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

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.

ACKNOWLEDGEMENTS

A number of people deserve recognition and credit for their contribution to the development of this report, including the following:

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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

"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'

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

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

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).

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

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

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

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

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].

[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 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 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

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).

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 have adopted a philosophy referred to as Ecosystem Based Management (ESBM). ESBM has its origins in

Challenges Associated with Protected Area Management

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

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 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 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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- 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). The16.3(m)1r(y)8.8(d)-34si6.3(e1)-19.Tel 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

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

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
    -

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;

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),

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:	

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] 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 –

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 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

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 –	

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

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	

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 interdiscin Tw[(p 0 TD03(n)9.y)]TJ0 (t) 9.96 rk,.039 .r(rdi)4.7dp4.7(oci)-1 ond R 8.9()10.7(e)ds h aweay

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

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’

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,

Chapter 4

DECISION ANALYSIS

Chapter 4 presents an overview of the origins and methodological advancements of Decision Analysis 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 a stifnD considerations for risks and uncertainties[30]. Thus, Savage (1954) defined the final attractiveness of an alternative as dependent on two things:

1.

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'

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.

an infinite solution space (Hwang and Lin, 1987). Their variables are continuous, subsequently, their

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

Stage 1: Structuring

This stage is usually given great emphasis by MADM methods as they are often referred to as the "

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 degrt 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

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

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'

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:

➔

- Minority principle: Within the minority of the criteria not supporting the assertion |a**S**b |, none of them being strongly enough against the

0, if c

Discordance measure

The discordance measure, which indicates the weakness of assertion |a**S**b |, is not usually created by any aggregation over criteria. Rather, the assertion |a**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 |$a\mathbf{S}_j b$ | 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 |$a\mathbf{S}_j b$ | 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**S**b |, hel3de98.9.96 0.5( )-12.1(|)21.8(j)a h5542l conf

- If there are several 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**)

Qnea)

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

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).

---

[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

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

1	0.5	3

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

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

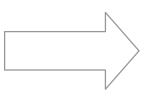
- Ranking of alternatives. The ELECTRE method’s concept of outranking relationships is applied to produce a final order, identifying which of the alternative(s) would be the most suitable to pursue under the given circumstances.

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.

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 Beacclpot u2n 9 u2n t6 6o31(th)c 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



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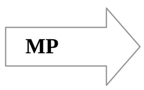
[68] An interesting discussion on the topic of decision-makers and those influencing decision-makers, can be found in Zionts (1997b).

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



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**		

Alternatives

Finally, we have arrived at the identification of alternatives. Obviously, an actual application would

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

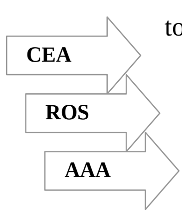
We have now identified and organised our decision components, and are prepared to take on the third and final step of the first stage: the 1st screening of the alternatives. As pointed out in Chapter 4, the screening criteria employed at this stage will be too crude to be used for the final evaluation. 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,



awareness about the local businesses in the area, the area's ecological sensitivity, as well as to increase visitors'

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|AA 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**

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.

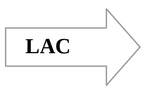
Veto (V): Signifies the absolutely highest or lowest value a criterion can take on before its performance would be found unacceptable by the DMs.

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:

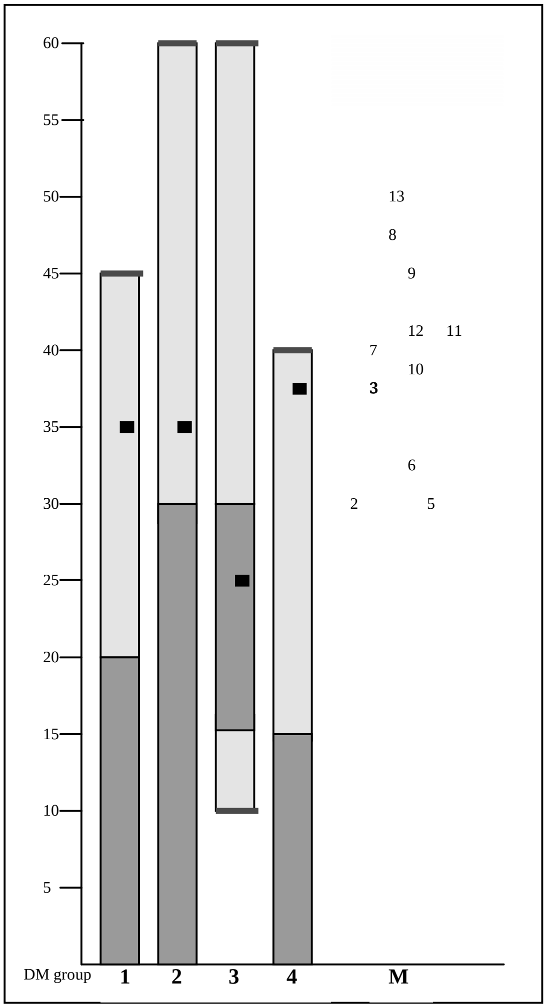
- What is your preferred performance level[77] for c_j? (P)
- What is your intermediate performance level for c_j? (Q)
- What do you find to be an acceptable range of variation for c_j's performance level? (I)
- What is your veto level for c_j'



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'

Criteria threshold levels



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- 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?

(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 $D_j(a, b)$

- In terms of $|(a, b) \in A|$

Chapter 6

DISCUSSION AND RECOMMENDATIONS

The preceding chapters have presented some strengths and weaknesses associated with Parks Canada's

- 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' 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:

-

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

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,

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

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

applications (Miettinen, 1999). Continuous problems however favour the application of methods with an

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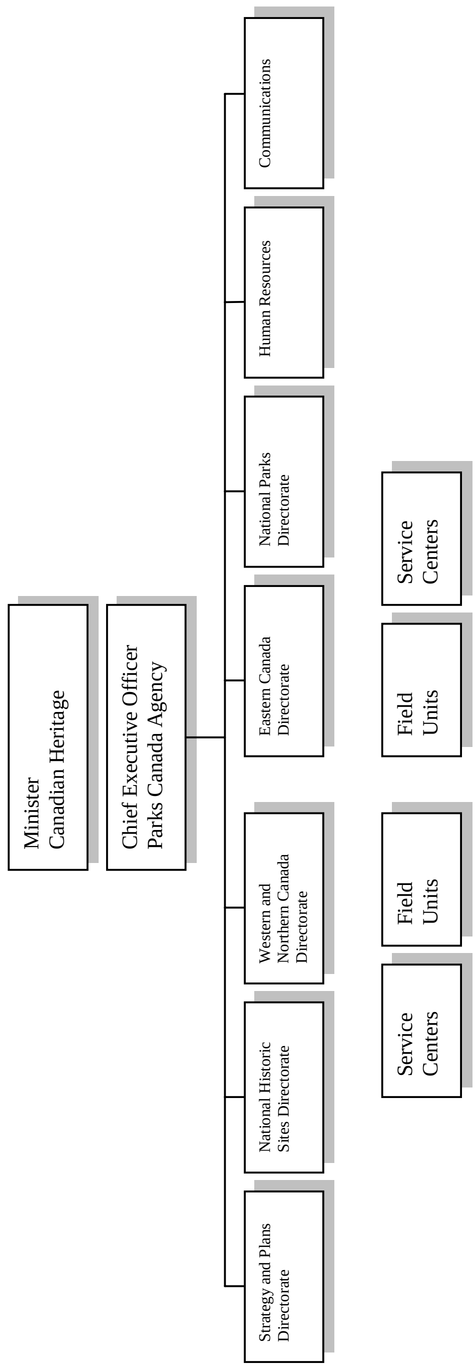
APPENDIX 2

ORGANIZATIONAL STRUCTURE OF THE PARKS CANADA AGENCY



APPENDIX 2

CONCORDANCE MATRICES

Concordance matrix

Criterion 2: Extent of erosion

Alternative	BC	

Concordance matrix

Concordance matrix

Crit Seasonal trail maintenance cost

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

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

Concordance matrix

Criterion 10: Employment opportunity

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

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

Discordance matrix

Criterion 4: Fire ring encounters

Discord[illegible]nce matrix

Criterion[illegible]: 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	-	-	-

Discordance matrix [redacted]

Criterion 8: Level of use [redacted]

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

--E1.685 496.425 0.36 -0.36af [redacted] E1.685 496.425 0.65 496.425 9.12 -0.36 ref225.1628.94.765 4.12 -0.36 ref225.1628.94.765 4.12 -0.34 -8.012 -0.36 ref225.1620-0.36

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

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%
	9.09%	85.70%	7.79%
		14.30%	1.30%
Group 2	57.51%	35.86%	20.62%
		12.38%	7.12%
		51.76%	29.77%
	30.42%	12.51%	3.80%
		87.49%	26.62%
	12.07%	100.00%	12.07%
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%

criteria:	
1	13.92%
2	19.58%
3	20.19%
4	10.58%
5	13.88%
6	1.95%
7	0.32%
8	3.02%
9	12.33%
10	4.23%