Multi Criteria Decision Analysis as a Framework for Integrated Land use Management in Canadian National Parks

by

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ABSTRACT

Parks Canada, the primary Agency responsible for the protection and preservation of Commemorative and Ecological Integrity throughout the Canadian National Parks system, is advocating an integrated and collaborative approach to management, based on principles and concepts set forth by the Ecosystem Based Management philosophy.

The adoption of such a philosophy implies a recognition that firstly, environmental, economic, as well as social perspectives need to be considered for all decisions; secondly, that ecosystem components consist of dynamic functions and processes that span a multiple of temporal and spatial scales; thirdly, that ecosystems are not confined to any administrative boundaries; finally, that human knowledge about all ecosystem components, their functions, their interactions among each other, as well as the effects of human action on these systems is inherently poor, ascribing high levels of risk and uncertainty to any decision.

This report argues that, although Parks Canada has a wide array of management tools available, these tools have been designed and are used predominantly as situation- and type- specific management tools, and lack explicit linkages between them. Such a situation severely limits the efforts of implementing an ecosystem based management approach from the outset.

Consequently, this report argues in favour of a more all-encompassing decision-support framework that would complement, co-ordinate, and connect the present tools and their respective outputs. The proposed framework is based on concepts of Decision Analysis, mainly two Multi Attribute Decision Making methods. The report demonstrates that such a framework would improve the soundness and effectiveness of the Agency's decision-making and communication structure and would facilitate the integration of its existing data and information bases. By integrating these fundamental decision making components, the framework promotes: 1) sound documentation practices, which increase the acceptance of and compliance with actual decisions; 2) an increased awareness of the various management agendas and critical issues surrounding protected area management, which decreases the likelihood of goal fragmentation and sliding of objectives; and 3) an increased ability to capitalise on existing data and information while identifying data gaps for further analysis, which reduces the risk of costly duplications and overlapping of efforts.

Denna rapport är respektfullt tillägnad min familj.

This report is respectfully dedicated to my family.

Doubt is not a pleasant condition, but certainty is absurd.

Voltaire (Francois Marie Aruet) (1694-1778)

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AAA	Appropriate Activities Assessment
AHP	Analytical Hierarchy Process
CEA	Cumulative Effects Assessment
CEAA	Canadian Environmental Assessment Act
CI	Commemorative Integrity
DA	Decision Analysis
DM	Decision-maker
EA	Environmental Assessment
EI	Ecological Integrity
ELECTRE	Elimination et choix traduisant la realite
EMAN	Ecological Monitoring and Assessment Network
ESBM	Ecosystem Based Management
GP	Goal Programming
LAC	Limits of Acceptable Change
LP	Linear Programming
MADM	Multi Attribute Decision Methods/Making
MAUT	Multi Attribute Utility Theory
MCDA	Multi Criteria Decision Analysis
MCMP	Multi Criteria Mathematical Programming
MODM	Multi Objective Decision Methods
MP	Monitoring Program
NGO	Non Governmental Organisation
NPA	National Parks Act
NPR	National Park Reserve
PRNPR	Pacific Rim National Park Reserve
ROS	Recreational Opportunity Spectrum
VM	Visitor Management
WCT	West Coast Trail

"While we are increasingly realising that the [protected area] management issues to be addressed are the result of interacting ecological, social, and economic forces – our planning tools and decision-making systems have yet to be integrated."

Wright (1994, p. 49)

Chapter 1

INTRODUCTION

"*To commemorate, protect and present, both directly and indirectly, places which are significant examples of Canada's cultural and natural heritage in ways that encourage public understanding, appreciation and enjoyment of this heritage, while ensuring long-term ecological and commemorative integrity*."

Parks Canada's purpose statement (Parks Canada, 1995)

In adherence to the fundamental statement above, Parks Canada's overriding management goal is to protect Ecological[1] and Commemorative Integrity, and to ensure that it "takes precedence in acquiring, managing, and administering heritage places and programs" (Parks Canada, 1994b). This report takes an interest in analysing how the Agency[2], globally recognised as one of the world's leading protected area management agencies, conducts and organises its activities and internal operations in order to fulfil such a sizeable management task.

Parks Canada is not in a unique position. The care and management of protected areas is widely recognised as a complex undertaking, requiring continuously ongoing and dynamic management processes to be successful. This is because:

- Administratively imposed management boundaries are recognised as severely deficient in capturing the true complexity of ecosystems. The systems' functions and processes span far wider temporal and spatial scales than tenures or other management agreements typically would imply. Hence, sound protected area management calls for recognition of ecosystems geographical boundaries, and for the systems to be viewed as interlinked components of a more complex system (Galindo-Leal and Bunnell, 1995; More, 1996; Gerlach and Bengtson, 1994).
- Management issues in protected area contexts are inherently complex as they typically emerge from not one but several interacting and concurrent factors from ecological, economic, as well as social disciplines (Wright, 1994; Ruitenbeek, 1991; Rennings and Wiggering, 1997).
- The integrity of a protected area depends on more than its immediate internal management decisions. The integrity also depends on previous, concurrent, and future management activities in adjacent areas. Hence, explicit awareness and consideration of neighbouring jurisdictions' activities and management

[1] There are numerous definitions for Ecological Integrity. This report makes use of the following: "An ecosystem has integrity when its structure and function are unimpaired by human-caused stresses and are likely to persist" (Parks Canada, 1992b).

[2] Parks Canada is also referred to as the Agency in this document.

agendas[3] is required (Peterson, 1987; Woodley, 1991; Woodley, et al., 1993; Key and Schneider, 1994).

Consequently, protected area management is a complex challenge which involves various scales and disciplines, and which commands frequent decision-making under aspects of risk and uncertainty. Decision situations in this context habitually entail multiple decision-makers with various management agendas and power structures, or decision-making processes (Nijkamp, 1980). As a result, management decisions often take place in fields of conflicting goals and views on land use and economic, environmental, and social progress in our society (ibid.).

Faced with the task of achieving sound protected area management in a multifaceted context, Parks Canada managers are advised to advance the care of these systems in a holistic manner, focusing on an integrative and collaborative management approach (Parks Canada, 1996c). Researchers from a variety of disciplines corroborate the opinion that, in order to foster holistic management efficiently, management approaches benefit from the presence of an overall, integrative framework (Nijkamp, 1980; Lakshmanan, 1980; Nijkamp, et al., 1990; Schmoldt, et al., 1994). Such a framework plays the important role of enhancing the possibilities of implementing and operationalising the predominantly theoretical ideas of integrative and collaborative management given by most management philosophies (ibid.).

In reference to the Parks Canada management context, such a framework should be designed to:

- ensure that the various decisions and decision-making processes affecting an area are brought together into an overall management context (e.g. U.S.D.A., 1996);
- advance the ability for concurrent consideration of decision situations' various components, and for various groups' conflicting or differing opinions regarding how these components relate to the Agency's overall management objectives (e.g. Lakshmanan and Nijkamp, 1980; Schmoldt, et al., 1994).

By advancing integrative and collaborative management, such an overall framework would further the identification of acceptable solutions and compromise strategies (Nijkamp, 1980). The framework would also advance streamlined and efficient documentation practices (Schmoldt, et al., 1994). And, finally, such a framework would improve the efficiency of managers' data and information gathering processes by assessing various data and information's availability and subsequent gaps (Nijkamp and Rietveld, 1984; Daykin, 1999).

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[3] The term management agendas refers to the various legislation and regulations shaping the direction of activities undertaken by the various groups involved in management aspects of these areas.

Problem formulation

This report will start from the premise that Parks Canada has recognised the complexity of its management challenges and therefore has adopted a holistic ecosystem based approach to management. However, as the report will show, certain deficiencies can be observed with the Agency's current approach, especially with regards to its decision-making frameworks, i.e. management tools. Currently, the overall structure of the Agency remains fragmented into several areas of concern. Many decisions are made within one department, without explicitly considering how those decisions relate to the system and management context as a whole (Wright, 1994). This report will argue that the management tools that the Agency employs currently provide sound assessments of situation- and application- specific issues. However, the rather narrow design and underlying assumptions of the tools, as well as the lack of a coherent, overall framework, leave their assessments inherently ineffective for addressing the linkages between various management issues. The result is a fragmented depiction of the management context at large (Lakshmanan, et al., 1980; Nijkamp, et al., 1990; Malone and Bell, 1991). This report argues that such a situation might easily lead to a disjointed, as opposed to a holistic, management approach (Nijkamp, et al., 1990; Nijkamp, 1980; Lakshmanan, 1980), and consequently limiting the Agency's opportunities for integrative and collaborative management from the outset.

Research goal

It is the primary intent of this research to suggest an overall decision-support framework that would assist Parks Canada in its pursuit of more holistic management, by facilitating integrative and collaborative management efforts. The report provides the reader with an understanding of the need for such a framework by evaluating a representative set of the Agency's present management tools. With the evaluation's salient question being whether these tools and their application format provide a foundation sufficient enough to support the management principles by which the Agency's management approach revolves, the report assesses whether and how the application format of these tools can be improved. Thereafter, the report provides a methodological description, a hypothetical application, and an evaluation of a more all-encompassing decision-support framework, alternatively referred to as a decision-making tool. It will be demonstrated that the suggested framework has the ability to promote sound decision-making, effective communication, as well as easy integration of existing management tools' data and information output, for various types of management issues at the Agency's Field Unit level. It will further be demonstrated that such advancements are not only beneficial in respect to fulfilling Field Unit management objectives, but also provide significant advantages for the overall management context.

Study rationale and significance

The rationale for the specific type of method and framework proposed by this report is supported by the need for sound decision-making processes within Parks Canada. The report will argue that, in order for decisions to be considered sound, they must be well co-ordinated, of high quality, and must produce acceptable outcomes to the affected parties. Hence, the preceding decision-making processes must provide comprehensive, yet user-friendly, analytical components, that include explicit opportunities for the incorporation of decision-makers' preferences and management agendas. Such processes should further be capable of assessing problem situations and their critical issues both from their situation specific perspective as well as from a more overall perspective of the Agency's policy framework and general management directives. Finally, processes should provide consistent, yet flexible, templates to facilitate communication of their output between neighbouring jurisdictions and partners at scales matching the various areas of co-operation and concern.

The arguments above, favouring more comprehensive decision-processes, are reinforced in the recently published report by the Panel on Ecological Integrity of Canada's National Parks (Parks Canada Agency, 2000; 2000a)[4]. The Panel provides additional justification for the research below as their report also draws attention to the lack of explicit and consistent national standards to guide overall data collection and management. It suggests that Parks Canada is gathering much data and information in an ad hoc manner, leaving more specific data needs unidentified. The report also recognises that the lack of proper procedures and practices for sharing of knowledge often leaves data and information ineffectively communicated at various scales (e.g. within Parks Canada and between federal departments), resulting in a general unawareness of its existence. Hence, the Panel recommends a consolidation and standardisation of record management practices[5]. The Panel further recognises a need for improvements in regards to measures taken for proper justification and accountability for management decisions. The Panel therefore recommends that decision-making processes should become more transparent, and that their information and ideas should be presented in a more easily understandable format to the general public. The Panel also suggests that the Agency should become better at assuring all involved parties are given a clear understanding of the Agency's mandates and objectives. Finally, the Panel recommends that more emphasis should be placed upon improving the ability of decision-making processes' to ensure that decisions made through the involvement of the public, external stakeholders, or interest-groups uphold the maintenance and restoration of ecological integrity, and that all decisions demonstrate an overall concordance with relevant national park policies and regulations.

This report proposes that Parks Canada adopts a decision-support framework based on the concepts of Decision Analysis, that will greatly facilitate the attainment of the above recommendations. The

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[4] The panel was commissioned by the Government of Canada to assess the state of EI in Canadian National Parks from a scientific perspective (Parks Canada, 2000a). Their report (Parks Canada Agency, 2000; 2000a) identifies a number of remedial strategies and recommends improvements to the entire NP system.

[5] The issue of a lack of proper record management practices for human use data and information within Parks Canada is also addressed in other documents, such as the Banff National Park's Human Use Database Draft (Parks Canada, 2000b).

significance of the framework lies in its applicability as an extended management tool for Parks Canada, providing comprehensive assessment possibilities of various issues on the level of Field Units within the Parks Canada organisation. It further facilitates an amalgamation of existing information and data, and an improvement of practices for communication and sharing of knowledge at various scales of co-operation and concern. In doing so, the proposed framework offers significant improvements to Parks Canada's present management approach, facilitating the long-term maintenance and restoration of EI.

Additionally, it will be illustrated that the application of a more formal decision analysis process does not necessarily require complex modelling skills, or significant amounts of additional time or funding allocations. Rather, the framework's acknowledged concepts and user-friendly method, commonly referred to as "the formalisation of common sense for complex decision situations" (Keeney, 1982), should save managers both time, efforts, and costs over the long term and with repeated applications.

Notes and limitations

The application of formal decision analysis processes within the context of protected area management is not a new undertaking per se. However, the report's application to the Canadian National Park context, as well as the rationales for Parks Canada adopting such a framework, present the Agency with an innovative approach to integrated and collaborative management.

The case study presented in Chapter 5 draws on the problems encountered in one specific area of the Pacific Rim National Park Reserve: the West Coast Trail, but remains a hypothetical application with fictional data and the author's own assumptions. Therefore, the case study serves primarily illustrative purposes.

The critique of Parks Canada's present management approach and its associated tools should be interpreted from the following perspective: the currently employed management approach achieves many of the important aspects of ecosystem based management. Rather than suggesting a replacement of present tools, the framework proposes a sound addition to the current approach by supplementing and significantly enhancing the current management tools' capacities.

Report organisation

Besides this introduction, this report is organised into 5 further chapters:
Chapter 2 describes the current management context of Parks Canada. The Agency's goals, objectives and responsibilities are outlined for the two main administrative levels: the National level, and the Field Unit level.

Chapter 3 describes the Agency’s fundamental management philosophy, outlines the principles of ecosystem based management, and evaluates a representative set of the Agency’s present management tools. These tools are assessed for their individual and collective strengths and weaknesses. The evaluation revolves around the most essential characteristics that management tools should possess in order to contribute to sound protected area management.

Chapter 4 provides a background and technical overview of Decision Analysis. Two specific methods (ELECTRE and AHP), which will be applied in an ensuing case study, are described in more detail.

Chapter 5 presents a hypothetical case study shaped by the components of Parks Canada’s management context described in Chapter 1. The case study illustrates how management situations within the Agency would benefit from employing a formal decision analysis framework. The framework is formed using the fundamental concepts described in Chapter 4. The chapter further assesses the suggested framework’s strengths and weaknesses, using the same evaluative criteria as for the comparative evaluation of the management tools in Chapter 3.

Chapter 6 concludes the report with a summary assessment of the main points from the preceding chapters. This assessment leads up to a final discussion on the expected, immediate and long term advantages from applying the suggested decision-making process in the Parks Canada context.

Chapter 2

PARKS CANADA'S MANAGEMENT CONTEXT: MANDATES, OBJECTIVES, AND RESPONSIBILITIES

Parks Canada is organised into two levels of management – the National office and the Field Units (Parks Canada, 2000a)[6]. On the one side of the management structure, the National level, focus lies primarily on strategic management and policy development. External and internal demands on the Agency's management practices are translated here into prescriptive policies and regulative directives. These are operationalised into management codes of conduct, operating principles, and guidelines, and implemented at the Field Unit level, located at the opposite end of the management structure. Composed of national parks, national historic sites, and national historic channels, Field Units' main responsibility is adhering to and program delivery of national policies and codes of conduct in actual management situations. Between these two levels of administration are the Service Centres. The Centres function in support of the two levels by providing leadership, expert advice, innovation and the facilitation of knowledge transfer. They also supply professional and technical services in a variety of protected area disciplines such as planning, science and research, engineering and architecture, environmental assessments and data management/GIS. As such, the Service Centres provide the connective links between Field Units and the National office.

This chapter describes the Agency's management context in terms of its goals, objectives, and responsibilities, from the National and the Field Unit perspectives. The discussion will bring forth the interdisciplinary nature of Parks Canada's management context in which it is essential to consider social, economic, and environmental management aspects concurrently. Furthermore, it will be illustrated that the Agency recognises that successful achievement of these goals, objectives, and responsibilities relies on management principles which advocate integrated management, where stakeholders and interest groups take on active roles in management and decision-making processes.

National Level - Management Goal, Responsibilities and Objectives

The paramount goal of Parks Canada, and the first priority in management is to strive for the protection and preservation of Commemorative Integrity (CI) and Ecological Integrity (EI) throughout all protected areas under its care (*National Parks Act*, 1988: section 5.1.2; Parks Canada, 2000a). This fundamental management goal permeates all planning and management activities within the Agency, reflecting the primary responsibility inherent in Parks Canada's mandate (Figure 2.1 below). At the same time, this key mandate is also supported by Parks Canada's role as a federal agency (Parks Canada Agency, 1999), and as a contributor to the Canadian Biodiversity Strategy (Canada, 1995).

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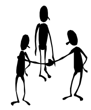
[6] Appendix 1 provides an organisational chart.

1

Fundamental Goal of Canadian Biodiversity Strategy:
Conservation and Sustainable use of Biological Diversity (Canada, 1995).



2

Federal Governmental Agencies Responsibilities:
Contributing on the international, national, and local levels to sustaining cultural and natural heritage (Parks Canada Agency, 1999.)

Parks Canada Parcs Canada

3

Parks Canada Mandate:
"To protect and preserve for all time representative natural areas of Canadian significance in a system of national parks, and to encourage public understanding, appreciation, and enjoyment of this natural heritage so as to leave it unimpaired for future generations." (*National Parks Act,* 1988)

Figure 2.1 Parks Canada's mandate and responsibilities

Based on the paramount goal and responsibilities mentioned above, prescriptive policies and regulative directives, as well as specific operating principles and guidelines are designed. Many of the critical points from these types of documents can be summarised into seven management objectives[7] (see below and Figure 2.2). These National level objectives collectively provide a formal frame and rationale for the spirit in which management of these protected areas are to be conducted. They serve as the foundation for the Agency's protected area management approach, supporting the pursuit of achieving ecosystem health (Parks Canada, 1994b).

Objective (1) Leadership and Stewardship

Parks Canada sets standards for environmental leadership and stewardship nationally as well as internationally due to its globally recognised leadership role. Hence, it is important that the Agency demonstrates good ethics and practices in its approaches to management.

Objective (2) Research and Science

Responsible management requires that the management methods are based on state-of-the-art knowledge. As an established and leading protected area manager, the Agency is not only required to lead a good

[7] The seven objectives below are based on Parks Canada's ten guiding principles (Parks Canada, 1994b). They are referred to as objectives rather than guiding principles in this document. Their numerical order does not imply an importance ranking.

example and apply state-of-the-art scientific management practices, but also to contribute to the advancement of research.

Objective (3) Collaboration and Co-operation

Sound management practices also need good ongoing working-relationships with all associated stakeholders and interest groups. Parks Canada is to promote inclusive decision-making and an open dialogue with interested and affected parties. The Agency further supports international, national and regional integration through initiatives such as partnerships and collaborative management arrangements.

Objective (4) Public Involvement

Public involvement in planning and management processes enhances the public's understanding and acceptance of decisions, and is at the same time an important source of knowledge and suggestions for management improvements. Therefore, the general public's input is to be taken explicitly into consideration in the Agency's policy, planning, and management processes.

Objective (5) Education and Presentation

The long term success of EI and CI is highly dependent upon the Canadian population's ability to understand and appreciate the value of protected areas. Sharing the Agency's knowledge with the public is essential in order to increase Canadians' understanding of these areas and consequently, to improve the public's contribution to policy, planning and management processes. As a result, it is important that Parks Canada provides the public with opportunities for learning and education in conjunction with the provisions of opportunities for participation.

Objective (6) In-Park Activities

Recreational activities, along with facilities management, constitute one of the primary threats to ecosystem health in protected areas (Parks Canada, 2000a). Hence, it is essential that the Agency regulates the appropriate types, locations, and extents of activities, to ensure that their positive contribution towards public enjoyment outweighs their negative effects on the overall CI and EI goal.

Objective (7) Accountability

The achievement of the final objective: demonstrating accountability towards the Canadian public and Parliament for the application of these objectives and related policies and directives, is assisted by the above described objectives themselves. They collectively provide the basis for a sound strategic management approach that is receptive to research advancements, and offer appropriate opportunities for learning, enjoyment, and collaboration in decision-making by stakeholders, interest groups and the general public. As such, the objectives jointly increase public understanding and respect for protected areas, and subsequently heighten the level of acceptance of and compliance with management decisions.

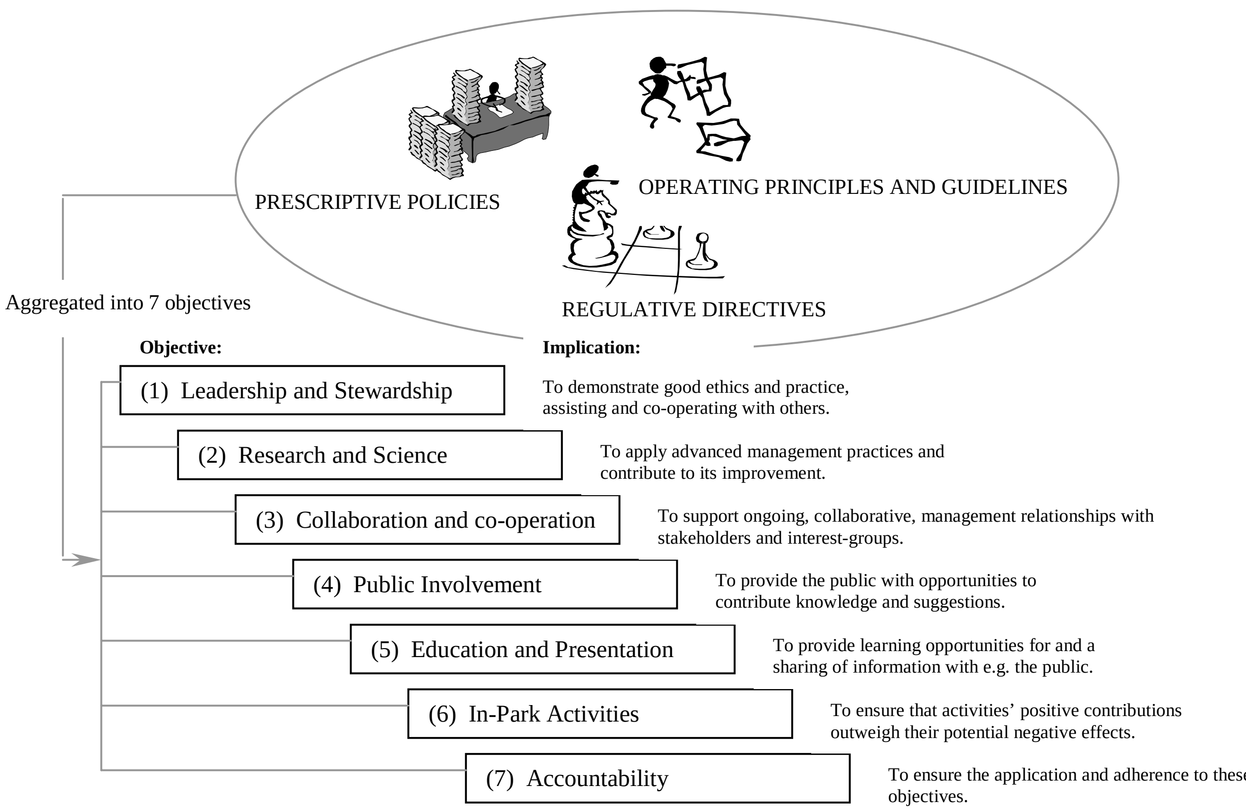


Figure 2.2 National Level: goal, responsibilities and objectives

Field Unit Level - Management Principles and Objectives

At the Field Unit level, the national policies, directives, operating principles and guidelines, represented in this report by the seven National level objectives above, are implemented through day-to-day management activities. At the Field Unit level, these strategic objectives are often paraphrased into more operational forms, still representing the same overall goal and ambitions but more readily reflecting Field Unit specific circumstances (Parks Canada, 1994b). The three objectives and four management principles below and in Figure 2.3, reflect the managerial conditions surrounding Pacific Rim National Park Reserve (PRNPR). Note that the objectives and their respective components presented were formulated based on a combination of information from the National Business Plan (Parks Canada, 1995), the Parks Canada's Mandate for Change (Parks Canada, 1999a), the Guiding Principles and Operational Policies (Parks Canada, 1994b), the State of the Parks Report (Parks Canada, 1997), and PRNPR's Ecological Integrity Statement (draft, 1999)[8].

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[8] The components' numerical order does not imply an importance ranking.

Objective (1) Ecosystem Health

The protection of biodiversity is essential for achieving the first objective, ecosystem health. Maintenance and enhancement of ecosystem structures within a park and its surroundings are key to maintaining viable populations of native species, by securing quality habitat and connectivity throughout a region. As well, the maintenance, restoration, and monitoring of natural processes that may have been reduced or eliminated from the system, are vital to quality ecosystem processes. To achieve the Ecosystem Health objective, park managers are advised to adopt a regional approach to management, including integrated monitoring efforts. A management principle under this objective is to actively involve stakeholders and other interest groups in the various stages of planning and management, fostering long-term working-relationships such as partnerships and collaborative arrangements.

Objective (2) Serving Canadians

The National Parks Act states clearly that the Agency's protected areas are "lands dedicated to the people of Canada" (*National Parks Act*, 1988, section 4). Hence, the second objective, serving Canadians, refers to the appropriate meeting of public expectations regarding use and non-use activities, as well as other, non-use, benefits provided to the public at large by these protected areas. The term "appropriate" is a key word, implying a two-tiered task. On the one hand, National and Field Unit specific regulations about the types, location, and extent of activities to be allowed should address the general public's expectations, ensuring their overall satisfaction. On the other hand, such regulations should also reflect the Ecosystem Health objective. Consequently, proper restrictions should be set to ensure that human induced stresses are minimised and not in conflict with management planning and practices striving to reduce such environmental impacts, or producing effects that are non-mitigatable.

The achievement of this objective is in a sense a self-regulating process. Because a pristine environment is one of the main factors contributing to visitor satisfaction, its protection is also in the visitors' self-interest. However, the high rate of visitation to national parks produces extremely high pressures on park environments. Therefore, in order to achieve this second objective it is necessary for management to recognise the importance of the following management principles: to educate the public, to involve them in planning and management activities, and consequently to promote their sense of environmental stewardship. These principles play a key role as they contribute to increased acceptance and adherence to restrictive management measures among the parties involved.

Objective (3) Wise and Efficient Management of Funds

The third objective for the Field Units is to ensure wise and efficient management of funds. A significant amount of Parks Canada's financial support is funded by governmental appropriations, which are of limited supply. Efficient management of these public funds includes the Field Units' responsibility to meet or exceed set revenue targets[9]. Such targets, increasing the Field Units' self-sufficiency given diminishing government funding, are met to a great extent by park fees, a concept introduced in the 1990s (Parks Canada, 2000). By making users of these protected areas pay for the additional personal benefits they receive, the user fees can help to off-set the cost of managing recreational impacts (ibid.). Field Units are also an integral part of their respective local and regional economies. As such, another important aspect of this fiscal objective is the Field Units' contribution, directly or indirectly, towards the prosperity of local and regional economies by meeting or exceeding business and employment opportunity targets. The working principles that complement this objective include working in a collaborative and co-operative fashion with stakeholders and interest groups, while ensuring meaningful public involvement.

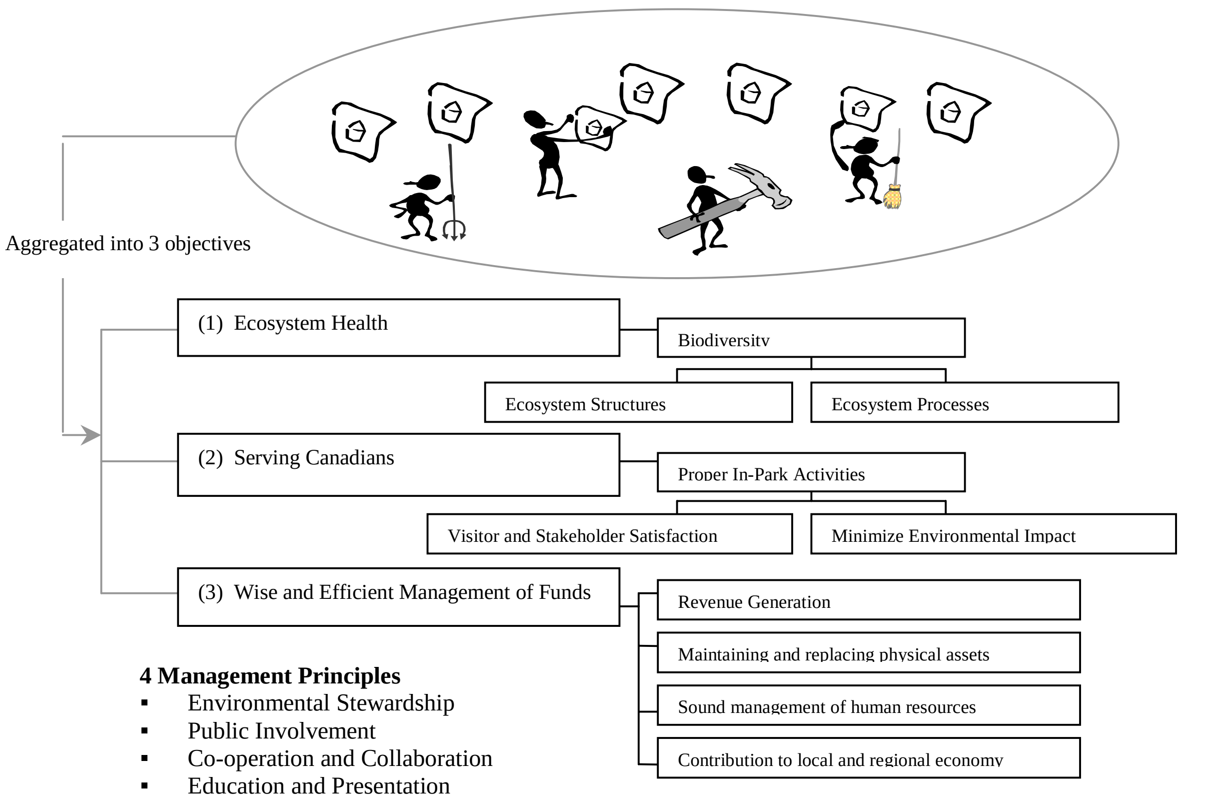

Figure 2.3 Field Unit Level: management principles and objectives

[9] Though excluded from further attention in this report, it should be noted that the fiscal objective also includes the maintenance and replacement of physical assets so as to meet or exceed quality standards, and sound human resource management to meet or exceed fair distribution standards of staff's working responsibilities (Parks Canada, 1994b).

Organisational Infrastructure

Collectively, the National and Field Unit objectives and principles form a comprehensive foundation for Parks Canada's protected area management approach. They recognise that protected area management is a complex undertaking whose success requires the involvement of all affected stakeholders and interest groups in the management and decision-making processes (Parks Canada, 1994b; 1995). They also reflect the fact that sound environmental management is an ongoing process where ecological, economic, and social aspects of a situation must be considered concurrently rather than separately (ibid.).

Achievement of the overall management goal of EI and CI, by way of the objectives and principles stated above, ultimately depends on the organisational capacity for implementation (Kennett, 1990; Day, 1992; Canadian Council of Ministers of the Environment, 1996; Baird, 1996). In 1999, Parks Canada became a free-standing agency; a "Departmental Corporation within the Canadian Federal Government" (Parks Canada, 1998/02). This, in combination with a shift in management vision from being considered a 'trustee' to a 'facilitator' for the grounds under its care (Parks Canada, 1995), has allowed Parks Canada to adopt an increasingly horizontal management structure. The practical implication of this is that the emphasis put upon integrated and collaborative management (see management principles) by sharing management responsibilities with external stakeholders and interest groups has become more practically feasible. Field Unit staff are being increasingly empowered to delegate selected elements of planning and management to external stakeholders and interest groups, resulting in an increasing amount of *de facto* decision-making groups (Parks Canada, 2000a; 1995).

The subsequent chapter will argue that it is increasingly important for the Agency to integrate its many areas of management to the extent that decisions made within any one department relate to the system and the overall management context. The Agency is experiencing a continuous increase in the number of internal and external participants in various decision making processes. These groups are all likely to have different management agendas and power structures, and subsequently varying goals and objectives. The chapter will demonstrate that such a combination, accompanied by Parks Canada's already complex management context, makes the proposed integration vital. Integration is central in order to certify that management groups and partners uphold the maintenance and restoration of ecological integrity, and that decisions demonstrate the needed overall concordance with relevant national park policies and regulations.

It will be proposed that, in order to ensure the above, decisions need to be of high quality, and also be sufficiently co-ordinated among, and accepted by the various partners. Consequently, respective decision-making processes need to support adequate processing of management decisions, addressing critical issues from both a situation specific perspective and a more general perspective of the Agency's policy framework and management directives. Additionally, they should be open and transparent, providing involved parties with input opportunities, as well as give them a clear understanding of the Agency's mandates and objectives. Finally, the processes' templates need to support efficient communication of subsequent information and data outputs between neighbouring jurisdictions and partners at scales matching the various areas of co-operation and concern. These remarks leave us searching for the practical tools and frameworks necessary to address the challenges and opportunities accompanying this complex management context.

Chapter 3

PARKS CANADA'S MANAGEMENT PHILOSOPHY AND TOOLS

Chapter 2 outlined how Parks Canada's principal mandate, the care and maintenance for healthy ecosystems in protected areas under its care, translates into management goals and objectives. The chapter explicated that designing an appropriate management framework for protected area management is a multifaceted and complex task. This chapter will provide more detail about the practical implementation of the Agency's principles and objectives. The presentation of Parks Canada's overall management philosophy, Ecosystem Based Management (ESBM), will be followed by a description and evaluation of five more specific management tools, all of which serve the purpose of aiding the practical implementation of the Agency's management goals and objectives.

The discussion will focus on how these selected management tools assist the Agency in its fundamental tasks of data and information gathering, decision-making, and communication. It will become obvious that the current institutional arrangements and the manner in which these tools are being used actually might present significant barriers to the achievement of the Agency's fundamental mandate. It will be argued that in the absence of explicit linkages between the specific tools, as well as a more concerted overall framework, the chances for successfully implementing integrative and collaborative management are limited from the outset (Nijkamp, et al., 1990).

Protected Area Management

Chapter 2 hinted at the complexity of protected area management. That fact is also reflected in the academic literature (Holling, 1995; Carley and Christie, 1993; More, 1996; Magnerum and Born, 1995), and Figure 3.1 summarises the main components. First of all, successful protected area management necessitates concurrent consideration of economic, social, and ecological factors (Slocombe, 1998; Wright, 1994; Reiger, 1993; Rennings, et al., 1997; Ruitenbeek, 1991; U.S.D.A., 1996). Secondly, each of these factors consists of dynamic functions and processes (Holling, 1995; Carley, et al., 1993) which operate across multiple scales (Galindo-Leal, et al., 1995; More, 1996; Malone, et al., 1991), both in temporal and spatial dimensions (Woodley, et al., 1993; Key, et al., 1994). Consequently, knowledge regarding these factors' impact responses and resilience potential is severely limited, leading to high levels of risk and uncertainty associated with their estimates (Skibicki, et al., 1994). Further, as ecosystems involve multiple disciplines, scales, and dimensions, most issues around protected area management are not confined to the administrative boundaries of one management group. Instead, management responsibilities tend to span over several jurisdictions (Parks Canada, 1994e; Galindo-Leal, et al., 1995; More, 1996; Gerlach, et al., 1994). Consequently, a large number of interest groups and stakeholders often share interests and influences in management decisions and are potentially affected by their outcomes (Rennings, et al., 1997;

U.S.D.A., 1996). Therefore, successful protected area management also depends on the ability to find acceptable compromise solutions, calling for collaborative management efforts (Agee and Johnson, 1988).

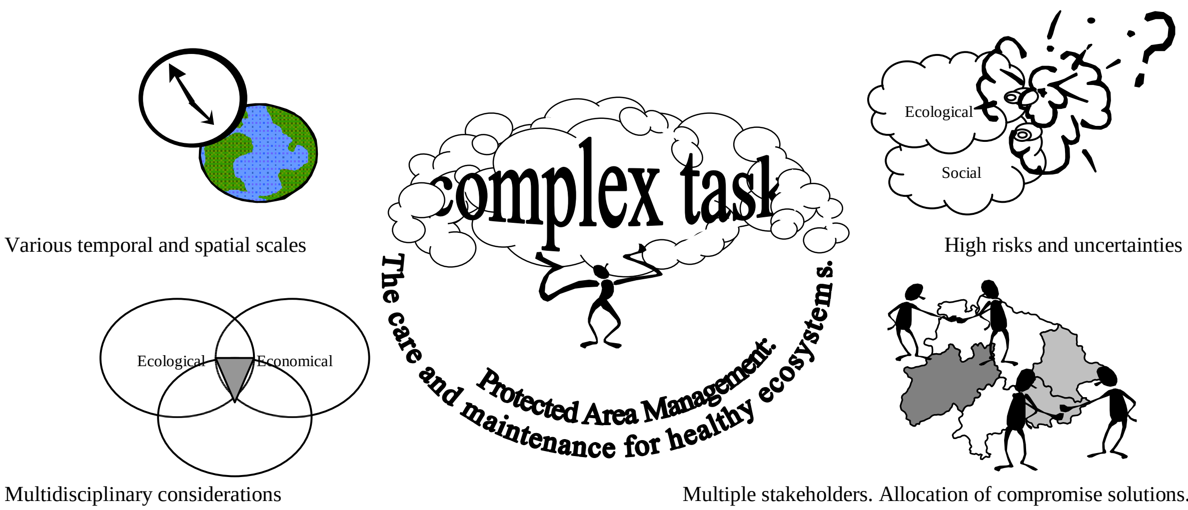

Fig. 3.1 Main components of protected area management

In order to successfully manage ecosystem health, an agency needs a comprehensive approach to management which considers interdisciplinary aspects, multiple scales and multiple dimensions. Furthermore, as our predictive capacities regarding management situations' ecological, economic, and social dimensions are inherently poor (Baird, 1996; Haines-Young, 1992) and consistently influenced by social processes and political agendas (Skibicki, et al., 1994; Weinberg, 1972), management should be guided by a precautionary and conservative approach in terms of risk taking (Davies, 1991). Finally, aspirations and interest of the various management and stakeholder groups (e.g. Parks Canada, local communities, stakeholders) should be weighted jointly to form sets of collectively held group goals and objectives, enabling an understanding of and respect for the preferences and management agendas of all affected stakeholders and interest groups (Hartig, 1995; Slocombe, 1998; Nilsen and Nepstad, 1993; Stankey and Clark, 1992; Field and Burch, 1988).

Ecosystem Based Management

In order to best address the management context presented above, many North American land and resource management agencies concerned with preserving long term ecosystem health[10], including Parks Canada[11],

[10] For example: the Ecological Society of America, the Forest Ecosystem Management Assessment Team, the BC Ministry of Environment, and the U.S.D.A Forest Service (see Christensen et al., 1996; Karr, 1990; Angermeier and Karr, 1994; and U.S.D.A. , 1996 respectively).

have adopted a philosophy referred to as Ecosystem Based Management (ESBM). ESBM has its origins in early forest ecology (Nilsen, et al., 1993), and has over the past two decades emerged as the pre-eminent conceptual resource management framework (Daykin, 1999). It provides a sound philosophical framework (Christensen, 1996; Agee, et al., 1988) with principles that relate very well to the complex managerial situations frequently encountered within protected area management[12] (Karr, 1990; Angermeier and Karr, 1994). Two of the driving principles and values behind the ESMB philosophy are the precautionary principle and a proactive management style (Magnerum, et al., 1995; Myers, 1993), as opposed to more conventional approaches with a predominately reactive focus (Malone, et al., 1991; Galindo-Leal, et al., 1995).

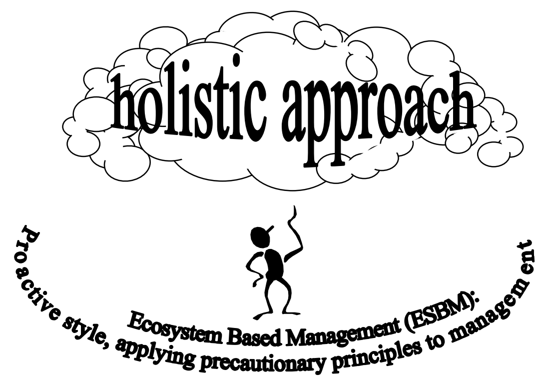

Fig. 3.2 Ecosystem Based Management

Accordingly, the philosophy supports early detection of change, enabling management to act, if required, before situations become irreversible. The approach is also considered comprehensive and holistic (More, 1996; Magnerum, et al., 1995; Gerlach, et al., 1994). Its comprehensiveness is based on the principles of precautionary and proactive management which are to pervade and support an organisation's entire planning and management process, from goal establishment through to monitoring and continuous research efforts (Christensen, 1996; Parks Canada, 1996c). The approach is regarded as holistic due to its focus on integration, working from the recognition that ecosystems are parts of complex interwoven systems rather than focusing management efforts on individual components (Day, 1992; Slocombe, 1998). Additionally, ESBM recognises that ecosystems need to be considered from a broad environmental, social and economic context (Day, 1992; Ruitenbeek, 1991; U.S.D.A., 1996; Parks Canada, 1996c).

[11] "The integrity of natural and cultural heritage is [to be] maintained by striving to ensure that management decisions affecting these special places are made on sound cultural resource management and ecosystem based management principles" (Parks Canada, 1994b). See also (Parks Canada, 1996c).

Challenges Associated with Protected Area Management

Managers concerned with protected areas management are inevitably going to run into several fundamental challenges:

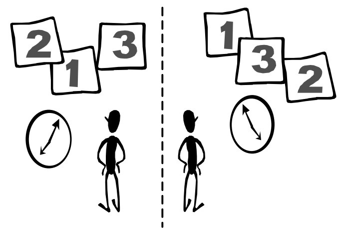

Fig. 3.3 Goal fragmentation and sliding of objectives

1. Goal fragmentation and sliding of objectives.

Without adequate levels of collaboration within and between relevant management groups associated with a management area, goal fragmentation and sliding of objectives are common consequences. While management initiatives by individual groups will gain in comprehensiveness when common denominators, such as group goals and objectives are clearly defined (Hartig, 1995), a lack of collaboration increases separation between groups (Watson, et al., 1996; Cortner and Moote, 1992). In a protected area management context, the various management groups often hold different management agendas and power structures as they are commonly subordinated to different legislation and regulations (Maguire and Boiney, 1994). In such a context, the absence of explicitly defined and shared targets can be detrimental, as the various management groups risk becoming isolated units. Scarce financial and human resources further this isolation, as each group becomes more preoccupied with its own priorities, often accompanied with a focus on finding immediate near-term solutions (Daykin, 1999). By reducing continuity, managers are likely to ignore the effects of their actions on areas outside their influence, temporally as well as spatially (ibid.). Subsequently, the suitability of management activities, with respect to their implications to the overall management context, is often left inadequately assessed (Malone, et al., 1991).

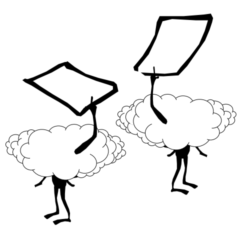

Fig. 3.4 Costly duplications and overlapping efforts

2. Costly duplications and overlapping efforts.

A work environment entailing low collaboration and an absence of group targets generally tends to limit the extent of managers' knowledge of management issues to that of individual group concerns (Cortner, et al., 1992; Canadian Council of Ministers of the Environment, 1996). In such a situation, groups are likely to regress into making use of more conventional proprietary and non-inclusive management approaches, again resulting in fragmented rather than integrated management decisions (Magnerum, et al., 1995). In the context of environmental management in general, and protected area

[12] Given the fact that various agencies and organisations differ in their management mandates and objectives, the operational frameworks for implementing ESBM vary accordingly. See Parks Canada, 1996c; Lajeunesse, et al., 1995; U.S. National Park Service, 1994; and U.S.D.A., 1996 for framework examples.

management specifically, such autonomous approaches often result in a lack of communication between groups' decision-making processes (Magnerum, et al., 1995; More, 1996). For example, information pertaining to what data and information were used, what the rationale for selecting a management alternative was, and what a management group believes the implications of their actions to be, are often poorly communicated (Hollic, 1992). This lack of awareness about other groups' activities and goals increases the potential for the overlapping of management efforts. Additionally, autonomous management approaches often result in a subsequent use of independent information gathering processes. A common by-product of this is costly information and data duplication, while failing to identify groups' real information gaps (Nijkamp, et al., 1984). The approach falls short of promoting a capitalisation of existing data and information by pooling of knowledge bases, both between and within the various management groups.

Fig. 3.5 Low acceptance and compliance towards made decisions

3. Low acceptance and compliance towards made decisions. The management and decision-making processes described above often lead to low acceptance of and compliance with decisions. When there is limited collaboration with other protected area management groups or limited consideration for the needs and preferences of other affected parties, their subsequent support for decisions tends to be low (Freemuth, 1996). This can be observed even when decisions are based on scientifically sound information (Macnaghten and Jacobs, 1997; Freemuth, 1996; Cawley and Freemuth, 1993). While scientific validity is essential, successful implementation of management actions is highly dependent upon their agreement with overlapping and complementary management groups' sentiments (Freemuth, 1996; U.S.D.A., 1996). Without adequate acceptance of the trade-offs associated with decisions, such groups' compliance with proposed strategies and guidelines will be low, impeding the success during implementation (Gerlach, et al., 1994).

Prerequisites for sound Protected Area management

Above, the ESBM philosophy has been described as a comprehensive and holistic approach to protected area management. Its precautionary management principle and proactive management approach advocates integrated and collaborative management throughout all planning and management stages of an organisation. To facilitate the implementation of these concepts, and to satisfactorily avoid or manage the potential consequences stemming from the challenges discussed above, it is paramount that there is soundness exemplified in an organisation's:

1. management decisions, and in its
2. decision-making processes.

The subsequent two sections will outline the fundamental components and prerequisites for its implementation.

Sound decisions

Sensible choice and the successful implementation of a management alternative are two fundamental components of sound protected area management. Both are dependent on the soundness of the decision leading up to them. This report argues that the requirements of sound decisions are threefold: co-ordination, acceptance, and high quality:

1. <u>Co-ordination</u>

Co-ordination refers to the synchronisation of decisions both between all relevant management groups, as well as within each group's internal organisational levels (Day, 1992; Rowe, 1990; Odum, 1986; U.S.D.A., 1996), in order to avoid overlapping and costly duplications of management efforts (Nijkamp, et al., 1990; Friend, 1969). It is achieved by collaborative management efforts, ensuring that communally held goals and objectives are formed and respected (ibid.).

2. <u>Acceptance</u>

To secure the necessary support for management actions, parties affected by a management decision have to be aware and acceptant of its consequences (Maguire, et al., 1994). This can be achieved by ensuring that interests, values and acceptance capacities of all management groups involved are incorporated and respected in the decision-making processes (Lundquist and Haas, 1999; Richardson and Healey, 1996; Grogan, 1993).

3. <u>Quality</u>

A quality decision is characterised by the following: it is in overall alignment with group goals and objectives (Magnerum, et al., 1995); it addresses, explicitly and comprehensively, relevant managers' list of critical issues (Williams, et al., 1998); and it gives appropriate consideration to all relevant aspects, scales and dimensions of ecosystem management, as well as brings attention to its associated risks and uncertainties (Agee, et al., 1988; U.S.D.A., 1996).

Sound decision-making process

The concepts and principles of ESBM, as well as their desired effect on management conduct, are readily identified in the literature. However, there exists a very limited body of literature on how this philosophy is to be put into practice (Slocombe, 1993; Magnerum, et al., 1995). In general, successful implementations of management philosophies and approaches depend on their compatibility with an organisation's institutional structure (Kennett, 1990; Day, 1992; Canadian Council of Ministers of the Environment, 1996). Central to an institution's structure are its decision-making processes (Daykin, 1999). This report argues that the following three aspects are prerequisites supporting sound and comprehensive decision-making processes in a protected area management context:

- The decision-making processes need to adequately compile, analyse, and synthesise the various types and amounts of data and information about social, economic, and ecological factors inherent to all management alternatives (Nijkamp, et al., 1990; Nijkamp, 1980).
- The data and information used as inputs to the decision-making process should be of adequate quality, and should address the critical issues in decision situations, both from a situation specific perspective, as well as from a more general perspective which considers implications for the overall management context (Nijkamp, et al., 1990; Rittel, 1982).
- Assuming that relevant data and information exist, it also needs to be readily available for use (Nijkamp, et al., 1990) .

Three types of management tools

The discussion above translates into a managerial need for three different types of tools to support the implementation of an ESBM approach. Obviously, sound decision-support tools are needed. Additionally, sound decisions and decision-making processes also require high quality data gathering/information generating tools and communication tools[13].

1. <u>Data gathering and information generating tools</u>

These tools should, individually or collectively, produce quality data and information that reflect the complexity of the protected area management context, i.e. addressing all aspects fundamental to ESBM (Day, 1992; Ruitenbeek, 1991; Parks Canada, 1996c)[14]:

- Multidisciplinary content

  The health of ecosystems depends upon the interaction between ecological, economic, and social factors. Imbalances within and between these factors commonly result in problematic management situations (Wright, 1994). Therefore, data and information should generate insight for both the individual health of these factors as well as about their interactions with each other.
- Multiples of spatial and temporal scales and dimensions

  Information and data should also span appropriate scales of both spatial and temporal dimensions. The state of a problematic management situation as well as the soundness of its potential solutions vary, depending on what time and spatial horizons are used at the time of evaluation[15].

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[13] In practice, the properties of most management tools overlap. Hence, it is difficult to categorise or distinctly label a tool as an information/data generating tool, decision support tool, or communication support tool . However, for the purpose of this discussion, a clear separation is useful.

[14] See section "Protected Area Management" for cross-references.

- Risks and uncertainty

  Because data and information are never complete nor fully accurate, their gathering, generating, and final use should always reflect conservative estimates, assuring management is practised on the side of caution.
- Multiple stakeholders/interest-groups

  Protected area management issues habitually cross over administrative or jurisdictional boundaries. Hence, it is important that all affected and interested parties' opinions, values, and management agendas are brought forward and respected when evaluating a management situation. Without proper knowledge of and respect for neighbouring jurisdictions and affected parties, it is impossible to reach a decision whose implications are endorsed by all concerned.

2. Decision-support tools

There is a need for tools that can assist in the comparative evaluation of management alternatives and outcomes. Such tools need to provide a structure or framework that can properly bound and process protected area management alternatives, facilitating the choice of well founded and acceptable solutions (Rittel, 1982; Nijkamp, et al., 1990).

Proper bounding and processing of management alternatives is a very important but difficult component of protected area management given that decision situations are many and varied. Proper bounding mean that each management situation and its associated alternatives require both an individual assessment and a more general evaluation (Nijkamp, et al., 1990; Rittel, 1982). The individual assessment should asses the situation and its alternatives in view of its specific key areas using data and information pertaining to these (Magnerum, et al., 1995; Kennett, 1990; Malone, et al., 1991). An additional broader assessment should evaluate the situation in its wider context (ibid.). This means that the related alternatives be evaluated in view of their overall implications, addressing issues such as the interconnectedness of factors between projects and the nature of cumulative effects. By bounding or defining a problem or situation too narrowly, the risk of excluding important factors and linkages arises. On the other hand, if a problem is defined too widely, it will likely be very diffuse and hard to comprehend (Carley, et al., 1993). The term processing implies that decision problems are typically so complex that decision-makers are incapable of logically considering all the necessary factors simultaneously in a systematic manner (Youdale, 1983; Schmoldt et al 1994). Hence, to arrive at a logical and rational decision, managers need a formal framework in which all

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[15] An example for environmental effects: an ecological stressor may not seem to pose a significant threat when looked at through a snap-shot in time and space. However, if viewed over a longer period of time on a larger scale, its consequences may very well prove to be imperative. An example for socio-economic effects: the social acceptance capacities for alternatives' associated economical tradeoffs, e.g. minimum revenue thresholds/month, maximum user fees, vary both depending on temporal and spatial scales. If put into a longer time-perspective, minimum revenue thresholds/month are likely to be lower as opposed to them representing a shorter time-perspective. Acceptance capacities for maximum user fees are equally likely to vary depending on, for example, the spatial scale the fee gives access to.

aspects relevant to a decision can be organised, analysed, and finally brought together, in a systematic and concurrent manner (Nijkamp, et al., 1990).

3. Communication-support tools

If data and information are not made available to managers, its mere existence is of little value (Nijkamp, et al., 1990). Communication is difficult, given the fact that data and information pertaining to protected area management are so varied in terms of types (e.g. ecological, economic, social), and specific in terms of the uniqueness of each management situation (e.g. visitor profiles, recreational activities, ecosystem types and threats, legislation, and management agendas). In addition, gathering information and data is very time consuming and expensive. Hence, it is unlikely that individual management groups will ever have complete information/data sets covering all aspects of management they should consider when following the ESBM concept (Odum, 1986; Daykin, 1999).

Therefore, it is important that existing information and data are shared between jurisdictions and partners at scales that coincide with areas of co-operation and concern (Parks Canada Agency, 2000a; Magnerum, et al., 1995). Even though a group may not benefit directly from another group's information, it will benefit from knowing what management actions have been taken and what criteria entered the decision-process in similar management situations. Furthermore, sharing of information assists in identifying the group's own data gaps (Nijkamp, et al., 1984).

Sporadic and indirect communication channels between and within groups limit interaction among information generating activities. This often leads to a weak integration between data and information collection efforts and the use of such knowledge by management (Watson, 1997). To facilitate the desired communication, especially in large organisations with many internal and external management groups, proper record management practices are needed. Hence, communication tools need to provide a template consistent enough to facilitate easy export and import of data and information within and between management groups (Nijkamp, et al., 1990). Since different management situations require different types and amounts of data and information, the tools also need to be flexible enough to accommodate such different communication requests (ibid.).

Current Management tools

Although ESBM may appear to be a complex and demanding management approach, its principles and concepts are instrumental to successful protected area management (Yaffee, 1996). This is especially true for Parks Canada as the philosophy matches the Agency's primary management mandate well: the care and maintenance for healthy ecosystems. Obviously, Parks Canada's objectives and mandates are multi-disciplinary; its horizontal management structure is rapidly increasing the number of active, more independent, management groups; and its need for proper management tools, supporting sound decisions and decision-making processes, to bring its ESBM philosophy into practice is greater than ever.

This report's literature review of Parks Canada's management practices has indicated that although the Agency has adopted the principles of ESBM in theory, its institutional arrangements (in this report represented by decision-making processes and their subsequent tools), fall short of supporting the successful implementation of the philosophy in practice. Operational management tools exists in abundance, but there is a lack of explicit linkages between them, or of an overarching framework. Instead, the tools are designed to focus on very specific aspects of certain management situations, and their assessments are regularly carried out by various management groups independently (Watson, 1997; Magnerum, et al., 1995). Consequently, this report argues that, without explicit linkages between them, the tools and their outcomes, by themselves, lack the ability to do justice to the principles of ESBM.

The following sections will present five of Parks Canada's management tools. Their individual as well as collective strengths and weaknesses as management tools will be evaluated. Focus lies on whether the tools provide sufficient support for sound decisions and decision-making processes in a protected area management context, or if further improvements are possible. Their current contribution to the ideal scenario of ESMB will be assessed in relation to the criteria presented in preceding sections. These five tools, used in whole or in parts by Parks Canada managers and other external management groups, all share the primary objective of ensuring that recreational and management activities within protected areas are contributing to, or at least are not in significant conflict with, sound resource management.

There are four main rationales for the selection of these tools:

1. They have been applied as management tools by Parks Canada as well as by other protected area management agencies (see assessment below for examples).
2. Between them, the methods cover three main management realms that Parks Canada has to embrace:
    - the realm of external legislation, e.g. laws, regulations, and obligatory assessments and programs;
    - the realm of internal regulations, e.g. policy, regulations, recommended assessments, and obligatory programs;
    - the realm of visitors and other interest groups, e.g. assessments, and surveys.

3. Three of the five tools selected relate to Visitor Management (VM). This may seem redundant. However, recreationally induced impacts are the prime stressors to CI and EI. Each one of these VM methods focus predominantly on one of the three main aspects of recreational management (Wagar, 1964)[16]:
   - what type(s) of activities should be allowed within a particular protected area setting,
   - where the activities should be occurring, and
   - to what extent the opportunity to practice such activities should be allowed.
4. The output from these tools lends itself conveniently as input to the decision-support framework that is suggested in Chapter 5.

The discussion and evaluation of each of the management frameworks below is organised around five themes. The first three themes provide discussions around the rationale behind selecting the respective tool as well as tool descriptions. The remaining two themes are more evaluative, addressing the strengths and weaknesses that are associated with the Agency's management tools, based on this report's literature review and my own opinions. The table at the end of each section summarises the information from theme one and three as well as the arguments set forth in theme four and five into an easy accessible format. The five themes are as follows:

Theme 1:

Rationale for selection. The discussion will focus on:

- type of tool,
- perspective represented,
- origin and/or main focus, and
- tool's application by Parks Canada.

Theme 2:

General description of area (only applicable to the sections addressing Cumulative Effects Assessments and Monitoring Programs).

Theme 3:

Description of each tool. Each tool will be described in regards of its:

- assumptions,
- focus, and
- results.

Theme 4:

Information gathering tool evaluation: Each tool will be evaluated regarding its ability to support the generation of data and information that reflects the complexity of protected area management and ESBM

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[16] This notion is also supported by Kuss, et al. (1990); Shelby and Heberlein (1986); and Hendee, et al. (1990), among others.

requirements. The criteria used for evaluation are the same five criteria as listed earlier in the "Information gathering tools' section above.

Theme 5:

Decision- and communication-support tool evaluation: Each tool will be evaluated regarding its provision of bounding and processing functions. The criteria used for evaluating the tools' decision-support functions are the same two criteria as discussed earlier in the "Decision-support tools" section. *And*, each tool will also be evaluated in regards of its ability to support the export and import of data/information. The criteria used to evaluate the tools' communication-support functions correspond to those discussed earlier in the "Communication-support tools" section above.

The Recreational Opportunity Spectrum

Theme 1 – Selection rationale

The Recreational Opportunity Spectrum (ROS) (Clark and Stankey, 1979) is a Visitor Management (VM) tool that typically represents an agency's internal regulations. The ROS assesses the question of where different types of recreational activities should be allowed to take place (Wagar, 1964). The tool was originally developed as a land use zoning system for the US Forest Service (Clark, et al., 1979) , but has also been applied, in whole or in parts, by many protected area management agencies (e.g. Stankey, 1990; British Columbia, 1985; Clark and Stankey, 1988; Driver, et al., 1987). Though Parks Canada has not formally adopted the framework, ROS's logic is reflected in the zoning of many park Management Plans (e.g. Canadian Park Service, 1992; Parks Canada, 1994d; 1988; 1997a). The basic ROS concepts are also frequently used in case studies related to issues of zoning. Canadian example of such studies exist in Pukaskwa and Yoho National Park (Parks Canada, 1997c).

Theme 3 – Tool description

The fundamental premise of ROS is that a range of environmental, social, and psychological factors influence how visitors feel about the quality of their recreation experience (Payne and Nilsen, 1994; Lucas, 1964; Wagar, 1964). Working under the assumption that the benefits sought by visitors are also functions of the above factors (Clark and Stankey, 1979), ROS designates particular tracts of land and specific resource and visitor management strategies to its assessment's targeted areas (Driver, et al., 1987)[17]. The method's planning process defines environmental settings, activities, and experience guidelines to be associated with certain land zones, also referred to as opportunity classes (ibid.). In its most generic form, ROS's opportunity classes are designed to provide visitors with experiences from wilderness to urban. However, depending on the specific application, opportunity classes may be defined using a narrower spectrum. The experiences are defined as the recreational goals associated with a particular setting based on

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[17] Driver (1987) provides a good description of the evolution and needed research of the ROS concept.

its respective attributes, e.g. a) the recreational experiences sought there, b) the environmental conditions of the setting, and c) the accessibility to the area (Clark, et al., 1979). Additional types of factors that the ROS assessment produces information about are e.g. non-resource use, social interaction, level of direct management, and visitor impact acceptability (Simpson, 1995)[18].

Theme 4 – Information gathering tool evaluation

The ROS framework is very capable of producing information that can be integrated with ecological management goals and objectives on a regional or landscape scale. The tool's simplicity, and the joint consideration of both social and ecological dimensions, have made it an attractive framework for recreational studies concerned with bringing together components of recreational opportunities (settings), demand (activities), and the individually defined experience (Payne, et al., 1994). The ROS is principally a spatial tool in that it assists managers in defining zones appropriate for an area's ecology and visitation. Temporal concerns can also be included, such as altering an area's boundaries depending on season. However, such aspects seems rarely applied. Arguably the most influential factor in determining the ROS zones is the concern about (road) access, or the distance of a recreational opportunity from an access point. Therefore, applications relate for the most part to larger, park wide, scales. In theory, the tool allows for consideration and respect for values and management agendas belonging to groups other than the ones central to a particular application (Driver, 1990). In practice however, the provisions of such participatory opportunities seem primarily implicit, as the actual decision-making process remains almost exclusively with one specific management group, while other groups take on a consultative role at best (Simpson, 1995). Also, ROS lacks explicit and quantitative functions for assessing risks and uncertainties. The level of caution practised when determining settings, activities, and experience guidelines is consequently left up to the discretion of the specific management group at the time.

Theme 5 – Decision- and communication-support tool evaluation

In terms of its decision-support functions, the framework supports the gathering and bounding of a reasonable amount of information and management aspects with respect to issues specific to the ROS focus, such as the establishment of appropriate combinations of recreational activities, settings, and experiences. The assessment of this information assists managers in making sound decisions about the location of specific activities, in view of internal regulations and ROS-specific circumstances. The tool's standardised format also provides the opportunity for consistent record management practices, facilitating easy import and export of data/information from one ROS application to another.

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[18] As an example of the type of output stemming from a ROS application one can look at the opportunity spectrum applied to PRNPR's West Coast Trail. The unit is sub-zoned into three areas: wildland, primitive, and semi-primitive zones (Parks Canada, 1994d). The wildland area, at the one end of the spectrum, is characterised by difficult access, no facilitates, and a low level of contact between visitors. The Semi-primitive zone, on the other end of the spectrum, is characterised by relatively easy access, several facilities, and a higher level of contact between visitors.

Management tool	The Recreational Opportunity Spectrum (ROS)
THEME 1 and 3 – Selection rationale and tool description	
Primary perspective reflected:	Internal regulations and policy related to zoning.
Tool's main focus and objective:	The establishment of appropriate combinations of recreational activities, settings, and experiences.
THEME 4 – Information gathering tool evaluation	
Types of data and information aspects given consideration to:	
▪ Multiple disciplines	Considers ecological and social dimensions concurrently.
▪ Temporal and spatial dimensions	Essentially spatial.
▪ Multiple of scales	Predominantly large scale, i.e. park wide.
▪ Risks and uncertainties	No explicit functions for quantitative estimates. The level of caution practised is at the discretion of the specific management group at the time.
▪ Stakeholder and interest-group input	Implicitly considered by external interests given, predominately, consultative roles.
THEME 5 – Decision- and communication-support tool evaluation	
Types of decision-support provided:	
▪ Bounding (compilation and assemblage of data/information; addressing situation specific and more overall implications).	ROS bounds issues related to its assessment specific focus reasonably well.
▪ Processing (analysis and synthesis of data /information, to properly reflect the complexity of protected area management).	ROS facilitates sound decisions pertaining to zoning in view of internal regulation and assessment specific considerations.
Types of communication-support provided:	
Consistent template, enabling easy import and export of data and information	The framework's standardised template provides possibilities for consistent record management practices within an agency, facilitating easy import/export of data/information between management groups concerned with ROS applications.
Template flexible enough to allow for communication of varying types and amounts of data and information.	The template facilitates communication of information/data used and generated by ROS applications, between ROS applications, exclusively.

Table 3.1 The Recreational Opportunity Spectrum

Limits of Acceptable Change

Theme 1 – Selection rationale

The Limits of Acceptable Change (LAC) is a VM framework that strives to answer to what extent a recreational or management activity should be allowed to occur within an area (Wagar, 1964) as seen from the perspective of visitors, managers, or other interest-groups (Stankey et al, 1985). The LAC concept was originally developed for management of designated wilderness areas in the US (Stankey, et al., 1985). The method has gained international recognition and its concepts have been applied by protected area managers throughout North America and Europe (e.g. Hof, 1993; Cole, 1985; Merigliano, et al., 1997; Roggenbuck, et al., 1993; Williams, 1994). In Canada, variations of the LAC approach have been applied by Parks Canada to set standards for hiking trails (e.g. Yoho NP (Parks Canada, 1992a) and rafting routes (e.g. Kluane NP (Dill, et al., 1998)), to name a few[19].

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[19] Cole and McCool (1997); (Stankey (1997), Cole and Stankey (1998), and Watson and Cole (1992) provide good backgrounds and more recent thoughts on refinements of the LAC method.

Theme 3 – Tool description

The LAC framework is based on the concept of carrying capacity (Stankey and McCool, 1984; Cole, et al., 1998). It expands from the rigours of that simple concept by acknowledging that there are no absolute standards in terms of biological carrying capacity (Stankey, et al., 1990). Nor are there any absolute standards for visitors' or other stakeholders' social, economic, and environmental acceptance capacities (Lundquist, et al., 1999, p 52) such as crowding, fees, or environmental degradation. The LAC also recognises that social, economic, and environmental impacts are likely sources of disagreement in areas with recreational use (Frissell, 1983; Lucas, 1985[20]). The crucial question is about levels of use and associated impacts acceptable to managers and affected parties (Stankey et al, 1985.). The LAC process answers this question in a sequence of nine steps, by defining a set of environmentally, economically, and socially desirable conditions for an area (ibid.). These conditions, including management actions necessary to achieve them, are compared and evaluated based on the norms (Shelby, et al., 1996; Vaske, et al., 1986) held by relevant groups[21]. Common evaluation factors include managers' and visitors' acceptance levels of environmental modification, visitors' probability of social contact, and managers' need for maintenance control (Simpson, 1995)[22]. The outcome is an acceptable compromise between parties' desired versus acceptable levels of use and associated impacts for a given area: a set of land use zones in which desired environmental resources, social and economic conditions are to be maintained (Williams and Gill, 1991)[23].

Theme 4 – Information gathering tool evaluation

It should be noted that LAC applications typically do not consider groups' norms regarding a situation's economic aspects (Lundquist, et al., 1999). However, it is within the tool's potential. Assuming that such considerations are made, the framework can provide managers with data and information for social, environmental, and economic factors concurrently. Explicit consideration and respect for stakeholders' and interest-groups' values and management agendas are also given for the purpose of generating compromise

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[20] (Lucas (1985) and Lucas and Stankey (1985) provide good reviews of the LAC process and relates research needs to each of the assessment's nine steps.

[21] It is acknowledged that no absolute standards can be set in terms of an area's carrying capacity and its visitors' acceptance capacities. However, managers', users', and other stakeholders' preferences for different types and levels of recreational and environmental impacts can be used to indicate the relative importance of the same, which become the norms (Shelby, et al., 1996; Vaske, et al., 1986). Norms can be described as "standards that individuals use for evaluating behaviour, activities, environments, or management proposals as good or bad, better or worse." (Shelby, et al., 1996). Such standards are later put to use at the decision-making stages of the LAC process, indicating different groups' preferred or 'acceptable' conditions. In that way, the public, ecological experts, planners and other stakeholders can theoretically work alongside each other to develop problem solving measures throughout the LAC process (McCool et al, 1986).

[22] Merigliano (1992) provides an interesting paper on indicator suggestions for LAC assessments.

[23] An example of the type of measures associated with a typical LAC application are encounter norms, e.g. the number of fire rings and extent of bare ground encountered at a campsite (Shelby, et al., 1988), or number and size of groups encountered on a trail section (Vaske, et al., 1993). In a visitor survey at Gwaii Haanas National Park Reserve/Haida Heritage Site, respondents were asked to rate their level of acceptance, ranging from unacceptable to acceptable, for a variety of variables, producing impact acceptability curves for e.g. bare ground, fire rings, and people encounters (Vaske, et al., 1995).

solutions between affected parties (McAvoy, et al., 1991). Theoretically the LAC can consider an activity's effects to an area over a multiple of temporal and spatial scales. However, applications typically revolve around smaller spatial and relatively short temporal scales like site-specific, local recreational activities, such as hiking and camping. The LAC framework provides no explicit, quantitative functions for evaluating risks and uncertainties. Instead, they are assumed by the participating groups and addressed implicitly through the use of norms.

Theme 5 – Decision- and communication-support tool evaluation

Similar to the ROS, the LAC facilitates sound decision-making by suggesting compromise solutions. The tool's decision-support functions provide good support in that they collect, bound, and assess proper amounts and types of data/information in respect to LAC's specific focus: the identification and setting of standards of a given area's desired social, economic, and environmental conditions. The information collected in a LAC assessment is often very application specific. Even so, owing to the nature of norms, it is not uncommon to see various LAC applications exchanging information between each other.

Management tool	The Limits of Acceptable Change (LAC)
THEME 1 and 3 – Selection rationale and tool description	
Primary perspective reflected:	Managers', visitors' and other interest groups' norms regarding desirable and acceptable changes to a given area.
Tool's main focus and objective:	Identifying indicators and standards for an area's socially, economically, and environmentally desired conditions, establishing acceptable compromise solutions between uses within a given zone.
THEME 4 – Information gathering tool evaluation	
Types of data and information aspects given consideration to:	
▪ Multiple disciplines	Economic, ecological and social issues can be considered concurrently.
▪ Temporal and spatial dimensions	Both.
▪ Multiple of scales	Predominantly smaller, site specific focus, on a short time scale.
▪ Risks and uncertainties	LAC have no explicit functions to estimate risks and uncertainties. The level of caution practised is at the discretion of participating groups.
▪ Stakeholder and interest-group input	Provides explicit opportunities for participation and input from affected parties throughout the decision-making process.
THEME 5 – Decision- and communication-support tool evaluation	
Types of decision-support provided:	
▪ Bounding (compilation and assemblage of data/information; addressing situation specific and more overall implications).	LAC bounds its own, application specific, issues well.
▪ Processing (analysis and synthesis of data /information, to properly reflect the complexity of protected area management).	LAC assists the making of sound compromise decisions related to use/preservation issues, in view of participating groups' norms.
Types of communication-support provided:	
▪ Consistent template, enabling easy import and export of data and information	Standardised template and substitutable data/information (norms) offer good potential for exchange between LAC applications.
▪ Template flexible enough to allow for communication of varying types and amounts of data and information.	Template allows only for communication of LAC specific information.

Table 3.2 The Limits of Acceptable Change

Appropriate Activities Assessment

Theme 1 – Selection rationale

The Appropriate Activities Assessment (AAA) process (Parks Canada, 1996d)[24]is, in comparison to LAC and ROS, a relatively new VM framework. Its main objective is to determine which recreational activities should be allowed within a particular protected area setting (Wagar, 1964). The AAA was initially developed for Parks Canada (Parks Canada, 1994a) and its application has not spread significantly beyond the scope of the Agency (Nilsen, 1999 June) (e.g. Parks Canada, 1996b; 1996a; Banff-Bow Valley Task Force, 1996). The tool reflects the perspective of the Agency's internal regulations and policies specifying that there is only a selected set of recreational activities that are appropriate to the settings of protected areas (Parks Canada, 1994b; 1994c).

Theme 3 – Tool description

Working under the assumption that certain recreational activities are more suited than others for a specific protected area environment, the AAA process assesses the appropriateness of a proposed activity within that area by means of a pre-established checklist (Parks Canada, 1994a). The goal of the assessment is to develop a management position regarding each activity by identifying its respective potential impacts (e.g. economic contribution towards local economies, its role in enhancing visitors' learning experiences, its environmental impacts), visitor experience expectations (e.g. serenity, level of social interaction), and infrastructure requirements (e.g. roads) (Parks Canada, 1996d). The evaluation frame connects the activity and the associated area's management goals and objectives by identifying their respective key cost and benefit criteria. The assessment, based on the compatibility between potential outcomes and situation specific management goals and objectives, results in a listing of negative impacts vs. positive opportunities associated with the activity. The list serves as the base for management recommendations which either support, permit, or prohibit the activity, ensuring that the allowed activities' chances for positive contributions outweigh their risks of potential negative effects on the overall CI and EI management goal (Parks Canada, 1996d)[25].

Theme 4 – Information gathering tool evaluation

The AAA framework can offer management a three-dimensional assessment of a particular activity's compatibility with an area's situation specific goals and objectives (Simpson, 1995). For example, an assessment can consider economic aspects (e.g. an activity's market expectations), environmental aspects (e.g. impact risk potential, setting opportunities), and social aspects (e.g. visitor conflict, experience

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[24] Initial efforts of developing the concept go back to the mid 1980s (Bronson, 1983).

[25] An outdoor recreation activity that is typically allowed within national parks is backcountry backpacking and hiking. On the other hand, an activity that is typically not supported is mountain biking, unless it is considered especially suited to the particular conditions surrounding a specific protected area (Parks Canada, 1994a).

opportunities) together. The assessments can be carried out on park or zone specific scales, and temporal considerations such as the time of year and duration of seasonal peaks, also enter the deliberation of an activity's suitability (Parks Canada, 1996d). Participation and input opportunities for external stakeholders and interest-groups are principally lacking in AAA. However, compared to the other visitor management tools, it is a tool with few applications to date (Simpson, 1995). Therefore, it remains to be seen how effectively it can incorporate values and management agendas of various groups into its assessment processes. Like the two previously discussed VM tools, AAA does not supply any significant quantitative functions for assessing risks and uncertainties. The level of risk taking is again indirectly determined via the decision-makers attitudes towards risk taking.

Theme 5 – Decision- and communication-support tool evaluation

On the whole, AAA provides a simple and consistent framework for evaluating the appropriateness of recreation activities within protected areas. It facilitates a multi-disciplinary evaluation of a specific activity's suitability for a particular setting. The question of whether positive contributions counterbalance potential negative effects is bound and assessed in a sensible manner, bringing situation specific issues to light. Even if collected information and decisions are very situation and application specific, the overall AAA criteria set can serve a much more general purpose and can be interchanged between different areas and assessments.

Management tool	The Appropriate Activities Assessment (AAA)
THEME 1 and 3 – Selection rationale and tool description	
Primary perspective reflected:	Internal regulations and policy related to acceptable activities.
Tool's main focus and objective?	Establish compatible combinations of recreational activities and specific settings in protected areas.
THEME 4 – Information gathering tool evaluation	
Types of data and information aspects given consideration to:	
▪ Multiple disciplines	Economical, ecological, and social issues can be considered concurrently.
▪ Temporal and spatial dimensions	Both
▪ Multiple of scales	Park or zone specific focus, with at most 1 year temporal scale considerations.
▪ Risks and uncertainties	AAA holds no quantitative functions to explicitly estimate risks and uncertainties. This is at the discretion of the decision-makers.
▪ Stakeholder and interest-group input	No significant opportunities are provided.
THEME 5 – Decision- and communication-support tool evaluation	
Types of decision-support provided:	
▪ Bounding: (compilation and assemblage of data/information; addressing situation specific and more overall implications).	Like ROS and LAC, AAA bounds aspects pertaining to its own focus well, addressing situation specific issues.
▪ Processing (analysis and synthesis of data /information, to properly reflect the complexities of protected area management).	The tool assists situation specific decisions regarding "what" activity should be allowed in what area, from the viewpoint of Parks Canada's internal regulations.
Types of communication-support provided:	
▪ Consistent template, enabling easy import and export of data and information.	The standardised and generic evaluative template and criteria used at evaluation offer certain potential for data/information exchange between AAA applications.
▪ Template flexible enough to allow for communication of varying types and amounts of data and information.	Template allows for communication of AAA origin only.

Table 3.3 The Appropriate Activities Assessment

Cumulative Effects Assessments

Theme 1 – Selection rationale

In addition to the National Parks Act, other federal legislation and guidelines also influence the decision-making processes of Parks Canada. One important example is the *Canadian Environmental Assessment Act* (CEAA). The Act stipulates when federal projects need to be subjected to an *a priori* Environmental Impact Assessments (EIA)[26]. The required assessments are designed to ensure that no projects with significant potential to violate established standards for acceptable environmental impacts are carried out and implemented. In addition to EIAs' focus on direct and primarily nearby impacts of single projects (McClod and Saulsbury, 1996), contemporary praxis of the Act also calls for the consideration and evaluation of cumulative effects for all completed EIAs (section 16(1) "Factors to be considered"). Such effects are addressed by a supplementary Cumulative Effects Assessment (CEA) (Paisley, 1998; Roots, 1986). In this

[26] An EIA is triggered under section 5 of the Act if the physical project is: initiated on federal land, or initiated by a federal agency, or funded in whole or parts by a federal agency, or if such an agency exercises a regulatory duty in relation to the project.

report, CEAs are regarded as externally imposed evaluation tools that Park Canada management needs to take into consideration due to national legislation.

Theme 2 – General description of area

There exists a wide range of different types of CEAs, and the manner in which they address the impacts of physical projects vary (Spaling and Smit, 1995a). Assessment types range from them being distinct from other planning and decision-making activities, focusing on specific issues (e.g. spatial (Cocklin, et al., 1992a; Johnston, et al., 1988), landscape (Bedford and Preston, 1988; Gosselink and Lee, 1989; Johnston, et al., 1990), and loop analysis (Lane, et al., 1988; Bronson, et al., 1991)), to more integrated approaches, where assessment processes are seen as a correlate to regional or comprehensive planning activities (e.g. regional planning (Hubbard, 1990; Stakhiv, 1991; 1988), Ecosystem Based Planning (Davies, 1991; Preston and Bedford, 1988), Multi Criteria Evaluation (Jourdonnais, et al., 1990)). Besides their methodological differences, most CEAs share the intent of providing project screening processes with evaluative frameworks that guide the identification of more long-term and incremental effects on immediate as well as more distant areas (Munn, 1994a; Contant and Wiggins, 1991). The assessments evaluate the suitability of projects using a wider time and spatial scale than regular EIAs typically would (Munn, 1994b). Therefore, CEAs also give the opportunity to consider potential impacts associated with other ongoing and future projects (McClod, et al., 1996; Paisley, 1998). In combination with EIAs, CEAs heighten the accuracy of environmental assessment screening processes by equipping them with more comprehensive ways to predict and calculate cumulative system responses.

Theme 3 – Tool description

In the case of Parks Canada, CEAs are typically applied in two ways: strategic or project assessments. Strategic assessments review new or revised Park/Site Management Plans at their draft stage, and are routinely undertaken pursuant to the Environmental Assessment Process for Policy and Program Proposals. This is an ideal time to conduct CEA and consideration of cumulative effects is usually done although at a cursory level. The Banff-Bow Valley study (Banff-Bow Valley Task Force, 1996a) is the Agency's best example of a strategic CEA to date. Project assessments, which are the focus of this report, revolve around the stipulated requirements set forth by the CEAA. Physical projects under the CEAA's dominion are to be subjected to more in-depth assessments, facilitating early detection and response to potentially adverse effects. The Agency's assessment manual (Kingsley, 1997) is to be applied in the developmental stages of project proposals' strategic plans (Parks Canada, 1999b). Frameworks like the one employed by the Agency rely on critical criteria's thresholds (Kingsley, 1997; Davies, 1991). They make use of pre-established templates with points of evaluation corresponding to various types of possible effects. While environmental consequences are obviously at the centre of attention, a project's economic as well as social implications can and should also be considered (Hundloe, et al., 1990; Cocklin, et al., 1992a) (e.g. Ross, 1990; Nottingham, 1990). An area's acceptable level of ecosystem health, or its acceptable levels of (primarily) environmental change, are determined based on key ecological indicators and components, forming sets of project specific screening criteria. Effects usually considered relate to distance (trans-boundary), small but incremental changes (nibbling), broken-up habitat (fragmentation), and those of a general compounding or synergistic nature (multipliers) (UBC, 1998; Cocklin, et al., 1992a; Peterson, et al., 1987). Following the evaluation, a CEA may conclude that a project's impact potentials are too close to, or goes beyond, acceptable thresholds. When a project's effects are regarded as unacceptable, its undertaking is considered infeasible (Smith, 1995), leaving the project either not implemented, subjected to modification, or referred to a public review process such as mediation or a panel review.

Theme 4 – Information gathering tool evaluation

Theoretically, CEAs incorporate considerations for impacts and effects over a multiple of geographical (local, regional, national, global) and temporal (day, months, years, decades) scales, as well as for multiple dimensions (social, economic, ecological), using interdisciplinary research and stakeholder input in the evaluation (CEARC, 1988). However, frequently cumulative impacts are not properly addressed during environmental assessments (Burris et al, 1997). As a consequence of their comprehensive nature, many CEAs are extremely demanding in terms of time and effort (Parks Canada, 1999b). Processes such as those advised by Kingsley (1997) and Davies (1991) lend themselves well to thoroughly assess the appropriateness of larger projects. However, optional and non-compulsory CEAs of smaller or medium sized undertakings are rarely conducted (Parks Canada, 1999b, Ross, 1990). One main reason appears to be their cumbersome evaluation templates (McCold and Holman, 1995; Paisley, 1998). Considering that small and medium sized projects represent a significant proportion of the total number of projects within protected area management, this results in a substantial amount of potentially accumulating effects which are either assessed inadequately or excluded from evaluation completely (Burris and Canter, 1997). When CEAs are employed, they provide a framework for an extensive data collection as well as a comprehensive bounding and assessment process of both spatially and temporally accumulating impacts. On the other hand, even though these frameworks theoretically have the ability to co-assess factors other than environmental attributes, they have been critiqued for their inadequate provision thereof (Paisley, 1998). Economic factors such as regional development impacts (CEARC, 1988) and various social impacts (Ross, 1990) are often left aside. Further critiques address CEAs' lack of explicit interaction procedures, limiting the consideration of stakeholders' and interest-groups' values and management agendas (Burris, et al., 1997; McCold, et al., 1995). External consultations, such as between scientists, risk assessors, and managers, also tend to be restricted (Paisley, 1998). CEAs provide some quantitative functions for the assessment of risks and uncertainties if designed appropriately. Also, the frameworks' critical thresholds are commonly defined at a precautionary level, which is one possible approach to account for risks.

Theme 5 – Decision- and communication-support tool evaluation

CEAs provide comprehensive assessments of (environmental) cumulative impacts. However, their rather cumbersome processes often leave many smaller and medium sized projects un-assessed. Sharing similar limitations as the previously discussed tools, CEA's role as data gathering, decision-support, and communication tool, is restricted to its focus specific issues.

Management tool	Cumulative Effects Assessment (CEA)
THEME 1 and 3 – Selection rationale and tool description	
Primary perspective reflected:	External legislation related to physical projects' obligatory assessments.
Tool's main focus and objective?	Ensures that projects with high risks for causing adverse environmental effect are screened and prevented from implementation.
THEME 4 – Information gathering tool evaluation	
Types of data and information aspects given consideration to:	
▪ Multiple disciplines	Considers predominantly environmental aspects. Have theoretical potential to consider social and economic issues.
▪ Temporal and spatial dimensions	Both
▪ Multiple of scales	Varies depending on scope and scale of project assessed. Successful applications are predominately larger scaled.
▪ Risks and uncertainties	Depending on the size of the project to be assessed, hence the assessment's level of comprehensiveness. Theoretically, explicit quantitative functions exists. Level of caution practised is up to the discretion of decision-makers.
▪ Stakeholder and interest-group input	Explicit provisions of opportunities are limited.
THEME 5 – Decision- and communication-support tool evaluation	
Types of decision-support provided:	
▪ Bounding (compilation and assemblage of data/information; addressing situation specific and more overall implications).	Same as for ROS, LAC, and AAA. Bounds and assembles data/information pertaining to its own specific focus well (particularly larger projects).
▪ Processing (analysis and synthesis of data /information, to properly reflect the complexities of protected area management).	Facilitates sound decision-making pertaining to its own focus and considerations.
Types of communication-support provided:	
▪ Consistent template, enabling easy import and export of data and information.	Consistent, yet often too lengthy, template provide possibilities for consistent record management practices.
▪ Template flexible enough to allow for communication of varying types and amounts of data and information.	Facilitates import/export of data/information in-between CEA assessments.

Table 3.4 Cumulative Effects Assessment

Monitoring Programs

Theme 1 – Selection rationale

Following international conventions such as the United Nation's Biological Diversity Strategy, and the Canadian Global Change Program, protected area managers in general, and Parks Canada specifically, are advised to develop national strategies and action plans to aid the achievement and conservation of ecosystem health. Monitoring Programs (MPs) are internationally recognised as an intrinsic component to these processes (Woodley, 1996; Gwynne, 1982). Biodiversity, ecosystem health, and ecological integrity are all concepts that are very difficult to define and operationalize (Francis, 1991; Schaeffer, et al., 1988). The answers to questions of ecological integrity will always remain subjective. The concepts are biased by the state of ecosystem science as well as by our own values and awareness of the environment (Skibicki, et al., 1994). Though our definitions regarding systems' health, integrity, or biological diversity may or may not be accurate, it is hoped that MPs, by facilitating early detection of system change, enable managers to act prior to irreversible change (Skibicki, et al., 1994). Also, MPs can provide diagnostic assessments of the overall state of ecosystems under stewardship, making it possible to study system responses and resilience potential to disruptions over time and space (Drysdale and Howell, 1995), improving our knowledge and understanding.

Theme 2 and 3 – General description of area and tool

Woodley (1996) has reviewed a wide variety of MPs and approaches. As he points out, programs may focus on the reduction of ecosystems into components, or the monitoring of change and behaviour through their attributes (reductionist); on identification and monitoring of specific perceived threats (threat-specific); on testing for cause-effect relationships (hypothesis testing); and mixed approaches where systems' parts are monitored in conjunction with more overall measures of ecosystem structures and functions (integrated) (ibid.). Obviously, the latter has been described as the most difficult of the approaches, but is considered the preferred method for protected area monitoring (Munn, 1988). These programs are typically geographically bounded by specific administrative boundaries, focusing on monitoring indicators of a sectoral nature such as individual elements and processes (e.g. water quality indicators, meadow quality indicators, visitor experience quality indicators, etc.), over a relatively short period of time (Brown and Roughgarden, 1990). These approaches are not appropriate when considering the following four points:

- park boundaries have little to do with ecosystem boundaries (Schonewald-Cox and Bayless, 1986);
- ecosystems have a rather intertwined nature by definition (Goldstein, 1992), making environmental management an interdisciplinary science (Dorney, 1989);
- there are limits to ecosystems' supposedly deterministic nature, making them susceptible to overshoot (Kay, 1989);
- there is a clear interrelationship between people and the environment (Stankey, et al., 1992).

Considering the above, protected area's MPs need to reach beyond the individual components identified above, and move toward becoming more continuous and connective (Hollic, 1992). Programs should: extend over a multiple of temporal and spatial scales; regard the system as a whole and not only its parts (including indicators of social and economical elements alongside the environmental) (Goldstein, 1992; Ruitenbeek, 1991); and apply caution when assigning or measuring thresholds of acceptable change. A popular approach to protected area monitoring, often used by Parks Canada[27], is a two-tiered scheme, based on a combination of the integrated and threat-specific methods mentioned above (Woodley, 1996) (see

[27] E.g. Drysdale, 1994; Dionne, 1994.

Figure 3.3 below). This way, both a system's overall health as well as its specific stresses or threats are monitored. The scheme's integrated nature uses measures from various schools of ecology (e.g. stress ecology, conservation biology, landscape ecology), allowing different hierarchical levels to be represented, ranging from individual to landscape. Its threat-specific component makes use of area-specific stress indicators, allowing for prediction of system responses to certain threats. Additionally, to facilitate the co-operative data sharing necessary to increase monitoring connectivity, respecting ecosystems national, international, as well as global scales, it is important that independent monitoring programs are linked together (Drysdale, et al., 1995). Network programs act as connectors between various programs (e.g. the Ecological Monitoring and Assessment Network (EMAN) (Roberts-Pichette, 1995), enabling comparative assessments and long-term environmental protection. The main objective of programs like EMAN is to link independent monitoring activities together to "facilitate co-operation and holistic ecological enquiry and ecosystem understanding" by having common site characteristics (ibid., p. 7).[28]

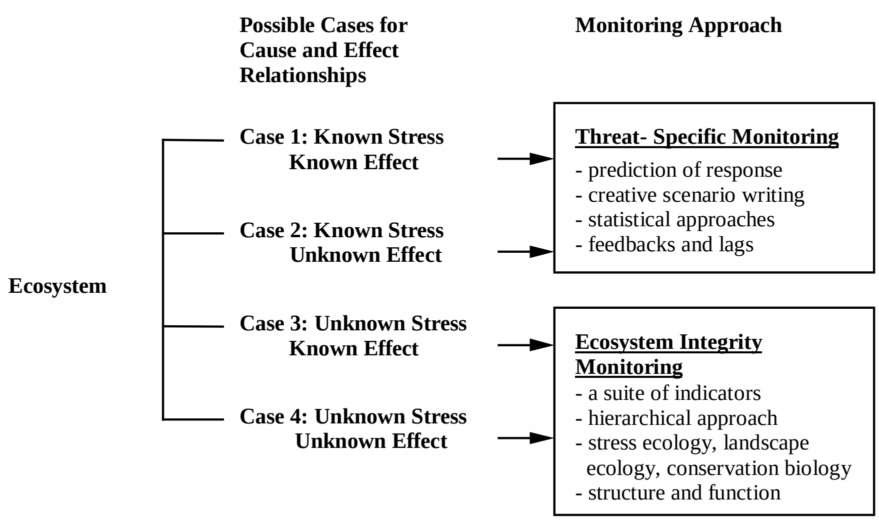

Figure 3.6 A two pronged framework for monitoring and ecosystem integrity (Woodley, 1996)

Theme 4 and 5 – Information gathering, decision- and communication-support evaluation

On the whole, Parks Canada's two-tiered approach to monitoring allows for early detection of change in regards to an area's specific threats, as well as for a more ongoing assessment of the system's overall health. Ideally, it provides data and information that span various temporal/spatial scales and disciplines, including concern for risks and uncertainties, and the incorporation of local knowledge. Although the establishment of such a MP is theoretically possible, in practise the approach as well as network programs

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[28] Examples of MP indicators include abundance measures of exotic/indigenous fauna/flora communities, erosion and deposition balances (PRNPR's Ecological Integrity Statement, draft,1999).

are rarely used within Parks Canada (Oates, 2000 November). This type of MP approach is very time and effort consuming, leaving most Field Units at the initial stages of its development at best (ibid.). Networking of data and information through explicit communication channels is also very limited. Programs may exist but appear not to be extensively used (e.g. EMAN) (ibid.). Export and import of data and information (which is also limited to MP specific outputs) between individual MPs are most often based on implicit and ad-hoc communication channels. Finally, MPs do not provide any direct decision-support functions, and are not intended to do so. However, though they neither bound nor process management situations per se, they supply essential components for informal and formal decision-making processes, such as indicators and associated thresholds.

Management tool	Monitoring Program (MP)
THEME 1 and 3 – Selection rationale and tool evaluation	
Primary perspective reflected:	External legislation.
Tool's main focus and objective?	Facilitate early detection of change as well as diagnostic assessments of the state of ecosystem health under protected area managers stewardship.
THEME 4 – Information gathering tool evaluation	
Types of data and information aspects given consideration to:	
▪ Multiple disciplines	Progressive programs include indicators of social, economical, and environmental elements concurrently.
▪ Temporal and spatial dimensions	Both
▪ Multiple of scales	Yes
▪ Risks and uncertainties	Practice of caution is recommended when assigning thresholds.
▪ Stakeholder and interest-group input	Progressive programs can and do.
THEME 5 – Decision- and communication-support tool evaluation	
Types of decision-support provided:	
▪ Bounding (compilation and assemblage of data/information; addressing situation specific and more overall implications).	N/A
▪ Processing (analysis and synthesis of data /information, to properly reflect the complexities of protected area management).	N/A
Types of communication-support provided:	
▪ Consistent template, enabling easy import and export of data and information.	N/A
▪ Template flexible enough to allow for communication of varying types and amounts of data and information.	N/A

Table 3.5 Monitoring Program

Conclusion

Each of the tools above is designed to facilitate different aspects of protected area management on an application and situation specific basis (except for MP). Data and information are typically gathered separately for each tool. Using such data and information as inputs, these tools then bound and process specific issues, providing the foundations for specific decisions. Finally, the more or less standardised assessment templates typically produce output that lends itself well to easy communication within the same type of management frameworks. Therefore, as individual tools, each of them performs relatively well on all evaluation accounts: their assessments support sound decisions and decision-making processes within each specific area of application. They provide Parks Canada with sound information for planning and management decisions related to questions such as where (i.e. ROS), what (i.e. AAA), and how much (i.e. LAC) recreational activity there should be, what physical projects are accepted (i.e. CEA), and what phenomena should be monitored and measured (i.e. MP).

The salient question is whether the application format of these tools can be improved to better suit the requirements posed by the Agency's overriding ESBM philosophy. This chapter has demonstrated that, while each tool is competent within its own narrow focus, each one remains largely ineffective at addressing connections and complexities between the various management issues. To a large extent, this deficiency can be traced to each tool's origin and way of application. Typically, the tools are designed to assist one specific aspects of management, and are subsequently applied on a situation and type specific basis without explicit linkages to other assessments and in absence of an overall integrative framework. For example, the information gathered for a ROS study refers only to the critical issues in the context of a ROS application. The tool is also limited to supporting decision-making situations with this narrow focus in mind. Its framework is not designed to support communication of other types of information and data (e.g. economic acceptance capacities of local businesses, visitors acceptance capacities for visual environmental degradation, or an area's expected and actual ecological response to campground expansions). Hence, its decision- and communication-support can only bound, assess, and communicate a situation referring to the establishment of appropriate combinations of recreational activities, setting, and experience. Similar limitations apply to the other frameworks discussed.

This report argues that the void of linkages between management tools and the lack of a coherent framework have significant potential to severely obstruct the attainment of Parks Canada's EI and CI management goals. With the desire to pursue an ESBM approach, and the fact that important issues will grow further in complexity, the severity of this limitation is likely to increase in the future. For example, as a result of Parks Canada's vision of environmental stewardship and a sharing of management responsibilities with its stakeholders and interest-groups, the number of authorised management groups for these areas can be expected to increase significantly. Subsequently, many more different assessments will be required, many more management decisions will need to be made, all by different management groups, which do not necessarily belong to the same organisation, and do not necessarily have the same management agendas and power structures. Without an overall integration of some sort, the assessments and decisions made by these groups can only be as good as individual pieces of a jigsaw puzzle. Regardless of the quality of the various, independent, decision-processes, if they and the decisions they produce are not explicitly linked, they will not contribute their maximum to the overriding agency's mandate. This will make it difficult to avoid the consequences of the three protected area management challenges discussed in this chapter, and will likely limit integrative and collaborative management efforts from the outset.

What is needed is an overall framework that provides simple and convenient integration and communication of the various types of information and data generated by these individual assessments. Furthermore, the framework should provide uncomplicated, yet comprehensive, decision-support functions for various management situations. It should complement and connect the decisions made by existing management tools, and contribute towards more holistic, overall evaluations of management issues. The remainder of this report will argue that such integrated decision-support tools exist already, but need to be adopted to meet Parks Canada's specific needs. The subsequent chapter will present such a framework, stemming from the field of decision analysis, a research area which provides a variety of methods suited to structuring complex decision problems. A subsequent case study will adopt the proposed framework to one specific management application.

Chapter 4

DECISION ANALYSIS

Chapter 4 presents an overview of the origins and methodological advancements of Decision Analysis (DA). DA refers to a diverse methodological field whose array of methods have in common that they all provide formal support for decision-makers in complex choice situations. The chapter will focus on one of DA's sub-disciplines, Multi Criteria Decision Analysis (MCDA), and more specifically Multi Attribute Decision Making (MADM). Within MADM, two methods will be looked at more closely: the Analytical Hierarchy Process (AHP), and the Elimination et Choix Traduisant la Realite method (ELECTRE). The intent of the chapter is to familiarise the reader with the key concepts and procedures of DA in general, and the two methods in particular. It will be argued that these kinds of techniques constitute useful methodological components for a more integrated framework that would assist Parks Canada in designing a sounder, more holistic protected area management approach.

The reader should note that the style in which this chapter is written intentionally differs from other sections of the report. The chapter is relatively technical and much of its content stands without explicit linkages to a protected area management context. The purpose of the chapter is to provide the appropriate technical background for readers who are interested in implementing the framework suggested in this report. The concepts of AHP and ELECTRE, which form the foundation of the suggested management framework, will be exemplified in the ensuing case study in a more accessible format. Readers with a more conceptual interest in this report may skip this chapter. The reader should also note the different meanings of the term "decision-making process" in this chapter compared to the other parts of this report. In accordance with DA terminology, this chapter defines decision-making processes as the procedures belonging to the various DA methods, as opposed to the different management agendas and power structures held by various managers, directing the ways in which decisions are made. Finally, the various sub-disciplines of DA and their respective methods presented in this chapter are used as decision aids for problems of different compositions and natures. Hence, the reader is directed to a number of case studies for further details regarding the respective methods/fields practical application.

The making of a decision

Many everyday decisions and compromises are made on the basis of intuition, common sense, chance, or all of these. However, sometimes problems of choice are so complex that DMs are not capable of arriving at a logical and rational resolution by using a process consisting merely of intuitive logic and reasoning (Schmoldt, et al., 1994). While informal decision-making may result in acceptable decisions in many cases, problems of medium or high complexity need more rigorous and rational appraisal procedures (ibid.), (Youdale, 1983). As suggested in Chapter 3, decision situations related to protected area management and planning are often characterised by their inherently uncertain setting (Keeney, 1982; LSE, 2000; Friend and Jessop, 1969), with often multidisciplinary and at least partly conflicting objectives, for which there is no single optimal solution (Nijkamp, et al., 1990; Canessa, 1997). Often this context is complicated further as decision situations have limited allocations of time and funding, as situations are intricately interrelated with one another, and as the values and management agendas of several DMs need to be recognised and considered concurrently (Maguire, et al., 1994). Thus, protected area decision situations are inherently varied and complex, making them difficult to deal with on an informal basis. A formal decision-making process provides techniques for eliciting preferences, a transparent structure, and a common decision rule (Maguire, et al., 1994), and further facilitates sound decisions by ensuring a situation's comprehensive assessment. Used on a continuous basis, formal procedures also provide DMs with important by-products such as consistent documentation of what decisions have been made (e.g. record management practices), rationales for the decisions (e.g. justification), and prescriptions of information and data requirements (e.g. information/data gap analysis) (Schmoldt, et al., 1994).

Decision Analysis

The field of Decision Analysis (DA) encompasses various methods and systematic procedures pertaining to formal and structured decision-making (Keeney, 1982)[29]. The formal analysis of a decision and its potential consequences is not a new conception in any sense. It dates back to the early 18th century with Pascal's mathematical probability studies and Bernouilli's attempt to conceptualise monetary utility functions (Covello and Mumpower, 1985). Studies like these, together with later theoretical reviews and developments by Ramsey (1931) and Neumann and Morgenstern (1944), laid the first building blocks of what was to become a philosophy articulated by a set of logical decision theory axioms, comprised by a wide range of systematic methods and procedures, able to consider a multiple of interdisciplinary aspects, objectives, and stakeholder preferences for complex problem situations (Keeney, 1982).

Decision theory axioms

In the 1950s, Savage (1954) created the set of decision theory axioms mentioned above, which formally define the concepts underlying DA The axioms are based on Ramsey's (1931) recognition that all decision-making inevitably needs to combine the concepts of probability and utility, with accompanying

[29] The discussion below provides an introduction to the DA field and is by no means exhaustive. Suggested readings for further details regarding the developments of various DA aspects and methods include books by Raiffa (1968b), von Winterfeldt and Edwards (1986), Keeney et. al. (1976), Holloway (1979), Winkler (1972), and Pratt et al. (1965). Clemen (1995), Bunn (1984), Fishburn (1989) , and Corner and Kirkwood (1991) provide good summary guides and methodological descriptions, as well as give many different types of application examples, for the intermediate reader.

considerations for risks and uncertainties[30]. Thus, Savage (1954) defined the final attractiveness of an alternative as dependent on two things:

1. the likelihood of its possible consequences (probability), and
2. the DM's preferences for those consequences (desirability).

This separation is an important one, as it implies that the assessments for estimating the likelihood of consequences vs. their desirability should be done separately, by employing probability theory to the former issue and utility theory to the latter (Phillips, 1986). By later combining the probabilities and utilities for respective alternatives, their overall expected utilities can be determined, allowing for a ranking or grouping to take place. Savage's (1954) four main axioms address the principle relationships among decision components (or elements): their order, transitivity, dominance, and "sure thing". For the purpose of clarifying these concepts, assume a choice situation between alternatives A, B, or C. In terms of logic ordering, the axiom of order assumes that a DM can assign an order of preference to the alternatives, i.e. alternative A can be deemed more desirable than B. Next, the transitivity axiom suggests that if alternative A is preferred over B, and B is preferred over alternative C, then A is also preferred to C. Dominance refers to the situation if alternative A is as good as B in every respect and A is better than B in at least one respect, then A is preferred to B. Finally, the "sure thing" means that when the above preferences are formed between alternatives A and B, identical aspects held in common by A and B should not influence the decision-making process. However, it should be noted that these identical aspects may have different meaning to different options (Pratt, et al, 1965).

Assuming acceptance of these axioms, Savage (1954) explained that the alternative with the highest score will always become the most preferred by the decision-maker(s) because it maximises hers/his expected utility. Though initially subjected to much debate and controversy, these axioms provide a practical and defensible approach for the systematic inclusion of subjective values and preferences in decision analysis (Phillips, 1986). Today, these axioms, accompanied by continuous contributions and refinements (e.g. Luce et. al., 1957; DeGroot, 1970; French, 1986; and Fishburn, 1970), constitute the foundation to the many modern DA methods[31].

Methodological advancements

Prior to the 1960s, DA applications primarily sought an optimal solution to various types of problems by way of linear programming (LP) techniques (Nijkamp, et al., 1990). Though LP still is an acclaimed DA process, its applicability is limited in certain decision situations. LP techniques seek the optimal allocation

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[30] For a more detailed description of the axioms, see for example Savage (1954), Luce and Raiffa (1957), or Pratt, et al (1965).

[31] It is important to note that although the axioms "tell you what to do" once a problem is structured and its values and respective uncertainties are assessed, all aspects of decision-making are not covered by them. For example, they do not provide guidance for issues such as sensitivity analysis, utility and probability assessments (Clemen, 1995).

of resources relative to a set of competing activities, and, as the name implies, assume that decision situations only involve linear relationships. Hence, one of the method's fundamental limitation is its inability to address problems of a multi-objective nature in situations where several DMs' divergent preferences need to be considered (Simon, 1958). LP assessment processes are also very mathematical and programming based. Therefore, they provide, if at all, very limited possibilities for DMs to actively participate and provide input to the process. During the 1960s, managers working in areas such as land use planning, health care and environmental management were beginning to show an increasing interest for formal decision-making techniques (Nijkamp, et al., 1990). DMs in these inherently multivariate settings were calling for techniques that would facilitate participatory decision-making, while enabling formal consideration for a multiple of objectives and stakeholder preferences (Dyer, et al., 1992).

Such demands, in combination with the quantitative revolution of the 1960s, initially contributed to the advancement of a technique referred to as goal programming (GP) (Charnes and Cooper, 1961). By providing the methodological extension needed to consider more than one objective at a time, GP gave decision-makers an alternative to LP's single objective optimisation focus; a multi-objective, compromise based, solution approach (ibid.). Contrary to LP, which deems a situation infeasible when the single objective function cannot be obtained, GP makes use of a multi-objective function that continues the search for the next best solution (Romero, 1991). It does so by introducing the concept of objectives' relative importance in the form of weights (Ignizio, 1976). By assigning individual importance ratings to each objective, GP applications search for the solution that performs most satisfactorily under these conditions (ibid.). By assigning weights to a decision situation's multiple objectives and associated criteria, GP attempts to allocate and prescribe DMs with the solution(s) that best meet(s) (multiple) objectives as defined prior to the start of the process (Ignizio, 1983). The weights used by GP applications are often derived as DMs' aggregated preferences for components' achievement (Romero, 1991). Such preferences are typically assumed to be adequately represented through established objective functions, which, in the case of GP, are fixed prior to assessments (Hannan, 1985).

In summary, GP provides a form of DA that more readily reflects "real life" situations by solving for compromise solutions with imperfect information under uncertainty[32]. However, original GP techniques were still highly dependent on large amounts of objective and quantifiable data for their assessments (Romero, 1991). Their analytical components are typically mathematically complex with extensive programming components, and require the use of modelling experts for their operation (Hannan, 1985). While the participatory component in formal decision-making processes was theoretically enhanced with the introduction of GP (by inclusion of preferences), in practice, the role of the decision-maker(s) was still at this time predominately of a consultative and indirect nature (Hannan, 1985; Dyer, et al., 1992).

[32] Extensive bibliographical surveys of GP can be found in Lin (1980), and Romero (1986). Schniederjans (1995), Hannan (1985; 1984), and Ignizio (1983) also provide good critical overviews of GP's methodology and applications.

Multi Criteria Decision Analysis

As interest in the use of formal decision-making processes in a variety of management settings continued to rise (Covello, 1987)[33], so did the demands posed by DMs regarding the improvement of methods. Three common requests were that DA techniques needed to (Nijkamp, et al., 1990):

1. become less time and funding intensive,
2. provide more explicit participation opportunities for DMs, and
3. provide more explicit mechanisms for the consideration of stakeholder preferences.

Extensive research efforts followed[34], focusing on refining the DA discipline to better meet these demands. Many of the resulting techniques are now referred to as Multi Criteria Decision Analysis (MCDA) (Nijkamp, et al., 1990)[35].

MCDA consists of a spectrum of methods whose methodological heredity and influences range from economic utility theory to mathematical programming (Vincke, 1992). As the MCDM field is both extensive and diverse, there is good reason to classify the methods on the basis of their 1) methodological heredity, 2) the properties of their feasible solutions (i.e. discrete or continuous sets of alternatives[36]) (Miettinen, 1999), and 3) the characteristics of their decision-making process (Nijkamp, et al., 1990)[37]. Along these three criteria, MCDA can be sub-divided into three distinct categories: Multi Criteria Mathematical Programming (MCMP), Multi Objective Decision Making (MODM), and Multi Attribute Decision Making (MADM)[38].

1. Multi Criteria Mathematical Programming (MCMP) methods represent the techniques with the strongest ties to GP, as they rely heavily on mathematical programming for their assessments (Evans, 1984; Miettinen, 1999). Assessments typically require large amounts of objective and quantitative data (ibid.). Again, similar to GP, methods within MCMP solve for optimal solutions of problems that have

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[33] Early DA applications researched a diverse set of issues, such as resource/environmental management and conflict resolution (Maguire, 1986; Bacow and Wheeler, 1984; Edwards and von Winterfeldt, 1987; Gardiner and Edwards, 1975; von Winterfeldt, et al., 1986), health care (Krischer, 1980), regulatory settings (von Winterfeldt, 1980; Keeney, 1980; Keeney and Nair, 1977), and R&D (Sebenius, 1984).

[34] Crucial contributions to the development of this field were made by von Neumann, et al. (1944); Arrow (1951); Savage (1954); and Fishburn (1970). For statistics on developments and applications, see Steuer, et. al. (1996).

[35] Good comprehensive reviews on MCDA are provided by Vincke (1992; 1986); Voogd (1983).

[36] A situation's alternative space can either be continuous or discrete. This property indirectly limits the situation's solution possibilities. In the case of a continuos alternative space, solution possibilities are limited only by minimum performance requirements on certain variables of measure. For such situations, optimisation focused methods are favourable. When a situation is composed of a discrete set of alternatives, the selection process is explicitly limited to this particular set of alternatives. In these situations, compromise based methods are favoured (Miettinen, 1999).

[37] A brief historical account and arguments in favour of the above classification can be found in Dyer et al. (1992) and Zionts (1992b).

[38] The categories are not intended to be viewed as mutually exclusive as there exists much overlap between the three fields, and other classifications exists; see MacCrimmon (1973), and Miettinen (1999).

an infinite solution space (Hwang and Lin, 1987). Their variables are continuous, subsequently, their feasible alternatives are not explicitly known in advance. Rather, the infinite number of alternatives are represented by decision variables that are restricted by explicit constraint functions (Miettinen, 1999). The MCMP methods' decision-making processes are demanding and complex in their operational requirements, making them more suited for programming experts than everyday DMs (Hwang, et al., 1987)[39].

2. The field of Multi Objective Decision Making (MODM) is often described as a less programming intensive extension to MCMP (Rosenthal, 1985). Accordingly, methods rely primarily on mathematical algorithms to analyse large, possibly infinite, sets of alternatives. Solutions are predominately defined around the identification of a situation's single optimum solution (ibid.)[40].

3. Multi Attribute Decision Making (MADM) represents the group of methods which are methodologically the furthest removed from GP (Zionts, 1992a). Its methods are primarily influenced by the basic concepts of economic utility theory and subjective probability (Keeney, et al., 1976). The available space of alternatives is discrete, predetermined, and finite. As such, choices are implicitly constrained and MADM methods do not solve for a problem's optimal solution (Hwang and Yoon, 1981). Rather than prescribing DMs with the perfect solution, their focus is on allocating and describing "satisfactory" solutions for the DMs, constrained by available alternatives' attributes (ibid.). Depending on what type of decision problem is being tackled, the end product of a MADM application is either a recommendation to choose one alternative, or a subset of alternatives containing the most suitable alternatives. These recommendations are derived by either a ranking or a sorting process. The DA research community generally considers MADM methods to have the most user-friendly interfaces of all MCDA methods (Edwards and Newman, 1982). A variety of standardised frameworks provide different analytical procedures and decision rules, enabling the actual DMs, rather than modellers, to compile, analyse, and synthesise a situation's components (Hwang, et al., 1987). As a rule, MADM methods are also quite cost and time effective in that their frameworks can accommodate the use of both objective and subjective data in both quantitative and qualitative form (Nijkamp and Spronk, 1981)[41].

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[39] For application examples, see White (1990).

[40] For examples and an overview of the MODM area see Hwang and Masud (1979), McDaniels (1994), Keeney (1977), and Chankong and Haimes (1983). Note that as the two classes above are closely related, many of the applications in White (1990) and the references in this section, overlap.

[41] A classic reference for MADM is Keeney and Raiffa (1976). Other good literature on MADM includes Yoon and Hwang (1995), Healey (1984), Hwang, et al. (1981), Edwards, et. al. (1982), Farquhar (1977; 1983). For more specific application examples, see Sarin (1980), Fandle and Gal (1980), Keeney and Raiffa (1991), Janssen and Rietveld (1985), Janssen and Hafkamp (1986), and Keeney (1980).

All things considered, it is the specific characteristics and needs of a particular decision situation that determine what DA method constitutes the most appropriate choice (Janssen, et al., 1984). Considering the arguments in earlier chapters of this report about the management situations that Parks Canada specifically and protected areas in general face, it is obvious that besides multiple objectives, formal decision-making processes should also provide opportunities for DMs participation in an explicit manner. With several stakeholders and management groups involved in most decision situations, their active involvement in the process and explicit consideration of their preferences, increase the odds of arriving at decisions of good quality with a high level of acceptance. Furthermore, in order to achieve successful co-ordination and documentation among the various decision situations, the method of choice should be introduced as a standard feature in the management process, hence it needs to be pragmatic and flexible. Finally, methods need to be time and cost effective as budget and time allocated for these processes are usually constrained. With this in mind, the next section will take a closer look at the field of MADM.

Multi Attribute Decision Making

There exist numerous techniques within the field of MADM, and comprehensive technical reviews are readily available (in addition to the references in the previous section, see Nijkamp et. al. (1984), Voogd (1983), and Vincke (1992)). Therefore, this report will refrain from an in depth review. Rather, the sections will first provide a general discussion of how MADM conceptualises decision-making, and then focus on key elements of two specific techniques: The Elimination et choix traduisant la realite (ELECTRE) with its thresholds and outranking concepts, and the Analytical Hierarchy Process (AHP) with its pairwise comparisons. Note that these two methods are not being presented as superior to the other decision aids within the MADM category. As many comparative studies have concluded “There are obvious differences between the methods, but it is not obvious that one method is stronger than the other” (Simpson 1996a, p. 928). Again, the suitability of a method depends on the situational context (Olson, et al., 1990). The report’s choice of AHP and ELECTRE over others is based on the methods’ ease of application as well as their relatively low time, funding, and data requirements. Also, ELECTRE’s ability to incorporate the fuzzy nature[42] of decision-making (its thresholds of indifference), and AHP’s ability to present preferences using a ratio scale (its pairwise comparisons) make these two methods particularly attractive for applications in the context of protected area management.

There is a common misconception regarding DA’s techniques in general. It is often assumed that the costs associated with their use (time, money, and effort) are too high to be justifiable in comparison to the diligence provided by these methods. This report argues that the MADM methods, commonly defined as “the formalisation of common sense for complex decision situations” (Keeney, 1982), prove this assumption wrong. Independently of type, these methods can structure, analyse, and synthesise a problem

[42] For detail on the concept of fuzzy natured decision-making, see Zadeh (1965), Bellman and Zadeh (1970).

situation for a reasonable cost. Financial and time commitments are on average kept low through MADM methods' capability to complement or substitute objective and quantitative data/information gaps with qualitative and subjective estimates (Rosenthal, 1985). These estimates, stemming from expert opinions, stakeholder and decision-maker input, are both time and cost effective, as well as temporal, and sometimes permanent substitutes of adequate quality to primary data/information (Weber, 1987). The amount of effort required to perform these types of assessments is also low in comparison with other DA methods (Rosenthal, 1985). By supplying DMs with frameworks and structures that use clear "common sense" concepts to analyse and synthesise a situation, learning curves are kept to a minimum (Dyer, et al., 1992).

A standard MADM process

As pointed out previously, decision-making processes can be broken down into three stages: 1) the structuring of situation components, 2) the analysing, and 3) the synthesising of information (Keeney, 1982). It should be noted that although the stages are often separated in theory, they are interdependent and overlapping in reality. Decision-making is an iterative process. Repetition of the steps, as well as of the order in which they are carried out can differ, and are all elements of a dynamic process (ibid.). Though the stages and steps involved in a formal decision-making process are generic to most MADM methods (and to other formal decision aids as well), certain components differentiate one method from another. For example, they can differ by the level of detail assigned to each step (varying from very detailed to very general), by the techniques by which probabilities and preferences are estimated and exploited, and by the methods' aggregating procedures[43]. Figure 4.1 below describes a generic MADM process as described by Keeney (1982), and the subsequent discussion will outline its components and highlight some of the main differences between the various methods.

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[43] Good comparative analyses regarding MADM methods' aggregation differences (for example regarding their weights, ranking procedures, and attribute sorting) include them by Poyhonen and Hamalainen (1997), Simpson (1996a), Krovak (1987), Miettinen and Makela (1998), Miettinen, et al. (1996).

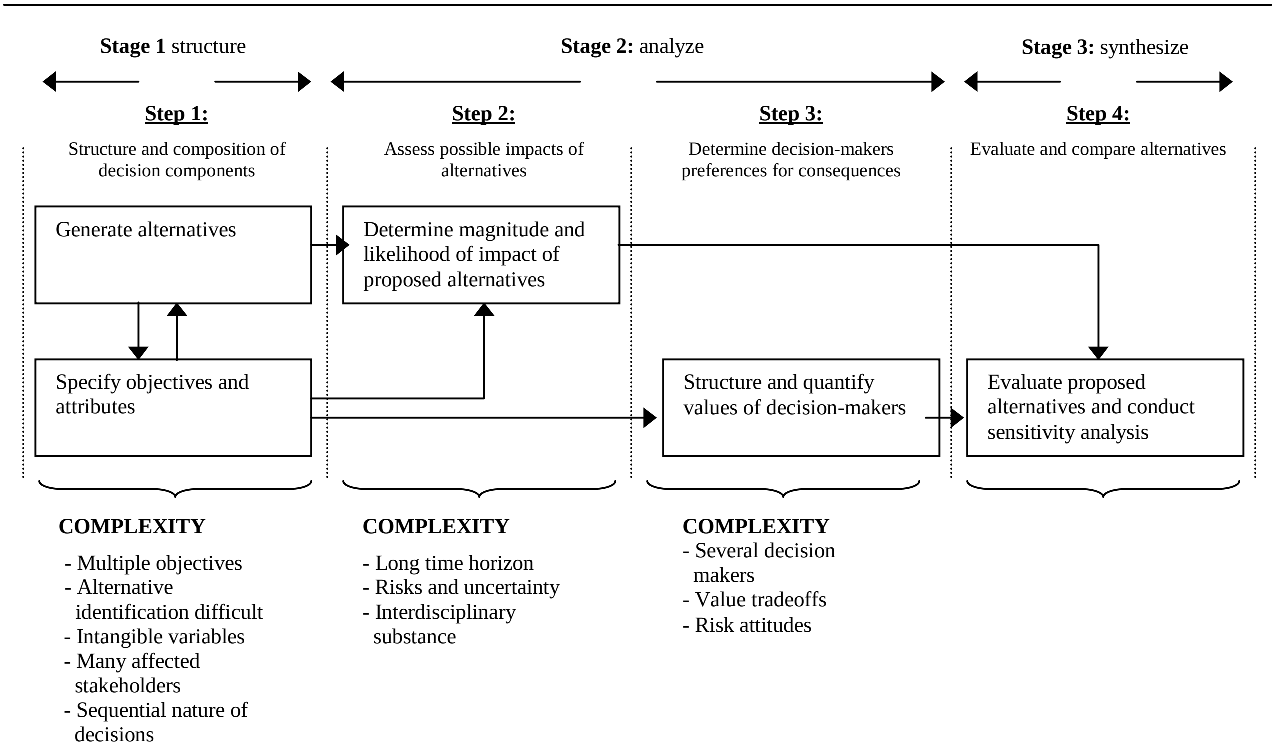

Figure 4.1: Schematic representation of a generic MADM process. Modified from Keeney (1982)

Stage 1: Structuring

This stage is usually given great emphasis by MADM methods as they are often referred to as the "formalisation of common sense" (Keeney, 1982). The steps in this stage involve the creation of an assessment table consisting of the identification of alternatives and specification of objectives, criteria and attributes (ibid.). Basically, a decision problem is broken down into smaller, more manageable parts to prepare for the coming analysis. One way of specifying a situation's objectives $|O_i$, i = 1, …, i | is by listing possible consequences from identified alternatives $|A_n$, n = 1, …, n |. Non-ranked, but organised by sets of general concerns, for example potential environmental and socio-economic impacts, the list serves as a starting point for more detailed descriptions (ibid.). An objectives' hierarchy is formed where higher-end objectives are essentially defined by lower-end criteria $|c_j$, j = i, …, j |. Attributes $|a_m$, m = i, …, m | are also established, which are the measures by which the alternatives' performances are identified and to what degree a particular objective is achieved (ibid.). To enhance transparency and ease of display, these components are essentials for compiling a decision tree (Raiffa, 1968a; Kirkwood, 1997) (Figure 4.2). A decision tree can be perceived simply as an upside-down tree. The base represents the situation's fundamental goal. From there, the objectives, criteria, alternatives, and alternatives' attributes, branch out towards the top, forming the crown.

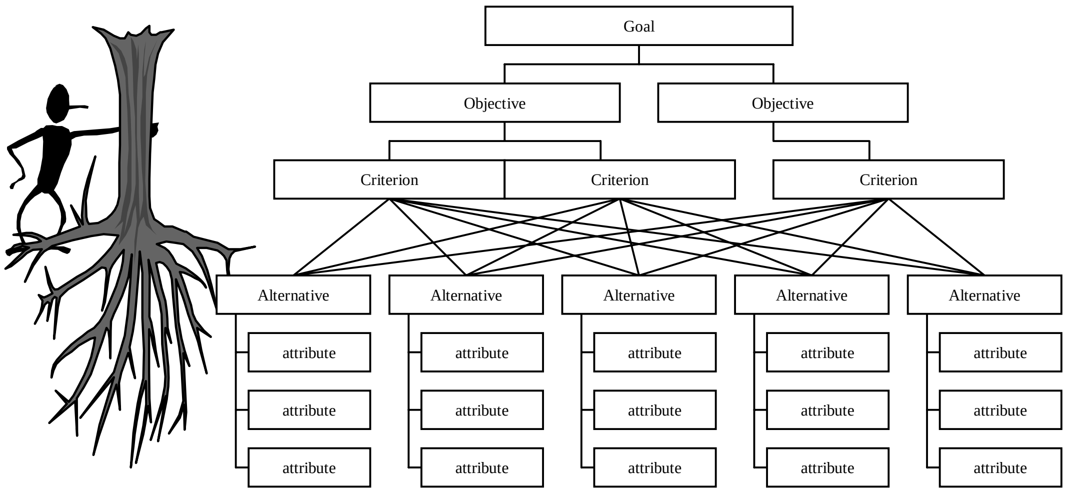

Figure 4.2 A generic Decision tree

Before moving to the next stage, it is common practice to undertake an initial screening of the alternatives. This is to discard unfeasible or inferior alternatives. The measures for the screening process are made up by a set of basic assumptions revolving around alternatives' minimum performance requirements (Keeney, 1982). Only alternatives with a certain degree of criteria performance are considered 'good enough' to consider pursuing. The assumptions employed at this stage of the process are generally too crude to use for any coming evaluation or ranking of alternatives. However, they should be sensitive enough to help trim the decision tree to a manageable size.

Stage 2: Analysing

The analysing stage consists of two steps. First comes the assessment of the potential magnitude, likelihood, and uncertainty associated with the possible impacts from the remaining alternatives (Hwang, et al., 1981)[44]. The second step involves the elicitation of DMs' preferences for value tradeoffs[45] and

[44] Given the hypothetical nature of the subsequent case study, this report does not explicitly consider risk and probability assessments. However, much information about this subject can easily be found in most DA and financial economics literature. For example: Covello and Mumpower (1985), and Schlaifer (1969) provide a good history and general assessment of uncertainties and risk management. Fischhoff et al. (1981) and Raiffa (1968a) provide a good discussion on risks and their assessment within DA specifically. Covello (1987), Schoemaker (1980), Tversky and Kahneman (1990), Morgan and Henrion (1989), Kahneman et al. (1981), and Holloway (1979), all provide good information and examples of applications for various approaches to assess decisions under uncertainty. More directed to the novice reader, Clemen (1995) and Dawes (1988) gives the topic of risks and behavioural issues in DA a basic and introductory treatment, and Morgan and Henrion (1990) give the use of uncertainty for risk analysis an in-depth treatment.

[45] Answering the question "How much should we/are we willing to give up in regards to one objective/criterion to achieve a specified improvement in another?"

willingness towards risk taking[46] (ibid.). The two steps, as well as their later aggregation (see stage 3), differ significantly among the various methods. In step one, some methods establish distribution functions $|p_j(x)|$ in the form of probabilistic dependency models over the set of attributes $|a_m|$ and criteria $|c_j|$ for each alternative $|A_n|$ (Savage, 1954; Fishburn, 1989). In these situations the probabilistic dependency among attributes/criteria for given alternatives is usually acknowledged and considered by modelling of the dependence using the output of the model. Other methods employ more informal styles. Possible consequences can be directly determined by simple aggregation of the best available information (Hwang, et al., 1981). In these situations the probabilistic dependency among attributes/criteria for given alternatives is usually acknowledged and considered by bounding the possible probability distributions by use of simple logic and a basic understanding of the problem. Independent of method, the information used for the assessment of potential magnitude and likelihood of possible impacts is typically derived from quantifying participating DMs' expert opinions or professional judgements (Miettinen, et al., 1997)). There also exist several different ways and techniques for conducting step 2: determining DMs' preferences for these consequences. The simplest method for deriving objectives', criteria's, and attributes' weights, is by way of linear utility functions or weighted summations[47] (Shoemaker and Waid, 1982; Hwang, et al., 1981). Other approaches include the specification of non-linear utility functions (e.g. Multi Attribute Utility Theory: (Farquhar, 1977; Fisher, 1975)), concordance (e.g. ELECTRE: (Roy, 1991)), or pairwise comparisons (e.g. AHP: (Saaty 1980)).

Stage 3: Synthesising

At the final stage, the alternatives' advantages and disadvantages are evaluated and compared against each other by amalgamating available information (Keeney, 1982). Each alternative's situation specific efficacy is predicted using the decision rules from the DA axioms as the foundation. Probabilities and preferences are aggregated into a value model where $|u(x)|$ represents the utility of the consequence $|x|$, hence indicating the desirability of $|x|$ relative to all other consequences. The alternative $|A_n|$ with the highest expected utility $|Ej(u) = \int pj\ (x)u(x)dx|$, assuming adherence to the axioms, will be the most desirable (ibid.). Note also that aggregation procedures vary for different methods. The different procedures can be classified into three main categories (Guitouni and Martel, 1998): 1) single synthesising criterion procedures; 2) outranking procedures; and 3) mixed procedures[48]. These methods differ on a number of accounts, one of them being the solution focus. Methods either allocate and recommend the choice of one or a subset of acceptable alternatives, by way of a final ranking or sorting of options (Nijkamp, et al.,

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46 Answering the question "Do the potential benefits outweigh the potential risks?". This topic is given a good introduction by Copeland and Weston (1979), and by Pratt's (1964) study on the concept of risk aversion. Further suggestions of material covering how individuals perceive risk include Slovic (1987), Morgan and Henrion (1989), and Morgan (1993).

47 The additive utility function is given a comprehensive coverage in a book by von Winterfeldt and Edward (1986). Other good references covering material related to preference modeling include Keeney and Raiffa (1976), Keeney (1980), and Edwards and Barron (1994).

48 More detailed descriptions of these procedures and their methods can be found in Abi-zeid (1998).

1990). Before a MADM process is considered complete, it is important to conduct an examination regarding the sensitivity of the projected outcomes (Clemen, 1995). Sensitivity analyses are related to a number of procedural aspects[49]. One aspect that is commonly addressed is the DM's value judgements or preferences.

Time, funding, and data/information availability

As described above, the differences between the various MADM methods are found predominately in the analysing and synthesising stages of the decision-making process. The level of detail that the methods ascribe to each of these stages, the type of technique they use for estimating probabilities and preferences, as well as the type of aggregation procedure employed, all have great influence on the overall cost of the evaluation process. Commonly, the costs of evaluation also determine the *de facto* criteria, and influence the choice of method decisively: amounts of time, funding, and data/information existing vs. needed (Faludi, 1986). Four simplified types of combinations of situations (A, B, C, D) and methods (1, 2, 3, 4) can be distinguished (Janssen, et al., 1984):

A/1) high availability and demand for information and data, time, and funding,
B/2) high availability and demand for information and data, low for time and funding,
C/3) low availability and demand for information and data, time, and funding, or
D/4) low availability and demand for information and data, high for time and funding.

The circumstances assumed in the case study to be presented in Chapter 5 represent a situation where availability of information and data, time, and funding is limited. The following section presents two type 3 methods: the Analytical Hierarchy Process (AHP) and the Elimination et choix traduisant la realite (ELECTRE).

The Elimination et choix traduisant la realite

The Elimination et choix traduisant la realite (ELECTRE) method was originally developed in France by Benayoun, et. al. (1966; 1971). The extensive methodological developments and refinements that followed (e.g. Roy, 1968; 1971; 1990; 1991; 1996; Nijkamp and van Delft, 1977; and Voogd, 1983) have made ELECTRE a widely used decision tool in many applied management areas (e.g. Roy and Hugonnard 1982; Massam and Askew, 1983; Massam, 1980; Massam and Askew, 1982; Nijkamp and Vos, 1977a; Ali, et al., 1986; Roy and Bouyssou, 1986). Some researchers even classify ELECTRE as more than just a solution method and regard it as a philosophy of decision aid (for discussion see Roy, 1991). However, looking at it

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[49] Sensitivity analysis, one of the more recent additions to DA, play an important and central role in guiding the analysis and in interpreting its results (Clemen, 1995). There exist many different approaches whose techniques are used to assess various parts of a decision-process. Introductory overviews of the concept can be found in Samson (1988), Watson and Buede (1987), and Clemen and Reilly (1996).

strictly as a method, there are five basic model versions: I, II, III, IV, and TRI[50]. These models are based on the same fundamental concepts but are operationally somewhat different[51]. In this report, concentration lies on the method referred to as ELECTRE III (Roy, 1978).

The fundamental idea behind ELECTRE's process is to establish outranking relationships between a set of alternatives, thereby determining the relative dominance of alternative plans (Roy, 1990). In reference to stage two, step one discussed above (see Figure 4.1), ELECTRE employs an informal style for determining possible consequences by way of structured logic. Further, in step two, the desirability of alternatives is established through concordance and discordance analysis (Nijkamp and van Delft, 1977; Yoon, et al., 1995). DMs' preferences regarding objectives' and criteria's performance levels are used to indicate importance thresholds for these components. An alternative's value is subsequently determined by the degree to which it's attributes are in agreement (concordance) minus disagreement (discordance) with predetermined objectives/criteria and constraints (i.e. the thresholds) (ibid.). As for aggregation procedures, ELECTRE uses the concept of outranking (Guitouni and Martel, 1998). The non-dominated set (the kernel) of alternatives is obtained by associating the thresholds, in combination with criteria/objective weights, to an outranking relation and exploiting the relation, using status quo or an ideal situation as the reference point for comparison (ibid.). At the end, the method's solution focus is to allocate and recommend to the DM the highest ranked alternative (pareto optimal[52]), or a subset of alternatives that are considered equally good: the option(s) that comes closest to the desired optimum (ibid.). Below follows a more detailed outline of ELECTRE's four basic concepts. Unless stated otherwise, the information in the following 5 pages should be credited towards the following authors: Nijkamp, et al. (1977), Yoon, et al. (1995), Phaneuf (1990), Hwang, et al. (1981), and Roy (1990).

Thresholds and outranking

The sections below will look closer at ELECTRE's threshold and outranking concepts. Assume the existence of an assessment table, displaying a set of actors (the DMs), a set of potential actions (the alternatives) $|A_n, n = 1, 2, \dots n|$, situational objectives $|O_i, i = 1, 2, \dots i|$, as well as assessment criteria $|c_j, j = 1, 2, \dots j|$ and attributes $|a_m, m = 1, 2, \dots m|$.

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[50] Basic introductions to the ELECTRE methods can be found in e.g. Roy (1990), Vanderpooten (1990). Massam (1988) also provides some good case studies on the methods.

[51] Differences lie mainly in the manner in which a) concordance and discordance sets are calculated, b) weights are calculated, and c) the preferred alternatives finally selected (Cook, 1988).

[52] "Pareto optimal" (Pareto, 1971) refers to the following: a decision-maker has a set of alternatives she wants to rank or choose from. To do that, she has a set of criteria to consider. In order to gain in one criterion, she would have to give up performance in another. For example, the car with the cheapest price is usually not the one with the highest quality. An optimal car however, would be a car for which we could not have a higher quality without paying more, i.e., we have the best quality for a given price. This is optimality in the sense of Pareto. Consequently, non-dominated alternatives

Preference thresholds

The first step of the process is to establish the decision-makers' sets of threshold levels. These thresholds, determined by using DMs' input, are fundamental components for the subsequent outranking of alternatives. The threshold values will serve as indicators, generically the upper and lower acceptable limits, for criteria performance in the ensuing concordance/discordance analysis: specifying one alternative's dominance over another. ELECTRE uses four different threshold levels (Vincke, 1990; Roy and Vincke, 1984):

- strong preference threshold (**P**): The range within which a criterion's preferred performance lies; the aspired level.
- weak preference threshold (**Q**): An intermediate or buffer zone. A criterion's performance within this range is still accepted and aspired, however it represents DM's hesitation between P and I.
- indifference threshold (**I**): The acceptable range of movement (+/-) that a measure can take on before its variation becomes significant.
- veto threshold (**V**) The absolute min/max acceptable value, beyond which any deviation would be considered as affecting a criterion's state too severely.

Outranking relationships

The concept of outranking relationships, the preference for one alternative over another, has its origin and base in concordance and discordance theory, as expressed by Condorcet (1785). Basically, one alternative is considered to outrank another if:

➔ the alternative is at least as good as the other alternative with respect to the majority of criteria being assessed, *and*, without being too inferior to the other alternative with respect to the remaining criteria.

With this in mind, ELECTRE builds a series of outranking relationships |**S** | between the alternative sets |(a, b) ∈ A |[53]. Considering previous statements, the outranking of alternative b over a (i.e. acceptance of the assertion |a**S**b |) is conditioned by the following two principles:

- Majority principle: The majority of criteria, after consideration of their relative importance (weights[54]), being in favour of the assertion |a**S**b |;

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are situations in which one objective can be improved only by negatively affecting some other objectives, and the criteria are at their maximum (for a more formal definition see Miettinen (1999, p. 11)).

[53] Note that these relationships are applied to each of the *j* criteria, where a$\mathbf{S}_j$b means "a is at least as good as b with respect to the j^{th} criterion".

- Minority principle: Within the minority of the criteria not supporting the assertion |a**S**b |, none of them being strongly enough against the assertion, i.e. in favour of an inverse outranking |b**S**a |.

These two principles lead us to the next notion of the concordance (agreement or acceptance of the assertion |a**S**b |) and discordance (disagreement or rejection of the assertion |a**S**b |) measures' significance levels. For example, imagine that one criterion of relatively low weight is in favour of an inverse ranking. If this criterion's disagreement is of strong enough significance, but of low weight, it can make the outranking implausible. This concern is addressed by ELECTRE's application of its threshold values. The established thresholds give indication as to what performance levels are strongly preferred, weakly preferred, indifferently preferred, and not acceptable, for a specific criterion. This answers the question as to whether the j^{th} criterion is in significant agreement or disagreement with the assertion |$a\mathbf{S}_jb$ |. The binary descriptions of these outranking possibilities are as follows:

- Concordance: a criterion is in concordance with |a**S**b | if and only if:

$a\mathbf{S}_jb$	and	not $b\mathbf{S}_ja$	$c_j(a) \geq c_j(b) - q_j$
$a\mathbf{S}_jb$	and	$b\mathbf{S}_ja$	$c_j(a) + p_j \geq c_j(b)$

This premise holds since, even if |$c_j(a)$ | is less than |$c_j(b)$ | with an amount up to |$q_{j,}$ | it is not breaching the assertion of |$a\mathbf{S}_jb$ |.

- Discordance: a criterion is in discordance with a**S**b if and only if:

$b\mathbf{S}_ja$	and	not $a\mathbf{S}_jb$	$c_j(b) \geq c_j(a) + p_j$,

If |b | is strictly preferred to |a | for |c_j |, then it is clearly not in concordance with the assertion of |$a\mathbf{S}_jb$ |. Additionally, if |a | plus an amount of more than |v_j | exceeds |b |, then it is clearly breaching the assertion of |$a\mathbf{S}_jb$ |.

Concordance and discordance matrix

The above concordance and discordance relationships are summarised in a concordance and discordance matrix. The different outcomes, or relationships, for all the alternative sets |(a, b) ∈ A | on each of the |c_j | are given the following values:

$$c_j(a,b) = \begin{cases} \mathbf{1,} & \text{if } c_j(a) + q_j \geq c_j(b) \\ 0, & \text{if } c_j(a) + p_j \leq c_j(b) \\ \dfrac{p_j + c_j(a) - c_j(b)}{p_j - q_j}, & \text{otherwise} \end{cases} \quad , j = 1,\dots,r$$

[54] In the case study, weights will be derived using AHP's concept of pairwise comparisons, a choice supported in Cook and Kress (1988). Note that the ELECTRE method also offers several different techniques to determine the weights of decision components. For description and examples, see Nijkamp, et al. (1977a).

$$
d_j(a,b) = \begin{cases} 0, & \text{if } c_j(a) + p_j \geq c_j(b) \\ \mathbf{1,} & \text{if } c_j(a) + v_j \leq c_j(b),\ j = 1,\ldots,r \\ \dfrac{c_j(b) - c_j(a) - p_j}{v_j - p_j}, & \text{otherwise} \end{cases}
$$

This is how a concordance or discordance matrix would look:

c_1					c_2					c_7				
Alt.	A_a	A_b	A_c	A_n	Alt.	A_a	A_b	A_c	A_n	Alt.	A_a	A_b	A_c	A_n
A_a		$c_j(a,b)$	$c_j(a,c)$	$c_j(a,n)$	A_a		$c_j(a,b)$	$c_j(a,c)$	$c_j(a,n)$	A_a		$c_j(a,b)$	$c_j(a,c)$	$c_j(a,n)$
A_b	$c_j(a,b)$		$c_j(b,c)$	$c_j(b,n)$	A_b	$c_j(a,b)$		$c_j(b,c)$	$c_j(b,n)$	A_b	$c_j(a,b)$		$c_j(b,c)$	$c_j(b,n)$
A_c	$c_j(c,a)$	$c_j(c,b)$		$c_j(c,n)$	A_c	$c_j(c,a)$	$c_j(c,b)$		$c_j(c,n)$	A_c	$c_j(c,a)$	$c_j(c,b)$		$c_j(c,n)$
A_n	$c_j(n,a)$	$c_j(n,b)$	$c_j(n,c)$		A_n	$c_j(n,a)$	$c_j(n,b)$	$c_j(n,c)$		A_n	$c_j(n,a)$	$c_j(n,b)$	$c_j(n,c)$	
c_3					c_4									
Alt.	A_a	A_b	A_c	A_n	Alt.	A_a	A_b	A_c	A_n					
A_a		$c_j(a,b)$	$c_j(a,c)$	$c_j(a,n)$	A_a		$c_j(a,b)$	$c_j(a,c)$	$c_j(a,n)$					
A_b	$c_j(a,b)$		$c_j(b,c)$	$c_j(b,n)$	A_b	$c_j(a,b)$		$c_j(b,c)$	$c_j(b,n)$					
A_c	$c_j(c,a)$	$c_j(c,b)$		$c_j(c,n)$	A_c	$c_j(c,a)$	$c_j(c,b)$		$c_j(c,n)$					
A_n	$c_j(n,a)$	$c_j(n,b)$	$c_j(n,c)$		A_n	$c_j(n,a)$	$c_j(n,b)$	$c_j(n,c)$						
c_5					c_6									
Alt.	A_a	A_b	A_c	A_n	Alt.	A_a	A_b	A_c	A_n					
A_a		$c_j(a,b)$	$c_j(a,c)$	$c_j(a,n)$	A_a		$c_j(a,b)$	$c_j(a,c)$	$c_j(a,n)$					
A_b	$c_j(a,b)$		$c_j(b,c)$	$c_j(b,n)$	A_b	$c_j(a,b)$		$c_j(b,c)$	$c_j(b,n)$					
A_c	$c_j(c,a)$	$c_j(c,b)$		$c_j(c,n)$	A_c	$c_j(c,a)$	$c_j(c,b)$		$c_j(c,n)$					
A_n	$c_j(n,a)$	$c_j(n,b)$	$c_j(n,c)$		A_n	$c_j(n,a)$	$c_j(n,b)$	$c_j(n,c)$						

Degrees of credibility – the indefinite outranking relation

The next step, following the matrix establishment, is to assess the degree of credibility $|d(a, b)|$ of alternative sets $|(a, b) \in A|$. This is also referred to as the indefinite outranking relation for the alternative sets. This step assesses to what degree the assertion $|a\mathbf{S}b|$ is accepted or rejected: the strength and weakness of the outranking. This is estimated by creating and combining a concordance index: $|C(a, b)|$, and a discordance measure $|D_j(a, b)|$[55].

Concordance index

The concordance index, which is the measure of strength for the assertion, is created by aggregating the individual criteria measures from the concordance matrix, with the addition of one multiple agent: criteria weights[56] $|k|$, creating a total concordance value for an alternative set:

$$C(a,b) = 1/k \sum^{r}_{j=1} k_j\, c_j(a,b), \qquad \text{where } k = \sum^{r}_{j=i} k_j$$

---

[55] The "robustness" of the subsequent measure is often further assessed by means of sensitivity analysis, see Nijkamp, et al. (1977) for discussion and illustrative examples.

[56] The process of deriving criteria weights is discussed in the AHP section below.

Discordance measure

The discordance measure, which indicates the weakness of assertion $a\mathbf{S}b$, is not usually created by any aggregation over criteria. Rather, the assertion $a\mathbf{S}b$ is considered to be in discordance if $c_j(a,b) = 0$ for an alternative set $(a, b) \in A$ on c_j (ibid.). The discordance measure will increase (i.e. decreasing the credibility) in proportion to the difference between the $a\mathbf{S}_jb$ assessment on the j criterion, up to a value of V (the veto threshold). At and beyond this value, discordance is complete and no credibility at all is assigned to the outranking relation. In other words, when the difference between the $a\mathbf{S}_jb$ assessment on the j criterion is greater or equal to the veto level (V), discordance is $D_j(a, b) = 1$. If the difference is less or equal to the strict preference level (P) of a, the discordance is $D_j(a, b) = 0$.

We are now ready to form the indefinite outranking relation $d(a, b)$ for the alternative sets $(a, b) \in A$ by combining the two measures above. There are three basic assumptions underlying this ranking:

- If the strength of an alternative set's concordance exceeds that of discordance $D_j(a, b) < C(a, b)$ then the concordance value should not be modified:

  $$d(a, b) = C(a, b)$$

- The same is true for a situation where an alternative set is $c(a, b) = 1$. This implies that all the $c_j(a, b) = 1$ hence all the $D_j(a, b)$ values equal 0, giving the reasonable assumption of:

  $$d(a, b) = C(a, b)$$

- If the discordance is 1 for an alternative set on any criterion j, $D_j(a, b) = 1$, there is no confidence that $a\mathbf{S}b$, hence credibility equals 0:

  $$d(a, b) = 0$$

Although the outranking process in the application for Chapter 5 will only draw on the three previous assumptions, the following theoretical considerations deserves mentioning: in some cases, a certain criterion can reflect significant discordance in comparison to the concordance, e.g. one or more of the $D_j(a, b)$ values are greater than $C(a, b)$, but at a value less than 1. When this is the case, ELECTRE calculates the degrees of credibility as follows:

- If there is one criterion with a significant discordance level, at a value less than 1 $D_j(a, b) < 1$ and this criterion's discordance is greater than the concordance value $D_j(a, b) > C(a, b)$, then the degree of credibility is calculated as follows:

  $$d(a,b) = C(a,b) \quad x \quad \frac{1 - D_j(a,b)}{1 - C(a,b)}$$

- If there are <u>several</u> criteria in significant discordance, at a value less than 1 $|D_j(a, b) < 1|$, and these criteria's discordance is greater than the concordance value $|D_j(a, b) > C(a, b)|$, then the degree of credibility is calculated as follows:

$$d(a,b) = c(a,b) \quad x \quad \prod_{D(a,b)} \frac{1 - D_j(a,b)}{1 - C(a,b)}$$[57]

By combining the measures of strength and weakness, a credibility matrix is formed:

d(a, b)[58]				
Alt.	A_a	A_b	A_c	A_n
A_a		.87	.65	.30
A_b	1		.46	.00
A_c	.86	.48		.30
A_n	.57	.58	.00	

Finally, the entries in the credibility matrix are related to their levels of significance for the indefinite outranking relation[59]. There are three possible outcomes (Vincke, 1990):

- The sum is too weak to be of any significance, i.e. the sum is below or equal to value **q**, leading to a situation of indifference:

  a**I**b (**a** is indifferent to **b**; and **b** to **a**) $\quad |c(a) – c(b)| \leq q$

- The sum is strong enough to be of significance, i.e. there is a value greater than **p**, leading to a situation of strict preference:

  a**P**b (**a** is strictly preferred to **b**) $\quad |c(a) – c(b)| > p$

- The sum is between **q** and **p**, leading to a situation of weak preference, also referred to as the zone of hesitation:

  a**Q**b (**a** is weakly preferred to **b**) $\quad q < |c(a) – c(b)| \leq p$

The establishment of an indefinite outranking relation as above, and a simple aggregation of the credibility matrix, is considered to provide an acceptable result for this report. However, when more detail is needed, the credibility matrix is subjected to further exploitation to determine a final, definite ranking. Such exploitation consists of a two stage process:

1. The construction of two complete pre-orders in accordance with the outranking relation; and
2. The combination and comparison of these two orders, developing a final ranking.

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[57] D(a,b) = the set of $D_j(a,b)$ values in significant discordance for pair (a,b)

[58] The numbers in the matrix are fictional values.

[59] Note that we only consider the simplest case, where thresholds p and q are constants, as opposed to being functions of the value of the criteria, i.e. variable thresholds. In a real application, this simplification should be exchanged with variable thresholds if possible.

For a more detailed outline of the above final ranking process see Roy et al (1986), Vincke (1992), or Phaneuf (1990).

The Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) was developed in the early 1980s by Saaty (1980; 1977). Its concepts are widely accepted and its practices have proven valuable for planning and decision-making within a wide range of managerial fields (e.g. resource allocation (Ramanujam and Saaty, 1981), energy (Gholomnezhad, 1981), marketing (Dyer and Forman, 1991), and project planning/selection (Brown, et al., 2000)[60]).

The most prominent characteristic of this method is its strong focus on a hierarchical structure of the decision-process. Though this concept itself is not new but probably as old as human thoughts, AHP is considered to be the MADM method with the strongest focus on hierarchical structure throughout all stages of the decision-making process (Dyer, 1990). The fundamental idea behind AHP is to bring order into chaos by organising, analysing, and synthesising data with hierarchical ordering as the cornerstone, resulting in an outranking of alternatives based on DMs' preferences (Saaty, 1980). Much like ELECTRE, AHP makes use of an informal style for determining possible consequences (Figure 4.1). Further, DMs' preferences are considered by way of pairwise comparisons, from which subsequent objectives, criteria, and attribute weights are derived. The final compilation, or aggregation, of all data is undertaken using the concepts of outranking (Liang and Sheng, 1990). This commonly results in one preferred alternative being recommended to the DMs.

Pairwise comparison

It is AHP's concept of pairwise comparison that is of special interest to this report. Note that the concept of pairwise comparison is not unique to AHP. It is the use of ratio scales, rather than ordinal or interval scales, that represents the method's originality (Saaty, 1986). Assume the existence of an assessment table as for ELECTRE, consisting of a set of actors (the DM), a set of potential actions (the alternatives) $|A_n, n=1, 2,\dots n|$, situational objectives $|Oi, i=1, 2, \dots i|$, and assessment criteria $|c_j, j=1, 2, \dots j|$ and attributes $|a_m, m=1, 2,\dots m|$.

Quantitative ratings of one criterion's importance over another are often unavailable (Youdale, 1983). However, Saaty (1986) suggested that DMs are still adept at qualitatively recognising whether a criterion is more important than another, as well as to what extent this importance exceeds the other. Using a pre-established set of relative priorities matched with quantifiable numbers, AHP produces an importance

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[60] A wide selection of case studies and advancements of the AHP method can be found in the proceedings from the 4th AHP international symposium (Wedley, 1996), and in Golden, et al. (1989).

index. Criteria and objective importance percentages are subsequently obtained by comparing the index values relative to one another, using basic matrix algebra. These percentages reflect the importance coefficients for the assessment criteria and their related objectives; their respective role and contribution towards the fulfilment of the overall goal (ibid.)[61].

The basic notion of pairwise comparison is to use DMs' preferences to determine the relative importance rankings of the various decision components (Chief and Broxton, 1995; Saaty, 1994). This is done by performing sets of comparative judgements for each set of nodes in the hierarchy[62]. To ease derivation of these measures, DMs use pre-established numerical values, or their assigned verbal equivalence, to express their preferences (see Table 4.1 below)[63].

Numerical value	**Verbal scale**	**Explanation**
1.0	Equal importance of both elements.	Two elements contribute equally.
3.0	Moderate importance of one element over another.	Experience and judgement favour one element over another.
5.0	Strong importance of one Element over another.	An element is strongly favored.
7.0	Very strong importance of one element over another	An element is very strongly dominant.
9/0	Extreme importance of one element over another.	An element is favored by at least an order of magnitude.
2.0, 4.0, 6.0, 8.0	Intermediate values	Used to compromise between two judgements.

Table 4.1: Classifications for comparison scales. Modified from Nijkamp (1990).

The outcome of this step is a matrix, with a set of numerical values, set on a ratio scale, representing the relative performance importance of the decision components (in this example, the three criteria).

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[61] In addition to serving as criteria weights, these indices are often used as direct indications of the concordance's degrees of significance, i.e. discrimination levels S(λ) – at the final ranking steps, which we are not looking at in this example. However, this report looks at absolute weights, rather than relative. Therefore, weight derivations are stopped at the criteria and attribute level, omitting a weighting of alternatives per se.

[62] Each set of nodes is evaluated against each of its peers in relation to its parent node(s).

[63] It should be noted that as this verbal mode is used to derive the numerical values, the representation consists of imprecise verbal judgements, lacking the intervals between the orderings. As such, specific attention needs to be paid to accuracy through use of redundancy. For more detail, see Saaty (1994).

The next step is to turn the matrix into an actual ranking of the criteria by converting the component values into percentage weights. These are the values that will be used to indicate the desirability of the different alternatives performances. They are obtained by a simple 3-step process (using the concepts of eigenvectors and eigenvalues (Saaty, 1977)):[64]

Step 1) Begin with converting the fractions into decimals:

1	1/2	3/1
2/1	1	4/1
1/3	1/4	1

$\longrightarrow$

1	0.5	3
2	1	4
0.333	0.25	1

Square the matrix: (1*1) + (0.5*2) + (3* 0.3) = 3

1	0.5	3
2	1	4
0.333	0.25	1

X

1	0.5	3
2	1	4
0.333	0.25	1

$\longrightarrow$

3	1.75	8
5.3332	3	14
1.1666	0.6667	3

Step 2) Sum and normalise the rows:

3	1.75	8	=	12.75	=	0.3194
5.3332	3	14	=	22.3332	=	0.5595
1.1666	0.6667	3	=	4.8333	=	0.1211
				39.9165		1

Step 3) repeat the above until the difference between the row sums in two consecutive calculations is smaller than a prescribed value, e.g. within 4 decimals.

This results in your criteria weights[65]: c_1 = 32%, c_2 = 56%, c_3 = 12%. The same process is undertaken to establish the weights for remaining decision components[66].

Conclusion

Earlier parts of this report have argued that, due to Parks Canada's complex management context in general, and its increasing number of *de facto* decision-making groups specifically, the Agency is in need of an overall framework to guide management activities towards a greater integrative whole. The line of reasoning has been that, due to the lack of such a framework, efforts for integrative and collaborative management, two fundamental characteristics for sound protected area management, are limited from the

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[64] Cook, et. al. (1988) and Krovak (1987) provide good descriptions of the process.

[65] It is important to note here that in reality, rather than assigning one fixed weight for $c_{1\text{-}m}$, the weight should and would be connected to a range on a continuum, reflecting changes in importance as the criteria value varies, e.g. in relation to the below p, q, and v levels (see Phaneuf,1990)

[66] Note that AHP differentiates between absolute and relative measures for its elements. When using relative measures, local or individual weights are derived for the elements (including the alternatives), and are finally brought together into global weights. Global as opposed to local weights are the indices of importance that represent the priorities of the criteria relative to the goal, the alternatives relative to each criterion, and the attributes relative to each alternative – providing the possibility to rank the alternatives in terms of their overall preference. In contrast, absolute measures do not assign weights to the alternatives. Since this report is not using AHP for its ranking of alternatives, merely for its establishment of elements weight, we are using the absolute measures.

outset. The methods presented in this chapter are techniques used to aid complex decision-making in a variety of management areas. The chapter has focused on describing the essential components of two MADM methods, AHP and ELECTRE, on the basis of their potential to provide the foundation for such an overall framework. The ensuing case study will demonstrate this suggested framework by bringing together and exemplifying the use of the AHP and ELECTRE concepts in a more accessible format. It will illustrate how the framework would provide comprehensive, yet user-friendly, decision-support functions for a variety of management situations, and how it would facilitate simple and convenient integration as well as communication of the Agency's various types of information and data. Functioning as a complementary tool to existing management practices, connecting decisions and their respective decision-making processes to the overall management context, the framework would assist the Agency in furthering collaborative and integrative management, providing a more holistic protected area management approach.

Chapter 5

CASE STUDY – THE WEST COAST TRAIL, PACIFIC RIM NATIONAL PARK RESERVE

Chapter 5 provides an illustrative example of how a decision situation within a Parks Canada management context would benefit from employing a more rigorous decision-making process. It has been argued that, by using applied decision analysis (DA) methodology (represented in this report by ELECTRE and AHP), the Agency would benefit in two ways. First, by adopting a formal DA framework the Agency would allow for a consolidation of the concepts and outputs from several of its currently employed management tools (represented in this report by AAA, LAC, ROS, MP, and CEA), and this would constitute an innovative approach to protected area management. Second, by adopting such a framework the Agency would significantly streamline existing efforts of data collection as it would provide a purposeful and defined framework for future data collection. The chapter argues that the suggested framework would facilitate sound decisions and the emergence of a consistent and clearly structured decision-making process, that would be transparent and understandable to all parties involved.

This chapter begins with a brief introduction to the case study area: the West Coast Trail, one of the components of Pacific Rim National Park Reserve. Subsequent sections outline and structure a hypothetical problem situation; evaluate the situation's potential solutions, and finally; recommend the choice of one, or a few, alternatives that best meet the specific needs of the situation. The components of this DMP correspond to the three basic DA concepts described in Chapter 4 for the ELECTRE and AHP method. The presentation of this case study will follow the same three-stage MADM sequence described in Chapter 4[67]:

Stage one: Structure and composition of decision components

- Creation of an assessment table: The content of Chapter 2 and parts of Chapter 3 serves as background, forming the situation's decision components.
- Organising of decision components: The decision elements are structured using the format of a decision tree.
- 1st screening of alternatives: An initial screening for unfeasible alternatives is undertaken based on the information from Chapter 3.

[67] The technical details and references pertaining to this process' implementation have already been presented in Chapter 4 and will therefore be omitted from this chapter.

Stage two: Analysis of alternatives

- Estimating magnitude and likelihood. DMs' estimates for the likelihood and magnitude of potential impacts from the alternatives are derived.
- Determining preference thresholds and relative preferences. The concepts of the ELECTRE method's preference thresholds, and the AHP method's pairwise comparisons are applied, and content from Chapter 3 is used as the input to their evaluation.

Stage three: Synthesising of information

- Ranking of alternatives. The ELECTRE method's concept of outranking relationships is applied to produce a final order, identifying which of the alternative(s) would be the most suitable to pursue under the given circumstances.

It should be recognised at the outset that the conditions surrounding this case study have been simplified intentionally for illustrative purposes. Also, the study's circumstances are a combination of factual components and hypothetical assumptions. Factual components include information stemming from management goals and objectives, externally legislated and internally regulated perspectives, reflecting the routine in most Parks Canada management situations. Hypothetical circumstances include the supposed decision situation, the DMs and their respective input, the evaluation criteria and possible alternatives. These components have been designed for illustrative purposes only.

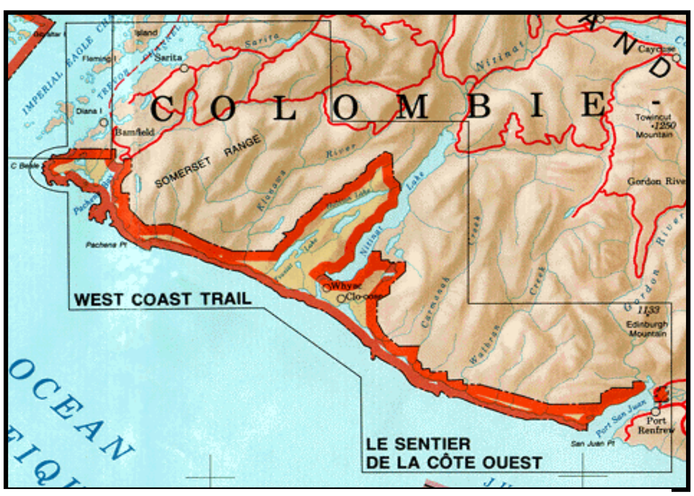


Figure 5.1 Map of the West Coast Trail (www.sookenet.com/activities/trail)

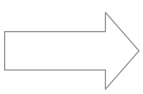
Study site

The West Coast Trail

The Pacific Rim National Park Reserve (PRNPR) is a component of the Coastal British Columbia Field Unit. The park reserve is located on the western coast of Vancouver Island and consists of three components: Long Beach; Broken Group Islands; and the West Coast Trail (WCT) (Parks Canada, 1991), the latter being the location for the case study. The 75 km trail stretches along the coastal strip south-east of Barkley Sound, from the community of Bamfield in the north to Port Renfrew in the south (see Figure 5.1). The origin of the trail dates back to the late 1800s when the area acquired the infamous reputation as the “Graveyard of the Pacific” (ibid.). The trail was constructed to permit improvements in rescue activities following the frequent occurrences of shipwrecks. The original telegraph line, connecting the west coast with the outside world, was converted into the much needed life saving route. In the 1940s, following the development of more sophisticated navigation equipment and a subsequent decrease in the amount of shipwrecks, trail maintenance was discontinued. It was not until the 1970s, when Parks Canada performed major redevelopment to the old route, that the present trail was established. Visitors to the area encounter a topography ranging from sandy beaches to rocky headlands, all of which are bordered by a temperate coastal rainforest, dominated by old-growth cedar, hemlock, and spruce. This landscape, with caves, tidal pools and waterfalls as some of its special features, has made the trail a very popular destination. Thousands of hikers come to travel all (6-10 days hikes) or segments (1-2 days hikes) of the trail each year, seeking various types of wilderness experiences (Parks Canada, 1991). In 1992, due to the popularity of the trail, Parks Canada instituted a reservation system to address concerns regarding environmental impacts, hikers safety, and visitors’ enjoyment of the area (Parks Canada, 1994d). With the reservation system in place, the trail is enjoyed by 60 persons/day on average, at a total of approximately 8000 hikers every season (May – September) (ibid.). Besides its ecological values and the experience related benefits provided to the visitors and residents of the area, the existence of the trail also supports business opportunities in the surrounding communities (Parks Canada, 1995). Several tourism operators reside in the areas of Bamfield and Port Renfrew, making the WCT an indirect contributor to the well-being of the local economy (ibid.).

Suggested Decision-Making Framework

One of the purposes of the subsequent sections is to exemplify how and where Parks Canada’s existing information and data can be consolidated into the suggested framework. Therefore, to emphasise when



these discussions take place, an arrow, as the one on your left, will be inserted in the left margin, indicating where and what type of information or data (i.e. ROS, CEA, AAA, MP, LAC) is being considered.

The table below reiterates the stages and their respective steps to be discussed in the subsequent sections:

Overview			
Stages		**Steps**	
Stage 1:	Structure and composition of decision components	Step 1:	Creation of an assessment table
		Step 2:	Organising of decision components
		Step 3:	1st screening of alternatives
Stage 2:	Analysis of alternatives	Step 1:	Estimating magnitude and likelihood potential
		Step 2:	Determining preference thresholds and relative preferences
Stage 3:	Synthesis of information	Step 1:	Concordance and discordance matrixes
		Step 2:	Degrees of credibility
		Step 3:	Ranking of alternatives

Table 5.1 Overview of the stages and steps involved in the case study.

Stage 1 – Structure and composition of decision components

There are three steps to the first stage: 1) the creation of an assessment table, 2) the organising of the table's components, and 3) the initial screening for infeasible alternatives.

Step 1: Assessment table

When creating an assessment table, the following components need to be identified:

- What is the decision problem?
- Who are the DMs?
- What are the DMs' respective management goals, objectives $|O_i, i = 1, \ldots, i|$ and criteria $|c_j, j = i, \ldots, j\,|$.
- What are the potential alternatives $|A_n, n = 1, \ldots, n\,|$ to choose from?

Decision problem

In spite of a reservation system being in place, managers at PRNPR, along with associated stakeholders and interest-groups, have for quite some time been battling with a number of environmental, social, and economical impacts in the WCT area. Neither the environmental, social, or economic impacts can be ascribed as the effects of one stressor alone. They are more likely the direct or indirect results of a combination of known and unknown stressors (Parks Canada Agency, 2000a; Woodley, et al., 1993). However, human disturbance, as inflicted by visitation and maintenance operations, is considered to be one of PRNPR's primary known stressors (PRNPR, draft 1999; Parks Canada Agency, 2000a; Welch, 1995). Recreational overuse is further recognised to be one of the main contributors to a series of direct and indirect impacts, affecting environmental as well as social and economical aspects in the area (ibid.). Thus, recreational overuse, which subjects relatively small areas to high and concentrated amounts of use (Kuss, 1995), is the focus of this decision situation. The impacts at the WCT are assumed to be caused directly and exclusively from this stressor. The impacts, described in more detail in the section "Management goal, objectives, and criteria" below, manifest themselves in such effects as trampling (indicating the type of environmental impacts considered), crowding (social impacts considered), cost of maintenance and cost of living in the area (economical impacts considered). It is assumed that the present situation needs readjustment in terms of one or more of the following aspects:

- What amount of recreational use should be allowed in the area,
- Where recreational use should be allowed,
- When recreational use should be allowed,
- What types of recreational use should be allowed.

Decision-makers

Next, we need to identify who should be involved in the decision-process and whose preference and viewpoints should be considered[68]. In a real-life application, an analysis of DMs should preferably be carried out (Grimble and Chan, 1995). Such an analysis will help to accurately identify the proper DMs, e.g. managers, stakeholders and interest groups with common objectives and shared interests with regards to the situation in question. Additionally, such an analysis should distinguish between primary, secondary, and external DMs, all in accordance with their respective degree of influence of the potential decision (ibid.).

In keeping with Parks Canada's management principles which emphasise that protected area management is as a joint venture, our fictious application considers four groups of DMs. For the sake of the example, it is further assumed that the groups are representative of all relevant viewpoints and preferences related to the decision situation. The DM groups are assumed to have equal influence in the decision-making process, except that group 1, Park management, holds the final decision-making authority. The groups considered are:

1. **Park management** (four employees belonging to the on-site park reserve staff).

Their input to the process is considered representative of the knowledge, values, and references held by the Coastal British Columbia Field Unit, PRNPR.

2. **Visitors** (four persons visiting the WCT)

Their input is considered representative of the knowledge, perspectives and values of the predominant visitor groups associated with the WCT area.

3. **Local business community** (four persons residing and managing tourism operations in the area).

Their input to the process is considered representative of the knowledge, values and perspectives held by all tourism dependent businesses in the local Bamfield and Port Renfrew area.

4. **Non Governmental Organisations** (NGOs) (four persons residing and working for a NGO in the area).

Their input is considered representative of the knowledge, perspectives and values held by all NGOs in the western Vancouver Island area.

Management goal, objectives, and criteria

The principal management goal for this application is to strive for ecological and commemorative integrity (EI, CI). This goal is to reflect the fact that Parks Canada is the primary steward of the protected area in question, and that the Agency bears final decision authority in management issues.

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[68] An interesting discussion on the topic of decision-makers and those influencing decision-makers, can be found in Zionts (1997b).

The means to attain EI and CI are assumed to be the endeavour for a healthy balance between groups' ecological, economic, and social objectives. Table 5.2 below describes each groups' hypothetical management objectives and respective evaluation criteria. The variables considered in this example constitute a mere fraction of all measures that should be included in a real application. However, it its assumed that they are operationally feasible and interpretable (Kneeshaw, et al., 1993), and that they represent the complexity of our decision situation sufficiently for the purpose of this study. In a real application, evaluation criteria might be selected from a series of criteria performance/importance ratings established by the DMs (Hollenhorst and Gardner, 1994)[69]. It is assumed that such ratings for the economic

MP

and social criteria, stem from and represent each decision making group's individual concerns. Criteria selection and ratings for ecological concerns are assumed to be derived from Parks Canada's two-tiered monitoring approach, as described in Chapter 3, section "Monitoring Programs", representing such a program's stress indicators. The rationale for the chosen social criteria is supported by studies such as Parks Canada's Gwaii Haanas backcountry inventory study (Parks Canada, 1996g), Shelby et. al's (1988) study in the Mt. Jefferson Wilderness in Oregon, using fire rings, and bare ground criteria, and Kuss et. al's. (1992) study at Logan Pass/Hidden Lake Trail in Glacier National Park, as well as Hollenhurst (1994) study using parties encounters criteria.

DM group	Ecological aspect	Social aspect	Economical aspect
Park Management group: General management objectives	**Ecosystem Health**	**Serving Canadians**	**Wise and efficient management of funds**
Represented in this study by:	*Ecosystem Processes and Ecosystem Structures*	*Client satisfaction*	*Trail maintenance costs*
Measured in this study by:	Unconsolidated organic matter:	Fire rings:	Seasonal $ maintenance cost:
	Recorded % of trail segment's unconsolidated or loose organic matter not covered by vegetation on location (e.g. needles, leaves, twigs, pine cones).	# of fire rings, new and old, present within the campsite.	Direct cost, including items such as staff costs, material, time, etc. for trail maintenance related to the campsite and trail segment.
	Extent of erosion:	Size of parties of people:	Seasonal rescue cost:
	Recorded % of camping area eroded. Natural and human induced erosion separated when possible.	Largest size of backpacker parties present on trail/day .	Rescue specific cost * number of rescues.
	Fauna abundance:		
	Recorded # of individuals/spp X along trail segment.		
Visitors group: General management objectives	**Ecosystem Health**	**Trip Satisfaction**	**Willingness to Pay**
Represented in this study by:	*Perceived degradation*	*Privacy and wilderness experience*	*User fees*
Measured in this study by:	Unconsolidated organic matter:	Fire rings encounters:	Level of user fees:

[69] Typical questions regarding performance/importance ratings would be:
How is the criterion/objective performing at this point in time, relative to the other criteria/objectives of interest?
How important is the improvement of this criterions/objective performance, relative to the other criteria/objectives?

DM group	Ecological aspect	Social aspect	Economical aspect
	Same as above but measured by % encountered on trail segment/trip.	Same as above but measured by # encounters at campsite/trip.	Amount of trail user fee/person, including reservation fee, park use fee, two ferry fees.
	Extent of Erosion: Same as above but measured by % encountered at campsite/trip.	Parties of people encountered: Same as above but measured by # encounters/day.	
	Fauna Abundance: Same as above but measured by # encounters/trip.		
Local business community group: General management objectives	**Ecosystem Health**	**Residential Contentment**	**Economic Standard**
Represented in this study by:	*Perceived degradation*	*Privacy and wilderness experience*	*Desired Income*
Measured in this study by:	Unconsolidated organic matter: Same as above but measured by % encountered on trail segment/trip.	Fire rings encounters: Same as above but measured by # encounters at campsite/trip.	Business gross output: Value of total outputs produced by this particular group, indicating economic activity in the region.
	Extent of Erosion: Same as above but measured by % encountered at campsite/trip.	Parties of people encountered: Same as above but measured by # encounters/day.	
	Fauna Abundance: Same as above but measured by # encounters/trip.		
NGO group: General management objectives	**Ecosystem Health**	**Residential Contentment**	**Economic Standard**
Represented in this study by:	*Perceived degradation*	*Privacy and wilderness experience*	*Job security*
Measured in this study by:	Unconsolidated organic matter: Same as above but measured by % encountered on trail segment/trip.	Fire rings encounters: Same as above but measured by # encounters at campsite/trip.	Employment opportunities: # of people employed by NGO's and type environmental jobs in the local region.
	Extent of Erosion: Same as above but measured by % encountered at campsite/trip.	Parties of people encountered: Same as above but measured by # encounters/day.	
	Fauna Abundance: Same as above but measured by # encounters/trip.		

Table 5.2 DM groups' objectives and criteria for the case study

Alternatives

Finally, we have arrived at the identification of alternatives. Obviously, an actual application would preferably identify its options based on some collective brainstorming process with the DMs, their previous experiences, or from insights gained in previous and similar applications. Independently of how alternatives are developed, it is important that the process assures coverage of as many angles as possible, and no significant interests are being overlooked.

The type of alternative compositions presented below are based on a study by Cole et. al. (1987), discussing a number of strategies for attacking recreation problems. Additionally, the alternatives, being purely speculative, have been deliberately formed to fit a series of arguments and to highlight a number of issues, as will be shown in the subsequent sections. In accordance with MADM decision situations, our number of alternatives is discrete and pre-determined, totalling 17. The alternatives can be sub-divided into two groups: alternatives 1-13, and alternatives 14-17. The composition of the first 13 options varies on one or more of the following three attributes:

1. the number of visitors per season;
2. the length and timing of season; and
3. size and distribution of visitor groups.

The remaining four alternatives vary according to one or more of the following three attributes:

1. reallocation of the recreational activities to other parts of the area;
2. change in types of activities; and
3. construction of physical features in the area.

The table below provides an overview of the options and how they differ from one another. Reference to "as base case" in any of the columns refers to the present situation for that particular criterion.

Alternative	Number of visitors/season	Length and time of season	Size and distribution of groups	Reallocation or change of activity, and/or construct. Initiatives
Option 1 Base Case	**8 000**	▪ **5 months** ▪ **May – September**	▪ **30% of groups ≤ 3 people, 55% of groups ≤ 8 people, 15% of groups up to 10 people** ▪ **maximum of 10 groups/5 km** ▪ **maximum of 10 groups/camp**	**N/A**
Option 2	75% of base case: 6 500	▪ as base case	▪ as base case	N/A
Option 3	75% of base case: 6 500	▪ 3 months ▪ June – August	▪ as base case	N/A
Option 4	75% of base case: 6 500	▪ 3 months ▪ June – August	▪ 35% of groups ≤ 3 people, 60% of groups ≤ 8 people, 5% of groups up to 10 people ▪ maximum of 8 groups/5 km ▪ maximum of 6 groups/camp	N/A
Option 5	75% of base case: 6 5000	▪ 6 months ▪ May – October	▪ as base case	N/A

Alternative	Number of visitors/season	Length and time of season	Size and distribution of groups	Reallocation or change of activity, and/or construct. Initiatives
Option 6	75% of base case: 6 5000	▪ 6 months ▪ May – October	▪ 25% of groups ≤ 3 people, 50% of groups ≤ 8 people, 25% of groups up to 10 people ▪ maximum of 8 groups/5 km ▪ maximum of 10 groups/camp	N/A
Option 7	110% of base case: 8 800	▪ as base case	▪ as base case	N/A
Option 8	110% of base case: 8 800	▪ 3 months ▪ June – August	▪ as base case	N/A
Option 9	110% of base case: 8 800	▪ 3 months ▪ June – August	▪ 40% of groups ≤ 3 people, 50% of groups ≤ 8 people, 10% of groups up to 10 people ▪ maximum of 8 groups/5 km ▪ maximum of 6 groups/camp	N/A
Option 10	110% of base case: 8 800	▪ 6 months ▪ June – August	▪ as base case	N/A
Option 11	110% of base case: 8 000	▪ 6 months ▪ June – August	▪ 20% of groups ≤ 3 people, 60% of groups ≤ 8 people, 20% of groups up to 10 people ▪ maximum of 8 groups/5 km ▪ maximum of 10 groups/camp	N/A
Option 12	50% of base case: 4 000	▪ 2 months ▪ June – July	▪ 100% of groups ≤ 3 people ▪ maximum of 4 groups/5km ▪ maximum of 4 groups/camp	N/A
Option 13	200% of base case: 16 000	▪ 8 months ▪ March – September	▪ 80% of groups ≤ 3 people, 20% of groups ≤ 8 people ▪ maximum of 10 groups/5 km ▪ maximum of 10 groups/camp	N/A
Option 14	as base case	▪ as base case	▪ as base case	Reallocation of present recreational activities during June-July.
Option 15	as base case	▪ as base case	▪ as base case	Option 14 + extension of the information centre at the trail head.
Option 16	as base case	▪ as base case	▪ as base case	Introducing mountain biking as a recreational activity along the trail (for ½ of the allowed quota).
Option 17	as base case	▪ as base case	▪ as base case	Construction of elevated boardwalks for especially exposed and vulnerable trail segments.

Table 5.3 Alternatives for the case study

Step 2: Organising of decision components

Before we move on to the next step, our situation's decision components are repositioned into a decision tree to enhance the situation's transparency (Figure 5.2). Note that each decision making group's objectives and criteria are presented separately (signifying their group-specific relevance), yet in relation to the overall goal (signifying their interconnected nature, hence shared relevance).

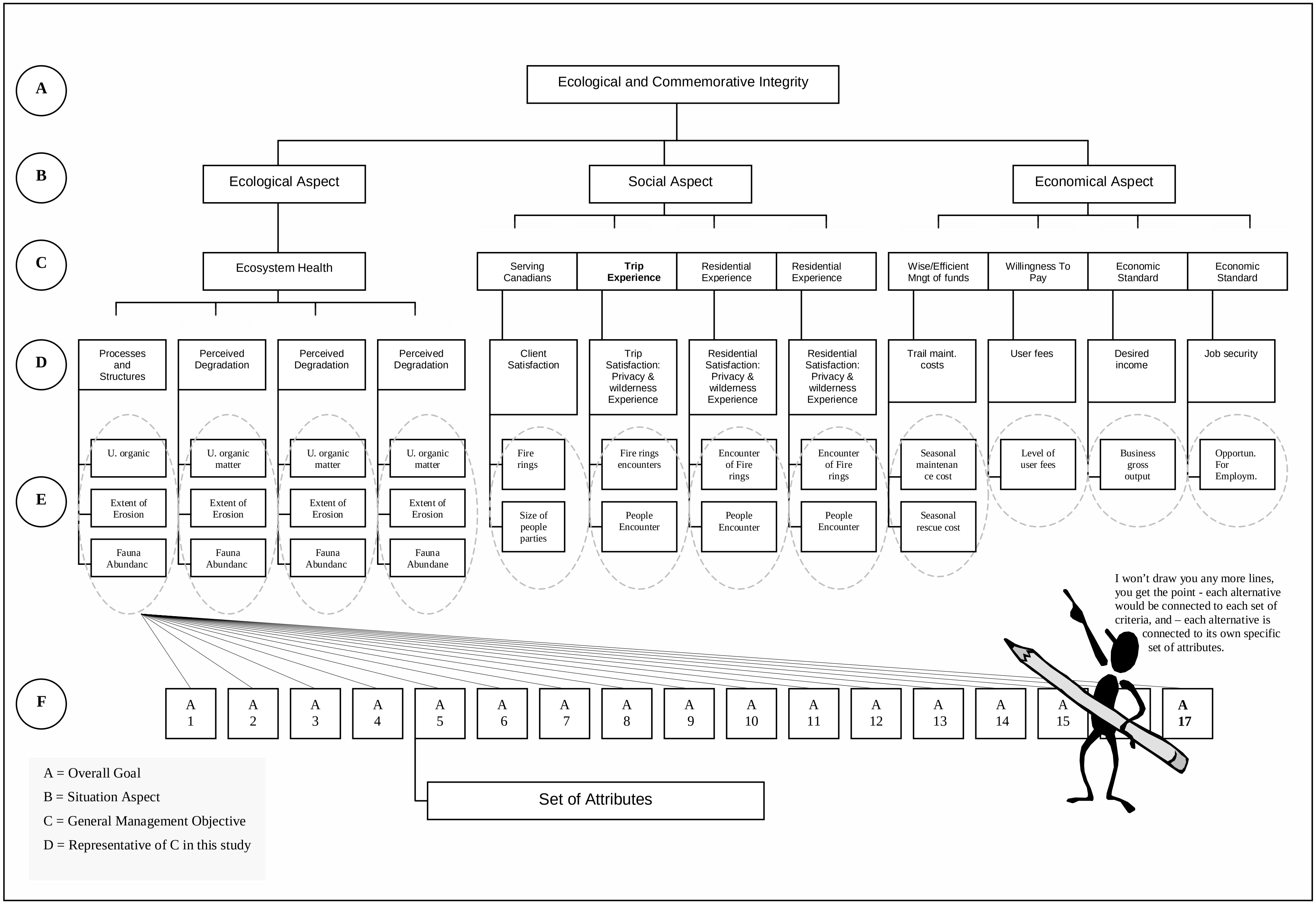


Figure 5.2 Decision Tree for the case study

Step 3: 1st screening of alternatives

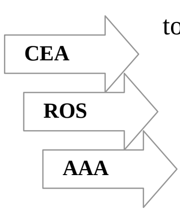
We have now identified and organised our decision components, and are prepared to take on the third and final step of the first stage: the 1st screening of the alternatives. As pointed out in Chapter 4, the screening criteria employed at this stage will be too crude to be used for the final evaluation. However, they need to be sensitive enough to trim the decision tree to a manageable size, leaving only a small set of feasible alternatives remaining. Given that decision situations are unique events in themselves, each situation requires its own respective screening criteria for determining alternatives' feasibility. In our case, with Parks Canada as the primary steward and consequently the final DM, the term "feasible alternatives" refers to:

> "options whose undertaking do not contravene any legal requirements or regulations relevant to the Parks Canada management context."

The Agency needs to comply with a multitude of such directives, regulating how management in these areas ought to be conducted. The directives stem from various perspectives. This study, as discussed in Chapter 3, considers three directives:

1. external directives imposed by legislative bodies such as the house of parliament (e.g. obligatory assessments);
2. internal directives imposed by Parks Canada's national level management onto operational staff at the Field Units level (e.g. policy and management regulations); and
3. directives imposed by visitors and other interest groups, expressed as their preferences and values for associated areas (e.g. various survey results).

Four of the management tools discussed in Chapter 3, CEA, ROS, AAA, and LAC, exemplify the implications of these three perspectives. CEA was identified as a tool used to assure that certain perspectives of external legislation were followed. ROS and AAA exemplified two tools that were identified to represent compliance with internal regulations. Finally, LAC was identified as a tool used to record visitors' and other interest groups' expectations. As mentioned in the introduction to this chapter, the purpose of this case study is not to suggest the discarding of any of the existing management tools, but rather to document how the applicability of these respective tools can be enhanced by consolidating their output and types of assessment criteria into a larger framework. In the development of the example so far, we have made use of the output from the Agency's monitoring programs (MPs). A set of criteria, assumed to represent the ecological stress indicators used by the MP, now serve as this study's criteria for the Ecosystem Health objective (see section "Management goal, objectives, and criteria" above). In the present step, we will make use of criteria from the CEA, ROS, and AAA assessments. It is assumed that these criteria correspond to those used for the 1st screening (we will return to the LAC information in stage 2). Note that in the example it is not assumed that these three assessments have been performed, or will be performed for each of the alternatives. It is assumed however, that the DM groups involved in our example are familiar with, or will be introduced to, the criteria used for the respective assessments.



Note that the 1st screening step applies a non-compensatory approach in determining an alternative's feasibility. A non-compensatory approach means that an alternative is considered feasible only if all its attributes are in explicit agreement with all the prerequisites expressed by the total of screening criteria[70].

Imagine that our appropriate criteria from the CEA, AAA, and ROS assessments are laid out in a table format. The actual number of criteria used, the selection of which criteria are to be used, as well as the level of detail provided for each criterion description for the 1st screening step, depends on each situation's specific needs and would be determined by the DMs. Following the criteria table, a series of questions, asked to each of the DM groups, for each of the alternatives, addresses the following concern:

> - Are all the attributes of alternative A_n in explicit harmony with all the requirements set forth by the criteria representing legislation and regulations relevant to the Parks Canada management context (in this report represented by CEA, AAA, and ROS assessments)?

Each alternative's feasibility is now evaluated using the DMs' knowledge in light of the chosen criteria. Let us assume that each of the DM groups have been given the opportunity to provide input to the type of question above, for the 17 alternatives, resulting in the following evaluation: at least one of the DM groups believed that alternatives 14, 15, 16, and 17 would encounter significant problems on at least one account, to pass the screening criteria posed by either the CEA, AAA, or ROS requirements. The rationale of the groups' arguments was assumed to be as follows:

<u>Alternative 14:</u> This option suggested a reallocation of the hiking/camping activities during part of the season to lessen negative impacts associated with recreational overuse of the trail area. The choice of this option would have required alternative trail segments to be developed. Group 1, Park management, expressed reservations for this alternative's potential performance on a number of ROS criteria, as they believed the suggested development to most likely be incompatible with the zoning of the area[71]. Consequently, as option 14 was believed to not be in agreement with all the criteria set forth by a ROS assessment, the alternative was screened out.

<u>Alternative 15:</u> Option 15 builds on option 14, hence is automatically not in agreement with at least one of the ROS assessment's criteria. This in itself constitutes sufficient reason to discard the alternative. Additionally, the option suggested to extend the information centre at the trailhead to further increase

[70] Compensatory models assume that any one attribute can be "traded off" against any other attribute, i.e. x units of attribute i compensates for, or is equivalent to, y units of attribute j. Non-compensatory models do not assume such tradeoffs (Cook, 1988). A disadvantage or unfavourable value in one attribute cannot be offset by an advantage or favourable value in some other attribute, hence each attribute stands on its own (Hwang, et al., 1981).

[71] In this report, ROS represents the concept of zoning, addressing the question of where recreational activities are to be allowed. The Wilderness Opportunity Spectrum (an adaptation of the ROS concept) is applied to the WCT unit, sub-zoning the area into wildland, primitive, and semi-primitive wilderness zones (Parks Canada, 1994d). All of the WCT is designated zone 2 – Wilderness (Parks Canada, 1994d) (with the exception of Pachena Bay trailhead, two satellite parcels of land in Bamfield and Port Renfrew, and the lighthouses along the WCT (and the designed Environmentally Sensitive Areas). The area is to be maintained in a wilderness state (ibid.), and offer opportunities for solitude. Only certain activities are appropriate, which require limited primitive visitor facilities and impacts (ibid.).

awareness about the local businesses in the area, the area's ecological sensitivity, as well as to increase visitors' knowledge about proper hiking conducts. Though option 14 was seen as an attractive option with good education potential, group 1, Park management, expressed significant doubts that the type of physical construction specified would successfully pass at least one of the CEA requirements considered. Thus, alternative 15 was also concluded infeasible.

Alternative 16: Alternative 16 suggested that mountain biking should be introduced as a recreational activity on the trail. The choice of this option was expected to increase local operators' business opportunities, and to attract other types of visitors in addition to hikers. The groups came to the conclusion that, according to the criteria set forth by the AAA assessment, mountain biking would not qualify as an appropriate activity within this particular setting. Hence, the option was discharged from further consideration.

Alternative 17: This option suggested to address recreational overuse by constructing elevated boardwalks for particularly sensitive and exposed trail segments. However, Park management expressed significant concerns about this option. It was believed that the trail segments for which boardwalks were suggested were located in such inaccessible areas that the physical alteration required would go beyond what was acceptable on at least one of the CEA criteria. Hence, alternative 17 was also screened out.

Based on the above argument, alternatives 14-17 were all found to fall outside the legislated and regulated space allowed for management options involving Parks Canada as a primary steward and final DM. In other words: at least one of the DM groups had significant reason to believe that the alternatives had the potential to perform inadequately on at least one of the criteria for at least one of the assessment types. Thus, only options 1-13 remained as feasible alternatives.

Stage 2 – Analysis of alternatives

The second stage of the procedures focuses on two things: 1) determining the alternatives' impact potential both in terms of magnitude as well as likelihood, and 2) deriving the DMs' preference thresholds (also referred to below as acceptance capacities, or acceptable space, see Lundquist, et al. (1999)), and relative preferences for these potential consequences.

Step 1: Magnitude and Likelihood

As discussed in Chapter 4, there are several ways to estimate the alternatives' impact potentials. The ELECTRE method applies an informal approach. Possible consequences from choosing the alternatives are directly determined by aggregating available information. The information, consisting of estimates for the likelihood, associated uncertainty, and magnitude of potential impacts from choosing an alternative, customarily stems from DMs' previous experiences and expert opinions in the matter (Munda, et al., 1994; Raiffa, 1968a). This study assumes that the values just specified are determined using this simple approach.

Picture a detailed spreadsheet containing our situation's objectives, the objectives' assessment criteria, the alternatives, and the alternatives' attributes. Each alternative's potential impacts in terms of its likelihood and magnitude, is subsequently estimated by having each participant or each DM group provide answers to the following types of questions:

- Considering its attributes, what is the likelihood of alternative n $\lvert A_n \rvert$, affecting objective i $\lvert O_i \rvert$, on criteria j $\lvert c_j \rvert$?
- What is the level of uncertainty[72] associated with this estimate?
- What is the potential magnitude of such an effect?

The types of questions are replicated until all combinations of alternatives, objectives, and respective criteria have been properly addressed. Magnitude estimates are provided in relation to changes from the base case (i.e. alternative 1), either in percentage form or in the type of units associated with the respective criteria[73].

Next, the information from the different DMs is aggregated into one set of measures as displayed in Table 5.4. The actual values making up this final set will depend on the DMs willingness towards risk taking (Kirkwood, 1997). The lower their risk taking propensity, the more conservative the estimates will be that are finally used as assessment guidelines. In accordance with the precautionary principle, this report assumes that the values in the table below represent the most conservative estimates provided by the DMs.

Before we move on to the next step, deriving the DMs' preferences for these potential outcomes, three things need to be pointed out:

1) Criteria's interdependencies: As a rule, criteria are usually highly correlated, with a high degree of dependency between them. Since the example is hypothetical, dependent correlation is an issue set aside, and the state of each criterion is assumed to be independent from another. However, these types of relationships require explicit attention in an actual application (Clemen, et al., 1996).
2) Levels of magnitude and likelihood: In our example, all criteria for all alternatives are assumed to pose significant likelihood and magnitude potential. In a real situation however, the brackets would be further subdivided (e.g. low-low, medium-low, high-low), and as some criteria might not be associated with significant impact potentials, they should therefore be exempted from further consideration (Kahneman, et al., 1981; Clemen, et al., 1996).
3) Likelihood, uncertainty, and magnitude relationships: In our example, only the magnitude estimates from Table 5.4 below are used for the subsequent evaluation. During the later assessment,

[72] Uncertainty in this example is represented by our limited knowledge, lack of information, cost of data gathering, natural phenomena, and changes of priorities, all if which affects the way we perceive effects over time (Keeney, 1982).

[73] This concept, in lieu of comparing projects to one another, was introduced by Nijkamp and Vos (1977).

the magnitude potentials are assumed to be of equal likelihood, and are also used as independent measures. In reality, all three measures, likelihood, uncertainty, and magnitude, ought to be used jointly so as to better reflect their relationships with one another (Covello, 1987)[74]. Additionally, the three measures should be connected to the later assessment of DMs' preferences and criteria's importance ratings, using continuous scales (see section "Relative preferences").

[74] Suggested reading on the topic include Morgan, et al. (1989), Fischhoff, et al. (1981), Covello (1987), and Kahneman, et al. (1981).

Criteria	Alternatives' likelihood (L), uncertainty (U), and magnitude (M) estimates													
Alternative		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Ecological criteria														
Unconsolidated organic matter:	L	N/A	L+[75]	L -[76]	M +	M +	M +	M -	H -	M -	L -	M -	L -	H -
	U	N/A	L	M	M	H	H	M	H	H	M	M	H	H
(units of change = %)	M	**35**	**30**	**37**	**30**	**30**	**32**	**39**	**48**	**45**	**38**	**40**	**40**	**50**
Extent of erosion:	L	N/A	L+	L -	M +	M +	M +	M -	H -	M -	M -	M -	M -	H -
(%)	U	N/A	L	M	M	H	H	M	H	H	M	M	H	H
	M	**25**	**22**	**27**	**10**	**18**	**22**	**32**	**35**	**32**	**30**	**35**	**30**	**45**
Fauna abundance:	L	N/A	L+	L -	L +	M +	M +	M -	H -	H -	H -	H -	M -	H -
(#)	U	N/A	L	M	M	M	H	M	M	H	L	M	H	H
	M	**7**	**8**	**6**	**8**	**9**	**22**	**6**	**5**	**5**	**6**	**5**	**6**	**3**
Social criteria														
Fire rings:	L	N/A	L+/-	L+/-	L+ /-	L+/-	M+/-	M-/+	M-/+	M-/+	L+ /-	L+ /-	L+ /-	L- /+
(#)	U	N/A	L	M	M	L	L	M	M	H	M	L	H	H
	M	**5**	**4**	**4**	**3**	**4**	**3**	**6**	**7**	**6**	**4**	**3**	**4**	**8**
Parties of people:	L	N/A	M +	L -	M +	M +	M +	H -	H -	H -	M -	L -	H -	H -
(#)	U	N/A	L	M	M	L	L	M	M	H	M	M	H	H
	M	**10**	**9**	**11**	**9**	**9**	**8**	**12**	**13**	**13**	**12**	**11**	**18**	**15**
Economic criteria														
Seasonal $ maintenance cost:	L	N/A	L -	L -	L +	M +	L +	H -	H -	H -	M -	M -	L +	M -
	U	N/A	L	M	M	M	M	M	M	H	L	L	H	H
(%)	M	**5000**	**+ 3**	**+ 3**	**- 3**	**- 5**	**- 5**	**+ 10**	**+ 13**	**+ 10**	**+5**	**+ 8**	**- 4**	**+12**
Seasonal rescue cost:	L	N/A	L -	L -	M +	L+	L -	M -	H -	M -	M -	L -	M +	L -
(%)	U	N/A	L	M	M	M	M	H	M	H	M	M	H	H
	M	**7000**	**+ 3**	**+ 5**	**- 5**	**- 3**	**+ 7**	**+ 10**	**+ 15**	**+ 10**	**+7**	**+ 8**	**- 22**	**+ 20**
Level of user fees:	L	N/A	L -	L -	L -	L -	L -	L +	M -	M -	L +	L -	H -	M +
(%)	U	N/A	L	M	M	M	L	L	M	H	M	M	H	H
	M	**125**	**+ 4**	**+5**	**+ 7**	**+ 3**	**+ 8**	**- 3**	**+ 8**	**+ 5**	**-5**	**+ 12**	**+ 23**	**- 22**
Business gross output:	L	N/A	L -	L -	L -	L -	L -	M +	H +	H +	H +	H +	H -	H +
(%)	U	N/A	L	L	M	L	M	L	L	H	H	M	H	H
	M	**496'**	**- 5**	**- 8**	**-5**	**-8**	**-3**	**+ 13**	**+13**	**+15**	**13**	**+15**	**- 20**	**+ 25**
Employment opportunities:	L	N/A	L -	L -	L -	L -	L -	M +	M +	M +	M +	M +	H -	H +
	U	N/A	L	L	M	L	M	L	L	M	H	M	H	H
(#)	M	**20**	**19**	**18**	**19**	**18**	**19**	**25**	**25**	**28**	**25**	**28**	**15**	**35**

Table 5.4: Aggregated estimates for alternatives' impact potentials: likelihood (L), uncertainty (U), and magnitude (M).

[75] + = improvement from base case (alternative 1), relative to the criteria and DM

[76] - = worsening from base case (relative to the criteria and DM)

Step 2: Preference thresholds and relative preferences

In this step, the DMs' preference thresholds (i.e. acceptance capacities) and relative preferences for the potential consequences (i.e. criteria weights), are going to be elicited. The two types of values will later be used in stage 3 as indicators for criteria's performance, and criteria's relative importance over one another, respectively.

Preference thresholds

Preference thresholds essentially refer to a set of performance ranges for each criterion, as determined by the DMs. These ranges indicate the DMs' preferences for different criteria's performance. ELECTRE commonly establishes four types of threshold levels: strong preference (P), weak preference (Q), indifference (I), and veto levels (V):

Strong preference (P): Signifies the range within which DMs prefer a certain criterion's performance to lie between.

Weak preference (Q): Indicates a buffer zone: performance within this range is still acceptable as well as aspired by the DM, however to a lesser extent than what was specified for (P).

Indifference (I): Represents the range that a criterion can move within before the variation significantly affects the desired state of the criterion.

Veto (V): Signifies the absolutely highest or lowest value a criterion can take on before its performance would be found unacceptable by the DMs.

In other words, the preference thresholds represent the acceptance capacity for the DMs by collectively designating the desired and acceptable performance space for each criterion.

It was previously mentioned that the criteria's relationships with one another will not be considered in this study. As a result, our example uses the simplest type of preference thresholds: fixed thresholds. This means that the values used are treated as constants rather than functions of the value of the criteria, i.e. relative thresholds. In an actual application, it would be more appropriate to use relative thresholds as such measures reflect a more accurate picture, considering the fact that the different preference values are likely to vary according to an alternative's composition (Clemen, 1995; Clemen, et al., 1996). For example, preferences for criterion 5, the preferred number of "parties of people encountered", are likely be greater if the season ranged over 6 rather than 3 months.

Preference values are conveniently estimated in a similar manner as the likelihood and magnitude estimates above. Imagine that a similar type of question sheet is given to each of the participants in the DM process or to each of the DM groups. Four types of questions require answers:

- What is your preferred performance level[77] for c_j? (P)
- What is your intermediate performance level for c_j? (Q)
- What do you find to be an acceptable range of variation for c_j's performance level? (I)
- What is your veto level for c_j's performance level? (V)

Each participant, or DM group, is asked to state their preference values for each criterion pertaining to their concerns. If each participant is stating his/her preferences individually, the estimates will subsequently be aggregated to one set representing each group. The assumed threshold levels for this study are outlined in Table 5.5 below. Note that ultimately, the preference thresholds should be connected, using e.g. acceptability curves, relating specific levels of acceptability with specific levels of impacts on a continum. (Shelby and Shindler, 1992).

LAC

The type of thresholds generated by ELECTRE are very similar to the measures derived in a LAC assessment. Both type of measures identify an acceptable space for criteria performance, determined by its participants. Furthermore, they are both norm type measures[78]. Norms are, to a certain extent, interchangeable measures (e.g. visitors' norms for acceptable number of fire ring encounters in one area as derived by one study can be assumed to correspond with such norms for other, similar, areas) (Williams, et al., 1991; Roggenbuck, et al., 1991), allowing individual studies to build on one another (see Vaske, et al. 1993; 1986 for reviews and background[79]). Consequently, existing and qualifying LAC measures could favourably be used in place of, or complement, ELECTRE's threshold measures. This report argues that such exchanges could be of a temporary and complementary sort, as well as of a more permanent nature. For example, imagine a situation where time and funding constraints prohibit a more extensive assessment. The actual derivation of preference thresholds from affected parties can then be substituted with the use of existing LAC measures previously derived in a different situation of similar circumstances. If eventually more time and funding becomes available, the DA process can be refined further by making the adequate additions. If the LAC measures provide sufficient level of detail for the situation at hand, these measures could also be adopted in the model as permanent replacements for the ELECTRE thresholds.

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[77] The preferred performance level can also be labeled as the DM's aspiration level, i.e. the desired outcome of a decision in terms of a certain level to be aimed at for each attribute (Nijkamp, et al., 1990).

[78] It has been established that the percentage of people who can specify an encounter norm for wilderness experiences is fairly high. E.g. 84% of the Grand Canyon respondents, 90% of the Rogue River visitors, and 90% of the Illinois River rafters reported encounter norms (Shelby, 1981).

[79] Good examples of informative case studies on the subject of encounter norms for different activities include Heberlein and Vaske (1977), Vaske, et al. (1995), Heberlein and Alfano (1983), Shelby, et al. (1986), Lewis, et al. (1996). Articles summarising findings from backcountry studies specifically include Shelby and Vaske (1991), Vaske, et al. (1993), Shelby (1981) and Vaske, et al. (1986). Norms for ecological impacts include a study of campsite impacts by Shelby, et al. (1988).

Relative preferences

The next step is to derive DMs' preferences as to the criteria's relative importance. These type of values can be established most appropriately by using the AHP method's pairwise comparisons (Saaty, 1980). The process of deriving criteria's indices of importance (i.e. criteria weights) is described in detail in Chapter 4. Pairwise comparisons have been undertaken by all participants for all their relevant criteria combinations in relation to their parent, i.e. respective management objective. The same type of comparisons need to be completed by all the participants for all the objectives in relation to the management goal. For a more detailed description of the actual comparisons, see Appendix 4. This process provides the relative weights presented in the right column in Table 5.5 below (note that the far right part of the column contains the aggregated criteria weights).

Note that the indices of importance hold similar limitations as were described earlier for the preference values. The weights are fixed and are relative in the sense that they compare one criteria weight to another. Hence, the components' importance levels are representative of the base case situation only. In an actual application, weights should reflect the changes as the criteria values vary, e.g. in relation to the (P), (Q), (I) and (V) threshold levels (Phaneuf, 1990, p. 22).

DM groups and their respective objectives	Criteria; Indicators	Present value[80]	Criteria threshold levels				W % (k)	
			Strong (P)	Weak (Q)	Veto (V)	Indif. (I)[81]		
Park management group:								
Ecosystem Health								
Ecosystem Processes and Ecosystem Structures	Unconsolidated organic matter:	35	0-20	21-44	45%	-1.15%	26	14
	Extent of erosion:	25	0-10	11-39	40%	-2.00%	46	20
	Fauna abundance:	7	10-14	5-9/ 15-24	4/25	+0%	10	20
Serving Canadians								
Client satisfaction	Fire rings:	5	3-5	2/ 6-7	1/8	-1.50%	7	11
	Parties of people:	10	5-7	4/ 8-12	3/13	-1.20%	2	14
Wise and efficient management of funds								
Trail maintenance costs	Seasonal $ maintenance cost:	5 000	-18% (and less)	+/-17	+18%	-1.05	8	20
	Seasonal rescue cost:	7 000	-23% (and less)	+/-22	+23%	-1.06%	1	0.3
Visitors group:								
Ecosystem Health								
Perceived degradation	Unconsolidated organic matter	35	0-30	31-59	60%	-1.15%	21	14
	Extent of Erosion:	15	0-10	11-59	60%	-2.00%	7	20
	Fauna Abundance:	5	5-7	3-4/ 8-20	2/21	+0%	30	20
Trip Satisfaction								
Privacy and wilderness experience	Fire rings encounters:	5	5-7	3-4/ 8-9	2/10	-1.50%	4	11
	Parties of people encountered:	12	6-7	4-5/ 8-14	3/15	-1.20%	27	14
Willingness to Pay								
User fees	Level of user fees:	125	-18% (and less)	+/-17	+18%	-0%	12	3

[80] These present values form the "base case", representing the present situation. Note that it is group 1's, Park management, present values that take precedence, except for criteria 8, 9, and 10. This is done for no other reason than that of simplifying the subsequent calculations.

[81] Indifference values are given in %-change relative to the base case. Values of 0% indicates that any change to the present situation pose a significant change.

DM groups and their respective objectives	Criteria; Indicators	Present value[80]	Criteria threshold levels				W % (k)	
			Strong (P)	Weak (Q)	Veto (V)	Indif. (I)[81]		
Local business community group:								
Ecosystem Health								
Perceived degradation	Unconsolidated organic matter:	25	15-30	11-15/ 31-59	10/ 60%	-1.15%	3	14
	Extent of Erosion:	15	10-15	6-9/ 11-59	5/ 60%	-2.00%	10	20
	Fauna Abundance:	2	0-5	6-15	16	+0%	18	20
Residential Contentment								
Privacy and wilderness experience	Fire rings encounters:	5	5-8	3-4/ 9-15	2/16	-1.50%	2	11
	Parties of people encountered:	10	8-10	5-7/ 11-15	4/16	-1.20%	17	14
Economic Standard								
Desired Income	Business gross output:	496 000	+15% (and more)	+/- 14%	-15%	+1.15%	49	12
NGO group:								
Ecosystem Health								
Perceived degradation	Unconsolidated organic matter:	38	0-15	16-39	40%	-1.15%	6	14
	Extent of Erosion:	28	0-10	11-39	40%	-2.00%	16	20
	Fauna Abundance:	6	10-20	5-9/ 21-24	4/25	+0%	23	20
Residential Contentment								
Privacy and wilderness experience	Fire rings encounters:	5	0	0-7	8	-1.50%	29	11
	Parties of people encountered:	10	4-6	2-3/ 7-12	1/13	-1.20%	10	14
Economic Standard								
Job security	Employment opportunities:	20	30	17-29	16	+0%	17	4

Table 5.5: Aggregated preference levels and criteria importance ratings for all four DM groups.

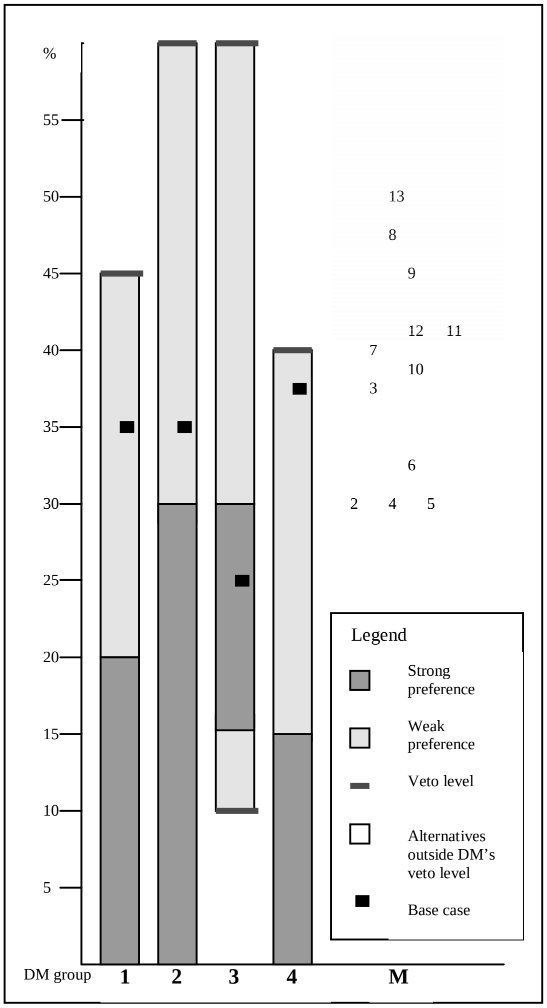

Figure 5.3: Unconsolidated organic matter

At this point, it is favourable to display the contents of Table 5.4 and 5.5 in a series of graphs, to provide an overview of the situation. An example of such a graph can be found in Figure 5.3. Even though such figures are not detailed enough to provide information as to alternatives' final ranking or performance, they provide a visual picture, helpful for the understanding of the upcoming outranking analysis. Each graph would illustrate one criterion (in the cases where DMs share the same type of criteria, they are displayed together, i.e. objective 1: ecosystem health, criteria 1: unconsolidated organic matter), and each graph illustrates three different matters. The shading in the four columns present the information from Table 5.5, the four DM groups' preference values. Green/dark grey indicates (P), the strong preference thresholds, yellow/light grey indicates (Q), the weak preference thresholds, and red/thin horizontal bar indicates (V), the veto thresholds. The numbers plotted on the right side of the figure contain the magnitude measures (M) of Table 5.4. The numbers in this free-form column correspond to the numbers of the alternatives. Their respective placements on the y-axis correspond to the measure given as their impact potential onto the graph specific criterion. The shaded area imposed onto this right column's numbers indicates the alternatives that fall outside any of the DM groups' veto levels, i.e. outside the acceptable space. The squares in the four bars indicates the base case's situation.

Stage 3 – Synthesising of Information

Now that we have derived measures for our alternatives' impact potentials, as well as measures for our DM groups' preferences for criteria performance and criteria importance, we are ready to move to the third stage and begin integrating all the information. The purpose of stage three is essentially to narrow down the potential alternatives to one, or a smaller set of suitable alternative(s), the one(s) that are the most likely to bring all the DMs collectively the closest to attain their shared goal and objectives. ELECTRE arrives at such a recommendation by applying the concept of outranking relationships (see Chapter 4). The basic thought behind the concept of outranking is that an alternative is considered to outrank another if it is at least as good as the other alternative with respect to the majority of criteria being assessed, *and*, without being too inferior to the other alternative with respect to the remaining criteria. This is also referred to as an alternative being in agreement with the assertion aSb. The step-by-step process applied by ELECTRE, leading up to this type of final recommendation for alternative choice, is sub-divided into the following three steps: the establishment of: 1) concordance and discordance matrixes, 2) degrees of credibility, and 3) the establishment of a final ranking of alternatives[82].

Step 1: Concordance and discordance matrixes

The first task is to determine to what degree each of our 13 alternatives are in agreement, as well as in disagreement, with the assertion aS_jb, i.e. that:

> "alternative a is at least as good as alternative b with respect to the j^{th} criterion".

To establish these agreement/disagreement measures, which later on will jointly indicate the level of advantage/disadvantage that one alternative has over another, two types of matrixes will be produced: a concordance (i.e. level of agreement) matrix and a discordance (i.e. level of disagreement) matrix. Note that we are introducing the four DM groups' relative weights in this step.

Concordance matrix

The values entered into this type of matrix are the results from a series of tests about true/false relationships for each of the alternative sets on each of the criteria. Every alternative set $(a, b) \in A$ is compared to determine its respective concordance level, i.e. to what degree it is performing better, or is at least as good as, the other alternative, on each of the criteria. To determine these types of relationships we will make use of three types of measures. The previously established strong preference thresholds (P), and the weak preference thresholds(Q) (see Table 5.5), will be used as the alternatives' performance indicators. The third type of measure, the magnitude estimates (see Table 5.5), will also be used, and here are referred to as the alternative's performance level. The following three relationships will be tested for:

- In terms of $(a, b) \in A$: is the value of alternative a's performance level on c_j, plus the value of the weak preference level (Q) for c_j greater than the value of alternative b's performance level for c_j?

  ➔ $c_j(a) + q_j \geq c_j(b)$

  If yes, then the value entered into the concordance matrix for alternative a on c_j would be 1.
- In terms of $(a, b) \in A$: is the value of alternative a's performance level on c_j, plus the value of the strong preference level (P) for c_j, less than the value of alternative b's performance level for c_j?

  ➔ $c_j(a) + p_j \leq c_j(b)$

  If yes, then the value entered into the concordance matrix for alternative a on c_j would be 0

---

[82] Note that the actual calculations for this case study example take into account both the upper and lower thresholds as specified in Table 5.5. Additionally, the formulas for concordance and discordance are inverted depending on the desired direction, i.e. increasing or decreasing value, of each specific criterion.

- In terms of $(a, b) \in A$: is the value of alternative a's performance level on c_j not in accordance with neither one of the above relationships?
  - ➔ $\cancel{c_j(a) + q_j \geq c_j(b)}$
  - ➔ $\cancel{c_j(a) + p_j \leq c_j(b)}$

  If so, then the value entered into the concordance matrix for alternative a on c_j would be:

$$\frac{p_j + c_j(a) - c_j(b)}{p_j - q_j}$$

Each alternative set is to be tested for these relationships for each DM group's preference thresholds. The table results would subsequently be consolidated, resulting in one matrix signifying the alternative sets' concordance values according to all DMs on one criterion, giving a total of 10 tables. Table 5.6 below illustrates the concordance values derived for alternatives 1-13 on criterion 1, Unconsolidated organic matter. The additional 9 tables are provided in Appendix 2[83].

Concordance matrix

Criterion 1: Unconsolidated organic matter

	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25
A2	0.25		.25	.22	.22	.25	.25	.25	.25	.25	.25	.25	.25
A3	0.25	0.25		.25	.25	.25	.25	.25	.25	.25	.25	.25	.25
A4	0.25	0.22	.25		.22	.25	.25	.25	.25	.25	.25	.25	.25
A5	0.25	0.22	.25	.22		.25	.25	.25	.25	.25	.25	.25	.25
A6	0.25	0.25	.25	.25	.25		.25	.25	.25	.25	.25	.25	.25
A7	0.25	0.25	.25	.25	.25	.25		.25	.25	.25	.25	.25	.25
A8	0.20	0.22	.19	.22	.22	.21	.18		.15	.19	.18	.18	.25
A9	0.19	0.21	.18	.21	.21	.20	.17	.25		.17	.16	.16	.25
A10	0.25	0.25	.25	.25	.25	.25	.25	.25	.25		.25	.25	.25
A11	0.19	0.20	.18	.20	.20	.20	.18	.25	.25	.18		.17	.25
A12	0.19	0.20	.18	.20	.20	.20	.18	.25	.25	.18	.17		.25
A13	0.21	0.23	.20	.23	.23	.22	.19	.15	.16	.19	.19	.19	

Table 5.6: Concordance matrix for Criterion 1: Unconsolidated organic matter

Discordance matrix

Next comes the establishment of the discordance matrices. The same type of procedure is applied: each alternative set is compared on each of the criteria. But for the discordance matrix, we want to establish the respective discordance levels, i.e. to what degree one alternative performs worse than another on each of the criteria. As with the concordance matrices, the strong (P) preference threshold is used as our performance indicator, and the magnitude measure refers to our alternatives' performance levels. In place of the weak preference threshold (Q) used in the concordance matrix, the discordance matrix makes use of the veto level (V) as its second performance indicator. We test for the following three relationships:

[83] Note that as the values in the matrices include consideration for the groups' preference values, reflecting the criteria's relative weights, values of "1" are never attained.

- In terms of $(a, b) \in A$: is the value of alternative a’s performance level on c_j , plus the value of the strong preference level (P) for c_j , greater than the value of alternative b’s performance level for c_j ?

  ➔ $c_j(a) + p_j \geq c_j(b)$

  If yes, then the value entered into the discordance matrix for alternative on c_j would be 0.

- In terms of $(a, b) \in A$: is the value of alternative a’s performance level on c_j , plus the veto threshold level (V) for c_j , less than the value of alternative b’s performance level for c_j ?

  ➔ $c_j(a) + v_j \leq c_j(b)$

  If yes, then the value entered into the discordance matrix for alternative on c_j would be 1.

- In terms of $(a, b) \in A$: is the value of alternative a’s performance level on c_j not in accordance with neither one of the above relationships?

  ➔ $\cancel{c_j(a) + p_j \geq c_j(b)}$

  ➔ $\cancel{c_j(a) + v_j \leq c_j(b)}$

  If so, then the value entered into the concordance matrix for alternative a on c_j would be:

$$\left| \frac{c_j(b) - c_j(a) - p_j}{v_j - p_j} \right|$$

As with the concordance matrices, each alternative set is tested on each of the criteria, for each of the four DM groups’ preference values. After consolidating the table entries, a total of 10 tables will represent the alternative sets’ discordance values. Table 5.7 below illustrates the discordance values obtained for alternatives 1-13 on criteria 1, Unconsolidated organic matter. The other 9 matrixes are found in Appendix 3[84].

Discordance matrix

Criterion 3: Fauna abundance

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
A1		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	1	1	1	1	1	1	1		-	1	-	-	-
A9	1	1	1	1	1	1	1	-		1	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	1	1	1	1	1	1	1	-	-	1		-	-
A12	1	1	1	1	1	1	1	-	-	1	-		-
A13	1	1	1	1	1	1	1	-	-	1	-	-	

Table 5.7: Discordance matrix for Criterion 3: Fauna abundance

[84] Keep in mind that our simplified example only considers discordance measures of 0 and 1.

Step 2: Degrees of credibility

The next step is to assess each alternative set's degree of credibility; the strength and weakness of the assertion aSb, i.e. that

> "alternative **a** is at least as good as alternative b with respect to the majority of the criteria, *and* that a is not too inferior to **b** with respect to the remaining criteria".

To enable such an assessment, the values in the concordance and discordance matrixes are joined together to produce a concordance index (i.e. the strength of aSb) and a discordance measure (the weakness of aSb) respectively. These two measures are then brought together, forming a credibility matrix.

Concordance index

The concordance index is obtained by combining the individual criteria measures from the concordance matrices, bringing in the aggregated criteria weights to the equation. This gives each alternative set its respective, total, concordance value:

➔ $C(a,b) = 1/k\ \Sigma^{r}_{j=1}\ k_j\ c_j\ (a,b)$ $\quad k = \Sigma^{r}_{j=1}\ k_j$

Discordance measure

The discordance measure is essentially the opposite of the concordance index. However, indicating the weakness of aSb, the discordance measure is not derived by way of aggregation over criteria (hence the label measure as opposed to index). In our application, the discordance measure will be either 1 or 0: the outcome of either one of the relationships below:

- In terms of $(a, b) \in A$: is the difference between the aS_jb assessment on c_j greater or equal to the veto level (V)?

  If yes, then the discordance measure for that alternative set is 1.

- In terms of $(a, b) \in A$: is the difference between the aS_jb assessment on c_j less or equal to the strict preference level (P) of a?

  If yes, then the discordance measure for that alternative set is 0.

Credibility matrix

The two measures are now combined, producing a credibility matrix. As stated in Chapter 4, three statements underlie the shaping of the matrix value entries:

1) Does the strength of the alternative set (i.e. concordance index) exceed that of its weakness (i.e. discordance measure)?

   ➔ $C(a, b) > D_j(a, b)$

   If yes, then the <u>concordance value</u> should <u>not be modified</u>:

   $d(a, b) = C(a, b)$

2) Do all the concordance matrix values for the alternative set equal 1?

➔ $c_j(a, b) = 1$

If yes, then one can assume that all the $D_j(a, b)$ values equals 0, giving that the <u>concordance value</u> should <u>not be modified</u>:

$d(a, b) = C(a, b)$

3) Is any of the alternative set's discordance measures 1 on any criteria?

➔ $Dj(a, b) = 1$

If yes, then there is no confidence of concordance. Since one discordant criterion is sufficient to discard outranking, <u>credibility will equal 0</u>:

$d(a, b) = 0$

Credibility matrix													
	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.2073	0.2169	0.2073	0.2092	0.2146	0.2022	-	-	0.2022	-	-	-
A2	0.2138		0.2146	0.2109	0.2037	0.2141	0.2022	-	-	0.2022	-	-	-
A3	0.2047	0.2059		0.2059	0.2058	0.2138	0.1950	-	-	0.1950	-	-	-
A4	0.2138	0.2109	0.2146		0.2037	0.2128	0.2022	-	-	0.2022	-	-	-
A5	0.2135	0.2106	0.2143	0.2106		0.2138	0.2022	-	-	0.2022	-	-	-
A6	0.2064	0.2065	0.2077	0.2051	0.2063		0.1950	-	-	0.1950	-	-	-
A7	0.2081	0.2092	0.2102	0.2092	0.2087	0.2102		-	-	0.2072	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0.2081	0.2092	0.2102	0.2092	0.2087	0.2102	0.2072	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Table 5.8: Credibility matrix

Just by looking at the credibility matrix in Table 5.8 above, we can see that the credibility rating for alternatives 8, 9, 11, 12, and 13 equals 0. This means that these alternatives fail to perform at least as good as one of the other alternatives. It also means that these alternatives' expected performance have shown to breach at least one of the DMs' veto levels (V) on at least one criterion. Hence, these alternatives are not plausible, and are discarded. This leaves us with alternatives 1, 2, 3, 4, 5, 6, 7, and 10. While the credibility matrix does provide a certain outranking in itself, i.e. indicating each alternative's strength over another, one should not fail to take into account the alternatives' performance significance levels.

Step 3: Ranking of alternatives

This is the last step in the last stage of the process. It relates the entries in the credibility matrix above with the previously established levels of significance (i.e. the thresholds of indifference (I)). To arrive at the final ranking, the step will remove those alternatives from consideration that are not performing significantly better than at least one other alternative on at least one criterion:

- In terms of $|(a, b) \in A|$: is the sum of the following, at least on the account of one criterion, greater than the respective threshold of indifference (I)?

➔ $|c_j(a) - c_j(b) > I|$

If the answer is no, $|a\mathbf{I}b|$, then the alternative in question is removed from further consideration. This is because its contribution to the improvement of the problem situation is not significantly better than what can be achieved by another alternative, on any of the criteria.

Significance table

	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
c1	S	-	S	S	-	-	-	-	-	-	-	-
c2	-	-	S	-	-	-	-	-	-	-	-	-
c3	S	-	S	S	-	-	-	-	-	-	-	-
c4	-	-	S	-	S	-	-	-	-	-	-	-
c5	-	-	-	-	S	-	-	-	-	-	-	-
c6	-	-	-	S	S	-	-	-	-	-	-	-
c7	-	-	-	-	-	-	-	-	-	-	-	-
c8	-	-	-	-	-	S	-	-	S	-	-	-
c9	-	-	-	-	-	-	-	-	-	-	-	-
c10	-	-	-	-	-	S	-	-	S	-	-	-

Table 5.9: Significance table for the base case

After locating the significance values for all alternative combinations, we are left with alternatives 2, 5, and 6. In addition to what was discussed in the credibility section above, each of these alternatives are further unique in that:

- none of their criteria's performances fall outside the accepted range of variation as specified by any of the DMs, while
- at least one of their criteria performs significantly better than at least one other alternative's corresponding criteria.

Finally, after readjusting the significance matrix to reflect the removal of the non-significant alternatives, two options remain[85]:

1) finish the assessment right here, concluding that alternatives 2, 5, and 6 constitute the set of significantly better and non-dominated alternatives and could therefore be equally recommended, or
2) continue to seek out the pareto optimal alternative among them. Since the relative importance of each of the criteria has already been accounted for, one simply needs to aggregate the entries across the rows in the final matrix in order to produce such a ranking.

[85] Independent of the option chosen, sensitivity analysis should be carried out at this stage as discussed in Chapter 4.

Conclusion

Chapter 3 suggested that Parks Canada could benefit from a more integrated decision-making framework that would accommodate the principles of ESBM. It was recommended that the framework should function as a complementary to the Agency's existing management tools, thus contributing towards a more holistic and overall evaluation of management situations, by providing:

1. a simple and straightforward way of integrating the various types of data and information generated by the currently existing assessments tools,
2. comprehensive, yet adaptable and user friendly, decision-support functions for managers to adequately bound and process various management decision situations, and
3. a consistent, yet flexible, template to facilitate easy communication, i.e. export and import, of data and information within and between management groups.

Chapter 5 has presented a hypothetical case study of such a decision-making framework. In order to judge how successfully the tool achieved these goals represented above, the subsequent sections will apply the evaluative framework developed in Chapter 3. The situation used to exemplify the proposed framework assumed four decision making groups, that each had different management objectives and aspirations. The assessment included seventeen (17) alternatives. The intention of the assessment was to identify and recommend the choice of one alternative, or a small set of alternatives, the implementation of which would have the best likelihood of a) significantly improving the present situation, while b) not breaching any legislation or regulation associated with the area, and c) not posing unacceptable tradeoffs to any of the DM groups.

1. <u>Facilitate the integration of various types of information and data</u>

With respect to the question of the process' ability to consider multidisciplinary content, the framework's assessment included all the economic, social, and ecological factors assumed to be of importance to the situation. The example was limited to consider these factors as individual components, disregarding any of the positive or negative relationships between the measures. However, such relations and interactions can be accounted for and incorporated into such an assessment. Further, the framework considered a multiple of scales and dimensions. This was done by incorporating output from MP, CEA, AAA, ROS, and LAC, each of which represents tools using varying scales and dimensions in their own assessment. The concepts of risk and uncertainty were dealt with by deriving a series of preference thresholds, representing each DM group's individual risk attitudes. These thresholds signified what the DMs thought to be acceptable tradeoffs and consequences for each alternative, creating an acceptable range of variation within which each alternative's effects were allowed to fluctuate. Finally, the process explicitly involved several DM groups throughout the entire course of the evaluation. By making use of their opinions, values, as well as their respective management agendas, group goals could be established as well as respected.

2. Provide comprehensive, yet adaptable and user friendly, decision-support functions

The framework has the ability to properly assess and bound management situations of varying types and varying scopes. The assessment's well recognised and tested concepts provide a comprehensive evaluation with adequate depth to the analysis. Yet, it is not a cumbersome assessment tool. Its analytical functions are straightforward enough to be used by any participating party. The actual scope of the assessment can also be easily modified by the DMs to fit various decision situations' needs, without compromising the quality of the assessment.

3. Provide a consistent, yet flexible, template that facilitates easy communication

Finally, the framework's clearly structured decision-making process provides opportunity for consistent and streamlined record management practices that in turn facilitate the sharing of information and data between management groups. Increased levels of information/data exchange not only give cost effective use of existing information, but good opportunities for information gap analysis, providing useful guidelines in regards to future data collection needs.

Management tool	Formal DA: Electre and AHP
THEME 3 – Tool description	
Tool's main focus and objective?	To allocate and recommend the choice of one management alternative, or a small set of alternatives, whose implementation would have good potential to a) significantly improve the present situation, while b) not be requiring a breach of any associated legislation or regulation, or c) pose compromises of unacceptable magnitude for any of the DM groups involved.
THEME 4 – Information gathering tool evaluation	
Types of data and information aspects given consideration to:	
▪ Multiple disciplines	Yes
▪ Temporal and spatial dimensions	Yes
▪ Multiple of scales	Yes
▪ Risks and uncertainties	Yes
▪ Stakeholder and interest-group input	Yes
THEME 5 – Decision- and communication-support tool evaluation	
Types of decision-support provided:	
▪ Bounding: compilation and assemblage of data/information. Addressing situation specific and more overall implications.	Yes
▪ Processing: analysis and synthesis of data /information, to properly reflect the complexities of protected area management.	Yes
Types of communication-support provided:	
▪ Consistent template, enabling easy import and export of data and information.	Yes
▪ Template flexible enough to allow for communication of varying types and amounts of data and information.	Yes

Table 5.10 Suggested management tool/framework

This is not to say that all these benefits will materialise automatically with the mere establishment of one arbitrary MADM application. If Parks Canada truly desires to benefit continuously and consistently from such a framework, then serious and ongoing efforts need to be undertaken towards its implementation. A case specific application as presented here will provide an important first step. But in order to explore the larger scale benefits, a more strategic initiative also need to be undertaken. These aspects will be discussed further in the final chapter.

Chapter 6

DISCUSSION AND RECOMMENDATIONS

The preceding chapters have presented some strengths and weaknesses associated with Parks Canada's present approach to protected area management. It has been argued that the Agency would greatly benefit from adopting a more formal, all-encompassing decision-making framework, as it would complement and significantly improve the capacity of its current management tools. It was argued that the main shortcoming of the current approach is the tools' ineptness to account for linkages and connections between various management issues. The tools are primarily designed and consequently used for providing situation- and application- specific assessments of the various management issues. The report has argued that the lack of explicit linkages, either between these assessments, or of the individual tools to a more integrated overall framework, severely limits opportunities for more integrative and collaborative management efforts. Based on the shortcomings identified in the first part of this report, an alternative framework was suggested, which was subsequently applied to a hypothetical decision situation within one Field Unit. An overall evaluation of the framework has also been conducted in the report. It concluded that the proposed, more formal, management framework would facilitate sound decision-making, effective communication, and easy integration of existing management tools' data and information output for many different management issues at the Field Unit level of Parks Canada.

This concluding chapter will provide a summary assessment, in which attention will be drawn to the key advantages expected to accrue when applying the suggested framework to the Parks Canada management context. The chapter will argue that the tool would greatly enhance the Agency's ability to work in an integrated and collaborative manner, facilitating the operationalization of the principles and conduct set forth by ecosystem based management, the Agency's overarching management philosophy.

Summary assessment

It has been recognised for a long time that the management responsibilities of Parks Canada are inherently complex and interdisciplinary. In order to meet all its goals and objectives, the Agency has adopted an ecosystem based approach to protected area management, which strongly emphasises integrated and collaborative management efforts. The principles of this holistic philosophy recognise the need to acknowledge ecosystem boundaries, as well as the interdisciplinary nature of most management issues. The approach recommends that managers work in a collaborative fashion with neighbouring jurisdictions, that they pay concurrent consideration to interdisciplinary management aspects such as economic, social, and ecological factors, and that they assess all management issues not only in respect to their immediate circumstances, but in view of how they relate to the system and management context as a whole.

For Parks Canada in particular, sound protected area management also specifically requires the development of shared goals and objectives with neighbouring and regional partners. In the ongoing shift of the Agency adopting more and more the role of a “facilitator” rather than a “trustee” of the areas under its care (Parks Canada, 1995), the Agency has promoted sharing of management responsibilities and consequently delegation of decision-making authority. Therefore, it is important for the Agency to ensure that management decisions made through the involvement of the public, external stakeholders, or other interest-groups do not stray from the Agency’s fundamental management concepts but uphold the maintenance and restoration of ecological integrity. To make it possible for decisions to demonstrate an overall concordance and compatibility with all relevant national park policies and regulations, Parks Canada needs to ensure that all involved parties are given a clear understanding of Parks Canada’s mandates and objectives. However, in order to successfully achieve the collaborative and integrative management approach described in the preceding section, it is important that the shared goals and objectives not only provide the partners with an understanding of Parks Canada’s management perspectives, but that all partners’ management objectives are incorporated and respected to a reasonable extent. Raising such awareness of neighbouring partners’ management agendas assists in assuring that chosen management propositions offer tradeoffs that are within acceptable limits with overlapping and complementary managers’ sentiments, which is essential to ensure adequate compliance with management decisions. Finally, in order for this type of collaborative management to be effective and for it to persist, partners need to be kept up to date with and made aware of one another’s activities, avoiding overlapping and costly duplications of efforts.

Ultimately, the successful achievement of integrated and collaborative management requires managers to be able to access and use decision-making processes that enable sound decisions. If an organisation's decision-making processes are to meet the requirements associated with implementing ESBM, then the management tools need to, individually or collectively:

- Generate and gather information and data that reflect the complexity inherent to protected area management situations;

Data and information should be collected to properly reflect the composition and issues comprising management situations by providing knowledge from the appropriate types of disciplines, reflecting suitable scales and dimensions, and accounting for the associated risks and uncertainties. Management tools should also be capable of including managers’ and associated partners’ preferences and management agendas.

- Comparatively evaluate management options and their respective potential outcomes;

Assessments should provide a transparent and factual basis for the selection of management alternatives by properly bounding (evaluating management situations from both their issue-specific and wider contexts) and adequately processing (logically and comprehensively organise, analyse, and synthesise decision components) management situations of various types and scopes.

- Facilitate easy communication of different types of data and information between management groups; Easy exchange of the diverse knowledge between the various management groups and associated partners needs to be facilitated, requiring a provision of consistent yet flexible assessment templates.

Earlier in this report, when the internal operational design of Parks Canada was reviewed, five of the Agency's present management tools were assessed in terms of their individual as well as collective strengths and weaknesses according to the criteria above. The tools were found to perform relatively well as situation- and application- specific assessment tools, although certain deficiencies were noted. These tools were initially designed to be used as separate applications to specific management situations. Hence, they are inherently ineffective at accommodating the complexities of and linkages between different management tasks. This limitation, in combination with the absence of any explicit integration between the various assessment tools, or an overall concerted framework, ensures the continuation of a fragmented rather than a holistic approach to management. Management situations are left rather narrowly bounded and incomprehensively processed as the tools are limited to evaluate situations from within their own assessment focus. Since the tools in principle only support the export and import of the type of data and information that their own particular assessments use and produce, communication and sharing of knowledge is severely limited. In other words, the present tools' data and information gathering capabilities, their decision-support functions, and their communication-support potential are limited from the outset to encompass only each specific tool's assessment range, providing fragmented, yet sound, pieces of management. Given that such an approach obstructs collaborative and integrative management efforts, the two primary prerequisites for a holistic ecosystem based management approach, a wider, more encompassing framework is essential.

In response to the current tools' limitations, this report presented a description, a hypothetical application, and a subsequent evaluation of a more integrated decision-making process, that, depending on the application, can serve as a more sophisticated decision-support tool, as well as an overall management framework. It was argued that the framework would facilitate sound decision-making, effective communication, and easy integration of the traditionally more fragmented data and information bases that are collected for various purposes at the Parks Canada Field Unit level. Contrary to the current tools, the new framework's decision-support functions do not need to be limited to certain types of management issues. It can sufficiently bound management situations of various types and scopes, for which it provides a comprehensive framework for user-friendly compilation, analysis, and synthesis of the various elements of information and data. Given that the current tools' assessments operate on various scales, by integrating their output into its process, the framework enables evaluation of a particular issue both in view of its situation specific context, as well as from a more overall perspective. The framework also provides explicit opportunities for the incorporation of parties' preferences and management agendas. The framework further offers a consistent, yet flexible, process template that would facilitate communication of its output between neighbouring jurisdictions and partners at scales that match Parks Canada's various areas of co-operation and concern.

In its provision of the above process components, the framework promotes sound management at the Field Unit levels by increasing the co-ordination among, quality of, and acceptance for management decisions:

- Co-ordination of an area's management decisions and activities is essential in order to avoid overlapping and costly duplications of actions.

Communally held goals and objectives are essential for such co-ordination. The framework facilitates the formation of such measures by relating management groups' individual objectives and performance criteria with each other and the situation's overall goal by way of preference thresholds and criteria's indices of importance. The process further ensures that these goals and objectives are respected throughout the decision-making process by screening out and recommending only alternatives whose performance potential falls within the given range of acceptable tradeoffs/compromises. Alternatives falling outside are systematically discarded and prevented from implementation. Managers are provided with an awareness as to what performance standards are mutually agreed upon, and what neighbouring managers' preferences and management agendas are.

- Acceptance for management decisions is essential in order to acquire the compliance needed for the successful implementation of decisions.

A decision is not likely to be accepted or to eventually enjoy a high compliance rate unless associated stakeholders and interest-groups who are affected by its implementation are willing to take on the tradeoffs and consequences associated with its implementation. The framework facilitates high acceptance for decisions by its explicit involvement of and consideration for multiple parties and their respective preferences and acceptance capacities throughout its assessment process. The inputs from these groups form a sort of "allowed space" and ensures that the alternatives that are finally recommended for implementation would not only significantly improve the present situation, but their consequences are accepted by the parties involved.

- A quality decision 1) is in alignment with group goals and objectives, 2) is made while considering all critical issues, and 3) is made while paying consideration to the appropriate aspects, scales, and dimensions associated with protected area management.

The items regarding co-ordination and acceptance above pointed out the framework's ability to produce decisions that would be in alignment with specified group goals and objectives as well as with parties' critical issues. By easily integrating the present tools' data and information into its assessments, the framework also produces quality decisions, as they have been assessed both according to the requirements for comprehensive ecosystem management and according to the needs of each specific situation.

Advantages with the suggested management framework in relation to Parks Canada's management goals and objectives

The two sections below offer a concluding discussion and a final summary as to how the suggested framework relates to and assists managers with the achievement of both Parks Canada's Field Unit- and National- level objectives.

Field Unit level

Chapter 2 described the three fundamental management objectives for the Field Unit level, which are to strive for ecosystem health, to serve Canadians, and to ensure wise and efficient management of funds. The section below briefly reviews the components of these three objectives.

Objective (1) Ecosystem Health

Two key requirements for achieving ecosystem health in national parks are to ensure that ecosystem structures and ecosystem processes are properly maintained, enhanced, and monitored within these parks and their adjacent surroundings. To facilitate the achievement of this objective, Field Units are advised to adopt a regional management approach with integrated monitoring efforts, by fostering long-term working relationships with its associated stakeholders and interest groups.

The suggested management framework assists this objective by ensuring that fair consideration and respect is given to partners' critical concerns, preferences and acceptance capacities, that situations are properly bounded and assessed, and that selected management alternatives are acceptable to the majority of parties involved. The case study in Chapter 5 exemplified this by including a multiple of partners and their respective critical assessment criteria in the process. The parties' preferences and acceptance capacities for the alternatives' potential ecological, social, and economic impacts were also recorded and respected throughout the process. The process ensured that the situation was properly bounded and assessed, as well as that the selected alternatives proved largely acceptable for all parties involved.

Objective (2) Serving Canadians

Parks Canada's objective of serving Canadians includes the establishment of proper limits for recreational activities within these protected areas. These regulations are to ensure that public expectations are met while at the same time the recreationally induced impacts are minimised and not in conflict with sound environmental management practices. To achieve the needed acceptance for management decisions and to attain the subsequent compliance from the visitors, allowing the decisions to be successfully implemented, the Field Units are to put emphasis on educating the public and involving them in the appropriate management and planning processes surrounding these type of decisions.

The suggested framework assists this objective by ensuring that explicit consideration is given to the public's acceptance capacities. This was exemplified in the case study by determining preference thresholds of the main visitor segments for social, economic, and environmental impacts. The framework also enhances educational opportunities. The process provides documentation of the rationales for decisions and their significance to the management context. Such records facilitate the necessary sharing of knowledge with the public and park visitors, and enhance their knowledge as to why certain decisions are made, together with their implications and associated tradeoffs.

Objective (3) Wise and Efficient Management of Funds

The third objective for the Field Units includes managing public funds efficiently, meeting or exceeding set revenue targets, and contributing to the local and regional economies of which Field Units are a part. The achievement of these components is related to meaningful involvement of the public, stakeholders, and other interest-groups in management and planning processes.

The suggested framework assists this objective by facilitating meaningful public involvement during management and planning processes. By enhancing the public's education in the matters of protected area management, the quality of their subsequent input to the processes is likely to improve. Further, by providing opportunities for nearby community stakeholders to get involved into the process, the framework also enhances the likelihood of meeting revenue targets and securing proper contribution to the prosperity of surrounding communities. The case study exemplified this by including explicit consideration for community stakeholders' preferences and acceptance capacities for relevant economic criteria performance. Only the alternatives that were within the acceptable economic thresholds for the community, i.e. seen as contributing sufficiently to the local economy, were included in the final selection process. Other economic criteria, posed by the park management group to represent their view on the alternatives' revenue generation potential, were also respected in the final selection process. By involving multiple parties into a situation's decision-making process, awareness is created about preferred and acceptable conditions and consequences, and about neighbouring partners' management activities. This combination facilitates the task of synchronising management activities and consequently reducing the risk for costly duplications and overlapping of management efforts.

National level

If we look at the advantages that a consistent use of the framework would pose for the overall National management context, with its more long term and strategic-oriented perspective, the following becomes evident:

- **Proper documentation**
  Used on a continuous basis, the framework's consistent yet flexible assessment template promotes formal and consistent documentation of data and information stemming from its applications. Such record management practices provide formal documentation for future justification and rationale of management decisions. By way of its standardised record management procedures, the consolidated framework also facilitates the establishment of proper standards needed for easy transfer of these records across the administrative system within Parks Canada. Additionally, because the type of information and data contained in these records are of a simple and straightforward format, understandable by non-scientists, its communication between other federal departments, external stakeholders, interest groups and the public in general is furthered. Such sharing of knowledge not only promotes a capitalisation of existing data and information as well as it simultaneously assists with the identification of data gaps (Schmoldt, et al., 1994). It also readily assists the Agency with providing the Canadian public with opportunities for learning and education, the contribution to state-of-the-art research, and the promotion of an open dialogue and integrative initiatives with neighbouring partners.

- **Collaborative management opportunities**
  A continued use of this type of framework promotes sound opportunities for collaborative management, inclusive decision-making, and public involvement. It does so by its initial screening process, its explicit consideration for preferences and involved parties' acceptance capacities throughout its assessment, and by its thorough comparative evaluation of potential management alternatives. The initial screening process, by employing the Agency's (and other parties' if desired) legislative and regulative aspects as the alternatives' selection criteria, ensures that management decisions are kept consistent with Park Canada's policies and directives. By promoting the framework's continual use, the various external decision-makers would be provided with a clear understanding of the Parks Canada mandate and management objectives. The criteria used for the framework's initial screening process as well as the Agency's documented preferences and acceptance capacities regarding other management criteria would further assure that decisions made without the Agency's explicit involvement (e.g. solely by external stakeholders, public involvement, etc) uphold the overall management goal of maintaining and restoring EI and CI, selecting management alternatives whose potential consequences are acceptable to all parties. Finally, the framework provides comprehensive comparative evaluation possibilities for management alternatives. Its type of

evaluation ensures that all options are properly presented and discussed, allowing for a consequent selection of the alternative that best suits the circumstances.

In conclusion, by employing this type of suggested framework, Parks Canada would be setting a leading example for other agencies, demonstrating an innovative and progressive approach towards integrated and collaborative protected area management. The framework's application would promote 1) comprehensive, yet user-friendly, decision-support functions, supporting adequate processing of management issues, 2) simple and convenient integration of existing management tools' outputs, and 3) efficient communication of the Agency's various types of information and data between neighbouring jurisdictions and partners at scales matching areas of co-operation and concern. In doing so, its application, complementing the Agency's present management tools, would enhance complex management decisions' co-ordination, quality, and acceptance, furthering the maintenance and restoration of ecological integrity.

Recommendations for implementation and further research

With Parks Canada's present day management approach typically differing quite substantially from the method suggested in this report, the application and continuous use of this type of framework may seem as an overwhelming, even improbable, task. However, as Yaffee (1996) once put it:

> "The near-term promise of ecosystem management is as a process to transform organizations and decision-making processes to make them more willing to experiment, innovate, and look beyond themselves in both time and space."
>
> *Steven L. Yaffee (1996)*

Naturally, I am not suggesting a national scale implementation of the framework: a currently unreasonable idea, considering the current management structure of PC, as well as the fact that this case study is simplified and hypothetical in nature. Rather, I would suggest a series of smaller test applications on a Field Unit level, to assess the approach's suitability in a variety of Parks Canada's management settings, and to explore the potential benefits of such a co-ordinated effort. It is further recommended that such applications start with thorough considerations for and testing of the components of the framework that have been set aside in the case study, e.g. DM analysis, criteria interdependencies, relativity of weights, relationships between likelihood, uncertainty and magnitude estimates for alternatives impact potentials.

On another note, the framework proposed in this report is best suited for decision situations where problems are composed of discrete sets of pre-established alternatives. However, many Parks Canada management situations also include problems with a continuous number of implicitly defined alternatives. As discussed in Chapter 4, a problem situation's alternative space, either continuous or discrete, largely impacts the choice and suitability of a DA method. Discrete problems, typically composed of a solution space with a limited set of alternatives, as in the example in this report, are well suited for MADM applications (Miettinen, 1999). Continuous problems however favour the application of methods with an optimisation focus, where solution possibilities are infinite, limited only by for example minimum performance requirements on certain variables of measure (ibid.). Hence, it is recommended that, using the information provided in Chapter 4 as a starting point, methods belonging to the MODM and MCDM sub-disciplines be explored for their usefulness as decision aids under the above type circumstances.

Finally, discrete and continuous methods are not necessarily mutually exclusive. Continuous methods may be used to generate a representative subset of feasible alternatives, which in turn may be elaborated by means of a discrete multiattribute analysis (Nijkamp, 1990).

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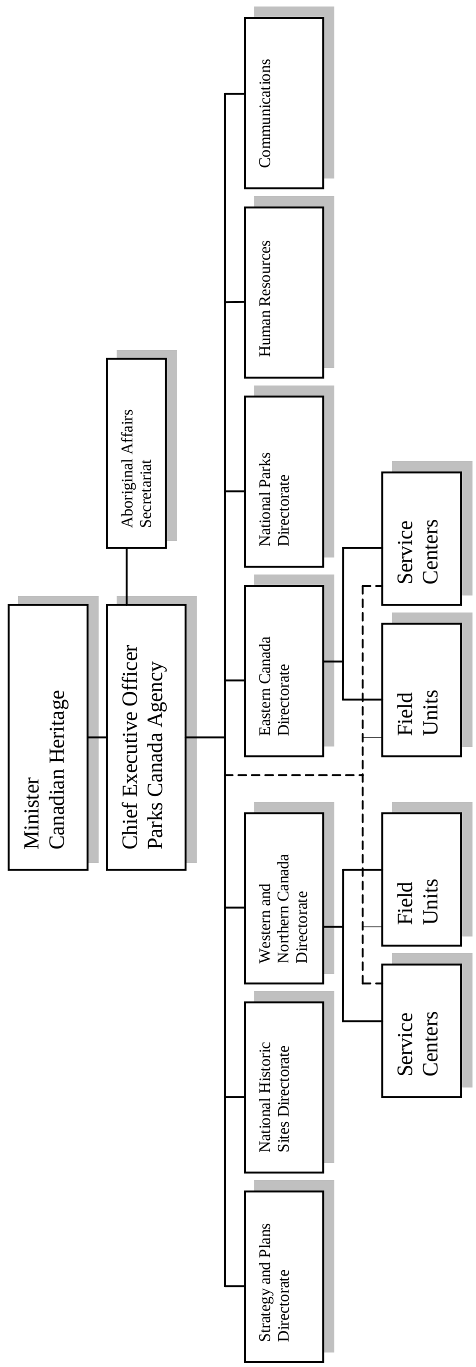
APPENDIX 2

ORGANIZATIONAL STRUCTURE OF THE PARKS CANADA AGENCY



Source: Parks Canada, 2000a, p. 12.

APPENDIX 2

CONCORDANCE MATRICES

Concordance matrix

Criterion 2: Extent of erosion

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35
A2	0.35		.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35
A3	0.35	0.35		.35	.35	.35	.35	.35	.35	.35	.35	.35	.35
A4	0.35	0.35	.35		.35	.35	.35	.35	.35	.35	.35	.35	.35
A5	0.35	0.35	.35	.35		.35	.35	.35	.35	.35	.35	.35	.35
A6	0.35	0.35	.35	.35	.35		.35	.35	.35	.35	.35	.35	.35
A7	0.35	0.35	.35	.35	.35	.35		.35	.35	.35	.35	.35	.35
A8	0.35	0.35	.35	.35	.35	.35	.35		.35	.35	.35	.35	.35
A9	0.35	0.35	.35	.35	.35	.35	.35	.35		.35	.35	.35	.35
A10	0.35	0.35	.35	.35	.35	.35	.35	.35	.35		.35	.35	.35
A11	0.35	0.35	.35	.35	.35	.35	.35	.35	.35	.35		.35	.35
A12	0.35	0.35	.35	.35	.35	.35	.35	.35	.35	.35	.35		.35
A13	0.32	0.33	.31	.38	.34	.33	.29	.28	.29	.30	.28	.30	

Concordance matrix

Criterion 3: Fauna abundance

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		.16	.20	.16	.16	.20	.20	.20	.20	.20	.20	.20	.20
A2	0.20		.20	.20	.16	.20	.20	.20	.20	.20	.20	.20	.20
A3	0.15	0.16		.16	.15	.20	.16	.20	.20	.16	.20	.16	.20
A4	0.20	0.20	.20		.16	.20	.20	.20	.20	.20	.20	.20	.20
A5	0.20	0.20	.20	.20		.20	.20	.20	.20	.20	.20	.20	.20
A6	0.16	0.16	.16	.16	.15		.16	.20	.20	.16	.20	.16	.20
A7	0.16	0.16	.16	.16	.15	.16		.20	.20	.16	.20	.16	.20
A8	0.11	0.11	.20	.11	.11	.11	.11		.11	.11	.11	.11	.20
A9	0.11	0.11	.11	.11	.11	.11	.11	.11		.11	.11	.11	.20
A10	0.16	0.16	.16	.16	.15	.16	.16	.20	.20		.20	.16	.20
A11	0.11	0.11	.11	.11	.11	.11	.11	.11	.11	.11		.11	.20
A12	0.16	0.16	.16	.16	.15	.16	.16	.20	.20	.16	.20		.20
A13	0.03	0.03	.04	.03	.02	.04	.04	.04	.04	.04	.04	.04	

Concordance matrix

Criterion 4: Fire ring encounters

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.10	.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
A2	0.10		.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
A3	0.10	0.10		0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
A4	0.10	0.10	0.10		0.10	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10
A5	0.10	0.10	0.10	0.10		0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
A6	0.10	0.10	0.10	0.09	0.10		0.10	0.10	0.10	0.10	0.10	0.10	0.10
A7	0.10	0.10	0.10	0.10	0.10	0.10		0.10	0.10	0.10	0.10	0.10	0.10
A8	0.10	0.10	0.10	0.10	0.10	0.10	0.10		0.10	0.10	0.10	0.10	0.10
A9	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10		0.10	0.10	0.10	0.10
A10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10		0.10	0.10	0.10
A11	0.10	0.10	0.10	0.09	0.10	0.09	0.10	0.10	0.10	0.10		0.10	0.10
A12	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10		0.10
A13	0.06	0.07	0.07	0.08	0.07	0.08	0.05	0.03	0.05	0.07	0.08	0.07	

Concordance matrix

Criterion 5: People encountered

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
A2	0.34		0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
A3	0.34	0.34		0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
A4	0.34	0.34	0.34		0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
A5	0.34	0.34	0.34	0.34		0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
A6	0.34	0.34	0.34	0.34	0.34		0.34	0.34	0.34	0.34	0.34	0.34	0.34
A7	0.34	0.34	0.34	0.34	0.34	0.34		0.34	0.34	0.34	0.34	0.34	0.34
A8	0.24	0.26	0.23	0.26	0.26	0.27	0.21		0.20	0.21	0.23	0.34	0.34
A9	0.24	0.26	0.23	0.26	0.26	0.27	0.21	0.20		0.21	0.23	0.34	0.34
A10	0.34	0.34	034	0.34	0.34	0.34	0.34	0.34	0.34		0.34	0.34	0.34
A11	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34		0.34	0.34
A12	0.32	0.34	0.29	0.34	0.34	0.36	0.27	0.25	0.25	0.33	0.29		0.21
A13	0.26	0.28	0.24	0.28	0.28	0.30	0.22	0.20	0.20	0.22	0.24	0.34	

Concordance matrix

Criterion 6: Seasonal trail maintenance cost

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
A2	0.02		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
A3	0.02	0.02		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
A4	0.02	0.02	0.02		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
A5	0.02	0.02	0.02	0.02		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
A6	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02	0.02	0.02	0.02	0.02
A7	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02	0.02	0.02	0.02
A8	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02	0.02	0.02
A9	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02	0.02
A10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02
A11	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02
A12	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02
A13	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	

Concordance matrix

Criterion 7: Seasonal rescue cost

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A2	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A3	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A4	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A5	0.01	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A6	0.01	0.01	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01
A7	0.01	0.01	0.01	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01
A8	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.01
A9	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.01	0.01	0.01	0.01
A10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.01	0.01	0.01
A11	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.01	0.01
A12	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.01
A13	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	

Concordance matrix

Criterion 8: Level of user fees

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
A2	0.03		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
A3	0.03	0.03		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
A4	0.03	0.03	0.03		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
A5	0.03	0.03	0.03	0.03		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
A6	0.03	0.03	0.03	0.03	0.03		0.03	0.03	0.03	0.03	0.03	0.03	0.03
A7	0.03	0.03	0.03	0.03	0.03	0.03		0.03	0.03	0.03	0.03	0.03	0.03
A8	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.03	0.03	0.03	0.03	0.03
A9	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.03	0.03	0.03	0.03
A10	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.03	0.03	0.03
A11	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.03	0.03
A12	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02		0.03
A13	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	

Concordance matrix

Criterion 9: Business gross output

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.10	0.12	0.10	0.12	0.10	0	0	0	0	0	0.12	0
A2	0.09		0.10	0.10	0.10	0.10	0	0	0	0	0	0.12	0
A3	0.09	0.10		0.10	0.10	0.09	0	0	0	0	0	0.12	0
A4	0.09	0.10	0.10		0.10	0.10	0	0	0	0	0	0.12	0
A5	0.09	0.10	0.10	0.10		0.09	0	0	0	0	0	0.12	0
A6	0.10	0.10	0.10	0.10	0.10		0	0	0	0	0	0.12	0
A7	0.11	0.12	0.12	0.12	0.12	0.12		0.10	0	0.10	0	0.12	0
A8	0.11	0.12	0.12	0.12	0.12	0.12	0.10		0	0.10	0	0.12	0
A9	0.12	0.12	0.12	0.12	0.12	0.12	0.10	0.10		0.10	0	0.12	0
A10	0.11	0.11	0.12	0.12	0.12	0.12	0.10	0.10	0		0	0.12	0
A11	0.12	0.12	0.12	0.12	0.12	0.12	0.10	0.10	0	0.10		0.12	0
A12	0.00	0.09	0.09	0.09	0.09	0.08	0	0	0	0	0		0
A13	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.12	0.11	0.12	0.12	

Concordance matrix

Criterion 10: Employment opportunity

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
A2	0.04		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
A3	0.04	0.04		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
A4	0.04	0.04	0.04		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
A5	0.04	0.04	0.04	0.04		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
A6	0.04	0.04	0.04	0.04	0.04		0.04	0.04	0.04	0.04	0.04	0.04	0.04
A7	0.04	0.04	0.04	0.04	0.04	0.04		0.04	0.04	0.04	0.04	0.04	0.04
A8	0.04	0.04	0.04	0.04	0.04	0.04	0.04		0.04	0.04	0.04	0.04	0.04
A9	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04		0.04	0.04	0.04	0.04
A10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04		0.04	0.04	0.04
A11	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04		0.04	0.04
A12	0.02	0.02	0.03	0.02	0.03	0.02	0	0	0	0	0		0
A13	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	

APPENDIX 3

DISCORDANCE MATRICES

Discordance matrix

Criterion 1: Unconsolidated organic matter

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Discordance matrix

Criterion 2: Extent of erosion

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Discordance matrix

Criterion 4: Fire ring encounters

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Discordance matrix

Criterion 5: People encountered

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Discordance matrix

Criterion 6: Seasonal trail maintenance cost

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Discordance matrix

Criterion 7: Seasonal rescue cost

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Discordance matrix

Criterion 8: Level of user fees

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Discordance matrix

Criterion 9: Business gross output

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	-	-	-	-	-	-	-		-	-	-	-	-
A8	-	-	-	-	-	-	-	-		-	-	-	-
A9	0	0	0	0	0	0	0	-		0	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

Discordance matrix

Criterion 10: Employment opportunity

Alternative	BC	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
BC		0	0	0	0	0	0	-	-	0	-	-	-
A2	0		0	0	0	0	0	-	-	0	-	-	-
A3	0	0		0	0	0	0	-	-	0	-	-	-
A4	0	0	0		0	0	0	-	-	0	-	-	-
A5	0	0	0	0		0	0	-	-	0	-	-	-
A6	0	0	0	0	0		0	-	-	0	-	-	-
A7	0	0	0	0	0	0		-	-	0	-	-	-
A8	-	-	-	-	-	-	-		-	-	-	-	-
A9	-	-	-	-	-	-	-	-		-	-	-	-
A10	0	0	0	0	0	0	0	-	-		-	-	-
A11	-	-	-	-	-	-	-	-	-	-		-	-
A12	-	-	-	-	-	-	-	-	-	-	-		-
A13	-	-	-	-	-	-	-	-	-	-	-	-	

APPENDIX 4

AHP CALCULATIONS

LOCAL CRITERIA WEIGHTS

	objective	criteria								4th squaring			row sums	%
Group 1	Ecosystem Health	unconsol. org. matter	1	1/2	3/1		1	0.5	3	15788738	9039506	41389542	66217786	0.319624
		extent of erosion	2/1	1	4/1	=	2	1	4	27586176	15793877	72316048	1.16E+08	0.55845
		fauna abundance	1/3	1/4	1		0.333	0.25	1	6022880	3448272	15788738	25259891	0.121926
													2.07E+08	1
	Serving Canadians	fire rings	1	4/1			1	4		32768	131072		163840	0.8
		size of people parties	1/4	1		=	0.25	1		8192	32768		40960	0.2
													204800	1
	Efficient Mngt of Funds	maintenence cost	1	6/1			1	6		33031	197988.1		231019.1	0.85702
		rescue cost	1/6	1		=	0.167	1		5510.669	33031		38541.67	0.14298
													269560.8	1
Group 2	Ecosystem Health	unconsol. org. matter	1	4/1	1/2		1	4	0.5	24701058	71314086	17061573	1.13E+08	0.358564
		extent of erosion	1/4	1	1/3	=	0.25	1	0.33	8530786	24629117	5892405	39052308	0.123834
		fauna abundance	2/1	3/1	1		2	3	1	35657043	1.03E+08	24629117	1.63E+08	0.517602
													3.15E+08	1
	Trip Experience	fire rings encounters	1	1/7			1	0.143		32899.29	4702.247		37601.53	0.125055
		people encountered	7/1	1		=	7	1		230179.9	32899.29		263079.2	0.874945
													300680.8	1
	Willingness to Pay	level of user fees	1				N/A			N/A			N/A	1
Group 3	Ecosystem Health	unconsol. org. matter	1	1/3	1/5		1	0.333	0.2	14608221	5172931	2749407	22530559	0.109422
		extent of erosion	3/1	1	1/2	=	3	1	0.5	41253226	14608221	7764253	63625700	0.309004
		fauna abundance	5/1	2/1	1		5	2	1	77642527	27494072	14613068	1.2E+08	0.581575
													2.06E+08	1
	Residential Experience	fire rings encounters	1	1/8			1	0.125		32768	4096		36864	0.111111
		people encountered	8/1	1		=	8	1		262144	32768		294912	0.888889
													331776	1
	Economic Standard	business gross output	1				N/A			N/A			N/A	1
Group 4	Ecosystem Health	unconsol. org. matter	1	1/4	1/3		1	0.25	0.333	25185915	8730689	6051222	39967825	0.124259
		extent of erosion	4/1	1	1/2	=	4	1	0.5	72676358	25193234	17461377	1.15E+08	0.358561
		fauna abundance	3/1	2/1	1		3	2	1	1.05E+08	36338179	25185915	1.66E+08	0.51718
													3.22E+08	1
	Residential Experience	fire rings encounters	1	3/1			1	3		32637.14	97960.41		130597.6	0.750094
		people encountered	1/3	1		=	0.333	1		10873.61	32637.14		43510.75	0.249906
													174108.3	1
	Economic Standard	employment opp.	1			=	N/A			N/A			N/A	1

LOCAL OBJECTIVE WEIGHTS

	goal	objective								4th squaring			row sums	%
Group 1	Ecological and	Ecosystem Health	1	9/1	9/1		1	9	9	14294783	1.29E+08	1.29E+08	2.72E+08	0.818231
	Commemorative Integrity	Serving Canadians	1/9	1	1/1	=	0.111	1	1	1587780	14299552	14299552	30186884	0.090884
		Efficient Mngt of Funds	1/9	1/1	1		0.111	1	1	1587780	14299552	14299552	30186884	0.090884
													3.32E+08	1
Group 2	ibid.	Ecosystem Health	1	3/1	3/1		1	3	3	43772949	82770176	2.09E+08	3.35E+08	0.575085
		Trip Experience	1/3	1	4/1	=	0.333	1	4	23155208	43784134	1.1E+08	1.77E+08	0.304211
		Willingness to Pay	1/3	1/4	1		0.333	0.25	1	9187490	17372605	43784134	70344228	0.120704
													5.83E+08	1
Group 3	ibid.	Ecosystem Health	1	1/1	1/1		1	1	1	43941682	69753073	27681525	1.41E+08	0.310814
		Residential Experience	1/1	1	1/4	=	1	1	0.25	27681525	43941682	17438268	89061476	0.1958
		Economic Standard	1/1	4/1	1		1	4	1	69753073	1.11E+08	43941682	2.24E+08	0.493386
													4.55E+08	1
Group 4	ibid.	Ecosystem Health	1	1/1	3/1		1	1	3	15788738	18079012	41389542	75257292	0.443445
		Residential Experience	1/1	1	2/1	=	1	1	2	13793088	15793877	36158024	65744989	0.387395
		Economic Standard	1/3	1/2	1		0.333	0.5	1	6022880	6896544	15788738	28708163	0.16916
													1.7E+08	1

FINAL, RELATIVE, CRITERIA WEIGHTS

Group 1	81.82%	31.96%	26.15%		
		55.84%	45.69%		
		12.19%	9.98%		
	9.09%	80.00%	7.27%		
		20.00%	1.82%	**criteria:**	
				1	13.92%
	9.09%	85.70%	7.79%	2	19.58%
		14.30%	1.30%	3	20.19%
Group 2	57.51%	35.86%	20.62%	4	10.58%
		12.38%	7.12%	5	13.88%
		51.76%	29.77%		
				6	1.95%
	30.42%	12.51%	3.80%	7	0.32%
		87.49%	26.62%	8	3.02%
				9	12.33%
	12.07%	100.00%	12.07%	10	4.23%
Group 3	31.08%	10.94%	3.40%		
		30.90%	9.60%		
		58.16%	18.08%		
	19.58%	11.11%	2.18%		
		88.89%	17.40%		
	49.34%	100.00%	49.34%		
Group 4	44.34%	12.43%	5.51%		
		35.86%	15.90%		
		51.72%	22.93%		
	38.74%	75.01%	29.06%		
		24.99%	9.68%		