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Visitor Management and Ecological Integrity: One Example of an Integrated Management Approach Using Decision Analysis

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Abstract: In this paper we argue in favor of using a decision analysis framework for more integrated decision-making when managing protected areas. Such an approach will enable agencies to balance between the frequently conflicting goals of visitor management and ecological integrity. We present a case study from the West Coast Trail in Pacific Rim National Park Reserve, BC, Canada, in which we use ELECTRE and AHP to establish a ranking of several management options. We conclude by suggesting that such a more formal framework constitutes a more objective decision support tool, assists in framing relevant management questions and tradeoffs, and at the same time provides guidance for data collection.

INTRODUCTION

When managing protected areas, agencies typically need to balance several divergent objectives, such as striving for ecological integrity and ensuring visitor enjoyment. To assist in these tasks, ecosystem-based management has, over the last decade, been adopted by many agencies as their overarching management framework. This situation also applies to Parks Canada, the lead agency for managing National Parks in Canada.

In Canada, the National Parks Act (2000) recognises the mandate of ecological integrity as the primary objective. As a result, Parks Canada has adopted the concept of ecosystem-based management as its overarching management framework (Parks Canada, 2000). The concept acknowledges the inherent complexity of the task at hand, the need to integrate knowledge generated by several academic disciplines, and the need to accommodate aspects of uncertainty and risk in decision-making processes. Typically, this management approach strives to balance ecological, social and economic concerns (Grumbine, 1994; Slocombe, 1998).

However, the de facto management framework of Parks Canada is still dominated by a more traditional management structure, in which separate departments within the agency are charged with specific mandates, make their own decisions, and usually collect their own relevant information (Rudolphi 2000). For example, separate policies and guidelines direct visitor management, ecological monitoring, and impact assessment. Such a situation effectively impedes the implementation of a more integrated management framework for at least three reasons (Watson et al., 1987):

- Goal fragmentation and sliding of objectives;
- Costly duplications and overlapping efforts; and
- Low acceptance and compliance towards decisions made.

Given the lofty goal of ecosystem based management, we consider it essential that decision processes be provided with adequate and timely information for the tasks at hand. For that purpose, Parks Canada requires state-of-the-art 1) data gathering and information generating tools, 2) decision support tools, and 3) communication support tools.

Such tools will provide important support to all decision-making structures, whether they are more traditional top-down approaches that are formulated and implemented within an agency, or alternative participatory forms of decision-making. We would like to acknowledge at this point that many decisions involving Parks Canada are undertaken in a shared or participatory manner. Our critique is not directed towards the decision processes themselves, but at the processes that guide data and information gathering, as well as management, and presentation. In this paper we will argue that several methods in the field of decision analysis (DA) can assist Parks Canada, as well as many other land management agencies, in the task of collecting, synthesising, and presenting large amounts of information, as well as structuring decisions and evaluating alternatives.

The next section will provide a brief overview of DA, and present the specific methods we propose to use in our case study. Then we will explain the specific circumstances at the West Coast Trail in Pacific Rim National Park Reserve in British Columbia, Canada, followed by a brief example of how to work through such a data set. We will conclude with a discussion of the benefits that would accrue to a management agency by adopting

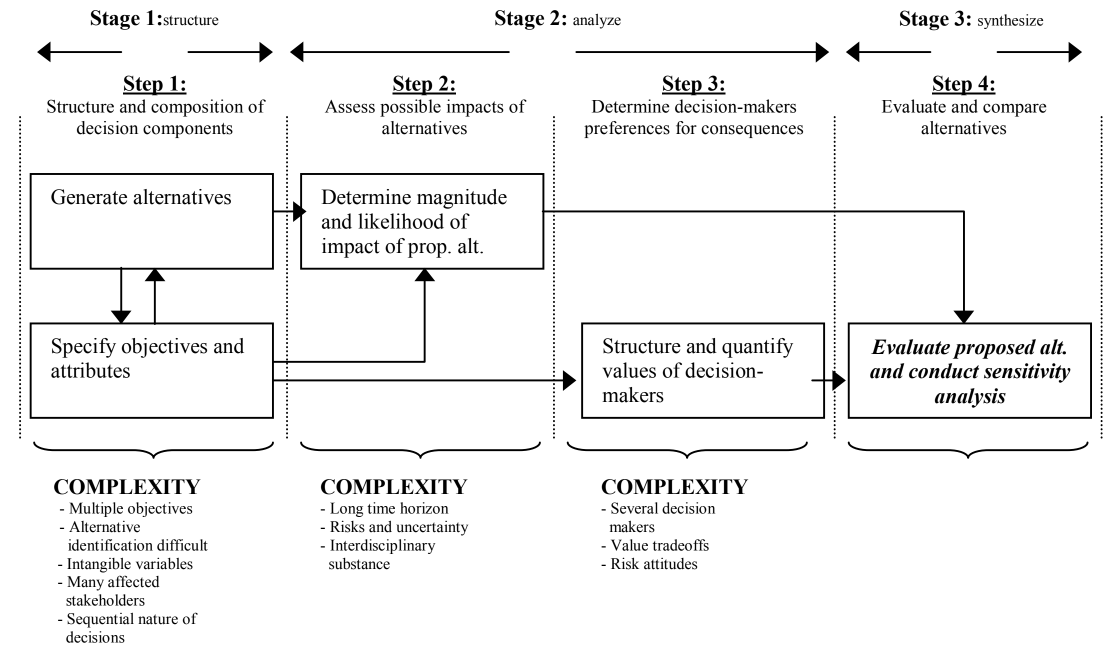

Figure 1: Schematic representation of a generic MADM process. Modified from Keeney (1982)

such a data and information and decision management methodology.

DECISION ANALYSIS

Decision Analysis refers to a diverse methodological field whose array of methods have in common that they all provide formal support for decision-makers in complex choice situations. In this paper we focus on Multi Attribute Decision Making (Vincke, 1992), and more specifically on two methods, the Analytical Hierarchy Process (AHP) (Saaty 1980) and the Elimination et choix traduisant la realite (ELECTRE) (Roy, 1990).

A typical MADM modelling process involves three iterative stages (Keeney, 1982) (Fig 1):

1) structuring -
2) analysis -
3) synthesis.

Structuring involves the specification of decision objectives, criteria and measurable attributes, and the identification of alternatives. To enhance transparency, these components are usually organized in a decision tree. During that stage, an initial screening of alternatives might discard unfeasible or inferior alternatives in order to trim the decision tree to a manageable size.

In the first step of analysis the potential magnitude, likelihood and uncertainty associated with the remaining alternatives are assessed. The second step in the analysis stage involves the elicitation of decision-makers' preferences for tradeoffs and/or willingness to take risks. It is on this latter point that many of the methods differ.

At the final stage, the alternatives' advantages and disadvantages are evaluated and compared against each other by amalgamating all available information (Keeney, 1982). Each alternative's situation specific efficacy is predicted using the preferences (utilities) determined earlier. The model will identify the alternative with the highest expected utility.

We will now present the two preference elicitation methods that we used in our case study. We decided on using elements of each of the two methods as each contains characteristics of particular importance to our application.

ELECTRE.

The Elimination et choix traduisant la realite (ELECTRE) method (Roy, 1990) is a widely used decision tool (e.g. Massam, 1980). The fundamental idea behind it's process is to establish rankings among several alternatives (Roy, 1990).

ELECTRE establishes the desirability of an alternative by using concordance and discordance analysis (Nijkamp and van Delft, 1977; Yoon, et al., 1995). The decision makers' preferences in regards to the objectives' and criteria's performance levels are used as indicators, forming importance thresholds for the objectives and criteria. An alternative's value is subsequently determined by the degree to which its attributes are in agreement (also referred to as being in "concordance"), minus disagreement (discordance), with the predetermined objectives/criteria and constraints (i.e. the thresholds). An alternative's ranking is then determined using the concept of outranking (Guitouni and Martel, 1998) as aggregation procedure. The set of alternatives that are non-dominated are singled out by associating the previously established thresholds, in combination with the criteria / objective weights, to an outranking relation, using status quo, or an ideal situation, as the reference point of comparison (ibid.).

The threshold levels are a subjective and influential ingredient in ELECTRE's outranking process. As these values are to serve as indicators for criteria performance in the subsequent concordance / discordance analysis, specifying one alternative's dominance over another, they should be given considerable attention and appointed with as much correctness and care as possible. Four different threshold levels (Vincke, 1990; Roy and Vincke, 1984) should be determined:

- Strong preference threshold, also referred to as the aspired range. This is the zone within which the decision makers find a criterion is preferred to be positioned.
- Weak preference threshold, or buffer zone. A performance range that represents the hesitation between the strong (above) and the indifference (below) threshold. Not a perfect place for a criterion to be located, but still acceptable.
- Indifference threshold. The acceptable range a measure can move within (+/-) before its deviation becomes significant to the decision makers.
- Veto threshold, or the minimum/maximum value. Any value placing itself above or below these thresholds would be considered unacceptable, as it would be affecting the situation too severely.

The Analytical Hierarchy Process (AHP)

Like ELECTRE, the AHP process has found wide application since the early 1980s (Saaty 1980) in many different decision-making processes (Gholomnezhad, 1981, Brown, et al., 2000). The main characteristic of the AHP method is its strong focus on identifying the underlying hierarchical structure for the decision problem at hand (Dyer, 1990) .

Preferences are not elicited for the alternatives directly, but for the attributes, objectives, and criteria, using a series of pairwise comparison evaluations. These evaluations then provide the weights for the decision trees (Saaty, 1980). The decision trees serve as the formal structure used to display the situation in an ordered and hierarchical manner, linking the situation's alternatives together with the goal(s), objectives, criteria, and attributes. The final aggregation procedure used by AHP, to rank one alternative over another, is, similar to ELECTRE, based on the concepts of outranking (Liang and Sheng, 1990). Combining AHP and ELECTRE will allow us to combine the most attractive aspects of either method.

STUDY AREA: THE WEST COAST TRAIL IN PACIFIC RIM NATIONAL PARK

The West Coast Trail (WCT) is a 75km long hiking trail along the Pacific Coast of British Columbia. It offers visitors encounters with sandy beaches and rocky headlands, bordered by a temperate coastal rainforest, and constitutes the main backcountry attraction of PCNPR. Thousands of hikers each year take between six and 10 days to hike the entire trail, or portions of it in single or two day hikes (Parks Canada, 1991). In 1992, Parks Canada introduced a reservation system to address concerns about environmental impacts, hikers' safety, and visitors' enjoyment (Parks Canada, 1994d). Now the trail is enjoyed by approximately 60 persons per day, resulting in about 8,000 hikers per season (ibid). Besides its ecological values and the experience related benefits provided to the visitors and residents of the area, the existence of the trail also supports business opportunities in the surrounding communities (Parks Canada, 1995).

In the case study below we take the current problem context of the West Coast Trail and structure the decision analysis based on hypothetical data.

SUGGESTED DECISION-ANALYSIS FRAMEWORK

Decision Problem

Obviously the large concentration of visitors in a relatively small and comparatively sensitive area, with many stakeholders and interest groups linked to its management, causes several direct and indirect impacts (e.g. trampling of vegetation, crowding, and cost of maintenance). The impacts are often paradoxical in that they frequently have a concurrent effect on environmental, social, and economical aspects, affecting the various stakeholders differently. Parks Canada needs to balance between concerns about the area's ecological integrity, various types of visitor requests, and a local businesses community which is dependent on a certain level of annual visitation. It would be in the interest of all parties involved to reach a long-term solution that balances conservation with the other social and economic interests.

IMPLEMENTING A DECISION ANALYSIS

We implemented our decision analysis in three stages.

Stage 1: Structure and composition of decision components - Defining management goals, objectives, and alternatives

The principal management goal at the West Coast Trail ought to be striving for maximum ecological integrity, as defined by the National

Parks Act of Canada. In addition to this overarching goal, the Field Unit of Pacific Rim National Park Reserve also needs to accommodate economic and social objectives. In this study, we identified these measures from relevant published literature. These objectives and criteria can be tabulated concisely in an assessment table for each respective group involved in the decision-making process (Table 1). Given the space limitations, we present the table for the parks management group and the visitor group only. The content of the table would look similar for the other groups participating in the decision making process (the local business community, and NGOs). Most of the objectives and criteria have been identified as relevant in the respective literature.

Based on these objectives and measurement criteria, one can define management alternatives (Table 2). Options 1 – 13 vary the attributes number of visitors per season, length and timing of season, and size and distribution of visitor groups. The remaining four alternatives vary according to the reallocation of the recreational activities to other parts in the study area, changes in the types of activities, and the construction of physical features. Before any analysis is undertaken, one can eliminate dominant alternatives during an initial screening procedure. During this initial screening, alternatives 14 to 17 were identified as lying outside Park Canada's mandate, and therefore eliminated from further analysis.

Stage 2: Analysis of alternatives

In the first step of this stage, the likelihood of an event occurring, the associated uncertainty, and the magnitude of each criterion associated with each alternative is estimated in one table (not shown here).

In a second step, first the ELECTRE method is applied to identify the preference benchmarks of strong preference, weak preference, indifference point, and veto level are identified for each criterion through formal interviews with decision-makers. Conceptually, these benchmarks resemble the concerns that are addressed in the Limits of Acceptable Change Process (Stankey et al, 1984).

Second, the pairwise comparison method of AHP is used to determine the criteria's relative importance (Table 3). These present values form the "base case", representing the present situation. Notably, the park management group's present values take precedence, except for criteria 8, 9, and 10. This assumption simplifies subsequent calculations, and could be changed if desirable. The criteria thresholds have been explained before. The indifference values are expressed in %-change relative to the base case. The second last column (W%) contains the relative weights for each criterion, and the last column represents the aggregated criteria weights (AW%).

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

Table 1: Group objectives and criteria for the case study (NGOs and business community are excluded).

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

Stage 3: Synthesis of information

Concordance and discordance matrices (not shown here) provide the formal base for comparing alternatives objectively. By combining the concordance and discordance measures, one can calculate a credibility matrix, which contains the ranking of the remaining alternatives (Table 5.8). The matrix reveals that only alternatives 1, 2, 3, 4, 5, 6, 7, and 10 reach a performance on each criterion so that no single veto level is violated, i.e. holds a credibility high enough to be interesting to pursue at this point. As such, the credibility matrix does provide a certain outranking in itself, indicating each alternative's strength over another. However, the analysis should also take into account the alternatives' performance significance levels, by relating the entries in the credibility matrix with the established levels of significance (i.e. the thresholds of indifference). This is the final step, in the ranking procedure that is, removing those alternatives from consideration that are not performing significantly better than at least one other alternative on at least one criterion.

DM groups and their respective objectives	Criteria; Indicators	Present value	Criteria threshold levels				W % (k)	AW (%)
			Strong (P)	Weak (Q)	Veto (V)	Indif. (I)		
Visitors group:								
Ecosystem Health								
Perceived degradation	Unconsolidated organic matter	35	0-30	31-59	60%	-1.15%	21	14
	Extent of Erosion:	15	0-10	11-59	60%	-2.00%	7	20
	Fauna Abundance:	5	5-7	3-4/ 8-20	2/21	+0%	30	20
Trip Satisfaction								
Privacy and wilderness experience	Fire rings encounters:	5	5-7	3-4/ 8-9	2/10	-1.50%	4	11
	Parties of people encountered:	12	6-7	4-5/ 8-14	3/15	-1.20%	27	14
Willingness to Pay								
User fees	Level of user fees:	125	-18% (and less)	+/-17	+18%	-0%	12	3

Table 3: Aggregated preference levels and criteria importance ratings for the DM groups (Parks Management, NGOs and business community are excluded)..

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

Table 4: Credibility matrix

DISCUSSION & CONCLUSIONS

The hypothetical case study showed how a formal decision analysis framework can be applied to Park Canada's decision-making processes when complex decisions between several divergent objectives need to be made.

ELECTRE has been selected as the specific analytical tool because it includes different types of preferences, including threshold and veto options, which make it very attractive for modelling ecological concerns. AHP provides the final weighting of the alternatives. That combination constitutes an objective evaluative framework for pending decisions.

Such a decision support framework will improve the soundness and effectiveness of Parks Canada's decision-making and communication structures. The framework also facilitates the formal integration of existing data and information bases. The framework promotes:

- sound documentation practices, which increase the acceptance of and compliance with actual decisions;
- a formal and consistent method of assessment for various management situations;
- an increased ability to co-operate across various stakeholder interest, increasing the awareness of different management agendas and critical issues surrounding protected area management, and consequently decreasing the likelihood of goal fragmentation and sliding of objectives; and
- an increased ability to capitalise on existing data and information while identifying data gaps for further analysis, which reduces the risk of costly duplications and overlapping efforts. In addition, situation specific data and information becomes more readily available.

In conclusion, we would like to reiterate, that despite its name, decision analysis does not actually make decisions automatically. Plenty of thought needs to go into the design of such a framework, which we would rather label a more objective and integrated management and decision support tool, to be used in traditional as well as participatory decision processes.

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