create a translation of principles and processes for Adaptive Management in EAs; a translation which is meaningful, understandable and practical for both Indigenous and Western science collaborators. In order to develop this translation, several research methodologies were employed.

First, a thorough search and review of the available literature (primary and technical) surrounding AM was completed. This literature included perspectives from both Indigenous and Western science scholars, and incorporated technical literature available from Agency reports. Second, knowledge holders with expertise in Indigenous and/or Western science perspectives were engaged in telephone interviews to solicit opinions on a variety of topics related to AM and EAs. The goal of this stage was not to sample a large number of individuals but rather to seek out detailed and thoughtful information to enrich the literature and expand the knowledge base.

A total of 63 candidate knowledge holders were identified on the basis of (a) professional experience, (b) scholarly contributions, or (c24/) snowball sampling, where interview participants were referred by previously identified knowledge holders (Berg, 2004). Candidates were chosen based on their expertise in areas of AM or Indigenous experience with EAs; they were employed in many different capacities, including academia, government, community organizations, consultants or non-governmental organizations. Age, gender and location of the participants were not a concern in this study.

Individual email invitations were sent by the Principal Investigator to each of the candidates, with a description of the project (Appendix I), and a draft copy of the Research Ethics Consent Form (Appendix II). Within three weeks of sending the invitations, a total of 24 (38.1%) candidates had agreed to participate in the study, and 12 (19.0%) interviews had been completed, transcribed and made available for consideration in this report by the 31 March 2010 submission deadline. Of the 6 candidates who declined the invitation, 4 redirected the research team to alternate candidates who they thought would be qualified and interested in participating.

In keeping with the expectation that knowledge holders are research partners rather than subjects, semi-structured interviews were held with participants who had agreed to the written consent terms (Smith, 1999). This interview approach involved a component of active-listening and the use of pre-determined, but open-ended questions which allowed for flexibility with responses by the participants (Huntington, 1998; Sillitoe et. al, 2005; Berg, 2004). The themes and associated question used in this project are presented in Appendix III. In order to maintain consistency with the interviews, the same techniques were used for participants with Indigenous and/or Western science expertise; however, there was a parallel set of questions created for each perspective. In order to

determine what questions were to be asked during the interview, the participants were asked to self-identify where their expertise lay, regardless of whether they were coming from an Indigenous or Western science cultural background. Participants who identified expertise in both perspectives were offered both sets of questions.

The identities of participants were kept confidential, that is, all participants were assigned a non-descriptive ID code; any identifying information, other than the area of expertise of each participant, will not be released (Berg, 2004). General opinions and quotations from participants are associated in this report with the alphanumeric code indicating the expertise and participant number (e.g. IW-02 means the second participant with declared expertise in Indigenous and Western perspectives on AM and/or EAs). The condition of confidentiality (as opposed to anonymity) is important to note in the final report because it demonstrates the diversity of the participants. All participants were notified of this social risk, both in writing and verbally before completing the telephone interview. All interviews considered in this report were recorded via telephone speaker with a Roland Edirol R-09HR audio recorder, saved to mp3 file format on a secure computer, where it was transcribed to text using Express Scribe Transcription Playback Software.

Throughout the duration of the project, the research team kept in close contact with a liaison team at the Agency through weekly video/teleconference meetings. The purpose of these meetings was to ensure full disclosure and discussion of the research methodology, including the ethics review process, methodology and progress reports. The meetings were also important to ensure that the project (a) stayed on course with regard to the objectives outlined in the proposal, and (b) continued to meet the expectations of the Agency team. Project materials (excluding participant identification and associated interviews) were made available to the research team and Agency liaison team via MediaWiki file structure on a password-protected computer server. The wiki pages were updated on a daily basis with any new information relating to the project objectives, bibliography, literature extractions, progress reports and weekly meeting agendas.

4. Research Findings

The information presented in this section has been compiled and distilled from the available scholarly and technical literature and interviews conducted with Indigenous and Western science knowledge holders on EAs. Subsections have been organized according to the specific objectives for this project, with additional subsections to reflect important themes that emerged from the literature and/or interview participants.

A deliberate attempt has been made to write in common-sense language that is relatively non-technical and accessible (Nadasdy, 1999). Quotations from the literature and participant interviews were selected to express important ideas, and convey them in the original words of the people who know the subject best. In this way, we hope to share these important ideas with the widest possible audience; from Agency senior management to people who live on the land; from Western science university professors to Indigenous Traditional People; from Elders to Youth in both cultures.

4.1 Principles and Processes of Adaptive Management

This section presents information from the literature and participant interviews on the fundamental principles and processes associated with Adaptive Management in a general sense. An introduction to the Western scientific method explains the central role of hypotheses and predictions, which in turn are essential for understanding the modern theory and application of AM cycles and stepwise implementation.

4.1.1 Western Science

> "*There aren't many different definitions of science, and people need to realize that. Not Western science anyway*." (W-01)

In its most general sense, the word 'science' (L. *scientia*) simply means "the state or fact of knowing, knowledge" (OED, 2010). Use of the word 'Western' in the phrase Western science refers to a specific knowledge system that developed from a Greek-Roman cultural context (and their respective origins), into European and subsequent colonial culture (Lindberg, 1992). In a modern sense, Western science has become strongly associated with use of the 'scientific method,' which is a specific technique for learning (i.e. creating new knowledge) about the condition of the world and how it works (Tsuji and Ho, 2002). Although the scientific method is often poorly described by many scientists and teachers, the essential principles can be effectively explained to anyone.

Consider the following example from a recent Forum of the Journal of the Royal Society of New Zealand on "*Mātauranga Māori*[2], Science and Seabirds:

> "[There are] two essential hallmarks of the Western scientific method - hypotheses and predictions. For the purpose of this discussion, hypotheses can be considered to be 'logically possible explanations of cause-and-effect for how the world works'. The primary job of Western scientists is to explicitly organize the different possible explanations of cause-and-effect, and collect and consider evidence to evaluate our degree of confidence in one or more competing hypotheses. For example, consider the muttonbirders'[3] idea that vegetation "slows up" the emergence of tītī chicks from their burrows and fledging from the island (Moller et al. 2009c). Hypotheses are used to generate specific predictions about what we would find if we looked closely at the world (e.g., that chicks will emerge earlier on the steep side of an island with less vegetation), or what would happen if a natural or manipulated change occurred in the world (e.g., an experiment that would artificially reduce vegetation in some areas of the island). If the prediction is tested and determined to be true, we increase our confidence (measured as probability) in the hypothesis that generated that prediction; we reduce our confidence in hypotheses that generate predictions determined to be false. In a nutshell, this is the Western scientific method. Inductive logic allows for the generation of a hypothesis from observations, deductive logic allows a general hypothesis to generate specific predictions, and inductive logic allows the test of predictions to assign a probability that the generating hypothesis is correct." (Crawford, 2009, p.163)

This simplified representation of the Western science cycle of learning using the scientific method is shown in Figure 1. A general explanation of cause-effect (=hypotheses) generates specific statements about the future (=predictions) that would be true, if the general explanation is true. Deductive logic is the idea that IF a general explanation is true, THEN a specific prediction generated from that explanation must be true. The advantage of working with predictions is that they can be tested with observations from the world, whereas the general explanations are not directly testable. If the predictions from a hypothesis are tested and shown to be false, then it is unlikely (if not impossible) that the hypothesis would be true. Inductive logic allows us to use the results of tests at the specific level of predictions, and thus assign a probability of confidence (0=false, 1=true) to the hypothesis that generated the prediction. Our confidence in possible explanations (hypotheses) about the world changes as we gather

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[2] *Mātauranga Māori*, loosely translated as *Māori* knowledge of the world.

[3] Referring to Māori people who harvest *tītī* = muttonbirds = sooty shearwater (*Puffinus griseus*).

evidence from the world about the predictions. All of this is just one, culturally specific way of learning about the world.

This kind of simple explanation can help non-scientists when they read the highly technical explanations that can come up in the literature, for example:

> "*In general, scientific approaches have been described as being systematic, subject to peer and public review, part of a collective process, and self-reflexive (Palys 1997). This positivistic-reductionist (or positivistic-rationalist) approach includes a common method of observation, hypothetico-deductive reasoning, verification by experimentation or other forms of testing (e.g., computer simulation), and replication (Johnston, 1983).*" (Tsuji and Ho, 2002)

The key terms and ideas to look for are (a) hypothesis=possible explanation of cause-effect, generating (b) prediction=something that will happen in the future (which is not used explicitly in the quotation above), and (c) testing the predictions to evaluate the hypothesis.

> "*It would be useful if we could all come to a common understanding or a common definition of science and I say that just so we can all be on some kind of level understanding or level playing field to write guidance or do experiments. Now that being said I think it is obviously easier said than done. (…) There are so many different ideas of it. It is very difficult to come up with a concrete definition so we can all have a common understanding. It would be great if you could have a definition but it's very hard to do that*." (W-02)

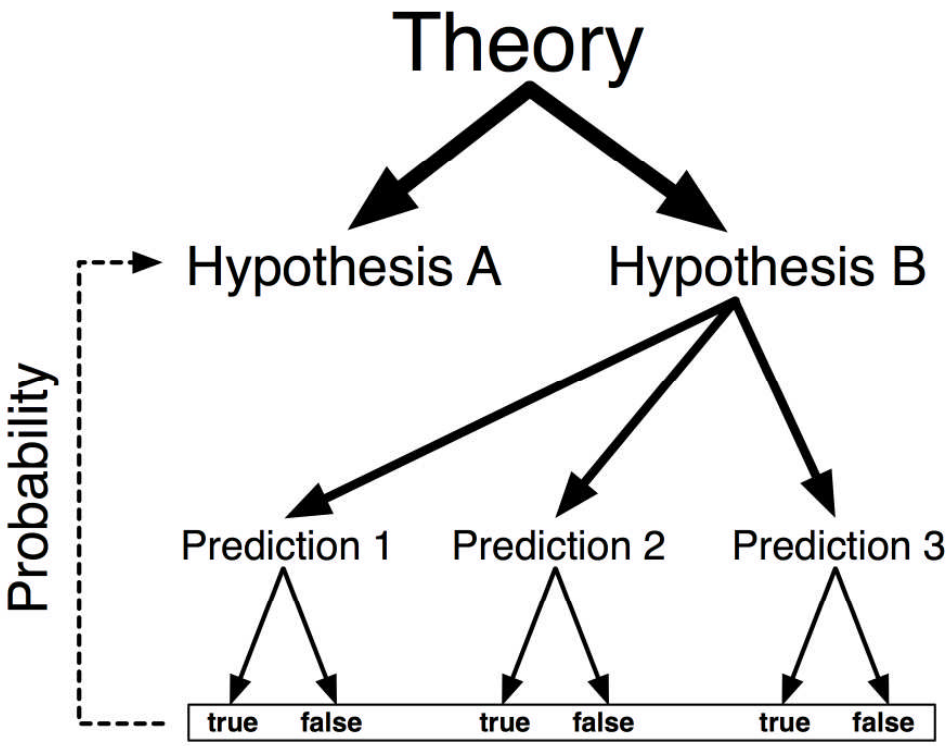

Figure 1. Diagram showing the Western science cycle of learning by application of hypothetico-deductive logic (i.e. general hypotheses generate specific predictions that can be tested) and inductive logic (assigning probabilities to general hypotheses based on tests of specific predictions). In this case, hypotheses are possible explanations of nature (e.g., cause-effect mechanisms), and predictions are statements about what will happen in the future if the hypothesis is correct.

4.1.2 Adaptive Management

> "*Adaptive management is not really much more than common sense. But common sense is not always in common use.*" (Holling, 1978, p.136)

With the fundamentals of Western science in mind, we turn our attention to the closely related process of Adaptive Management – another concept that has become needlessly confused and misapplied (IW-04).

Adaptive management is all about learning through management. It is designed to identify and address key questions about environmental dynamics, and to use information from the system being managed to answer those key questions (Walters, 1986). Key questions can be associated with management objectives, with data, or with models that we create to help us describe and understand the interactions between the various components of the system (Lee, 1993; Peterman and Peters, 1998; Anderson et al., 2003). From a management perspective, AM can provide information to managers on "what works and what does not work" (Stolnack et al., 2005). In this sense, every management planning session is a learning opportunity (Grumbine, 1994; Murray and Marmorek, 2003).

At this point it would be helpful to take a brief look at the history of AM in the scientific literature. Numerous reviews and evaluations of AM have been published on this topic (e.g. Holling, 1978; Walters, 1986; Hilborn and Walters, 1992; Lee, 1993; Gunderson et al., 1995; Lancia et al., 1996; Walters, 1997; Parma et al., 1998; Johnson, 1999; Grafton and Kompas, 2004; Schreiber et al., 2004; Walters and Martell, 2004; Crawford et al., 2005; Williams et al., 2009).

In 1978, C.S. (Buzz) Holling edited a volume entitled "Adaptive Environmental Assessment and Management" (AEAM) in which a group of colleagues[4] first synthesized the concept of AM in a broad, preliminary manner. Co-authors Walters and Hilborn (1976, 1978) had actually published a specific form of AM in the fisheries literature just prior to the AEAM text. However, it seems clear from Holling's (1978) acknowledgements that the authors saw their work as a scientific response to the realization that natural resources were more limited than previously considered. If these resources were to continue providing sustainable benefits, then people were going to require a new way of dealing with uncertainties in their understanding of the ecological systems, and the possible consequences of human use (Holling, 2004). In this earliest state, AM took the form of 'hands-on' examples and case demonstrations; however there wasn't any

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[4] The names of Holling's (1978) international co-authors (including some very famous ecologists) are often overlooked when this historic text is cited. They included: Alexander Bazykin, Pille Bunnell, William C. Clark, Gilberto C. Gallopin, Jack Gross, Ray Hilborn, Dixon D. Jones, Randall M. Peterman, Jorge B. Rabinovich, John H. Steele, and Carl J. Walters.

step-wise description of the AEAM technique. Regardless, managers and scientists soon began to recognize the great value in the Holling (1978) edited volume – it became widely cited as the source for this new way of thinking, and the term AEAM became synonymous with AM (Schreiber et al., 2004).

By the mid-1980s, scholars such as Baskerville (1985) had divided the AM concept into operational steps in an attempt to promote the application in real world management situations (Jackson et al., 2006). In 1986, Carl Walters published his book entitled "*Adaptive Management of Renewable Resources*," in which he laid out a highly structured description and discussion of what AM was meant to be, and how it could be formalized in a manner that worked for quantitative analysts, ecological researchers and policy-oriented managers. In particular, Walters (1986) stressed the importance of incorporating Western science (hypotheses, predictions, tests, probabilities) as part of management decision-making, to produce efficient learning about essential ecosystem questions that could not be answered in laboratories. Walters (1986) also tried to help organize AM into operational steps that would encourage managers to consider this kind of science-based institutional learning:

- "Bounding of management problems in terms of explicit and hidden objectives, practical constraints on action, and the breadth of factors considered in policy analysis;
- Representation of existing understanding of managed systems in terms of more explicit <u>models</u> of dynamic behavior, that spell out assumptions and <u>predictions</u> clearly enough so that errors can be detected and used as a basis for further <u>learning</u>;
- Representation of uncertainty and its propagation through time in relation to management actions, using statistical measures and imaginative identification of alternative <u>hypotheses (models)</u> that are consistent with experience but might point toward opportunities for improved productivity;
- Design of balanced policies that provide for continuing resource production while simultaneously probing for better understanding and untested opportunity." (Walters, 1986, p.8, <u>emphasis</u> added)

A quick review of the previous section should confirm the observed relationship between Western science and AM; an observation offered by several of the knowledge holders interviewed for this project (IW-03, IW-04).

> "*AM is Western science. I was once on a review panel for Western science and they wanted us to conduct a review of their science and adaptive management. I said we're either going to review your science, or your adaptive management, but adaptive management is science - so that is redundant."* (W-01)

Similar to the scientific method, AM is most appropriately thought of as a learning cycle (Figure 2) which helps participants to obtain more reliable information by processing new knowledge through a feedback cycle.

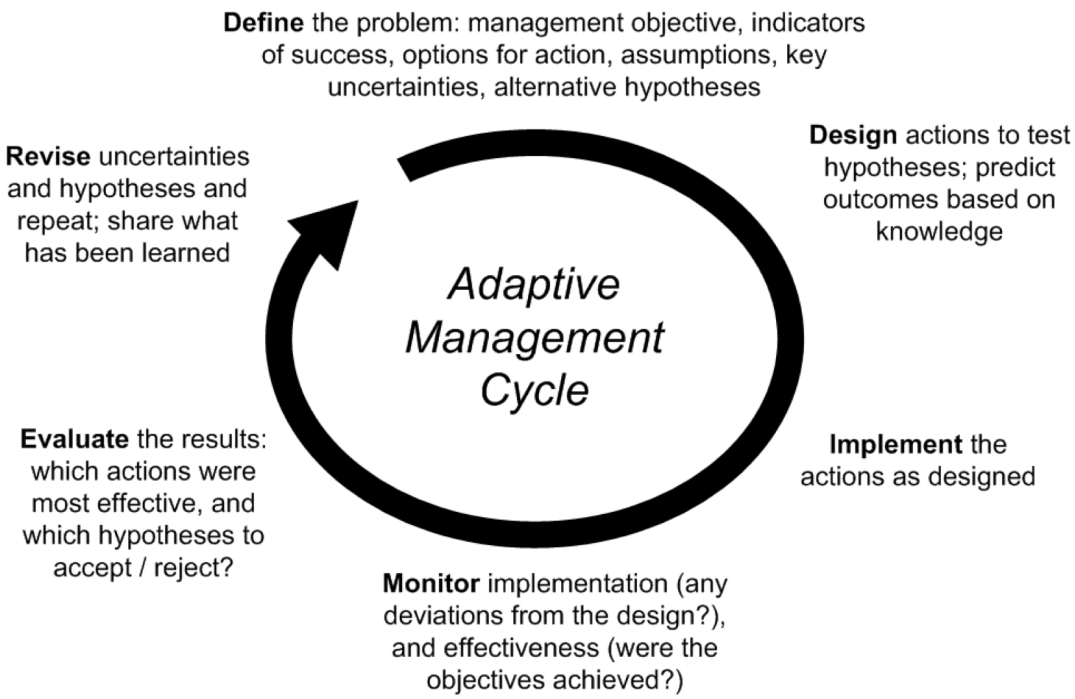

Figure 2. Adaptive Management (AM) cycle of learning presented by Murray and Marmorek (2004). In this approach, steps in the cycle are refined in terms of how they relate to management objectives, learning within a Western science context (competing hypotheses=models generating testable predictions), management experiments and institutional learning.

Despite the recent increase in adoption and application of AM, it still remains a frequently misunderstood management tool (Schreiber et al., 2004). Part of the reason for this confusion is that AM is easy to understand – almost (Lee, 1993). In some cases managers have increased confusion by mistakenly applying the label ‘AM’ to management systems that do not satisfy the fundamental requirements (Wall, 2003; Wheaton et al., 2004a. Murray and Marmorek (2003) identified some of the most common misconceptions: AM is trial-and-error learning; AM ‘adapts’ by making up spurious policies as you go; AM requires sophisticated modeling skills and tools; AM requires consensus from all stakeholders; AM is something that only scientists do; and AM is a panacea that can solve all problems. Many people continue to think that by simply monitoring the ecosystem, and occasionally changing management actions when policies fail to have desired effects, they are doing AM (Williams et al., 2009). How can there be so much confusion about AM?

Designing and implementing an Adaptive Management program is a lot of work (Jones and Greig, 1985): it requires a great deal of organization, meaningful discussion with collaborators - including those with starkly contrasting opinions about objectives and ecosystems. AM requires identification of key uncertainties and associated hypotheses, predictions, and tests, and finally a commitment to using the results to update knowledge and adjust management actions. Some people just might not want to do all of the work; others might forget some important steps in the AM process.

The U.S. Department of the Interior (DOI) has a long history of using and promoting AM for its management planning, especially for large projects with multiple and diverse interests, and where environmental uncertainty is a major factor in successful management decision-making. In a recent technical guide to clearly articulate the process of AM for its various offices, DOI consolidated its institutional understanding of AM into a standard protocol; a protocol that was intended to provide clarity and consistency in AM planning and implementation (Williams et al., 2009). Consider the following operational definition that accompanies the DOI standard protocol:

"For the U.S. Department of the Interior to effectively implement adaptive management in a consistent and coherent manner across all bureaus, an operational definition is needed that will be applicable for all of DOI. The definition used in this technical guide is adopted from the National Research Council (19):

> Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a ‘trial and error’ process, but rather emphasizes

> learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders. This definition gives special emphasis to uncertainty about management impacts, iterative learning to reduce uncertainty, and improved management as a result of learning. ... There are many definitions in the literature on adaptive management, but a common theme shared by them all is that adaptive management is a learning-based process. The definition used in this guide was chosen because it emphasizes the use of learning to improve management decisions and because it is germane to resource management in DOI." (Williams et al.. 2009)

Table 1 shows the nine steps associated with the DOI standard for the execution of the AM Cycle, with summarization of key points for each step. With regard to the Western scientific method within the AM Cycle, notice especially Step 4 (hypotheses and predictions) and Step 8 (tests of predicted versus observed results). It would be difficult to find a more succinct and structured presentation of AM principles and processes for use by resource management agencies - including those such as the Agency with specific responsibilities regarding EAs. For the remainder of this report, when we use the term Adaptive Management, we are referring to this operational definition and summary steps of the AM Cycle (see also Appendix IV).

What about the many articles that have emerged over the past decade on 'Adaptive Co-Management'? - especially the paper by Berkes et al. (2000) entitled "Rediscovery of traditional ecological knowledge as adaptive management." As we discuss in Appendix V, a close examination of this literature shows that in this context, the term 'Adaptive' is being used in very different ways than the operational standard of 'Adaptive Management' presented in our report. When in doubt regarding different ideas called 'Adaptive Management', we strongly recommend that the reader keep their attention focused on the essential role of hypotheses (possible cause-effect explanations, models) and predictions in the AM learning cycle; if these concepts are absent or vague in the discussion, then - in our opinion - the authors are not discussing Adaptive Management.

We would like to end this description of AM principles and processes by drawing attention to the phrase “Policy as Hypothesis, Management by Experiment” that was referenced both in the literature (Lee, 1993; Lancia et al., 1996; Armitage, 2005) and by interviewees (W-01, IW-02). Figure 3 shows a schematic representation of the similarities between policy development and Western scientific methodology. Policies are created as possible mechanisms to achieve some goal; when implemented through management programs, the effectiveness of policies can be evaluated in terms of achieving the goals, which in turn can be revised by feedback from the policy test. When seen in this context, the idea of

experimental management is not really so risky and dangerous as might be expected by policy-makers and senior managers. In this context, institutional learning associated with AM truly is not much more than common sense (Holling, 1978).

> "That's Adaptive Management – learning while doing, not learning then doing." (W-01)

Table 1. Summary steps for implementation of Adaptive Management Cycle developed by US Department of Interior (adapted from Williams et al. 2009).

Step 1: Involve Stakeholders

a) A strong effort must be made to identify and engage the appropriate stakeholders.
b) All phases of the AM process must be open, transparent, and accessible to the stakeholders.
c) Stakeholders must strive for agreement on scope, objectives, and management alternatives for the Adaptive Management application.
d) Stakeholders must commit to a process for adjusting management strategy over time, based on resource status and learning.
e) Stakeholder organizations must be encouraged to commit time and energy to adaptively manage over the agreed-upon timeframe.
f) Stakeholders must commit resources for monitoring and assessment, in addition to decision-making.

Step 2: Establish Objectives

a) Objectives substantively influence decisions and management strategies.
b) Objectives should incorporate the social, economic and/or ecological values of stakeholders, and reflect the value of learning over time.
c) To be useful as guides for decision-making and evaluation, objectives should be specific and unambiguous, measurable with the appropriate field data, achievable but challenging, results-oriented, and applicable over the timeframe of the enterprise.

Step 3: Identify Potential Management Actions

a) Potential management actions consist of activities under management control.
b) Alternative management actions typically focus on alterations of resource status or process rates.
c) The suite of available management actions should be designed to promote learning.
d) The alternative management actions should be explicit and documented.
e) Stakeholders should participate in the identification of AM alternatives.

Step 4: Identify Models (Hypotheses) about Cause-Effect

a) Models in AM should characterize system behaviors and responses to management actions.
b) Models should incorporate different ideas (hypotheses) about how the resource system works and how it will respond to management (predictions).
c) The suite of models should capture key uncertainties (or disagreements) about resource processes and management effects.
d) Models must be compatible with, and calibrated to, available data and knowledge.

Step 5: Identify/Design Monitoring Plans

a) A monitoring plan should be designed to estimate system state and other attributes needed for decision making and evaluation.
b) The monitoring plan should promote learning through a comparison of estimates against model-based predictions.
c) The monitoring plan should be efficient, in that it produces estimates that have maximum precision for a given cost, or minimum cost for a given level of precision.

Step 6: Select Management Actions

a) At each point in time, selection of a management action is made from the set of possible alternatives.
b) The selection of a management action is guided by objectives, which are used to evaluate alternatives and identify an action that contributes to meeting the objectives.
c) Management is adjusted over time as resource conditions change and understanding evolves.

Step 7: Monitor (Follow-Up) System Responses

a) Monitoring typically occurs after interventions.
b) Resource status and other key indicators of impacts are estimated with monitoring data.
c) Estimates based on monitoring data are used to evaluate management impacts and inform decision-making at the next AM decision point.
d) Because the amount of monitoring data increases over the course of an application, the amount of information about system processes also increases.

Step 8: Assess/Analyze Predicted Versus Observed Changes

a) Assessment/analysis includes parameter estimation, comparative assessments, and prioritization of management alternatives.
b) Comparison of predicted and actual responses is used to update understanding of management impacts.
c) Comparison/ranking of desired and actual projected outcomes for management alternatives is used in selection of management actions.

Step 9: Iterate Through the AM Cycle

a) The cycle of Steps 6 through 9 is iterated until the end of the timeframe.
b) Iterations can begin at any point in the cycle; however a natural entry point is with decision-making.
c) The direct linkage from assessment to management action expresses the contribution of learning to decision-making, by providing information on which to base smart decisions.
d) The two-step linkage from management action to assessment expresses the contribution of management to learning, through interventions that are useful in investigating the resource system.

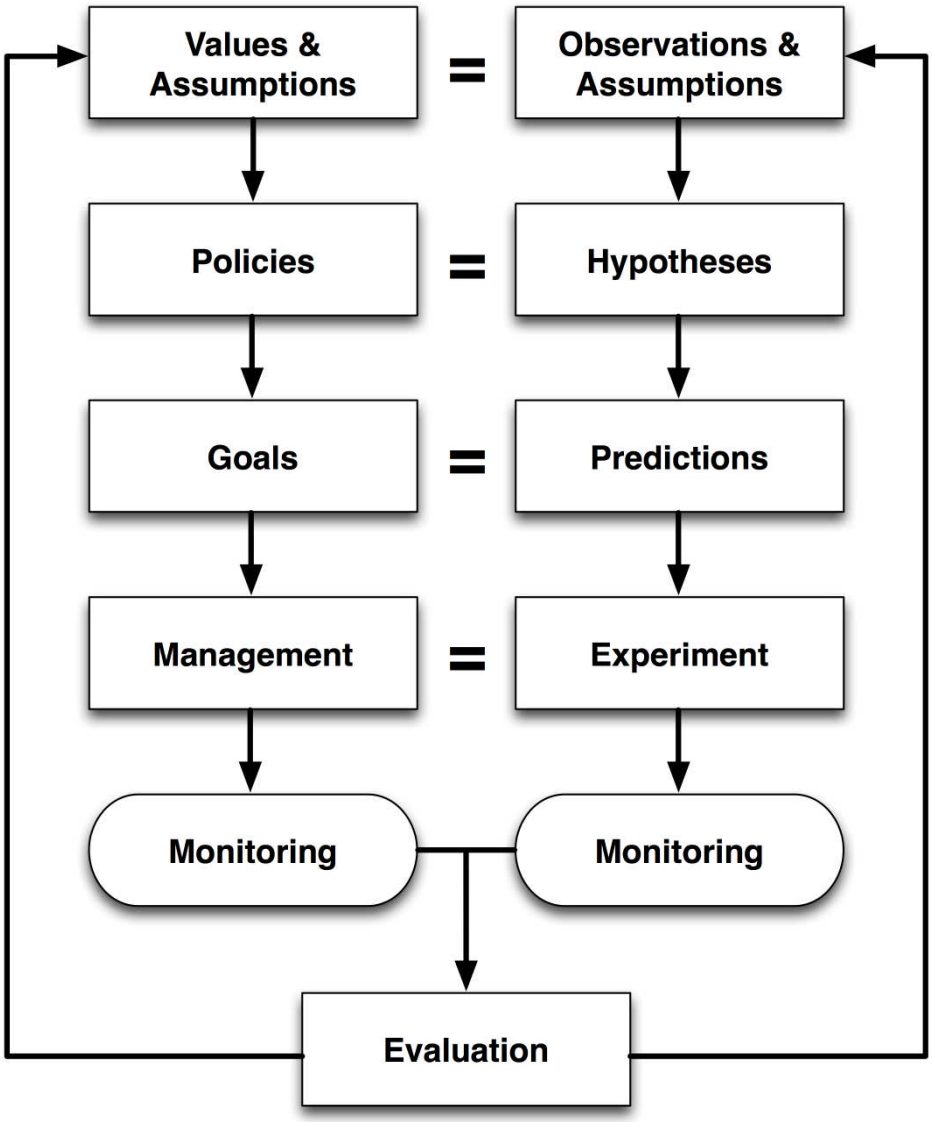

Figure 3. "Policy as Hypothesis, Management by Experiment." A cycle of leaning framework for Adaptive Management (Panel on the Ecological Integrity of Canada's National Parks Report 2000; pg. 3-2 – adapted from Holling, 1996; Nudds, 1996; Wiersma, 2005). In this cyclical AM approach, resource managers test their decision-making policies with management actions, reducing key uncertainties about the ecological/human system using the Western science method. This process of institutionalizing "learning while doing" is the essential characteristic of Adaptive Management for EAs or any other natural resource management application.

4.2 Western Science Perspectives on Adaptive Management for EAs

> "*And specifically with Adaptive Management, I know that it is somewhat limited, what we can do under the legislation. Basically, for a project to be approved you have to prove or say in the report that significant environmental effects will not happen but the nature of Adaptive Management basically is kind of testing to see if things are true. That basically admits that we don't really know how things are going to play out. We don't really know if an environmental effect will be significant and that it's kind of admitting that we don't know and under the Act you have to say that you do know.*" (W-02)

As discussed in the previous section, AM had its conceptual origins in "Adaptive Environmental Assessment and Management" (Holling, 1978). Since then, other disciplines (e.g. fisheries, forestry) have occasionally taken the lead on development and application of AM techniques, but it always seemed to come back to EAs sooner or later. Noble (2000) evaluated AM for environmental impact assessments, and concluded that the theoretical and empirical rigor associated with AM would strengthen decision-making for EA project management.

If AM is appropriate for EAs, at what point(s) in the process should it be involved? Several authors (e.g. Arts et al., 2001; Jackson et al., 2006) have divided the generic EA process into two major phases: Pre-Decision and Post-Decision (Figure 4). Usher (2000) further divided the Pre-Decision phase into three sub-phases: (a) Scoping/Guideline Development, (b) Preparation of an Environmental Impact Statement, and (c) Public Review of the EIS. During the Pre-Decision phase, EAs are largely focused on the need to predict the consequences of a proposed activity, and it is this need for prediction that highlights the importance of Western science and Adaptive Management in EAs (IW-03, Paci et al., 2002, although see Berkes, 1988c). According to the Agency, testable predictions for EAs need to be identified in a manner that is consistent with the definitions and operational protocol for AM:

> "*It is important to establish testable EA predictions when planning a follow-up program or potential adaptive management measures. For example, a prediction about the significance of an environmental effect should be specific enough that once a project is implemented, one is able to observe and collect information, analyse and interpret the data, and draw conclusions about whether the prediction was correct. Hypotheses should be constructed, tested and utilized in the further application of the scientific approach. Sound prediction methods provide a basis for understanding why change occurs in the environment and how to select adaptive management measures based on those conclusions.*" (CEAA, 2009a)

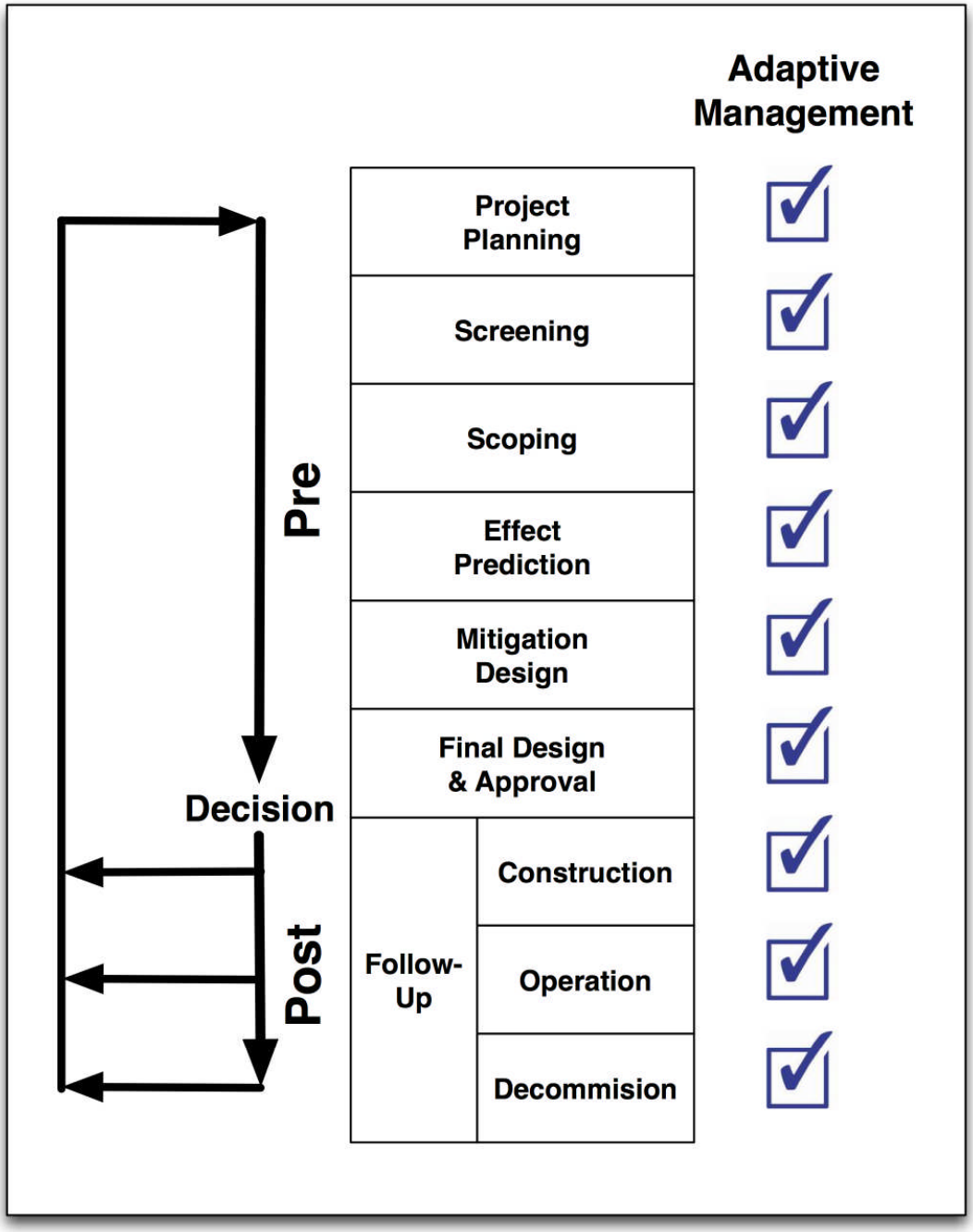

Figure 4. Adaptive management in the context of Canadian Federal Environmental Assessments (adapted from Jackson et al., 2006).

AM can also play an important role in the identification and evaluation of EA mitigation options for an EA during both Pre- and Post-Decision phases (Noble, 2000). The Agency specifically states that a responsible/regulated authority should be prepared to initiate AM measures if mitigation proves unable to eliminate or reduce the specified adverse effect (CEAA, 2009a).

> *"AM provides a forum within which people with different roles and perspectives can interact and share ideas or develop alternative ones. It provides an unfamiliar mix of interests, bringing together different approaches and views, and it draws from experiences in other areas and issues that relate to the particular scenario at hand." (Noble, 2000)*

Of the entire EA process, most people associate AM with follow-up monitoring; a phase that is explicitly intended: (a) to verify the accuracy of the EA, and (b) to determine the effectiveness of mitigation measures (Usher, 2000; CEAA, 2003). Although a Western Scientist would cringe at the idea of "verifying" predicted effects (implying that they are trying to prove the prediction is true, rather than determine whether the prediction is true or false), the basic idea of Western science is very easy to identify in the AM protocol: Step 7: Monitor Follow-Up System Responses and Step 8: Assess/Analyze Predicted Versus Observed Changes (Partidário and Arts, 2005; Slinger et al., 2005).

Some scholars have suggested that AM also has potential to assist EA practitioners in dealing with cumulative effects, despite the fact that such effects are typically complex and difficult to measure (Tollefson and Wipond, 1998). Jackson et al. (2006) suggested that EA examples from Everglades restoration and northern diamond mines demonstrate that AM has considerable promise, although the development of this potential is likely complex enough to warrant its own investigation.

Some of the participants interviewed for this project questioned whether there was currently sufficient commitment to the scientific method in EAs (conventional EAs or those involving AM) to actually have the desired effect on decision-making (IW-03, Jones and Greig, 1985).

> "*Unfortunately a lot of the EAs that I have reviewed or been involved in, the science is conducted by non-scientists and by non-scientist I mean someone like, particularly these consulting firms that are hired to collect data. It's in their best interest to find no impact and they don't particularly ask questions well and the methods are flawed or just simply the data aren't collected with the level of rigor I would expect as a scientist. And certainly would never accept as a peer review for a publication that I was reviewing but those same methods are used repeatedly in environmental impact assessment, incredibly important issues, and they are allowed to continue. Not only are the methods flawed but the motives of the people collecting the data, I think are ultimately flawed as well."* (IW-04)

This sense of caution seems to apply to the prospects of AM actually being implemented in Canadian EAs. Many of the participants surveyed in this project expressed the opinion that the Agency needs to assemble and/or orchestrate case studies of EA-AM implementation that could be used as training guides for both staff and practitioners (IW-03, W-02, W-03, I-01).

> "*Federal departments don't really incorporate [AM] all that much as of yet. You usually get a little paragraph or explanation of adaptive management within the follow-up program section of the EA training and guidance but there is very little guidance or advice out there for the departments on it and there is very little specific tools or templates or anything like that so I would say for the federal community its very poor quality. CEAA does have one guidance piece but I would say that doesn't go very far. CEAA may have 20 pages in two different guidance pieces and they are very general about concepts and roles and responsibilities and stuff like that. Rather than the more in-depth, focused tools and training, which can better explain to people.*" (W-02)

Others suggested that most Federal departments lack either the resources or "the appetite" to invest the energy into real, long-term AM for EAs (W-04, I-02, IW-01)

> "*I think that in the various stages of EA having it very clear where adaptive management, as a different process than they are used to, how it would change the questions you ask at each stage of the EA. It's the same thing you would have to do with Indigenous knowledge, you would say at this stage of the EA, project scoping or EA scoping, the scope of the EA. What would adaptive management say is the questions we would need to ask ourselves.* " (I-01)

Other participants suggested that, while AM was sorely needed and appropriate for the EA tasks at hand, the implementation could always be compromised by vested interests - unless steps were taken to bring in third-party facilitators who really understand AM <u>and</u> want to help proponents, opponents, and regulators work out a plan that everyone could live with (IW-04).

> "*I think (AM) has only relatively recently come in to the CEAA worldview, and I think the comments I made earlier apply. I think it is like cumulative affects assessment, it's one of those, in strategic environmental assessment, it's in that category of really awesome ideas that nobody knows how to do. I always say to myself, then get really practical, explain, give examples of how it has been done or how it actually fits in at each stage of decision-making. If you were doing Adaptive Management in terms of post-project EA what would it look like?*" (I-01)

4.3 Indigenous Perspectives on Adaptive Management for EAs

> "*There is no single definition for any of [the terms like Indigenous knowledge], as perhaps is reasonable since it will take on different meanings depending on the specific understanding of the First Nation, which is in turn based on its unique culture, language, and geography.*" (CIER, 2009)

Let's begin this section by not trying to create or evaluate the many detailed definitions that have been proposed for Indigenous Knowledge, Aboriginal Traditional Knowledge, Traditional Ecological Knowledge, local knowledge, etc. Rather, we ask the reader to consider that Indigenous communities are knowledge systems; communities made up of individual people (smaller knowledge systems), communities that in turn make up cultural groups (larger knowledge systems). Consider also that Indigenous knowledge belongs to the Indigenous community, and if the community chooses to share its knowledge with outside people for an EA, then the knowledge can and should be represented in context along with other knowledge in order to make good decisions about the EA (Paci et al., 2002). If the community wants its knowledge to be included in the EA, then the Agency or responsible authority is responsible for making sure that the knowledge is received and used in the spirit that it was intended.

As clearly described above, EAs in general - and EAs incorporating Adaptive Management in particular - are Western science decision-making systems, and they follow Western science protocols for conduct and decision-making. It is important to recognize that Indigenous communities can (and perhaps should) have their own EA decision-making systems, and these EAs would follow Indigenous protocols for conduct and decision-making (I-03, IW-06). It would be desirable for practitioners of Western science and Indigenous EAs to discuss their processes and conclusions in a relationship of respect and trust.

> "*Community knowledge and Aboriginal traditional knowledge <u>may</u> be considered in conducting an environmental assessment.*"
>
> Canadian Environmental Assessment Act (1992, S16.1, <u>emphasis</u> added)

For the purpose of this project, we distinguish between two different kinds of Indigenous knowledge that can relate directly to the Adaptive Management cycle for EAs. The first kind of knowledge relates to Indigenous values, principles and objectives that are necessary for AM Step 1: Involve Stakeholders, Step 2: Establish Objectives, and Step 3: Identify Potential Management Actions. The second kind of knowledge relates to Indigenous insight on 'states of nature,' which in turn can mean either conditional knowledge (e.g., how many, how far, how long) or causal knowledge (A causes B, if you do X then Y will happen).

Knowledge about states of nature is required for Step 4: Identify Models (Hypotheses) about Cause-Effect, Step 5: Identify/Design Monitoring Plans, Step 6: Select Management Actions, Step 7: Monitor (Follow-Up) System Responses, and Step 8: Assess/Analyze Predicted Versus Observed Changes.

As the reader can probably anticipate, we see absolutely no difference between the potential role for Indigenous and non-Indigenous knowledge holders in the Western science and/or AM methodology of EAs. The critical factor in this relationship is that the local Indigenous and Western science knowledge holders working on the EA must develop their own reciprocal knowledge exchange protocol. Once the terms of exchange have been negotiated, the science-based EA can proceed with both Indigenous and non-Indigenous knowledge systems engaged. There are, however, some important characteristics of Indigenous knowledge holders that may be important in their willingness or ability to participate in such a Western decision-making system.

One of the most important factors that distinguish Indigenous knowledge holders, especially those that lead traditional lives on the land (or water), is the fact that they are not quite so disconnected from the ecosystem as many Western people who live in urban or other technological environments (Ellis, 2005). Combined with a degree of inter-generational continuity, these connections to the ecosystem can be reasonably expected to increase expertise in evaluation and decision-making that would be functionally similar to EA methodology:

> "*Bring the people back to the ecosystem and realize that they are an integral part of it before that assessment is done. I believe that many assessments are done as if nature is separate from us, from people.*" (IW-06)

> "*Traditionally, the aboriginal perspective was holistic because environmental assessment was an integral part of daily life. It was a feedback loop by which people observed the consequences of past and present action and considered the likely impacts of future action. The process was integrated with the cultural life of the community. Environmental assessment was practiced directly and continuously by those who simultaneously harvested, managed and controlled the resources. The knowledge generated by environmental assessment was produced, refined, stored, disseminated and used by a rich system of testing, observing, theorizing and communication involving complex social structures, information networks, and rituals.*" (Paci et al., 2002)

But are we simply projecting Western characteristics onto our Indigenous colleagues when we describe their skill set in a manner that conveniently complements our scientific EA methodology?

Some Indigenous communities have strong reservations about the role of predictions in their knowledge systems, for example:

> "*As for the biologists' objectives of "controlling" fish populations and "predicting" sustainable yields, the Cree thought that these were immodest aims of apparently immature people playing god, given that the success of fishing depended on the fish and the respectful attitude of the fisher.*" (Berkes, 1999, p.117)

> "*I guess my experience is that there are very different approaches to prediction and the way, at least my understanding of the way, that is communicated is very different and certainly there's, in some ways, an important aspect to that but I have also been told by yet other communities that prediction of the future you have to be careful because predictions you state openly can actually change the future and cause it to occur. […] Others have placed almost a taboo on prediction or statement of future outcome so I would say, at least in my experience, that there is a whole range of potential perceptions of that.*" (IW-04)

However a sampling of references from the scholarly literature and interviewed knowledge holders demonstrates the practical importance of forecasting the future in other Indigenous cultures:

> "*My concern is that we're going to end up with lessened caribou and their reproduction will probably decrease as the result of being stressed and being moved and whatever... And, like I said again, I'm not an expert on any of this, so I'm only guessing on what I have seen in the past. (McWilliam, 1995:5)*" (Stevenson, 1996)

> "*He [a particular Elder] not only provides his own personal assessment based on his environmental knowledge, but also predicts the specific impacts of the proposed dam construction on the animals and, consequently, on the Cree.*" (Roue and Nakashima, 2002)

> "*In the case of the BHP diamond mines in the NT, TEK of the Dene people was incorporated into the EIA. The use of TEK in the EIA process allowed for the determination of the importance of the Lac de Gras area to the caribou herd, the range and variability of herd composition over time and at various locations, and the determination of the anticipated effects of anthropocentric emissions on the caribou.*" (Tsuji and Ho, 2002)

> "*[Predictions are] very important because it guides you in the decisions you're making today. Indigenous cultures are all based on seven generations into the future so the decision that you're making today, you have to account for a thousand years down the road.*" (I-02)

And this brings us to the interesting observation that many Indigenous cultures share a general prediction in the form of a 'Seventh Generation Prophecy' (Aikenhead, 1997):

"*This is a time of re-emergence for Native people; a "new springtime" which was foretold in ancient Indian prophecy. The prophecy said that the peoples of the earth would be dispersed separately to the four directions, where they would learn individual bodies of knowledge. The people represented by the color yellow would be keepers of the air knowledge; those represented by black would know the water wisdom; those associated with the color white would know the ways of fire; and the red people would be keepers of the earth. It was also said that one day, prompted especially by efforts of the white knowledge, the red, the yellow, the black and the white would begin to move back together to share their knowledge and create a time of wholeness. That time is now.*" (Simonelli, 1994, p.9)

For a culturally specific example, consider Benton-Banai's (1988) account of the *Anishinabe nee-gawn-na-kayg'* – the seven major prophets (Seven Fires) who came to the people with seven predictions of what the future would bring. We strongly encourage the reader to consider Benton-Banai's account in full, however in the context of this project we feel there is value in considering his account of the seventh prophet:

"*The seventh prophet that came to the people long ago was said to be different from the other prophets. He was young and had a strange light in his eyes. He said, "In the time of the Seventh Fire a Osh-ki-bi-ma-di-zeeg' (New People) will emerge. They will retrace their steps to find out what was left by the trail. Their steps will take them to the elders who they will ask to guide them on their journey. But many of the elders will have fallen asleep. They will awaken to this new time with nothing to offer. Some of the elders will be silent out of fear. Some of the elders will be silent because no one will ask anything of them. The New People will have to be careful in how they approach the elders. The task of the New People will not be easy.*

If the New People will remain strong in their quest, the Waterdrum of the Midewiwin Lodge will again sound its voice. There will be a rebirth of the Anishinabe nation and a rekindling of old flames. The Sacred Fire will again be lit.

It is at this time that the Light-skinned Race will be given a choice between two roads. If they choose the right road, then the Seventh Fire will light the Eight and Final Fire – an eternal Fire of peace, love, brotherhood and sisterhood. If the Light-skinned race makes the wrong choice of roads, then the destruction which they brought with them in coming to this country will come back to them and cause much suffering and death to all the Earth's people." (Benton-Banai, 1988, p.91)

Although there are certainly individual- and culture-specific differences among knowledge holders, it seems likely that many Indigenous cultures would use predictive capability for EAs. In a paper entitled "Knowledge and foresight: the

predictive capacity of traditional knowledge applied to environmental assessment," Roue and Nakashima (2002) argue that there is a basic, common-sense Indigenous approach to the scientific methodology of Western EAs:

> "*TEK can also be thought of as having the characteristics of scientific knowledge as defined by Palys (1997). There is a systematic element to the collection of TEK, as specific observations are gathered from certain activities during identified times of the year (e.g., caribou harvesting and distribution; Ferguson et al. 1998; Berkes, 1999). TEK is also subject to peer and public review. For example, predictions of where and when organisms will aggregate can be tested through observation by peers or by scientists (Johannes, 1978; Tsuji, 1996a; Berkes, 1999). Many studies have also indicated that TEK about any given phenomenon is not held by one person, but is understood and accepted by many people who have experience in that area (Shute and Knight 1995; Tsuji 1996a; Ferguson and Messier 1997). TEK is also part of a collective process as it depends on the observations and teachings of previous generations and other community members (see e.g., the Cree Elder's prediction of the return of the caribou in the eastern James Bay region of northern Quebec, Canada - Berkes, 1999). Finally, TEK is also self-reflexive as the knowledge holders are constantly incorporating new knowledge in the context of previously held knowledge (Tsuji et al. 1999).*" (Tsuji and Ho 2002)

or, to put a more friendly face on the issue:

> "*The approach we are suggesting was pioneered by Dr. Thorn Alcoze, who has a Ph.D. in biology and is of Cherokee ancestry (Greer, 1992). He holds the belief that "scientific concepts exist in Native American traditions" (Greer, 1992:12). Further, he stresses that similarities between western science and TEK must be emphasized to dispel <u>the myth that science is "a white man's thing. Indians don't do that. We don't analyze</u>" (Alcoze quoted in Greer, 1992:13).*" (Tsuji and Ho, 2002, emphasis added)

What then, is the relationship of Indigenous people to Adaptive Management?

As previously discussed, Berkes (1999) and associates (Berkes et al., 2000; Moller et al., 2004) have proposed that Traditional Ecological Knowledge systems of Indigenous people throughout the world can be considered functionally equivalent to AM - especially in regard to dealing with ecosystem uncertainty, and structured feedback learning.

> "*[AM] reflects their understanding that change is a constant in ecological and social systems. I think that the most adaptive people, especially in a northern context, have clearly demonstrated that its been Indigenous people because, depending on who you quote here on the documentation, the occupation of the north. Clearly their knowledge has been adaptive for thousands of years in very, very harsh conditions. I think that it closely reflects it and if you talk to them and discuss what adaptive management*

> *is and co-management you can in many ways start seeing Elders often nodding when you have that discussion so I think that is where it is similar to it. Its imperfect too and its changing so I think that once you have acknowledged that, you dispel the arrogance of the past - and unfortunately the present for some researchers - and then you acknowledge that all your knowledge is imperfect and contextual."* (I-02)

Given the fact that Western science is the heart and soul of AM, it might come as no surprise that scholars have reported that numerous Indigenous communities have been receptive and positive about AM methodology when applied to resource and/or environmental management in their traditional territories. McDaniels et al. (1994) reported on an ambitious effort to coordinate British Columbia salmon fishery management with multiple governments, First Nations, and other harvesters. Toledo et al. (2003) described successful application of AM for tropical forest management with Mexican Indigenous communities. Stankey et al. (2006) provided detailed reports of AM applications across multiple generations of Indigenous Micronesians for coastal and fisheries management. Wilson and Woodrow (2009) cited Adaptive Management experiments by Indigenous Australians for hunting, fire and land management.

For the final component in this section on Indigenous Perspectives on Adaptive Management in EAs, we turn to *Anishinaabe* scholar Deb McGregor who shared an insight of personal discovery regarding Indigenous and Western learning:

> "*I have only recently come across confirmation for my belief that [Indigenous knowledge] is a cycle. Gregory Cajete writes: Building on prior learning and traditions is never a direct or linear path. Instead, Indigenous science pursues a rather meandering path around things and over obstacles, a roundabout way. In the Western mind-set, getting from point a to b is a linear process, and in the Indigenous mind-set, arrival at b occurs through fields of relationships and establishment of a sense of meaning, a sense of territory, a sense of breadth of the context.*" (McGregor, 2004)

We challenge the reader to consider the degree to which Western science in general, and Adaptive Management in particular, are linear processes (Figure 1, 2, 3, 4). Perhaps if we focused on cycles of learning in cross-cultural EAs, we could find common ground upon which to learn together while making important management decisions.

4.4 Similarities and Differences in Perspectives on Adaptive Management

"*You often see these tables in books and in papers that say traditional knowledge on one side and then Western Science in the other and then trying to define it in terms of terms. In most cases, I disagree with those tables and the gross over simplification that occurs on both descriptions. Well for example, some people say that traditional knowledge is holistic and of course it is, it is very much holistic and that is one thing that impresses me about it. But then on the other hand someone will say that Western Science is reductionist only and that is clearly not the case with some science and certainly the way I practice Western Science isn't completely reductionist. (...) This idea of objective science versus subjective traditional knowledge is clearly not even close to being correct. And that is probably one of my big frustrations is this attempt to pigeonhole or define what science is relative to traditional knowledge ultimately. The vast majority of the descriptions I have seen are wholly inadequate in that regard."* (IW-04)

It should be clear from the way we have approached this project that the concept of knowledge systems (Indigenous, Western science) is much more important than knowledge. Knowledge is critical for EA practitioners; knowledge of (a) states of nature (e.g. how many, how big, how far), and (b) cause-effect relationships (action X will cause response Y). However, it is the knowledge systems producing knowledge that we really need to understand for cross-cultural EAs. Do the knowledge systems have fundamental similarities in the intellectual process of creating order out of disorder (Berkes, 1993; Stevenson, 1996)?

Agrawal (1995) identified three major types of similarities/differences that could exist between knowledge systems at the local level:

- substantive: similarities/differences in the subject matter;
- epistemological: similarities/differences in methods of knowledge acquisition; and
- contextual: similarities/differences in how deeply each is rooted in its own context.

For the purpose of this project, we have focused on the methods of knowledge acquisition, to show that AM is clearly based on the Western scientific method of learning. However, this observation does not mean that Indigenous cultures do not share some or all of the components of the Western knowledge systems. Do Indigenous people not employ something similar or identical to 'deductive logic'?

Tsuji and Ho (2002) offer an enlightened analysis of knowledge creation, with general references to Indigenous and Western science knowledge systems:

> "*Many academics hold different views on how TEK and science create knowledge, and whether or not they are in fact, different in their methods of knowledge acquisition. (Agrawal 1995); attempts to define or differentiate between science and TEK have failed for two reasons (Agrawal, 1995). The first is that both knowledge systems are highly heterogeneous. The second is that both knowledge systems are highly dynamic, evolving over time."* (Tsuji and Ho, 2002)

and

> "*From the brief examples given above, it appears that by the standards of the scientific approach, TEK more closely resembles science than lay-knowledge. However, some real differences exist between TEK and science in that non-testable phenomena such as intuition and beliefs, as well as inter-generational and personal observations, are components of knowledge in TEK."* (Tsuji and Ho, 2002)

In our opinion, common sense says that whether you are looking for similarities or for differences, you will surely find them.

Of course, the only meaningful discussion about similarities and differences between Indigenous and Western science knowledge systems needs to take place directly between individual knowledge holders in those local knowledge systems. It is these local people who will need to describe to each other how their people learn about the 'states of nature.' It is at this level that the prospects for collaboration must be evaluated (Nadasy, 1999; O'Faircheallaigh, 2007).

With specific reference to the suitability of Adaptive Management (i.e. Western science) for cross-cultural EAs, the local knowledge holders from both cultures will have to work this issue out for themselves. They are the only people qualified to determine if they can collaborate effectively for practical application of this learning technique on specific projects.

Some readers will be very dissatisfied with such a simple analysis and conclusion. Others will think it is the only viable conclusion.

"*I always say to myself, then get really practical, explain, give examples of how it has been done or how it actually fits in each stage of decision making. If you were doing Adaptive Management in terms of post-project EA, what would it look like?*" (I-01)

5. Conclusions/Recommendations

The goal of this project was to develop and evaluate a translation of principles/processes for Adaptive Management in the context of EAs - a translation that would be understandable and meaningful for both Indigenous and Western science collaborators. After reviewing the principles and processes of EA Adaptive Management, and considering AM from Indigenous and Western science perspectives, we conclude this report by identifying a key strategic uncertainty and associated tactical recommendations.

Adaptive management must be seen for what it is - a management technique that is fundamentally based in Western science, based on our need to use management decisions as an institutional learning tool. There is no separation between management and policy and science; they are one.

While Adaptive Management may be a culturally specific (i.e. Western) form of a general solution in human ecology, Indigenous communities must determine for themselves whether they see common elements and/or opportunities between Adaptive Management and their own culturally specific knowledge systems.

If so, then the Agency and other responsible authorities can offer Adaptive Management as a viable framework within which Indigenous and Western science knowledge holders can learn together: asking questions, putting forward possible explanations, generating and evaluating predictions as 'proof in the pudding,' and building trust in each other's commitment to ongoing improvement of our EAs.

If not, then Adaptive Management and Western science can not and should not be forced on Indigenous cultures for EAs, or any aspect of resource management for that matter. This cultural tyranny would only produce conflict, mistrust and bad management - the complete opposite of what Adaptive Management seeks to achieve.

So, the key issue really has to do with dialogue between community-based Indigenous and Western science knowledge holders, to determine if Adaptive Management is a viable framework for true collaborative management in EAs. If the Agency decides that it is willing to invest in these kinds of cross-cultural relationships, then we can identify a handful of tactically important recommendations for making progress:

1. The Agency should develop an internal concept and terminology guide to promote understanding and consistency in their policy and guidance. The concepts and terms in the guide should not be dictated as required definitions, but rather the guide should be offered to provide a clear

starting place for discussion between Indigenous and Western science knowledge holders.

2. The Agency should support the development and field testing of a process to help local Indigenous and Western science knowledge holders create their own local reciprocal knowledge exchange protocols to (a) describe the ways that their respective knowledge systems work, (b) determine if there is sufficient compatibility to consider working with Adaptive Management within EA, and (c) if so, exchange knowledge to try to implement the Adaptive Management learning cycle on specific projects.

3. The Agency should support the compilation, study and description of specific practical examples of Adaptive Management (in EA, and otherwise), with sufficient detail and clarity of presentation that Indigenous and Western science knowledge holders would be able to make their own evaluations regarding feasibility and effectiveness.

4. The Agency should work cooperatively with willing Indigenous communities to design and implement workable Adaptive Management approaches for specific EA test projects in which Indigenous and Western science knowledge holders are required to serve as full and equal partners.

Appendices

Appendix I. Email invitations sent by the Principal Investigator to the candidate knowledge holders, with a description of the project.

Dear <Knowledge Holder>,

My research team is currently seeking experts in the areas of environmental assessment, along with Aboriginal (Indigenous) knowledge and/or Adaptive Management, to participate in a research project sponsored by the Canadian Environmental Assessment Agency (CEAA). The purpose of the research is to explore the translation of principles and processes for Adaptive Management within the context of environmental assessments, in a manner that is meaningful for both Aboriginal and Western science collaborators.

Participants will be asked to complete a one-hour, semi-structured interview conducted in-person or over the telephone at a convenient time. The interview questions will be focused on the themes of: (a) Aboriginal knowledge in the context of environmental assessment, (b) Western science in the context of environmental assessment, and the relationship between learning processes in Aboriginal and Western science knowledge systems. Additional information about this research is contained in the attached Consent Form, which we would need you to review and sign for UofG Ethics approval.

Due to timeline restrictions, we would like to complete most interviews within the next two weeks (before 19 March 2010), however if you are not available during this time we would still like to arrange an interview. If you agree to participate, Cara Wehkamp (Post-Doctoral Research Associate) or Natasha Smith (Graduate Research Assistant) will be in contact to schedule the interview at your earliest convenience.

Although this is an initial scoping project, we want to consult with as many people with EA-Aboriginal and/or EA-Western science expertise as possible. Please feel free to distribute this email to other candidates who you feel might be particularly appropriate for the study, or advise us confidentially in your response,

If you are willing to take part in this study, or if you have any questions about this research project, please contact me.

Thank you for your consideration,

Steve Crawford
Chippewas of Nawash-UofG Faculty Partnership

Appendix II. Research Ethics Consent Form.

COLLEGE OF BIOLOGICAL SCIENCE
Department of Integrative Biology

CONSENT TO PARTICIPATE IN RESEARCH
28 February 2010

Reciprocal Translation of Aboriginal/Western Science Adaptive Management for Environmental Assessments

You are asked to participate in a research study conducted by Stephen

Crawford (Lead Researcher), Assistant Professor, Nawash-UofG Faculty

Partnership, Department of Integrative Biology; Cara Wehkamp (Post-Doctoral Research Associate), Aboriginal Student Advisor, Student Life and Counselling Services and Natasha Smith (Graduate Research Assistant), Master of Arts Candidate, Department of Sociology and Anthropology at the University of Guelph. This project is funding by the Canadian Environmental Assessment Agency's (CEAA) Research and Development Program.

If you have any questions or concerns about the research, please feel free

to contact: Stephen Crawford, Assistant Professor, Nawash-UofG Faculty

Partnership**,** Department of Integrative Biology at (519) 824-4120 extension 53544 or scrawfor@uoguelph.ca.

PURPOSE OF THE STUDY

The purpose of the study is to create a mutual translation of principles and processes for Environmental Assessment and Adaptive Management; a translation that is understandable and meaningful and practical for both Aboriginal (Indigenous) and Western science collaborators.

PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

Interview:
Participate in a semi-structured interview that will be no longer than one-hour long. The interview will take place in person or over the telephone and be focused on the themes of Aboriginal knowledge in the context of environmental assessment, Western science in the context of environmental assessment, and the relationship between Adaptive Management and Aboriginal knowledge.

At the conclusion of the study, the research findings will be available to the public on the Canadian Environmental Assessment Agency website under Research and Development Research Reports (www.ceaa-acee.gc.ca).

POTENTIAL RISKS AND DISCOMFORTS

There is possible social risk for participating in this project. Although procedures will be used to ensure confidentiality, there is a risk that if any of your comments become public, this could have a negative effect and result in a loss of status, privacy and/or reputation.

In order to avoid this, the research team intends to keep all interviews and information confidential. In order to do this, you will be assigned an ID code so that your name will not be attached to your interview or any quotations used in the final report submitted to the Canadian Environmental Assessment Agency.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

There is no direct personal benefit to the participants of this study.

The information gathered during this research could be used to change or add to the role of Adaptive Management and Aboriginal Traditional Knowledge in environmental assessments in Canada. Environmental assessment (EA) practices may be improved in at least three different ways.

First, Western EA managers and non-scientist knowledge holders will receive the benefit of having Adaptive Management explained in a straight-forward and understandable manner geared to them as a non-expert target audience. Having a better understanding of EA Adaptive Management should improve the frequency and participation of Western non-experts in future EA follow-up programs.

Second, Aboriginal EA managers and knowledge holders will receive the benefit of having Adaptive Management explained in a straight-forward and understandable manner geared to them as an Aboriginal target audience. Having a better understanding of EA Adaptive Management should improve the

frequency and participation of Aboriginal governments and communities in future EA follow-up programs.

Third, the Canadian Environmental Assessment Agency will benefit by being uniquely poised to work with both Aboriginal and Western EA managers and knowledge holders to develop and evaluate new methods of cross-cultural communication that can significantly improve the practical application of environmental assessment in Canada and throughout the World.

PAYMENT FOR PARTICIPATION

No payment is offered for participation in this research.

CONFIDENTIALITY

Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study.

The interview will be confidential to the best of the research team's ability, and participants will be assigned an ID code, which only the research team will have access to. The only identifying information that will be retained is the participant's self-declared area of expertise, which will be used to determine the range of expertise consulted during the research. All written records, with no names attached, will be kept private and secured in a locked storage unit in the researcher's private office. Any audiotapes of interviews will be kept password protected and stored securely. Data will be kept until the completion of the contract and following publication, the data will be destroyed by shredding hardcopy documents or deleting digital files. The final report that is released to the Canadian Environmental Assessment Agency will contain general findings that cannot be linked to the individual participants.

Audiotapes:

You have the right to refuse to be audiotaped during the interview. If you agree to be interviewed, you have the right to review the transcripts, which will be transcribed by the research team. If you refuse to be audiotaped, you have the right to see the notes of your interview done by the interviewer. No one but yourself and the research team will have access to the tapes or the transcripts/notes of your interview at any time during or after the research is completed.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing your data from the study. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the University of Guelph Research Ethics Board. If you have questions regarding your rights as a research participant, contact:

Research Ethics Coordinator
University of Guelph
437 University Centre
Guelph, ON N1G 2W1

Telephone: (519) 824-4120, ext. 56606
E-mail: sauld@uoguelph.ca
Fax: (519) 821-5236

RECORDING OF INTERVIEW

☐ **I agree to have the in-person or telephone interview audio-recorded.**

SIGNATURE OF RESEARCH PARTICIPANT

I have read the information provided for the study "*Reciprocal Translation of Aboriginal/Western Science Adaptive Management for Environmental Assessments***" as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.**

_____

Name of Participant (please print)

_____ _____

Signature of Participant Date

SIGNATURE OF WITNESS

_____

Name of Witness (please print)

_____ _____

Signature of Witness Date

Appendix III. Interview Themes and Questions for Semi-Directed Interviews with ATK-EA and WS-EA Experts. Total time for the interview did not typically exceed 1 hour, unless the interviewee wished to take more time to answer questions or explore related ideas.

1. Introduction

- Were you able to review and submit the consent form? Following the University of Guelph's ethics protocol, I'm going to take a moment to go over a few points with you.
- You are being asked to take part in a one–hour, recorded phone interview.
- As the consent form indicates there are potential social risks inherent to this type of interview and to mitigate these risks we will keep all recording and transcripts confidential and not include your identifying information in the final report.
- Additionally, there is no personal benefit associated with this study and no remuneration will be given for your time.
- You can chose whether to be in this study or not and you may withdraw at any time without consequences. Please contact Steve Crawford using the contact provided in the consent form if you have any questions.
- This is a semi-directed interview and I have a prepared list of questions to use as a guide however please feel free to present alternative ideas or make additional comments where you see fit.

2. Expert Self-Declaration

a) Do you identify as Indigenous (First Nation, Inuit or Métis) or non-Indigenous? (if Indigenous - what Nation/Community?)
b) What is your area of expertise – ATK/WS?
c) What is experience with – EA/AM?

3. Indigenous (Traditional) Knowledge in Context of EAs

a) From your perspective, what is AK-ATK (learning=creation of new knowledge)?
b) How should the Federal government deal with so many different definitions of AK-ATK (TEK, IK, etc.)?
c) Is learning (creation of new knowledge) in Indigenous culture different from learning in Western culture?
d) How is reliable knowledge evaluated in Indigenous culture (what if you had different possible explanations)?
e) Within Indigenous culture, how important is the ability to predict the future?
f) Do you think that the Federal government's guidance and policy effectively incorporates AK-ATK? Why?
g) What can the Federal government do to improve the role of AK-ATK in EAs?

4. Western Science in Context of EAs

a) From your perspective, what is the Western scientific method (learning=creation of new knowledge)? Can you elaborate on the method?
b) How should the Federal government deal with the many different definitions of science?
c) Is learning (creation of new knowledge) in Western culture (scientific method) different from learning in Indigenous culture?
d) How is reliable knowledge evaluated in Western culture (what if you had different possible explanations)?
e) Within Western culture, how important is the ability to predict the future?
f) Do you think that the Federal government's guidance and policy effectively incorporates the scientific method? Why?
g) What can CEAA do to improve the role of the scientific method in EAs?

5. Adaptive Management in Context of EAs

a) From your perspective, what is Adaptive Management?
b) How does Adaptive Management relate to Western science?
c) Do you know of any cases in which AM has been successfully used (EA or otherwise)? Examples?
d) Do you think that the Federal government's guidance and policy effectively incorporates AM? Why?
e) What can the Federal departments (CEAA) do to improve the role of AM in EAs?

6. Wrap-Up

a) Do you have any other comments or recommendations?
b) Are there any other experts (ATK or WS) that you think we should interview?

Appendix IV. Summary of Key Points about Adaptive Management (adapted from Williams et al., 2009).

1. What is Adaptive Management?

a) Resource management involves decision making in an environment of multiple management objectives, constrained management authorities and capabilities, dynamic resource systems, and uncertain responses to management actions.
b) Resource management increasingly involves the articulation of objectives and management options and the use of analytical techniques to identify optimal management strategies.
c) Adaptive management (AM) is a structured approach to decision making that emphasizes accountability and explicitness in decision making.
d) AM is useful when there is substantial uncertainty regarding the most appropriate strategy for managing natural resources.
e) AM acknowledges uncertainty about how natural resource systems function and how they respond to management actions.
f) AM is designed to improve understanding of how a resource system works, so as to achieve management objectives.
g) AM makes use of management interventions and follow-up monitoring to promote understanding and improve subsequent decision-making.
h) Active and passive approaches to AM can be distinguished from other management approaches based on their treatment of uncertainty and emphasis on learning.
i) Multiple sources of uncertainty can influence resource systems and alter the capacity for AM to manage them.
j) Learning is advanced by the sequential AM comparison of model predictions against monitoring data, whereby confidence in an underlying hypothesis is based on the relative accuracy of model predictions.
k) The practice of AM flourishes in a learning organization that is open to surprise, accommodates risk, and encourages and rewards learning.
l) Learning in AM proceeds most rapidly when pursuit of resource objectives is temporarily postponed so that management interventions are implemented according to an experimental design.

2. When Should Adaptive Management be Used?

a) AM requires stated management objectives to guide decisions about what actions to take, and explicit assumptions about expected outcomes to compare against actual outcomes.
b) For AM to be successful, executive leadership must support needed changes to existing institutional culture and structures.
c) Stakeholders must be willing to work collaboratively in a group environment to plan specific courses of action.
d) In order for a specific AM strategy to work on the ground, stakeholders must support the strategy goals and objectives.
e) Implementation of AM can be facilitated by using pre-existing structures and processes.

f) AM is not appropriate for single-time decision making.
g) AM is not appropriate if monitoring information is unavailable to decision makers.
h) AM is not appropriate if there are irresolvable conflicts about objectives or decision alternatives.
i) AM is not appropriate if management interventions cannot influence system behaviors in ways that affect management returns.
j) AM is not appropriate if there is not a commitment to sustained funding for monitoring and assessment.
k) AM promotes cooperative decision making in the face of uncertainty about the impacts of management interventions.
l) AM produces management strategies consisting of actions that are tied to resource status and current understanding.
m) AM brings resource managers, researchers, and other stakeholders together and encourages long term collaboration.
n) Resistance to institutional change and a complex legal environment can be impediments to AM.
o) Agencies must be willing to commit to monitoring and evaluation over the life of an AM project.

3. What Legal/Administrative Factors are Important for Successful Adaptive Management?

a) Adaptive management must be integrated with all existing legal obligations of the agency; it is not a replacement for environmental compliance.
b) Adaptive management must comply with environmental laws.
c) Integration of Adaptive Management and other legal obligations requires thoughtful “up-front” planning, and involves an investment of time and resources by the agency and other stakeholders.
d) Integrating environmental review procedures with Adaptive Management requires consideration of the range of adaptive actions and attendant environmental effects that can reasonably be anticipated at the time of the environmental review.
e) The management alternatives and effects considered in an Adaptive Management application must be reviewed in light of the relevant environmental laws and regulations, so that environmental compliance applies not only for the initial action, but also for adaptive redirections that may be needed in the future.
f) For some Adaptive Management applications, it may be appropriate to assess environmental effects of future adaptive actions on a case-by-case basis using streamlined EAs or informal consultations. Such an approach may serve to strengthen the case for compliance when uncertainty exists regarding the environmental effects of future adaptive actions.
g) Key to successful integration of environmental law and Adaptive Management is a well planned and thorough up-front consideration of the range of potential actions and their effects, so as to ensure that future

actions and their effects are within the scope of the initial analysis and do not require subsequent environmental analysis.

4. When is Adaptive Management Successful?

a) Adaptive management allows managers to determine systematically whether management activities are succeeding or failing to achieve objectives.
b) An Adaptive Management project is recognized as successful if (1) stakeholders are involved and committed to the process; (2) progress is made toward achieving management objectives; (3) results from monitoring and assessment are used to adjust management decisions; and (4) implementation is consistent with applicable laws.
c) The implementation of Adaptive Management can be facilitated by considering a series of questions related to the success criteria, and the operational steps.

Appendix V. The relationship between Adaptive Management and 'Adaptive Co-Management'.

It is important to recognize recent growth of the term ‘Adaptive’ in the ecological and management literature. This kind of conceptual development is common when stimulating ideas move across disciplinary boundaries, and can lead to powerful tool combinations and new ways of thinking about old problems. For the purpose of this report, the reader needs to be aware that ‘Adaptive’ concepts do not necessarily carry with them the principles and process of Western science and the operational AM Cycle presented above.

Interestingly, it seems that one of the most vigorous developments of ‘Adaptive’ thinking has its origin in the effort to better understand the relationship between Indigenous and Western science knowledge systems. In 1993, Fikret Berkes offered one of the first working definitions of ‘traditional ecological knowledge’ (TEK):

> “*Putting together the most salient attributes of TEK from these sources, one may arrive at a working definition: TEK is a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.*" (Berkes, 1993, p.3)

Over the course of a few years, this working definition developed to a point where it was re-presented by Berkes in his “Sacred Ecology” text with the following modifications:

> “*Putting together the most salient attributes of traditional ecological knowledge, one may arrive at a working definition of traditional ecological knowledge as a cumulative body of knowledge, practice, and belief, evolving by <u>adaptive processes</u> and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. This definition, evolving from our earlier work (Berkes 1993; Gadgil et al. 1993; Berkes et al. 1995), is the operational definition used in this volume.*” (Berkes, 1999, p.8, <u>emphasis</u> added)

In this text, Berkes used the term ‘adaptive’ in several ways:

> "*Cultural ecology is an ethnological approach that sees the modes of production of societies around the world as adaptations to their local environments. The field has its origin in the work of Steward (1936) on the social organization of hunter-gatherer groups. Steward argued against environmental determinism, which regarded specific cultural characteristics as arising from environmental causes. Using band societies as examples, he showed that social organization itself corresponded to a kind of ecological adaptation of a human group to its environment. He defined cultural ecology as the study of <u>adaptive processes</u> by which the*

nature of society and an unpredictable number of features of culture are affected by the basic adjustment through which humans utilize a given environment.

Subsequent work showed that the study of processes of human adaptation to the environment was a productive line of inquiry in cultural anthropology, and that sound empirical data were available to document wide-ranging and systemic ecological relationships (Lee and Devore 1968; Netting 1986). Even though traditional ecological knowledge is generated locally, comparative analysis has shown the existence of similar ecological adaptations in comparable areas. In some cases, such as in shifting cultivation systems, and the use of fire, traditional systems may should functional equivalents in quite different cultural and geographic settings ... All of this makes the study of traditional ecological knowledge more than just locally significant. Because traditional systems often involve long-term adaptations to specific environments and natural resource management problems, they are of interest to resource managers everywhere. One example of such an adaptation is human territoriality and the use of resources on a territorial basis." (Berkes, 1993, p.48, his emphasis)

"*Ecologically speaking, the human species may be reasonably characterized as a K-strategist, that is, a species adapted to maintain populations close to the ecological carrying capacity (Gadgil 1987). Thus, in human groups, one would expect to find social regulation of resource use, including territoriality and a range of other social mechanisms designed to prevent resource depletion [...] After all, basic principles of evolutionary ecology are applicable to the human species, too.*" (Berkes, 1999, p.60, our emphasis)

and perhaps most importantly,

"*Several chapters in part 2 [of this text] make reference to two concepts, adaptive management and Social Learning. Adaptive management is an integrated method for natural resource management (Holling 1986; Lee 1993; Gunderson et al. 1995). It is adaptive because it acknowledges that environmental conditions will always change, thus requiring management institutions to respond to feedbacks by adjusting and evolving. Adaptive management, like some traditional knowledge systems, takes a dynamic view of ecosystems, emphasizes processes (including resource use) that are part of ecological cycles of renewal, and stresses the importance of resilience, that is, the buffering ability of the system to absorb change without breaking down or going into another state of equilibrium. As well, adaptive management, like many traditional knowledge systems, assumes that nature cannot be controlled and yields predicted; uncertainty and unpredictability are characteristics of all ecosystems, including managed ones. In both cases, feedback learning is the way in which societies deal with uncertainty. Often, this is not learning at the level of the individual, but*

social learning at the level of society or institutional learning at the level of institutions (Ostrom 1990)." (Berkes, 1993, p.60, his emphases)

It is clear to us that Berkes was using the term ‘adaptive’ with very different meanings in different contexts.

Within the field of biology, there are at least three different uses of the term ‘adaptation’ or 'adaptive', each with substantially different meaning, leading to considerable confusion if the terms are not carefully defined with context (see West-Eberhard, 1992; Ch.2 'Adaptation, current usages'). ‘Adaptation’ to physiologists who study regulatory process within organisms, refers to a process used by an organism to respond to a change in its local environment (temperature, oxygen, pH, food, etc.). 'Adaptation' can also refer to the process or product of evolutionary change in a population of organisms (including humans) under natural or sexual selection. It is clearly this second meaning that Berkes was referring to when he described cultural ecology and evolution of 'adaptive' human social mechanisms.

To be clear - Adaptive Management as defined and operationalized by institutions like the U.S. Department of Interior (Williams et al., 2009) is ‘adaptive’ in the sense that institutional management uses decision-making as an active tool to obtain new knowledge, so that it can understand the world better (i.e. learning), and 'adapt' by making better decisions about future management plans. There is no direct emphasis on ‘adaptation’ in the sense of evolutionary ecology or cultural evolution; this was something qualitatively new that Berkes (1993) recognized from other literature, and brought into the discussion.

This discussion may seem overly-concerned with the definitions of words, however it has become very important to distinguish among the different uses of the word 'adaptive' that have developed over the past decade, especially 'Adaptive Capacity' (e.g. Berkes et al. 2003) and especially 'Adaptive Co-Management' (Davidson-Hunt and Berkes, 2003; Olsson et al., 2004; Davidson-Hunt, 2006). Consider, the following explanations of 'Adaptive Co-Management' that have been published in the literature:

"*Adaptive co-management may be referred to as "a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organized process of trial-and-error.*" (Marschke and Nong, 2003)

"*The inclusion of adaptive management into new contexts of shared NREM [natural resource and environmental management] decision-making has been referred to as adaptive co-management (Olsson et al., 2004a,b).*" (Davidson-Hunt, 2006)

"*Adaptive co-management, in particular, is an outcome of the adaptive management and collaborative management experiences in which the learning and linking functions (horizontally and vertically) of governance*

are emphasized. Ruitenbeek and Cartier (2001, p. 8) define adaptive co-management as "… a long-term management structure that permits stakeholders to share management responsibility within a specific system of natural resources, and to learn from their actions". Similarly, Olsson et al. (2004, p. 75) define adaptive co-management as a "… flexible, community-based systems of resource management tailored to specific places and situations, and supported by and working with, various organizations at different scales"." (Armitage et al., 2008)

"*While a considerable theoretical base has evolved for both co-management (eg Hanna 1994; Pinkerton 1994; Jentoft et al. 1998) and adaptive management (eg Holling 1978; Walters 1986), merging the two concepts engenders an approach that is distinct from either.*" (Armitage et al., 2009)

Examination of this newly emerging field of 'Adaptive Co-Management' shows that, despite explicit references to 'Adaptive Management,' there is virtually no recognition or discussion of the Western scientific method (hypotheses, predictions, tests) upon which Adaptive Management is actually based.

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